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**THE ACADEMIC MARKET AND THE RISE
OF UNIVERSITIES IN MEDIEVAL AND
EARLY MODERN EUROPE (1000-1800)**

David De La Croix, Frédéric Docquier, Alice Fabre
and Robert Stelter

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Abstract

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JEL Classification: N33, O15, I25

Keywords: Upper-Tail Human Capital, Universities, Discrete choice model, Scholars, Publications, agglomeration

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The Academic Market and the Rise of Universities in Medieval and Early Modern Europe (1000-1800)*

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March 2020

Abstract

We argue that market forces shaped the geographic distribution of upper-tail human capital across Europe during the Middle Ages, and contributed to bolstering universities at the dawn of the Humanistic and Scientific Revolutions. We build a unique database of thousands of scholars from university sources covering all of Europe, construct an index of their ability, and map the academic market in the medieval and early modern periods. We show that scholars tended to concentrate in the best universities (agglomeration), that better scholars were more sensitive to the quality of the university (positive sorting) and migrated over greater distances (positive selection). Agglomeration, selection and sorting patterns testify to a functioning academic market, made possible by political fragmentation and the use of a common language (Latin).

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1 Introduction

Both scholars and universities are thought to have played a role in the Rise of the West (Mokyr 2016, Cantoni and Yuchtman 2014). We argue and establish empirically that a functioning academic market in the pre-industrial period was a powerful institution allowing them to operate together, helping universities to harness the potential of upper tail human capital at the dawn of the Humanistic and Scientific Revolutions as well as, to a lesser extent, during the subsequent European primacy. Our results shed light on the importance of medieval roots in fostering scientific output, embedding in individual data the qualitative studies on the subject.

Universities are one of the most original creations of the Western Latin civilization during the Middle Ages, from the 11th century onwards.¹ They came into existence when society recognized that masters and students as a collective (*universitas* means community) had legal rights. Universities are voluntary, interest-based, and self-governed permanent associations (Greif 2006). As highlighted in Rashdall (1895), “such Guilds sprang into existence, like other Guilds, without any express authorisation of King, Pope, Prince, or Prelate. They were spontaneous products of the instinct of association that swept over the towns of Europe in the course of the eleventh and twelfth centuries.”

A university was thus originally a guild of either students or masters. Near the end of the 12th century, foreign law students at Bologna formed a union for the purpose of protection from discrimination by the town against foreign residents. At about the same time, teachers in Paris formed a corporation. Universities then began to spread across Europe, either through secession from existing ones (Cambridge from Oxford, Padua from Bologna, Orléans from Paris, etc.), or through creation ex nihilo. Some universities were founded from scratch by a higher authority (the University of Naples was arguably the first of this kind), but all followed the guild-like organizational principles of Bologna and Paris. Even at the Imperial Moscow University (established in 1755, charter of 1804), the rector was elected by his peers, not nominated by the emperor.

The European academic world in the medieval and early modern era provides a rich background for identifying location patterns within the upper tail of the skill distribution. The use of Latin helped mobility and, despite the political fragmentation of Europe, medieval universities were recognized for their independence and intellectual unity. Understanding the mobility of academic scholars in that period matters because it potentially influenced the creation of knowledge in the pre-industrial period, as well as technological and institutional progress. Focusing on a period from 1000 CE to 1800 CE,² our paper investigates whether location decisions were associated with distance and with measures of individual and institutional quality. We

¹A few notable exceptions outside Europe: the Buddhist university of Nalanda in India, where both students and masters are known to come from distant places (Monroe 2000), and the University of Baghdad, which was destroyed by the Mongol invasion in 1258 CE.

²Although the official creation date of the first university (Bologna) is 1088 CE, many universities were active before they were formally recognized (see Section 3).

distinguish three notions of quality. The *human capital of an academic scholar* is built from her/his achievements as seen today in the catalog of world libraries (Worldcat). The *notability of a university* in a given period is built from the human capital of its five best scholars. The *simulated output of a university* is the aggregation of the human capital of all scholars who were predicted to work there in a given period.

Although the literature has looked at the characteristics of migrant workers at different periods in history, little is known about the mobility of upper-tail human capital in general, and about the internationalization of medieval and early modern European universities in particular. To tackle this question, we develop a unique database that provides geolocalized information on the origin of thousands of academic scholars, on the location of universities, and on measures of individual human capital and institutional notability. We use it to estimate the effects of distance, the human capital of scholars, the notability of universities, and the attractiveness of European cities on location decisions. More specifically, we test (i) whether academic scholars tended to concentrate in the best universities in medieval Europe (*agglomeration*), (ii) whether those with more human capital were more likely to settle in more prestigious universities and/or in more attractive cities (*positive sorting*),³ and (iii) whether they were more mobile than others (*positive selection*).⁴ We finally use our estimated location choice model to compute the potential gains in the output of universities resulting from the agglomeration, positive sorting, and positive selection of academic scholars.

Our database builds on secondary sources (i.e. books and catalogues recovering information from institutional archives) and biographical dictionaries. It documents the mobility and the human capital of about 20,000 academic scholars over the whole period 1000-1800. Their location choice set varies across sub-periods, as new universities were created or disappeared over time. On average, each scholar selected their optimal place of work out of 100 possible locations. Our database includes about two million possible dyads (i.e. scholar–university pairs). By studying the mobility patterns of academic scholars in the medieval and early modern periods, we capture a substantial part of upper-tail human capital. The two other – less numerous – groups were the members of scientific academies that developed in Europe in the 17th century (preceded by the Renaissance academies in Italy in the 16th century), and the scholars making a living at the courts of princes, kings, or bishops.

We estimate the mobility patterns using a multinomial logit model, and several variants accounting for sample biases, heterogeneous effects, and endogeneity issues. We show that agglomeration forces are at work: the destination choice of academic scholars depended on distance, on the notability of the university, on the size of the city (used as a proxy for its economic

³In its common meaning, sorting is any process of arranging items systematically, and has two common, yet distinct meanings: ordering (arranging items in a sequence ordered according to a criterion) and categorizing (grouping items with similar properties). In the migration literature, it means that individuals with better attributes tend to concentrate in regions where returns are higher.

⁴In biology, positive natural selection is the force that drives the increase in the prevalence of advantageous traits. In our location choice model, we test whether better scholars are less sensitive to the distance from their birthplace.

development), and on the communal freedom enjoyed by the city (used as a proxy for local democracy). We also find robust evidence that better scholars were less sensitive to distance (positive selection) and more sensitive to the attractiveness of the university (positive sorting). Agglomeration and sorting patterns testify to the existence of a functioning academic market in Europe. Such market forces governed the concentration of upper-tail human capital across Europe and the total production of knowledge. They played an important role when there were few universities. By contrast, selection patterns tended to scatter talent across universities, and hardly influenced the aggregate production of knowledge. Agglomeration and sorting substantially helped universities to create knowledge at the dawn of the Scientific Revolution and during the subsequent European primacy. These effects became negligible later when the number of universities increased.

Our paper speaks to three strands of literature. Firstly, we contribute to the literature on stagnation to growth and on the role of upper-tail human capital. Many authors have searched for the profound causes of the “Rise of the West” (e.g. Landes 1998; Maddison 2007; Galor and Moav 2002;⁵ Galor 2011; Mokyr 2010; Mokyr 2016). For most of them, the self-reinforcing dynamics of technological and institutional progress played a key role. In particular, De la Croix, Doepke, and Mokyr (2018) argue that superior institutions for the creation and dissemination of productive knowledge help explain the European advantage in the medieval and early modern periods. The outstanding debate concerns the key forces that made these virtuous circles possible. There are currently no global quantitative analyses of the historical effect of upper-tail human capital on the dynamics leading to the Industrial Revolution. Recent country-level studies include Dowe (2017) for England, Squicciarini and Voigtländer (2015) for France, and Dittmar and Meisenzahl (2019) and Cinnirella and Streb (2017) for Germany. Squicciarini and Voigtländer (2015) show that the number of people who subscribed to Diderot’s and d’Alembert’s *Grande Encyclopédie* in 18th-century France predicts economic development later on, both at the city and county levels. Dittmar and Meisenzahl (2019) show that German cities that adopted better institutions following the Reformation grew faster and had more people recorded as famous in the German biography database.

There is a debate about whether or not universities facilitated the Scientific Revolution. It is true that the new science developed in the 16th century came into conflict with the traditional Aristotelian approach taught at universities. Still, following Applebaum (2003), 87 percent of the scientists listed in the *Dictionary of Scientific Biography* born between 1450 and 1650 were university educated, and 45 percent of them were employed by universities. Beyond science, medieval universities may have contributed to the rise of the West through (i) the revival of Roman law, which was better suited to regulating complex economic transactions than

⁵Galor and Moav (2002) explicitly refer to the universities: “Further, unlike the existing literature, investment in human capital increased gradually in the Pre-Industrial Revolution era due to a gradual increase in the representation of individuals who have higher valuation for offspring’s quality. (...) In particular, in the Pre-Industrial Revolution era, the increase in the number and size of universities in Europe since the establishment of the first university in Bologna in the eleventh century had significantly outpaced the growth rate of population.”

the prevailing customary law,⁶ (ii) the translation of philosophical and scientific works from Classical Arabic and Greek, (iii) the diffusion of scientific thinking in Europe (e.g. Ockham’s parsimony principle, Duns Scotus’s logic, or Roger Bacon’s empiricism), (iv) the promotion by theologians of cultural norms such as the nuclear family, strict monogamy (De la Croix and Mariani 2015), and the education of children (Thomas Aquinas), and (v) the interest in the natural sciences, reflected in the establishment of botanical gardens next to medical faculties. A recent work by Dittmar (2019) lends credence to the idea of higher productivity of university scholars during the Renaissance. Dittmar computes the real wage of 3,000 Italian professors during the Renaissance from archived payrolls, and shows that the premium of those involved in the new sciences increased after the adoption of the movable-type printing press. To our knowledge, this is the only paper other than ours focusing on university professors and using individual-level data.

Beyond the existence of universities (Cantoni and Yuchtman 2014) and the role of elites (Dittmar and Meisenzahl 2019), we stress what makes them operate better together: the academic market. Higher education institutions and elites are present as soon as a civilization reaches a certain level of sophistication, but European universities were unique as they were bottom-up institutions operating in a continental market without many barriers (common language, political fragmentation of Europe). This allowed scholars to sort and concentrate, increasing thereby the output of the whole academic system.

Secondly, our paper relates to the migration literature in general, and to historical migration in particular. Migration is a selective process, with some individuals choosing to leave their region of birth and others choosing to stay. Who moves and who stays depends on the costs and benefits of migration, which can vary across individuals for both systematic and idiosyncratic reasons. Two salient features of contemporary labor mobility are that well-educated people exhibit a much greater propensity to emigrate than the less educated, and they tend to agglomerate in countries/regions with high rewards to skill (Grogger and Hanson 2011; Beine, Docquier, and Ozden 2011; Kerr et al. 2017; Kerr et al. 2016). The geographic concentration of talent is stronger within the upper tail of the skill distribution and does not necessarily lead to a decline in returns to skills due to agglomeration spillovers. Skill-intensive clusters allow better technology exchanges, deeper labor market specialization, or strong complementarities (Stephan and Levin 2001; Kerr, Kerr, and Lincoln 2015a; Kerr, Kerr, and Lincoln 2015b; Franzoni, Scellato, and Stephan 2012). As far as positive selection is concerned, college-educated individuals are migrating three times more than the less-educated in the contemporary world. This ratio drastically varies with economic development at origin. It is slightly greater than one in high-income countries, while it reaches 20 in low-income countries (Deuster and Docquier 2019). Such positive selection results from both heterogeneity in incentives and capacity to

⁶Cantoni and Yuchtman (2014) show that university training in Roman law played an important role in the establishment of markets during the “Commercial Revolution” in medieval Europe. To establish this, Cantoni and Yuchtman determined the enrollment rates of German students at the universities of Bologna, Paris, Padua, Orléans, Prague, Heidelberg, Cologne, and Erfurt.

migrate (Borjas 1987; Chiquiar and Hanson 2005; McKenzie and Rapoport 2007), and immigration policies that favor education and skills.⁷

Migrant selection has also been examined in historical studies, most of them focused on the *Age of Mass Migration* to the United States, a period of unrestricted entry starting in 1850 and ending around 1920.⁸ Abramitzky, Boustan, and Eriksson (2012 and 2014) and Spitzer and Zimran (2018) show that selection patterns are consistent with income-maximization models. In the 19th and early 20th centuries, migration to the U.S. was positively selected from some European countries and negatively selected from others. The differences in selection lined up with those in the relative returns to skill across sending countries, or with the easing or tightening of the liquidity constraints (Covarrubias, Lafortune, and Tessada 2015). Using data on servitude contracts from the 17th and 18th centuries, Abramitzky and Braggion (2006) found similar self-selection patterns (on health, physical strength, and literacy) of servants to the American colonies.

Thirdly, we shed light on the mobility patterns at the upper tail of the human capital distribution. Despite the potentially far-reaching implications for international knowledge creation and diffusion (Breschi and Lissoni 2009; Tripll 2013; Miguelez and Moreno 2013; Pierson and Cotgreave 2000), empirical evidence about the drivers and selection of scientists' mobility remains scarce. Existing studies show that, compared to college-educated migrants, scientists and inventors are less sensitive to distance and more sensitive to linguistic proximity, economic conditions, resources dedicated to R&D, and visa-related restrictions (Laudel 2003; Agrawal et al. 2011; Kerr 2008; Fink, Miguelez, and Raffo 2013; Grogger and Hanson 2015). They also show the importance of circular flows which are mostly governed by the existence of scientific collaborations. To the best of our knowledge, none of these studies have focused on the self-selection of scientists. One of the very few studies identifying selection effects among scientists is that of Gibson and McKenzie (2014). Using a survey on the mobility of researchers from the Pacific Islands, they show that current migrants produce substantially more research than similarly skilled return migrants and non-migrants. Hoisl (2007) also shows that mobility is generally found to be positively associated with inventor productivity as proxied, for example, by the education level of the inventor and the use of external sources of knowledge such as university research or scientific literature. Finally, Akcigit, Baslandze, and Stantcheva (2016) find that the international mobility of superstar inventors is influenced by tax policies. A change in one country's top tax rate affects the retention rate of domestic inventors, and has much

⁷The structure of migration costs can give rise to many different migration patterns characterized by positive, negative, or intermediate selection. Chiquiar and Hanson (2005), however, observe that Mexican migrants to the United States are drawn from the middle rather than the low end of the Mexican skill distribution, although income inequality is higher in Mexico than in the United States. McKenzie and Rapoport (2007) confirm that Mexican migrants from rural areas mainly come from the middle class of the wealth distribution (those who have both the means and incentives to migrate), and that the intensity of selection decreases with the size of social networks abroad (in line with Beine, Docquier, and Ozden (2011)).

⁸A few studies on intra-European migration support the positive selection hypothesis. Beltrán Tapia and de Miguel Salanova (2017) show that, in the late 19th and early 20th centuries, the literacy level was higher among internal migrants moving to the Spanish capital city than among those who remained in their provinces of origin.

greater effects on the country’s capacity to attract foreign inventors in general and those at the top of the ability distribution in particular.

The remainder of this paper is organized as follows. In Section 2, we present the data sources and define the key concepts used in our analysis. In Section 3, we describe the micro-foundations of our empirical model and discuss key econometric issues. Results and robustness analysis are provided Section 4. In Section 5, we simulate the model to draw its implications for the output of universities per period. The conclusion is in Section 6.

2 Data and Concepts

We collect a large sample of academic scholars (denoted by $i = 1, \dots, I$) employed by the universities of Latin Europe over a period that started around the year 1000 CE and lasted until 1800 CE.⁹ The year 1800 CE is a convenient date to stop for several reasons. At a broad level, it spelled the end of the Malthusian pre-industrial period. At the university level, it corresponded to profound changes: all French universities were abolished by the Revolution in 1793, and would reappear in a different form later on. In Prussia, the Humboldt reform of 1810 was also a game changer.

The identification of academic scholars builds mostly on institutions’ secondary sources of different types (see Appendix D). Ideally, we aim to cover the universe of scholars involved in university teaching and research before 1800 in Latin Europe. Although this universe is more precisely defined than in other studies of European scholars (e.g. the universe of “famous people” in De la Croix and Licandro (2015), of “creative people” in Serafinelli and Tabellini (2017), or of “notable people” in Gergaud, Laouenan, and Wasmer (2017)), its boundaries remain somewhat flexible. For example, according to biographies of Nicolaus Copernicus, he delivered lectures as a professor of astronomy to numerous students while in Rome. It is unclear whether this teaching took place within the walls of the university of Rome (Sapienza), and how long it lasted. This appears however to be the only time Copernicus taught students. Should we count Copernicus when measuring the notability of the Sapienza? Probably not, as it would overestimate the attractiveness of Rome during this period. Should we include the decision of Copernicus to go to Rome in our study? We did, but it does not matter much as he is only one among thousands of scholars.

Another dimension of flexibility concerns how we define a university. This seems simple *a priori*. We can rely on Frijhoff (1996) who provides a list of institutions granting doctorate degrees, together with their official foundation date. It is however meaningful to extend this list in two directions. One extension is to include important learning institutions which were not formally universities. One example is the Herborn Academy (*Academia Nassauensis*) which was a Calvinist institution of higher learning in Herborn (Germany) from 1584 to 1817.¹⁰ In

⁹Latin Europe means Europe minus the Muslim world and the Byzantine world.

¹⁰To Frijhoff’s list, we have added the following institutions: the medieval cathedral schools of Chartres and

addition, another relevant extension is to consider that universities were active before their official creation. For example, the University of Amsterdam was officially founded in 1877, but its roots go back to 1632, when the *Athenaeum Illustre* was founded. For this reason, our period of analysis starts before the official creation date of the first university.

For each university, we first checked whether there is an online historical database of professors. For example, the list of professors at the University of Groningen has already been established. The *Catalogus Professorum Academiae Groninganae* includes all full professors from 1614 onwards (see the website at <http://hoogleraren.ub.rug.nl/>). The website is still under development, but it shows the interest of universities themselves in looking at their past in a more systematic way. For those universities without such a database but with books of biographies of their professors, we encoded the contents of these books. For the remaining universities, we checked whether *matricula* (people registered at a given university) and *chartularia* (containing transcriptions of original documents related to the historical events of a university) exist. We have built up a representative sample of professors from this information, and we are continually looking for other national biographies and other databases to complete the information needed. In some cases, the *matriculum* itself is of little use as the status of these people is not recorded (students, professors, etc.), but it follows the chronological succession of rectors, whose names are provided. As rectors were sometimes nominated every six months, their names provide good coverage of the universe of professors there (with some selection bias). Complementary strategies have also been used. For example, for Jesuit universities, there is a biographical dictionary by Sommervogel (1890) listing all Jesuits having published material; as they are classified by place of activity, we can match the professors to the relevant universities. Moreover, for the late Middle Ages and the Renaissance, information can be retrieved from two recent projects, both aimed at collecting biographical and social data on those who graduated from medieval universities: the project “Repertorium Academicum Germanicum - The Graduated Scholars of the Holy Roman Empire between 1250 and 1550” and the project “Studium” for the University of Paris from the 12th century to the Renaissance. Both projects are currently under development.

A key requirement of our analysis is to include at least the scholars with high human capital. This requirement is met by encoding the academic scholars included in thematic biographies, such as Taisand (1721) for law, Eloy (1755) for medicine, Junius Institute (2013) for Protestant theology, Herbermann (1913) for important Catholic figures, and Applebaum (2003) for the key actors of the scientific revolution.

Over the whole period 1000-1800, we identify 200 universities and teaching institutions. In the econometric analysis, we eliminate institutions with fewer than 10 scholars or a coverage (total number of professors per years of existence) below 0.05, and thus obtain a working sample of 138 institutions (denoted by $k = 1, \dots, K$). Each university k is linked to a geo-referenced

Liège, the school of translators in Toledo, the Majorcan cartographic school, the “Collège Royal” in Paris, the “Jardin Royal des Plantes” in Paris, the Imperial College in Madrid, the Herborn Academy, and the Technical University in Braunschweig.

location. Accounting for the date of creation of each university, we estimate that these 200 institutions represent a total of 49,184 years of existence. The heterogeneity in the quality and coverage of the institutional data implies that the number of scholars identified varies drastically across universities. A very comprehensive list of scholars can be obtained for the University of Heidelberg which includes 1,184 scholars over 414 years of existence. Note that Heidelberg is not the largest university in our working sample; the data related to the University Bologna allow us to identify 3,273 scholars over the whole period. However, Heidelberg is more representative of an average university than Bologna. Assuming Heidelberg is representative of all institutions, a back-of-the-envelope calculation suggests that the order of magnitude of the universe of academic scholars for the medieval and early modern periods is around 143,627 (i.e. $1,184/414$ scholars per year \times 50,221 years of existence). Observing that scholars taught in 1.12 universities on average, the universe has 128,224 unique persons. So far, our bibliographical searches have allowed us to identify 27,854 academic scholars. These include very well-known professors as well as obscure scholars. We thus estimate that our current sample covers around 21.7% of the universe (i.e. $27,854 \div 128,224$). This coverage is very likely to be higher for renowned scholars, as they are more likely to appear in the sources consulted, than for obscure scholars. Having obscure scholars in the sample is important to identify the characteristics of the famous ones – those who are more likely to play the academic market game. Including many obscure scholars in the analysis is thus a strength of our analysis.

We match each scholar's name with bibliographical dictionaries to identify their place of birth. We exclude the small number of persons born outside a rectangle encompassing Europe, North Africa, and the Middle East (defined by latitudes $\in [28, 66]$ and longitudes $\in [-17, 44]$) because those would be outliers when computing distances. We also search online for Wikipedia and Worldcat pages to generate the ex post indicators of human capital (see below).

One word about the quality of the data. In many cases it is quite high, as the secondary sources used – biographical dictionaries and university sources – were often compiled from archive materials. We should however warn the reader that for the earlier periods, we have chosen to adopt some approximations. A good example is the oculist *Benevenutus Hierosolymitanus*, also called Benevenutus of Jerusalem. His life is totally unknown to historians, but his book, *Ars probatissima oculorum*, was immensely popular and influential – having been translated into four languages already in the medieval period. From other writings citing his work, historians infer he lived between 1100 and 1290. Assigning Jerusalem as his place of birth is disputed, but seems the likeliest option, given the knowledge of Middle Eastern cultures displayed in his writings (remember that Jerusalem was for some time a Latin kingdom (1099–1187)). He was also obviously acquainted with the medical school of Salerno, and he likely taught there (being called the physician from Salerno in one manuscript, the *Besançon Manuscript*). The most intriguing part concerns his relation with Montpellier, another famous medical school. In 1921, the Faculty of Medicine in Montpellier placed a marble slab in its entrance hall listing him among its early faculty members. There are some arguments to link Benevenutus of Jerusalem to Montpellier, but there remains a “considerable disparity between the fragility of

the documentary basis for the Montpellier inscription and the robustness of the stone on which it was engraved” (Kedar 1995).

Each individual at university k is characterized by at most five dates: year of birth, year of death, first year of observation at university k , last year of observation at university k , and approximate date of activity at university k (this corresponds to a period or date that is sometimes denoted by “fl.”, from the Latin verb *floruit* “s/he flourished”).¹¹ From these dates, we define two dates, t_i^b and t_i^f , which hypothetically bound the active life of each scholar. These dates are computed as follows:

$$t_i^b = \min \left\{ \text{Year of Birth} + 30, \text{Year of Death}, \min_k[\text{first year of obs. at univ. } k], \right. \\ \left. \min_k[\text{last year of obs. at univ. } k], \min_k[\text{approximate date at univ. } k] \right\}. \quad (1)$$

$$t_i^f = \max \left\{ \min \{ \text{Year of Birth} + 50, \text{Year of Death} \}, \max_k[\text{first year of obs. at univ. } k], \right. \\ \left. \max_k[\text{last year of obs. at univ. } k], \max_k[\text{approximate date at univ. } k] \right\}. \quad (2)$$

We divide the whole period into eight sub-periods, denoted by

$$\tau \in \{0, 1, 2, 3, 4, 5, 6, 7\},$$

corresponding to major historical events: from the urban revolution to the first universities (1000–1199), from the official foundation of Paris and Oxford in 1200 to the Black Death (1200–1347), from the Black Death to the invention of the movable-type printing press (1348–1449), from the printing press to the rise of Protestantism (1450–1526),¹² from Protestantism to the beginning of the Thirty Years’ War (1527–1617), from the Thirty Years’ War to the revocation of the Edict of Nantes (1618–1684), from this revocation to the rise of Enlightened universities (1685–1733),¹³ and from Enlightened universities to 1800 (1734–1800).

We assign each scholar to a period τ based on t_i^b . The beginning date t_i^b should be seen as a time when the individual can make location choices. The final date t_i^f will be used to map the human capital achieved by a scholar to her universities. The period in which this end date falls determines the period for which we impute the quality of the scholar to their university.

Universities’ scholars were almost always male, but we found a few females: Trotula de Ruggiero (11th century) and a few others in Salerno, Maddalena Bonsignori, Clotilde Tambroni, Clotilde Zamboni, Bettina and Novella Calderini, and a few others in Bologna, Beatriz Galindo in Salamanca, Ekaterina Romanovna in Moscow, and Dorothea Christiane Erxleben in Halle.

¹¹The scholars for which we have no dates cannot be incorporated into the analysis.

¹²1527 corresponds to the foundation of the University of Marburg, the oldest Protestant university in the world.

¹³In 1734, the University of Göttingen was founded to propagate the ideas of the European Enlightenment.

Female scholars were a rare exception though. Novellà Calderini, for example, allegedly replaced her father repeatedly, teaching at Bologna veiled so that her beauty would not distract the students, according to the Italian Encyclopedia *Treccani*.

Table 1 shows the number of identified scholars per period, with some of their characteristics. We also report the number of universities per period, which increases steadily except from period 5 to 6, when French Protestant “academies” had to close (Bourchenin 1882). On average, institutional data and bibliographical dictionaries allow us to identify the birthplace of 73.1% of university professors, and 20,361 professors are characterized by a geo-referenced birthplace. Hence, we can compute the cost distance associated with each possible scholar-university dyad (denoted by d_{ik}) using Özak (2018)’s human mobility index. In addition, 25.5% of our identified scholars have a Wikipedia page, and 38.8% have at least one recorded publication in Worldcat. Overall, these shares increase from periods 0-1-2-3 (the Middle Ages) to periods 4-5-6-7 (early modern period). The least well documented period is 1348–1449, when we find many names of professors with no publications, either because they did not publish a lot, were never printed, or their publications did not survive.

Periods τ	Nb. obs	Nb. univ	Birthplace (%)	Wikipedia (%)	Worldcat(%)
1000-1199	202	14	75.1	51.0	48.5
1200-1347	1,446	32	61.6	19.6	19.8
1348-1449	3,431	48	70.5	10.9	10.4
1450-1526	4,211	72	69.4	14.6	19.0
1527-1617	5,549	136	76.8	28.5	44.0
1618-1685	4,570	132	73.7	29.0	48.3
1686-1733	3,464	129	71.3	27.9	50.0
1734-1800	4,981	140	77.8	37.4	57.8
Total	27,854	177	73.1	25.5	38.8

Table 1: Summary statistics for professors by sub-period

Figure 1 shows the university-scholar maps for all sub-periods. Red dots correspond to universities. The top universities are labelled in bold. Blue dots represent scholars’ birthplaces and again we have labelled some prominent names. The dashed lines link academic scholars to the university for which they taught. They represent the optimal (i.e. travel-time minimizing) route computed by Özak (2010, 2018).

As the first two maps (1000–1347) show, universities emerged in the territory of the late Western Roman Empire. Paris clearly attracted scholars from all over Europe, from Portugal to Scotland and the south of Italy. The density of universities in Italy was already impressive. The period 1348–1449 saw a decline in the number of observations in France, probably due to the Hundred Years’ War, combined with the Black Death. West German universities started to play a role, while Italy was very active. We can also see Greek scholars such as John Argyropoulos fleeing

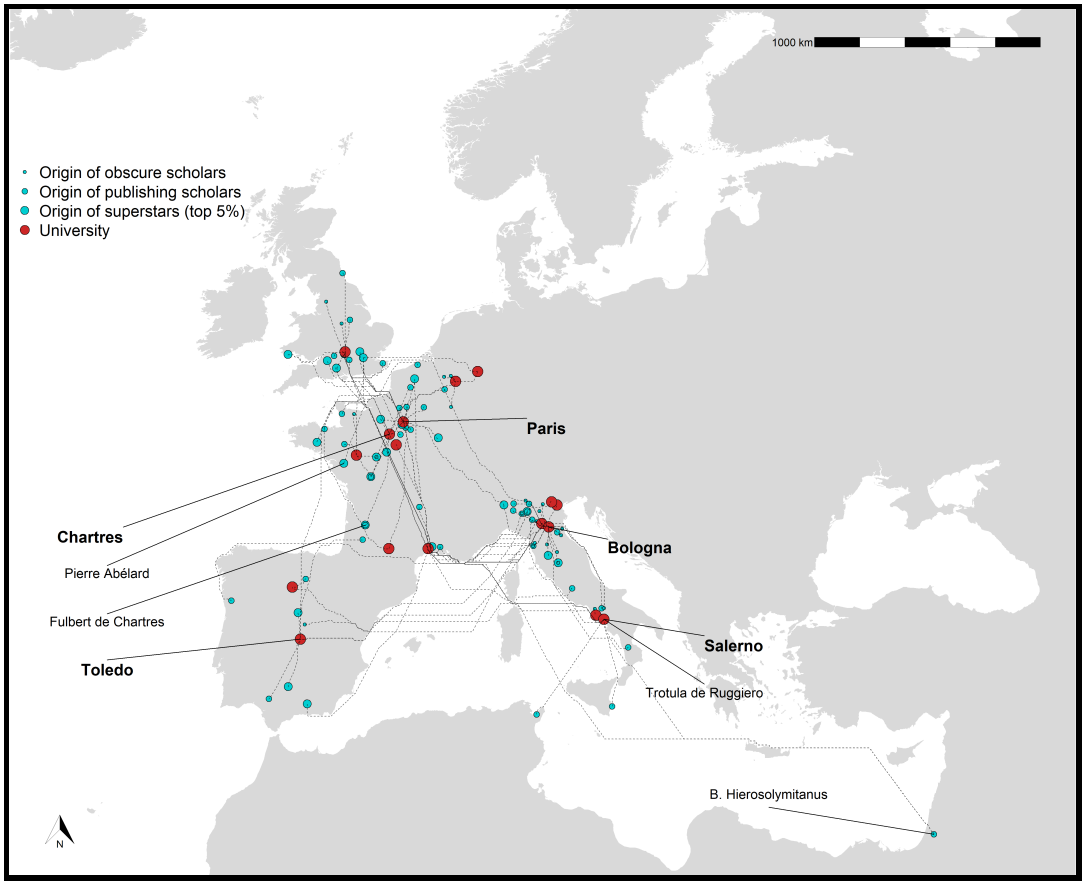
the expected fall of the Byzantine Empire (from Harris (1995)). The next period (1450–1526) has the same characteristics, but with more observations in Spain, Scotland, and southern Germany. The number of observations over the period 1527–1617 is high, with good coverage from Portugal to Poland: the portfolio of universities is expanding. The period 1618–1685 saw the development of Nordic universities, and a decline in movement in the south of Europe. A similar trend is observed for the period 1686–1733. The last period 1734–1800 is particularly rich in Germany, and universities expanded to the East. From Iceland comes Grímur Jónsson Thorkelin, who was professor of antiquities at Copenhagen University and is known for the first full translation of the poem Beowulf. On the whole, what can be seen on these eight maps corresponds closely to changes in economic primacy over time in Europe (Kindleberger 1996). More descriptive statistics (including barycenters) can be found in Appendices A and B.

Using bibliographical data, we define two key concepts that characterize the notability of academic scholars and institutions, and can potentially influence location choices.

Scholars’ human capital. – Firstly, we construct an index of *ability or human capital of scholar i* , denoted by q_i . Our index proxies individual notability as seen today in contemporary sources, Worldcat and Wikipedia. Worldcat provides a comprehensive measure of scientific output and citations, as books about the person are included in the measure. Wikipedia completes this measure by putting more weight on the mission of academics called, on today’s terms, “service to society” (e.g. becoming an ambassador or a pope, or being canonized a saint). For those who have no Wikipedia and/or Worldcat pages, we have to make two normalization assumptions. We assume first that having no Wikipedia page or a very short Wikipedia page of 10,000 characters is the same in terms of human capital. Second, we assume that having one publication in one language held by one library worldwide is the same as having no publication at all. To combine the information provided by Worldcat and Wikipedia into one measure, we compute the first principal component of five indicators: (i) the log of the number of characters of the longest Wikipedia page (ranging from a minimum of 10,000 to 802,899), (ii) the log of the number of languages in which a Wikipedia page exists (ranging from a minimum of 1 to 213), (iii) the log of the number of works (by or about) in Worldcat (ranging from a minimum of 1 to 67,871), (iv) the log of the number of publication languages in Worldcat (ranging from a minimum of 1 to 51), and (v) the log of the number of library holdings in Worldcat (ranging from a minimum of 1 to 953,129).

The results of this analysis are presented in col. (1) of Table 2. The first principal component explains 3/4 of the total variations in the five indicators. The usual heuristic approaches to determine how many principal components one should keep to represent high dimensional data in lower dimensions indicate that one is enough in our case. We finally subtract its minimum value from the first principal component in such a way that a person with no Wikipedia page and no Worldcat entry will have a human capital of zero ($q_i = 0$).

One could argue that a measure of human capital 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



Period
1000-1199

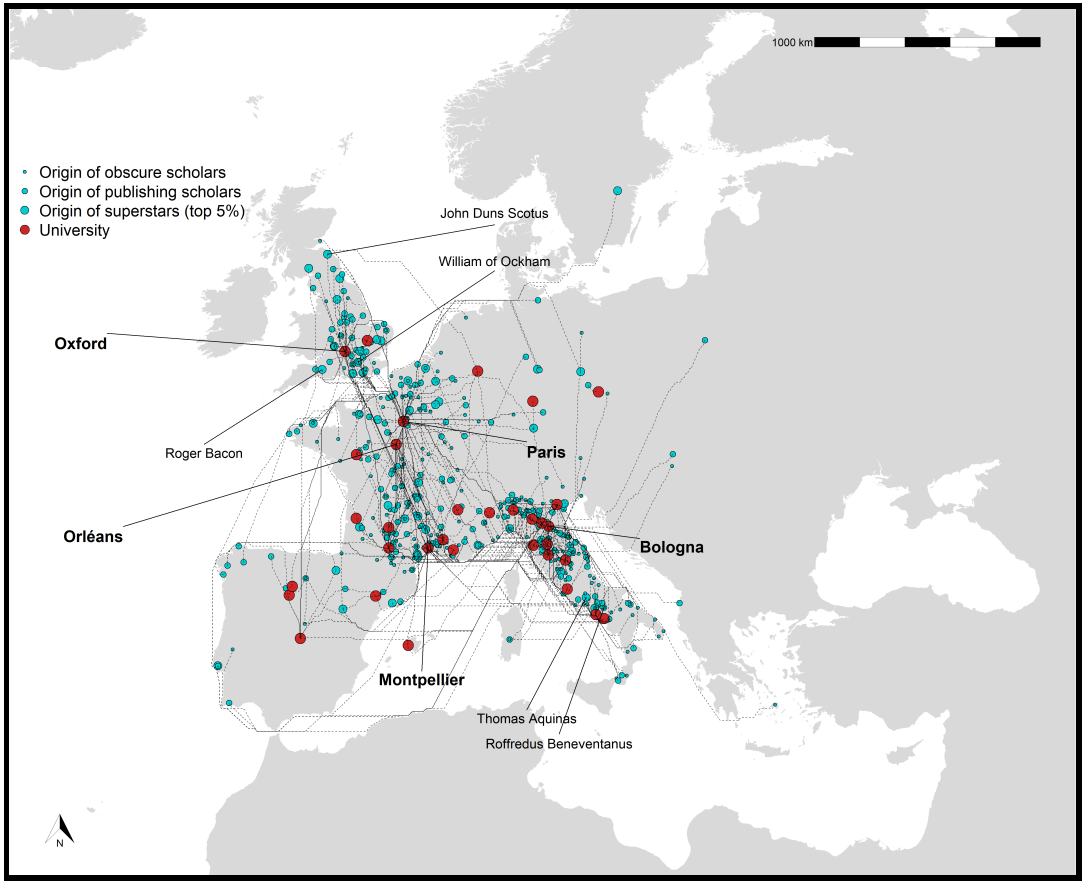
Blue dots:
birthplaces
of scholars

Red dots:
universities

Top
universities
in bold

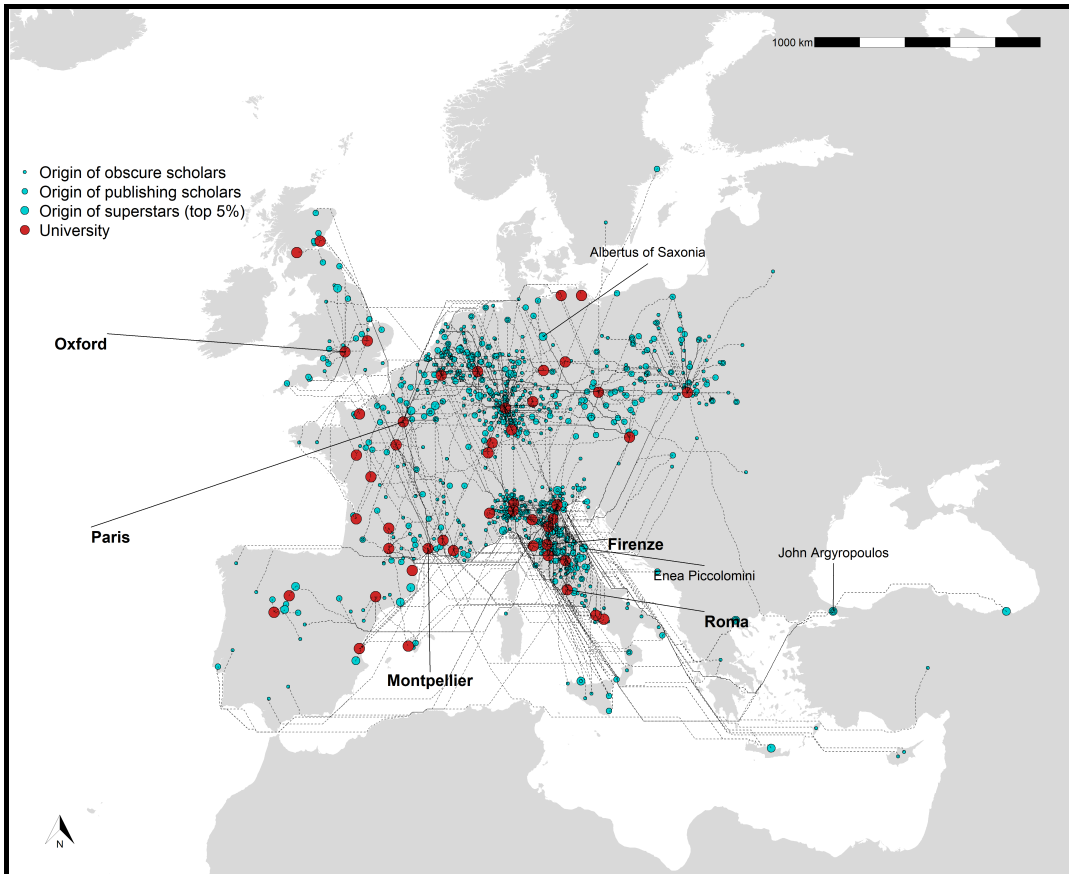
Includes
names
mentioned
in the text

Dashed
lines: cost-
minimizing
path

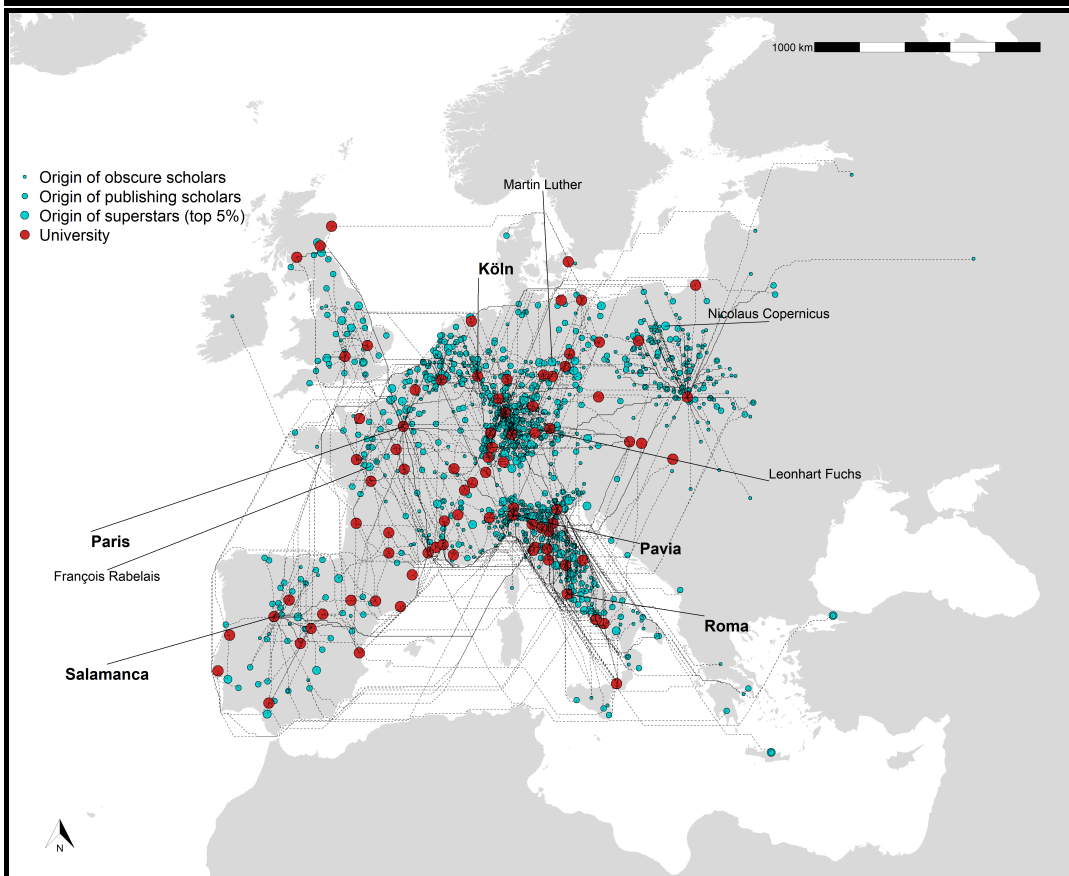


Period
1200-1347

Figure 1: Maps of scholar-university dyads by period (1/4)

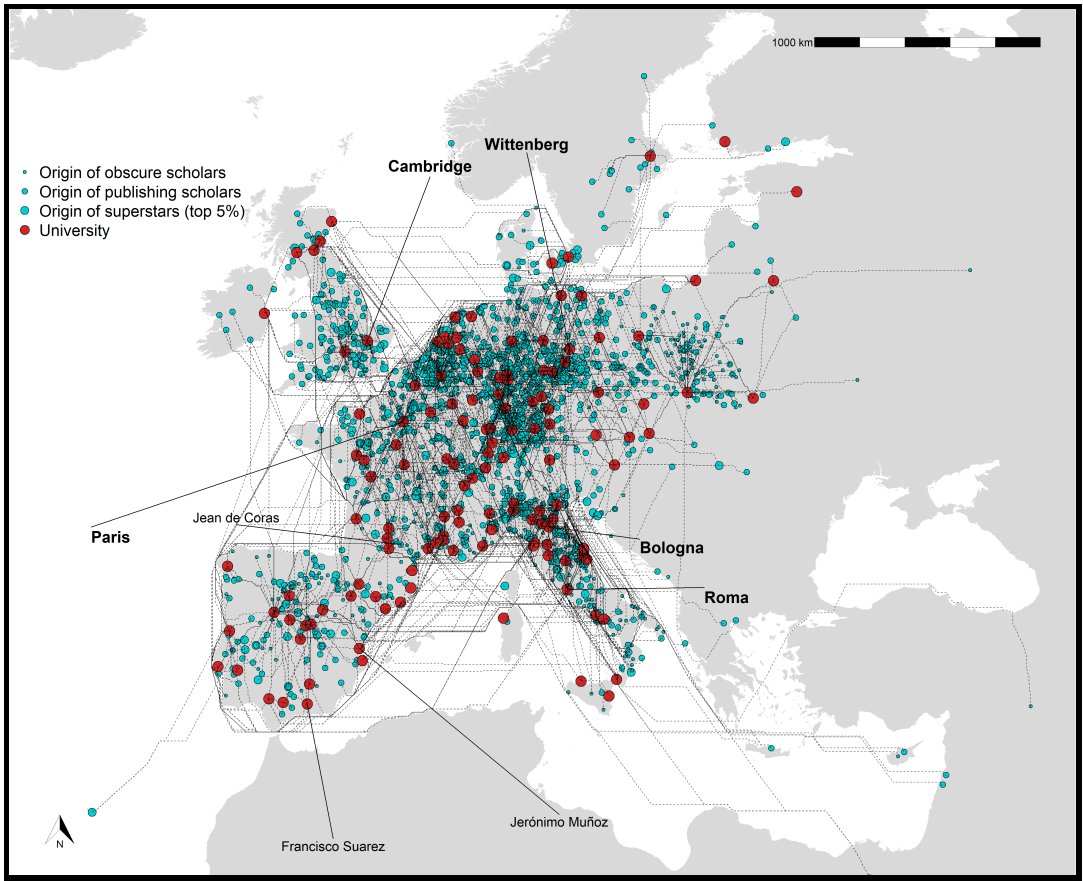


Period
1348-1449

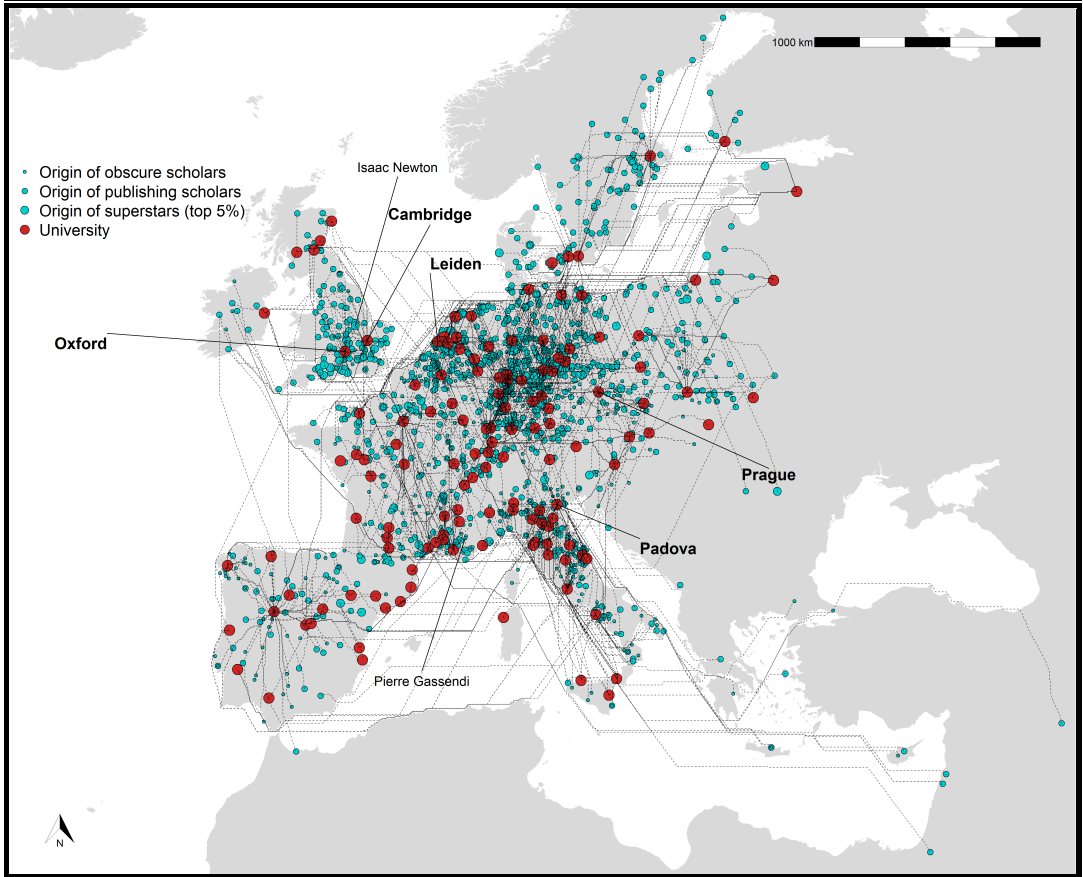


Period
1450-1526

Maps of scholar-university dyads by period (2/4)

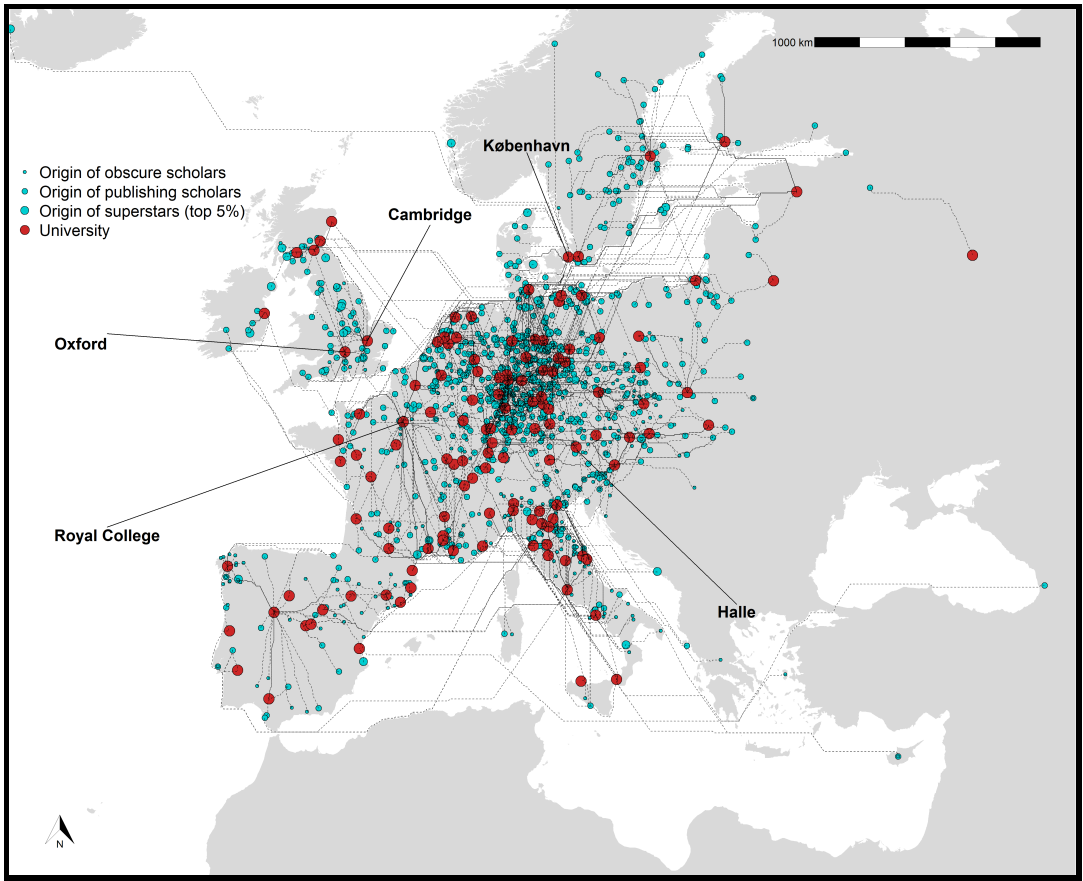


Period
1527-1617

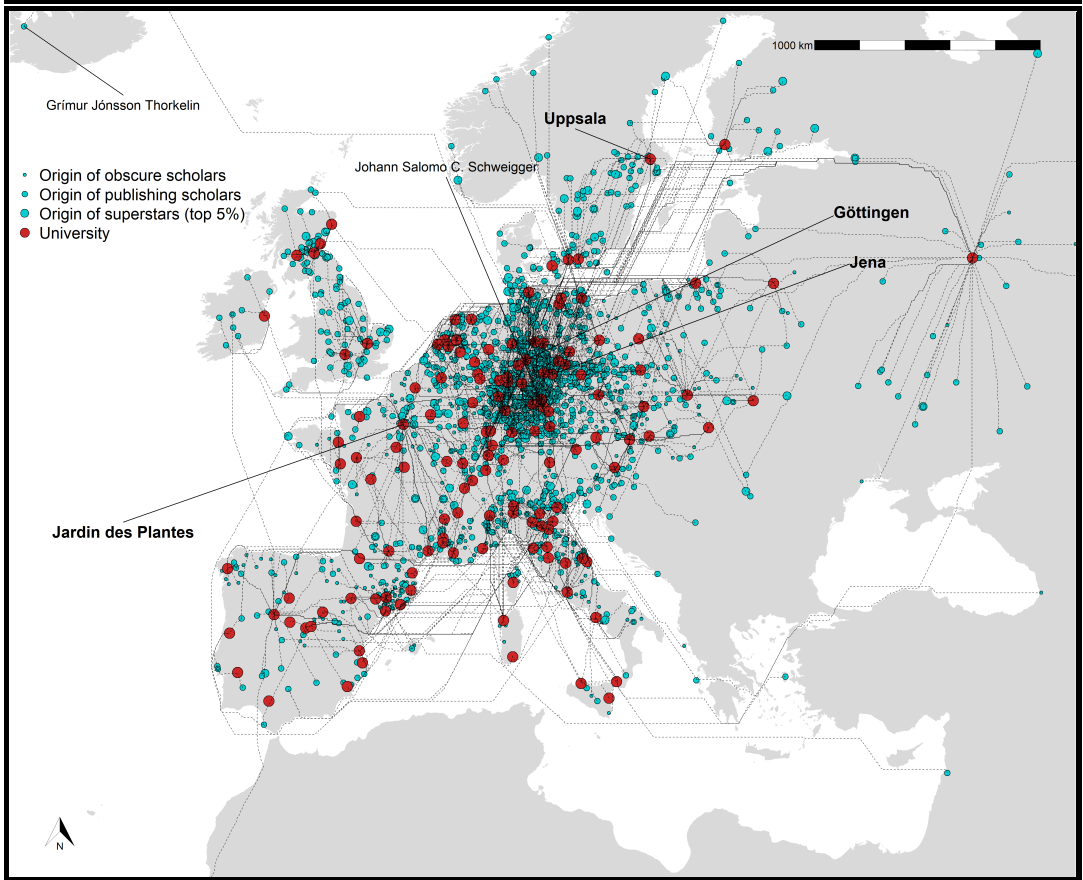


Period
1618-1685

Maps of scholar-university dyads by period (3/4)



Period
1686-1733



Period
1734-1800

Maps of scholar-university dyads by period (4/4)

	(1)	(2)	(3)
	Benchmark	No Wikipedia	Works by or about
Nb. characters of Wikipedia page	0.426	-	0.393
Nb. languages Wikipedia	0.400	-	0.384
Nb. works in Worldcat	0.472	0.586	-
Nb. languages in Worldcat	0.456	0.561	0.429
Nb. library holdings in Worldcat	0.476	0.585	0.390
Nb. publications by in Worldcat	-	-	0.415
Nb. publications about in Worldcat	-	-	0.435
Nb. Eigenvalues > 1	1	1	1
% variance explained by 1st PC	79.3%	93.4%	76.9%
S.E.	1.990	1.674	2.148
Corr. with (1)	1.000	0.964	0.992
Corr. with (2)	-	1.000	0.947
Corr. with (3)	-	-	1.000

Table 2: Principal component analysis of scholars' human capital

the author gained popularity *post-mortem*, which might not be relevant to determining their market value when they were active. It is not possible to implement this because many first editions have not survived. For example, there is no doubt that Pierre Abélard (1079-1142) was a philosopher of great renown during his life.¹⁴ All his written output available in libraries today, from philosophical works to love letters, was published after 1600, and, in many cases, in the last 30 years (see <https://www.worldcat.org/identities/lccn-n79142562/>).

Our measure of q_i is very robust to changes in assumptions. Disregarding Wikipedia leads to col. (2) of Table 2. The correlation between the ability indices computed with and without Wikipedia equals 0.96. In col. (3), we separate the publications by and the publications about the person, and replace the number of works aggregating both types by these two indicators. There is little gain in doing this, and the new measure is correlated with the benchmark with a coefficient of 0.99. Notice also that our measure of q_i is weakly correlated with the number of institutions each scholar worked for during their life (correlation coefficient of 0.19).

The most famous scholars according to our measure are presented in Table 3 by period. The scholar with the all-time highest human capital is Martin Luther. He was not a scientist like Galileo Galilei, Isaac Newton, or Carl Linnaeus, but it is fair to recognize that he profoundly affected the European sphere. In the list of Table 3, there are some scholars who only have a weak link to a university, and are thus not used to compute the notability of the university. For example, Leonardo da Vinci spent some time at the Studium (university) in Florence to make

¹⁴Pierre Abélard is also known to the general public for his love affair and correspondence with his pupil Héloïse.

anatomic dissections; François Rabelais, known for his novels, was also in fact a physician who taught briefly at Montpellier, and Baruch Spinoza never taught at a university, but interacted with people at the University of Leiden. There are also some who were actual teachers but are better known for non-scholarly reasons: Enea SB Piccolomini (Pope Pius II) or Friedrich von Schiller (German poet).

In the same table, we also report the median value of q_i from the set of positive q_i (those with either a Wikipedia or Worldcat reference). It is surprising that there is no visible trend for this q_i over time, which implies that more recent scholars did not produce more than older ones. It may be more likely that the writings of medieval scholars were lost compared to those of scholars active in the early modern period, yet this loss is compensated for by the accumulation of citations and new editions over time. Let us also note that the particularly high median q_i for the first period, which probably reflects a selection phenomenon, and the low median after the Black Death.

Institutional notability. – In theory, we can compute a measure of quality for each university using the observed location and ability levels of the scholars identified in our database. However, given that sampling varies from one institution to the other, computations based on the total number of observed scholars are not directly comparable across places. Taking the means or medians of individual human capital would also be biased in favor of the least well covered universities.

Hence, we introduce the concept of *notability of university k* in period τ as a CES combination of the ability or human capital of the top 5 academic scholars having spent time there and for which the date t_i^f falls in this period. This notability index is denoted by $Q_{k\tau}$. To account for the partial presence of multi-destination scholars, we weight the individual ability q_i by $(1/S_i)^\omega$ where S_i is the number of universities where scholar i spent time during their career (i.e. the number of career spells), and we define the adjusted ability level as $\bar{q}_i \equiv q_i (1/S_i)^\omega$. In our descriptive tables and benchmark regressions, we assume $\omega = 1$ (i.e. the ability of each multi-destination scholar is divided by their number of career spells).¹⁵ We then denote by $(\bar{q}_{1k\tau}, \bar{q}_{2k\tau}, \bar{q}_{3k\tau}, \bar{q}_{4k\tau}, \bar{q}_{5k\tau})$ the ability of the top 5 academic scholars of university k in period τ , and we define the notability index as:

$$Q_{k\tau} = \left(\frac{1}{5} \bar{q}_{1k\tau}^{\frac{\sigma-1}{\sigma}} + \frac{1}{5} \bar{q}_{2k\tau}^{\frac{\sigma-1}{\sigma}} + \frac{1}{5} \bar{q}_{3k\tau}^{\frac{\sigma-1}{\sigma}} + \frac{1}{5} \bar{q}_{4k\tau}^{\frac{\sigma-1}{\sigma}} + \frac{1}{5} \bar{q}_{5k\tau}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} + (1 - \delta)Q_{k(\tau-1)}, \quad (3)$$

where δ is a depreciation rate that generates some persistence of past notability, and σ is the elasticity of substitution between scholars in producing notability. Hence, $Q_{k\tau}$ is a stock variable. In the benchmark tables and regressions, we assume full depreciation over one period ($\delta = 1$); alternative specifications will be considered in the empirical analysis.

We use $Q_{k\tau}$ as a proxy for the attractiveness of the university. When making location decisions, it is unlikely that scholars were able to accurately quantify the quality of each university.

¹⁵We will show below that our results are robust to the choice of ω .

Period τ	1000-1199	1200-1347	1348-1449	1450-1535
Med[$q_i q_i > 0$]	4.229054	3.282429	2.024915	2.518277
1	Pierre Abélard (9.5)	Thomas Aquinas (11)	Nicolas de Cusa (9.3)	Martin Luther (12.3)
2	Thomas Becket (8.8)	Giovanni Boccaccio (10.7)	Enea Silvio Piccolomini (9.1)	Leonardo da Vinci (11.6)
3	Gratian (7.7)	Ramon Llull (9.6)	Johannes Hus (8.7)	Desiderius Erasmus (11.2)
4	Rolando Bandinelli (7.6)	John Duns Scotus (9.3)	Poggio Bracciolini (8.3)	Nicolaus Copernicus (10.2)
5	Pietro Lombardo (7.5)	William of Ockham (9.3)	Lorenzo Valla (8.2)	François Rabelais (10.2)
6	Jean de Salisbury (7.4)	Gioianni da Fidanza (9.1)	Francesco della Rovere (8.2)	Philipp Melanchthon (9.3)
7	Adéard of Bath (7.1)	Eckhart von Hochheim (9)	Leonardo Bruni (8)	Theophrastus von Hohenheim (8.8)
8	Gerardus Cremonensis (7.1)	Roger Bacon (9)	Jean Gerson (8)	Pico della Mirandola (8.7)
9	Alain de Lille (7)	Fernando Martins de Bulhoes (8.8)	Vincent Ferrer (7.9)	Julien Della Rovere (8.6)
10	Abraham Ibn Daud (6.9)	Albertus Magnus (8.7)	Coluccio Salutati (7.7)	Martin Bucer (8.4)
Period τ	1536-1617	1618-1684	1685-1739	1740-1800
Med[$q_i q_i > 0$]	2.847133	2.590868	2.580772	2.723717
1	Galileo Galilei (11.1)	Isaac Newton (11.1)	George Berkeley (9.7)	Immanuel Kant (12.1)
2	Johannes Calvin (10.1)	Baruch Spinoza (10.8)	Leclerc de Buffon (9.3)	Friedrich von Schiller (11.6)
3	Johan Kepler (9.8)	Baltasar Gracián (9.2)	Gianbattista Vico (8.9)	David Hume (10.8)
4	Tycho Brahe (9)	Thomas Browne (8.5)	Ludvig Holberg (8.7)	Adam Smith (10.6)
5	John Dee (9)	Pierre Bayle (8.3)	Hermann Boerhaave (8.3)	Carl Linnaeus (10.2)
6	Francis Bacon (10.7)	Samuel Pufendorf (8.3)	Christian Wolff (8.2)	Johann Gottlieb Fichte (9.8)
7	Giordano Bruno (9.9)	Attanasio Kircher (8.3)	Ruggero Giuseppe Boscovich (8)	Jeremy Bentham (9.5)
8	Torquato Tasso (9.7)	Nicolas Steno (8.2)	Johann I Bernoulli (7.9)	Christoph Martin Wieland (9.2)
9	Jean Bodin (9)	Christian Thomasius (8.1)	Francis Hutcheson (7.7)	Jean-Baptiste de Lamarck (9)
10	William Harvey (8.8)	Christopher Wren (8.1)	Daniel Bernoulli (7.7)	Bernardin de Saint-Pierre (8.7)

Table 3: Top 10 scholars by period with their q_i

However, they were aware of complementarity forces and they observed the highest ability scholars of each university belonging to their choice set. The notability indices of each university are provided in Table 10 (col. 3 to 10) in the Appendix; we report a blank when there is no scholar at that university during one period (e.g. before the year of creation of each institution) and a zero if all the scholars have $q_i = 0$.

Table 10 lists the institutions kept in the analysis. Compared to the full sample shown in Figure 1, we have removed universities with fewer than 10 scholars in total (as we need enough observations to identify university-specific fixed effects), and also those with extremely low coverage, i.e. fewer than 1 scholar per period of 20 years on average.

Our ranking of the top institutions varies across periods. Prior to 1200, the top universities are Bologna, Paris, Chartres’ cathedral school, Salerno, and Toledo’s school of translators. From 1200 to 1348, the top universities are Paris, Bologna, Oxford, Montpellier, and Toledo. In the period 1348-1449, we have Paris, Rome (Sapienza), Oxford, Florence (Studium generale), and Montpellier. Between 1450 and 1526, we have Rome, Paris, Salamanca, Cologne, and Pavia. Between 1527 and 1617, we have Wittenberg, Paris, Bologna, Rome, and Cambridge. In the period 1618-1684, we have Leiden, Cambridge, Oxford, Prague, and Padua. Between 1685 and 1733, we have Cambridge, Oxford, Halle, Collège Royal, and Copenhagen. After 1733, we have Jena, Jardins des Plantes, Göttingen, Uppsala, and Paris. This ranking contains a few surprises. For example, the University of Cambridge does very well in periods 5-6, contradicting the view that it was “an intellectual desert, in which a solitary man constructed a system of the world” (Manuel (1968) about Isaac Newton in Cambridge).

One can evaluate the relevance of our ranking of universities by comparing it with rankings obtained using different methods. The Casati Law (Italy, 1858) sets rules for accrediting the pre-existing universities into the new Italian University system (Cottini, Ghinetti, and Moriconi 2019). It ranked universities into three categories, A-B-C depending on their quality. We can compare this ranking with our estimate of Q_7 . The average Q_7 for the 9 universities ranked A is 4.74. The average Q_7 for the 8 universities ranked B is 1.43. And the two universities ranked C have $Q_7 = 1.31$ (including the university of Macerata for which we harvested about 800 professors).

3 Model and Econometric Issues

Economists have long recognized that spatial mobility decisions play a key role in the career choices of workers (e.g. Keane and Wolpin 1997; Neal 1999). Two types of models, spatial search and location choice, have been used to link mobility decisions to career choices. Spatial search and matching models formalize job search decisions across geographically segmented labor markets; they shed light on the effect of distance on the efficiency of a job search, on spatial heterogeneity in search frictions, and on the persistence of labor market disparities between regions (e.g. Manning and Petrongolo 2017; Schmutz and Sidibe 2019). The estimation

of matching models requires observing match-specific outcomes such as individual levels of earnings or employer’s profit (e.g. Abowd, Kramarz, and Margolis 1999). Location choice models explain how different types of workers self-select into labor market areas by maximizing their current and expected future levels of income (e.g. Borjas 1987; Dahl 2002; Gallin 2004; Grogger and Hanson 2011). The latter framework is particularly relevant when focusing on the role of workers’ attributes, and when match-specific outcomes, demand-side factors and local matching frictions are unobservable.

In this paper, we formalize the discrete location-choice problem of academic scholars in medieval and early modern Europe using a Random Utility Model (RUM), which provides the state-of-the-art microfoundations for most recent gravity models of migration. Our RUM leads to an empirical multinomial logit model which is in line with Akcigit, Baslandze, and Stantcheva (2016), who study the international mobility of superstar inventors since 1977. Standard location choice models assume that the demand-side of the market is perfectly elastic. In our context, this means that the demand for academic scholars (or equivalently, the supply of academic positions) adjusts perfectly to supply. Although most universities have a fixed number of chairs, they also offer a set of other positions which are easily adjusted (e.g. the fellows in Oxbridge, the *professores designati* in Copenhagen (Slottved 1978) , the *survivanciers* (designated successor) in Montpellier (Dulieu 1979)). We account for potential demand-side factors by including “competition costs” whose size depends on the attractiveness of universities and cities as well as on the ability and “market value” of academic scholars.

Compared to the standard literature on the determinants of migration, and beyond the fact that we use unique micro-data, our approach has three particularities. Firstly, we use *geo-referenced* location data. Each scholar i is assigned to a geo-referenced place of birth, whereas each university k is linked to a geo-referenced position. Each scholar-university dyad is associated with a cost distance d_{ik} , measured with the human mobility index (see *supra*). Since the place of residence of academic scholars before moving to university k cannot be observed, the distance between the place of birth and the university may capture the separation from family and friends (i.e. homesickness), the travel distance *per se*, or the costs of obtaining information about remote places. A striking example of the importance of distance is provided by Eloy (1755) and Michaud (1811) about *Septalius* (Lodivico Settala, 1552-1633). Born and living in Milan, he taught medicine at the nearby University of Pavia and received offers from: the King of Spain, the Duke of Bavaria, the Duke of Tuscany, the city of Bologna, and the Senate of Venice, all offers above what any local citizen could have dreamed of receiving. He enjoyed receiving them as tokens of well-deserved honors, but accepted none. He preferred the company of his fourteen children to the luster of these foreign positions.

Secondly, we exploit the *unbalanced panel dimension* of our database as some scholars made multiple/repeated choices. We do not necessarily know the timing of choices, but our database links several universities to some scholars. Jean de Coras and Francisco Suarez are extreme examples of this feature. Jean de Coras (1513-1572) was a French jurist who taught at Padua,

Toulouse, Ferrara, Valence, but also, according to Taisand (1721) at Orléans, Paris, and Angers (but we do not even know in which order).¹⁶ Francisco Suarez (1548-1617) was a Spanish Jesuit philosopher and theologian who taught at Avila, Valladolid, Alcalá, Salamanca, and Coimbra according to Herbermann (1913), but also at Paris and Rome according to Sommervogel (1890). For this reason, we assume an academic career is made of a maximum of S spells indexed by s . At each stage of their career, each professor has to select their preferred location from the feasible university choice set. In practice, if scholar i taught at S_i universities, we include S_i dyadic matches in the database. Several robustness checks will be conducted later to assess the role of sample selection issues.

Thirdly, our discrete choice model allows for *varying choice sets*. As new universities are created (or abandoned) over time, the choice sets are individual specific depending on the universities that existed during the active life of the scholar. Each university has a founding date t_0^k and an end date t_1^k , which we mostly take from Frijhoff (1996). Sometimes universities – or some schools which would later become universities – existed before this official date. For example, the University of Paris was officially founded in 1200, but colleges and cathedral schools existed before that date. Gerard Pucelle (1117-1184), an Anglo-French scholar in canon law, taught at Paris from 1156 to 1167 (Arabeyre, Halpérin, and Krynen 2007), before becoming the Bishop of Coventry. We should thus lower the initial date t_0^k for the University of Paris to match the first scholar who can be found there. More generally, the most ancient scholar in the database is Fulbert de Chartres (970-1029) who taught, at the turn of the millennium, at the cathedral school in Chartres and at what would become the University of Angers (Rangeard and Lemarchand 1868). This explains why our period of interest starts in the year 1000 CE. As far as individuals are concerned, we use the time interval $[t_i^b, t_i^f]$ defined in (1)–(2). Let us denote by $\tau(i)$ the period to which professor i is assigned, based on the beginning of her career. The portfolio available to individual i is denoted by $K_{\tau(i)}$. We include a university k in the choice set of individual $K_{\tau(i)}$ if $t_0^k < t_i^f$ or $t_1^k > t_i^b$.

The utility that a professor i obtains from locating at university $k \in K_{\tau(i)}$ at the stage $s \in S$ of her career is given by:

$$U_{isk\tau(i)} = V_{ik\tau(i)} + \epsilon_{isk} = \beta \mathbf{x}_{ik\tau(i)} + \epsilon_{isk}, \quad (4)$$

where $V_{ik\tau(i)} = \beta \mathbf{x}_{ik\tau(i)}$ represents the deterministic component of the indirect utility (net of moving costs), which depends on a vector of observable variables, and ϵ_{isk} is a vector of person-specific random taste shocks representing the unobservable determinants which enter the utility functions and are orthogonal to the deterministic component.

Assuming the random term ϵ_{isk} is independently and identically distributed as Extreme Value

¹⁶Jean the Coras might be known to the international audience as he instructed the famous trial of Martin Guerre. He wrote its best-known record, which was the basis for the movie *The Return of Martin Guerre* with Gérard Depardieu, which was nominated for Best Foreign Language Film by the U.S. National Board of Review of Motion Pictures in 1983.

Type I (EVT-I), which implies that multiple career choices are independent, we can model the probability that university k represents the utility-maximizing choice for professor i at the stage s of her career as the outcome of a standard multinomial logit model (McFadden 1974):

$$p_{isk\tau(i)} \equiv \text{Prob} \left[U_{isk\tau(i)} = \text{Max}_{k' \in K_{\tau(i)}} U_{isk'\tau(i)} \right] = \frac{\exp(\beta \mathbf{x}_{ik\tau(i)})}{\sum_{k' \in K_{\tau(i)}} \exp(\beta \mathbf{x}_{ik'\tau(i)})}. \quad (5)$$

In this formula, the probability of going to a given place depends on the features of that place (the numerator) compared to the features of all the other places in the portfolio (the denominator). The property of the multinomial logit model is that the relative probability of choosing between two alternative options in $K_{\tau(i)}$ depends on the attractiveness of these two options only, i.e.

$$\ln p_{isk\tau(i)} - \ln p_{isk'\tau(i)} = \beta \mathbf{x}_{ik\tau(i)} - \beta \mathbf{x}_{ik'\tau(i)},$$

and is independent of the presence of other alternatives (IIA: Independence of Irrelevant Alternatives). In addition, the choice probabilities are independent across career spells as long as ϵ_{isk} and $\epsilon_{is'k}$ are assumed to be independently distributed. The latter assumption will be relaxed later.

As in the literature on migration, in which the location choice of migrants conditional on the decision to migrate (Bertoli and Ruysen 2018) is studied, our estimations are conditional on the choice of having an academic career. As we cannot observe the universe of scholars, including those not choosing to teach at universities, we cannot model the *ex ante* problem of choosing between universities and other activities. Notice that this choice is more complex than a binary choice, as many scholars combined positions at universities with other occupations (such as physician or astronomer to the monarch, bishop or judge). Our estimation thus rests on the independence of irrelevant alternatives property within the choice set $K_{\tau(i)}$, which implies that the relative probability of choosing between two alternative options in $K_{\tau(i)}$ depends exclusively on the attractiveness of these two options. Even if selection into academia would not affect the location choice of individuals having chosen to teach, it might affect our simulations if – for example – the total number of professors depends on the notability of universities. Hence it is fair to acknowledge that our results remain partial equilibrium results.

Benchmark empirical model. – Estimating the multinomial logit (5) requires specifying the analytical form of the deterministic component of the utility function as a function of observable individual (q_i), institutional ($Q_{k\tau(i)}$), and dyadic characteristics (d_{ik}). In the benchmark model, we consider q_i as independent of her location choice. We also first consider $Q_{k\tau(i)}$ as exogenous, although we adjust it to eliminate the influence of any scholar i on the notability of the university. For each scholar i , we exclude their own ability index from the calculation of the university notability index. We thus make this notability index person-specific, $Q_{ik\tau(i)}$, to mitigate endogeneity concerns. The endogeneity of individual ability and adjusted institutional notability (influenced by the potential spillovers of scholar i on her colleagues) will be treated later.

The deterministic component of the utility function captures the average benefits and the average cost for i of locating at k , and is independent of the career spell s :

$$V_{ik\tau(i)} \equiv B_{ik\tau(i)}(\cdot) - C_{ik\tau(i)}(\cdot). \quad (6)$$

We model the benefits ($B_{ik\tau(i)}$) as an increasing function of the attractiveness of the city where the university is located (proxied by the population density, $P_{k\tau(i)}$, and by the indicator of local democracy from Bosker, Buringh, and Van Zanden (2013), $D_{k\tau(i)}$), as well as of the adjusted notability of the university ($Q_{ik\tau(i)}$), as suggested by anecdotal evidence. For example, Navarro-Brotons (2006) discusses the case of Jeronimo Munoz, who moved from Valencia to Salamanca in 1578. Although Munoz was one of the best paid professors at the University of Valencia, his salary was considerably lower than those paid at universities in Castille. The prestige of the University of Salamanca, and its greater proximity to the seat of royal power, was probably also a factor in Munoz’s decision to accept Salamanca’s offer. Furthermore, the effect of $Q_{ik\tau(i)}$ can vary with the ability of the professor as, for example, high-ability professors benefit more (or less) from expected interactions with high-ability colleagues (e.g. Stephan and Levin 2001; Kerr, Kerr, and Lincoln 2015a; Kerr, Kerr, and Lincoln 2015b; Kerr et al. 2017). We assume the following specification:

$$B_{ik\tau(i)} = a_0 + a_1 Q_{ik\tau(i)} + a_2 P_{k\tau(i)} + a_3 D_{k\tau(i)} + a_4 q_i Q_{ik\tau(i)} \quad (7)$$

where all coefficients are expected to be non-negative.

We model the cost of locating at university k ($C_{ik\tau(i)}$) as an increasing function of the cost distance from the place of birth (d_{ik}) and of the competition for finding a job at university k in period $\tau(i)$. The competition for finding a job reflects the demand side of the academic market. Again, anecdotal evidence suggests that the recruitment policy of the best universities included efforts to attract international talent. To give two examples, Eloy (1755) reports that Leonhart Fuchs (after whom the plant fuschia was named), a professor at Ingolstadt in 1526, was offered six hundred gold coins by the Duke of Tuscany, Como, to teach at the University of Pisa. Nadal (1861) discusses the case of the University of Valence, which was searching for a renowned legal scholar in 1583. They sent a messenger to convince a famous lawyer in Grenoble, Jean-Antoine de Lescure, to join the university. The latter reported that he would be willing to come for a salary of 1,500 pounds, provided his moving and house rental costs were covered by the university. They finally agreed on 1,200 pounds plus the house, partly paid by four merchants of the city. Later on, his colleague François Jossierand became jealous of Lescure’s treatment, threatened to go elsewhere, and obtained a pay rise.

We reasonably assume that the “competition cost” incurred by a professor increases with the attractiveness of the city ($P_{k\tau(i)}$ and $D_{k\tau(i)}$), as well as with the adjusted notability of the university ($Q_{ik\tau(i)}$). However, we also allow the latter “competition cost” to be negatively affected by the individual level of ability, as high-ability professors have a higher market value

and receive more generous offers from top universities. In line with the literature on self-selection in migration (e.g. Grogger and Hanson 2011; Beine, Docquier, and Ozden 2011; Kerr et al. 2017; Kerr et al. 2016), we allow the cost of distance to be negatively affected by the individual level of ability. We assume the following specification:

$$C_{ik\tau(i)} = b_0 + b_1 Q_{ik\tau(i)} + b_2 P_{k\tau(i)} + b_3 D_{k\tau(i)} - b_4 q_i Q_{ik\tau(i)} - b_5 d_{ik} + b_6 d_{ik} q_i \quad (8)$$

where all b s are expected to be non-negative.

Plugging (7) and (8) into (6) gives the expression for the net benefit of an (i, k) employment match. However, in our empirical regressions, we extend the number of generic determinants of location choices ($\mathbf{x}_{ik\tau(i)}$) to account for the imperfect coverage of our database and for unobserved heterogeneity. We add a university fixed effect, γ_k , which captures both the unobserved pull factors associated with university/city k that do not vary across periods and the quality and extent of the sources used for each university. This yields:

$$V_{ik\tau(i)} \equiv \beta \mathbf{x}_{ik\tau(i)} = \beta_0 + \underbrace{\beta_1 Q_{ik\tau(i)} + \beta_2 P_{k\tau(i)} + \beta_3 D_{k\tau(i)}}_{\text{Agglomeration}} + \underbrace{\beta_4 q_i Q_{ik\tau(i)}}_{\text{Sorting}} + \underbrace{\beta_5 d_{ik}}_{\text{Distance}} + \underbrace{\beta_6 d_{ik} q_i}_{\text{Selection}} + \gamma_k \quad (9)$$

where β is a set of parameters that are common to all individuals. In line with (7) and (8), the constant is given by $\beta_0 = a_0 - b_0$; $\beta_1 = a_1 - b_1$, $\beta_2 = a_2 - b_2$ and $\beta_3 = a_3 - b_3$ can be positive or negative and capture the *agglomeration* (or dispersion) effects resulting from the attractiveness and competition effects; $\beta_4 = a_4 + b_4$ is positive if high-ability scholars tend to agglomerate at better universities (what we refer to as *positive sorting*) due to higher benefits or smaller costs; $\beta_5 = -b_5$ is the standard *Distance* term capturing the expected negative effect of remoteness; and $\beta_6 = b_6$ is positive if high-ability individuals are more mobile than lower-ability ones (what we refer to as *positive selection*).¹⁷

Estimating the determinants of location decisions with the benchmark logit model (5) raises a number of econometric issues that might generate inconsistent estimates. Firstly, information about place of birth is missing for a relatively large number of academic scholars. In the benchmark regressions, these unknowns are eliminated from the sample, which induces a first sample bias. A second set of problems are due to the presence of scholars with multiple affiliations. Each (i, k) dyad appears as one observation in the database and is assimilated to a career spell. This means that scholars with six affiliations appear six times, while those with a single affiliation appear only once. This induces possible sample biases and raises the question of the relevance to model scholar i 's choice at stage s independently from her other career spells s' . Thirdly, the benchmark specification disregards the potential endogeneity of q_i , arising from the fact that the ability of scholar i is likely to be affected by her academic environment. We discuss below how we deal with these econometric issues.

Sample selection. – Our database does not include the universe of professors. Some are

¹⁷Positive selection and sorting can also arise if the utility function (4) is not additively separable.

not included in the sample. Some scholars are included but data on their place of birth are missing. This is usually the case for less well known professors. Hence, our sample is likely to overweight top-quality professors (high q_i) and underweight the less well known (low q_i). This is a limitation because the co-existence of professors who are famous and those who are not is key to identifying selection and sorting patterns. To measure the importance of sample selection, we re-estimate the multinomial logit (5) by making the sample less selective. To do so, we use the identified scholars of unknown origin, and assume that they were born in the city of their university.

Heterogeneous effects. – The benchmark assumption of a constant university fixed effect across fields and across periods (γ_k) is made for simplicity. In practice, the attractiveness of a university varied over time and across fields of study. To solve this problem, we separately re-estimate the multinomial logit (5) after excluding some periods, some fields of study, and some regions of birth. As far as periods are concerned, we distinguish between five periods (i.e. 1000 to 1526, 1200 to 1617, 1348 to 1684, 1450 to 1733, and 1527 to 1800). As for regions of origin, we successively exclude the Low Countries (Benelux), Germany (as of today), France (as of today), Italy, and the British Isles (currently the United Kingdom and Ireland). As for the fields, we successively exclude Theology, Law, Medicine, and Science. The field(s) of a scholar are mostly identified through the courses taught. Law includes both canon and civil law. Medicine includes Anatomy, Surgery, and Pharmacy. Sciences include Mathematics, Logic, Physics, Chemistry, Biology, Astronomy, Earth Science, Geography, and Botany. One should be aware that the distinction between these fields is a bit arbitrary, in particular when going back in time. For example, the theologians Thomas Aquinas and Albertus of Saxonia spent time reconciling the Aristotelian view of a finite world with the Christian view of an infinite God. In doing so, they contributed to the development of the mathematical notion of limit (Sergescu 1939). Pierre Gassendi (1592-1655) is known as an astronomer (a crater on the moon was named after him), but was a professor of theology at Aix-en-Provence.

Correlated career spells. – Assuming that career-spell-specific choices are independent, we ignore the possibility that multi-destination scholars may have had correlated preferences. To account for this, we generalize the standard logit model by relaxing the hypothesis of independence of individual choices. The independence property can be unrealistic in many settings, especially in situations with repeated choices over time. We can expect unobserved factors that affect a decision maker to persist over time. A more general deterministic component of utility can be written $V_{ik\tau(i)} = \beta_i \mathbf{x}_{ik\tau(i)}$, where β_i is a vector of coefficients that is unobserved for each i and varies randomly across professors, representing their tastes. This specification is the same as for the logit except that now the coefficients β_i vary in the population rather than being fixed. In particular, the coefficient β_i can be expressed as the sum of a population mean, $\bar{\beta}$, and an individual deviation, η_i , such that their utility of moving to destination k is written $U_{isk\tau(i)} = \bar{\beta} \mathbf{x}_{ik\tau(i)} + \eta_i \mathbf{x}_{ik\tau(i)} + \epsilon_{isk}$. The last two terms of such a *Random-Parameter Logit* capture the unobserved portion of utility. In other words, the marginal effect on the latent dependent variable is individual specific. The same tastes are used by the decision maker for

each career spell and the variance in β_i induces correlation in utility across destinations and career spells.

How these parameters vary across individuals is unknown. The mixed logit model assumes that these parameters vary according to the population PDF $g(\beta_i|\theta)$, where θ represents the moments of the distribution such as the mean and the variance, which must be estimated. A fully parametric mixed logit model arises once $g(\beta_i|\theta)$ is specified. We assume that the coefficient vector is independent and normally distributed, $\beta_i \rightsquigarrow N(\bar{\beta}, \sigma^2)$. The unobserved portion of utility is correlated across destinations and career stages due to the common influence of η_i , which violates the IIA property of the standard logit (Revelt and Train 1998). The full parametric model can be estimated using the simulated maximum-likelihood procedure (Sarrias et al. 2016).

Endogeneity of q_i . – The most problematic endogeneity problem arises because the ability of each professor i is measured by an index of human capital observed a long time after the end of her career (q_i), which is likely to be influenced by the quality of the university that was chosen. This means that we should distinguish between \bar{q}_i , the innate/exogenous level of ability, and q_i , the ex post level of notability. Let us denote by k^* the university chosen by a scholar. Ideally, we should use \bar{q}_i to estimate the multinomial logit (5). However, we only observe q_i , and this ex post level might be affected by $Q_{k^*\tau(i)}$, the notability of the chosen university. This implies that we do not observe the potential level of human capital if the individual had been working at a different university k . To illustrate we assume that $q_i = \bar{q}_i + \theta Q_{k^*\tau(i)}$ and we denote by $\bar{V}_{ik\tau(i)}$ the indirect utility level obtained after replacing q_i by \bar{q}_i in (9).

In theory, the multinomial logit implies that university k dominates university k' if $\bar{V}_{ik\tau(i)} + \epsilon_{isk} > \bar{V}_{ik'\tau(i)} + \epsilon_{isk'}$, which only depends on the characteristics of individual i and universities k and k' . In practice, we are unable to model $\bar{V}_{ik\tau(i)}$ and $\bar{V}_{ik'\tau(i)}$ properly because our measure of individual human capital is k^* -specific (i.e. influenced by $Q_{k^*\tau(i)}$). The endogeneity of q_i implies that the difference in utility is measured with additional noise: university k dominates university k' if

$$\bar{V}_{ik\tau(i)} + \epsilon_{isk} > \bar{V}_{ik'\tau(i)} + \epsilon_{isk'} + \theta Q_{k^*\tau(i)} \Delta_{ikk'\tau(i)}, \quad (10)$$

where $\Delta_{ikk'\tau(i)} \equiv \beta_4 (Q_{ik\tau(i)} - Q_{ik'\tau(i)}) + \beta_6 (d_{ik} - d_{ik'})$ results from the two interaction terms that are affected by our noisy measure of individual human capital in Eq. (9). The term $+\theta Q_{k^*\tau(i)} \Delta_{ikk'\tau(i)}$ in (10) is correlated across destinations, due to the presence of $Q_{k^*\tau(i)}$. Hence, the inability to observe \bar{q}_i leads to the violation of the IIA property.

To mitigate this problem, we estimate a nested logit model (McFadden 1978) where nests are defined as groups of universities sharing similar levels of notability ($Q_{ik\tau(i)} \approx Q_{ik'\tau(i)}$) during the period of activity of individual i . We partition the choice set $K_{\tau(i)}$ into four groups of alternatives, $K_{m\tau(i)}$ with $m = (1, 2, 3, 4)$ for the top, mid-high, mid-low, and bottom universities. Our partition is based on the notability index observed in the 4th and 5th periods. Each university belongs to exactly one nest. Building on Ortega and Peri (2013) and Bertoli and

Moraga (2015), we assume that the individual random taste shock is a mixture of a location-specific and a nest-specific term:

$$\epsilon_{isk} = \psi_m v_{isk} + (1 - \psi_m) v_{im},$$

where $\psi_m \in [0, 1]$ is the weight associated with the location-specific term, v_{isk} , which is assumed to be independently and identically distributed as EVT-I; and v_{im} is an error term that is specific to the m^{th} nest ($k \in K_{m\tau(i)}$), whose distribution depends on ψ such that the marginal distribution of ϵ_{isk} is also EVT-I (Cardell 1997). Parameter ψ_m also determines the mutual correlation in the realizations of the nest-specific error term. We have $\psi_m = \sqrt{1 - \rho_m}$, where ρ_m represents the correlation coefficient within nest m . Hence, ψ_m is a dissimilarity parameter. The higher ψ_m , the smaller the weight of the nest-specific component and the smaller the within-nest correlation of error term. When $\psi_m = 1$ for all m , the nested logit boils down to the standard multinomial logit ($\epsilon_{isk} = v_{isk}$).

The nested logit model assumes a generalized version of the EVT-I distribution, such that (i) the mean error varies across nests, and (ii) alternatives within a nest exhibit mutually correlated error terms (but the same mean). On the contrary, the error terms of two alternatives belonging to different nests are uncorrelated but have different means. In our context, this difference in the means captures the component of the error term $\theta Q_{ik^*\tau(i)} \Delta_{ikk^*\tau(i)}$ and hence corrects for the endogeneity bias. It reflects the influence of the chosen university on individual quality. Within a nest, this component is close to zero because $\Delta_{ikk^*\tau(i)} \approx 0$. Notice that this technique to correct for the endogeneity bias is possible only because the q_i always appears interacted with a variable for which we can build nests, and never appears alone (it cannot explain location choice alone as it is not destination specific).

The probability of individual i choosing university $k \in K_{m\tau(i)}$ is equal to the product of the probability of choosing alternatives in nest $K_{m\tau(i)}$ and the probability of choosing exactly k in $K_{m\tau(i)}$ (Heiss et al. 2002). It is given by

$$p_{isk\tau(i)} = \frac{\exp(\beta \mathbf{x}_{ik\tau(i)}/\psi_m)}{\exp(IV_{m\tau(i)})} \times \frac{\exp(IV_{m\tau(i)}\psi_m)}{\sum_{m'} \exp(IV_{m'\tau(i)}\psi_m)} \quad \forall t, \quad (11)$$

where $I V_{m\tau(i)} = \ln \sum_{k' \in K_{m\tau(i)}} \exp(\beta \mathbf{x}_{ik'\tau(i)}/\psi_m)$ is the inclusive value of each nest $K_{m\tau(i)}$, representing the rescaled measure of attractiveness of the nest for individual i (i.e. the expected value of the utility individual i obtains from the alternatives in nest $K_{m\tau(i)}$).

Other issues. – We close the discussion on econometric issues with a few words on the potential endogeneity of $Q_{k\tau(i)}$. In our benchmark model, we aim to identify the effect of $Q_{k\tau(i)}$ on the probability that scholar i chooses university k in period τ . One might fear a second endogeneity problem arising from the fact that the performance of each university k is measured by an ex post index of notability, which is determined by the quality of some professors having chosen to locate there. We do not think this is a major issue in our context for several reasons.

Firstly, remember that we replace $Q_{k\tau(i)}$ by $Q_{ik\tau(i)}$ in our estimations; the latter is computed after excluding individual i from the notability index. Secondly, top scholars might still have an effect on their peers. We define the notability of an institution in a given period as a function of the notability of its top five professors. Over the whole period under consideration, our estimation will rely on 138 universities and 19,980 scholars with known birthplaces making 23,044 location choices. The notability over the eight periods of our 138 institutions depends on the quality of 2,657 professors (i.e. 12.0% of our sample only). The risk of a reverse causal impact of q_i (and thus $p_{isk\tau(i)}$) on $Q_{ik\tau(i)}$ is less of an issue for 88% of our scholars. Thirdly, in Eq. (3), we allow for some persistency of past notability, which allows to assess the risk of endogeneity by letting the persistency parameter vary. Finally, notability is computed over periods which are longer than a human life, implying that the top scholars at a university for a given period did not necessarily meet in person, which also limits the endogeneity coming from face-to-face interactions. Hence, we consider $Q_{ik\tau(i)}$ as exogenous in our empirical analysis.

4 Estimation Results

Table 4 contains the results of our benchmark multinomial logit regressions for the whole period 1000-1800. The estimations are obtained by using the mlogit package of Croissant (2012), which allows for varying choice sets. These regressions characterize the location choices of 19,980 scholars with a mean number of career spells equal to 1.153 (the maximum number equals 8), which gives a total of 23,044 individual observations. Denoting the number of elements in set S , by \overline{S} , the mean number of institutions is equal to $E_i \overline{K_i} = 94$ (the total number $\overline{\cup_i K_i} = 138$), implying that our database includes 2,172,431 possible dyadic matches. We focus here on the sign and significance of the agglomeration, distance, selection, and sorting terms. In all regressions, we control for institution fixed effects. The sizes of cities, $P_{k\tau(i)}$ are obtained from Bairoch, Batou, and Pierre (1988) with the following mapping between periods τ and dates available in Bairoch et al.: 0:1000, 1:1200, 2:1400, 3:1500, 4: average between 1500 and 1600, 5:1600, 6:1700, and 7:1750. The level of local democracy, $D_{k\tau(i)}$, is obtained from Bosker, Buringh, and Van Zanden (2013) who created a binary variable equal to one when cities could organize themselves and claim a kind of self-rule that was often acknowledged by the sovereign in return for taxes or loyalty. The first occurrences of communal self-government were identified in the 11th and 12th centuries in Spain and Italy. They spread across the rest of Europe in the following centuries.

The regression in col. (1) can be seen as a textbook gravity equation, including distance d_{ik} and mass (in the fixed effect γ_k). This standard gravity regression shows that the probability of observing a scholar-university match decreases with the cost distance between the birthplace and the university location. This effect remains strong in all specifications. The coefficient of distance is slightly above unity, $\hat{b}_5 = -\hat{\beta}_5 > 1$, which is unsurprisingly greater than in the contemporary period. Focusing on the stock of international migrants in 2010, Beine, Docquier, and Ozden (2011) find a coefficient of 0.7 for all migrants and of 0.35 for college-educated

	(1)	(2)	(3)	(4)	(5)	(6)
Distance:						
d_{ik}	-1.331*** (0.006)	-1.328*** (0.006)	-1.381*** (0.008)	-1.326*** (0.006)	-1.373*** (0.008)	-1.372*** (0.008)
Agglomeration:						
$Q_{ik\tau(i)}$		0.215*** (0.007)	0.216*** (0.007)	0.170*** (0.008)	0.173*** (0.008)	0.346*** (0.005)
$P_{k\tau(i)}$		0.287*** (0.027)	0.286*** (0.027)	0.289*** (0.026)	0.289*** (0.027)	-0.058*** (0.007)
$D_{k\tau(i)}$		0.278*** (0.042)	0.278*** (0.042)	0.260*** (0.042)	0.261*** (0.042)	0.191*** (0.019)
Selection:						
$d_{ik}q_i$			0.027*** (0.003)		0.024*** (0.003)	0.042*** (0.003)
Sorting:						
$Q_{ik\tau(i)}q_i$				0.022*** (0.002)	0.021*** (0.002)	0.011*** (0.002)
k FE	yes	yes	yes	yes	yes	no
N. Obs.	23,044	23,044	23,044	23,044	23,044	23,044
Log Likelihood	-52,179	-51,543	-51,496	-51,475	-51,437	-56,087

Table 4: Multinomial logit regressions: benchmark results

migrants. Focusing on current academic researchers, Fink, Miguelez, and Raffo (2013) find a smaller coefficient around 0.2. Agglomeration forces are added in col. (2). Scholars are attracted by the notability of the university, the size of the city, and the level of local democracy. Notice that due to the presence of university fixed effects, the agglomeration effects are identified through the variations in institutional notability, city size, and democracy over time, while the effect of distance is identified through the spatial variation in d_{ik} . In col. (3), we add the interaction between distance and individual human capital $d_{ik}q_i$. This term is positive, which suggests that the most notable professors were more mobile than others (*positive selection*). In col. (4), we interact the individual human capital index with the notability of the university. We find evidence of *positive sorting*: the most notable professors were more likely to settle in more prestigious universities. Putting all regressors together in col. (5) shows that agglomeration, selection, and sorting are all significant. Using the values of the log likelihoods, we can mentally compute some simple LR tests: comparing (2) to (1), we can reject the null hypothesis that there is no agglomeration effect. Similarly, comparing (5) to (2), we reject the absence of selection and sorting. To illustrate, university fixed effects are excluded in col. (6); all results are similar with the exception of the local population effect, which becomes negative.

To determine whether the coefficient of distance is stable over time, we also ran a specification

with distance interacted with a period dummy. This allows us to test whether the speed of travel improved before 1800. The eight estimated coefficients are: -0.987, -1.248, -1.383, -1.337, -1.425, -1.417, and -1.422. The coefficient is thus quite stable over the last 5 periods, but lower during the Middle Ages, and especially during the period before the Black Death. The other coefficients are unaffected, except the effect of communal freedom, which is reinforced. The unexpected non-decreasing pattern in this coefficient reflects that there was little progress in the quality of roads until the 18th century (Bogart 2011), and little innovation in travel by boat before the invention of steamboats in the 19th century. The lower cost of moving during the Middle Ages may reflect weaker national states, and also the lower density of universities in this period.

The coefficient of the interaction term $Q_{ik\tau(i)}q_i$ captures the fact that high-quality scholars are more sensitive to the reputation of the university when solving the location-decision problem that they face, and/or that higher-quality universities reward scholars' quality more (i.e. higher wages per unit of quality). Wages are unobserved for us. Assuming that wages are proportional to q_i , we may want to include q_i among the determinants of location-specific utility, allowing its coefficient to vary across alternatives. This is standard in the estimation of a multinomial logit model with variables that are individual but not alternative specific. Still under the assumption that wages are proportional to q_i , it would purge the estimated coefficient of $Q_{ik\tau(i)}q_i$ from the confounding effect of differences in wages across universities. Including these choice-specific terms, we obtain $\overline{U_i K_i} = 138$ more parameters to estimate. The estimated coefficients of these q_i s vary from one university to the other, as does the university fixed factor. They also sometimes have a negative value, which is hard to interpret in the context where scholars would be remunerated in proportion to their q_i . In this new specification, the interaction term $Q_{ik\tau(i)}q_i$ is weakened but remains highly significant (0.016 (0.003) instead of 0.021 (0.002)) despite the inclusion of many terms correlated with q_i . The three agglomeration effects are barely affected.

In a non-linear model, the coefficients cannot be interpreted in terms of predicted probability as the effect of a change in a variable depends on the values of all variables in the model. To put it differently, the effect depends on where we evaluate it: the derivatives of the choice probabilities are given by $\frac{\partial p_{isk}}{x_{ik}} = \beta p_{isk}(1 - p_{isk})$, which is largest when $p_{isk} = 0.5$. For this reason, our coefficients β can only be interpreted as the effect of x_{ik} on indirect utility. This will be very clear at the beginning of the next section, where we will simulate the model with and without selection and sorting for a person with a high q_i , and compare with another one with a low q_i . The results in Table 4 also indicate that the effect of positive selection is relatively small: when q_i is around 10 (scholars at the top of the ability distribution), the utility loss due to distance is reduced by just 10%. By contrast, the effect of positive sorting is large: when q_i is around 10, sorting increases the gains from settling in a more prestigious university or in a more attractive city by a factor of 2 to 3. Besides the standard distance term, agglomeration and positive sorting are important forces governing the mobility decisions of academic scholars.

In Table 5, we assess the robustness of our empirical results to sample selection and estimation

	Benchm	Sample Unknown	Mixed	Nested Notability
d_{ik}	-1.373*** (0.008)	-1.488*** (0.008)	-1.697*** (0.014)	-0.988*** (0.011)
$Q_{ik\tau(i)}$	0.173*** (0.008)	0.177*** (0.008)	0.179*** (0.009)	0.106*** (0.006)
P_{kt}	0.289*** (0.027)	0.282*** (0.026)	0.290*** (0.027)	0.183*** (0.017)
D_{kt}	0.261*** (0.042)	0.276*** (0.042)	0.332*** (0.044)	0.152*** (0.027)
$d_{ik}q_i$	0.024*** (0.003)	0.047*** (0.003)	0.026*** (0.004)	0.022*** (0.002)
$Q_{ik\tau(i)}q_i$	0.021*** (0.002)	0.021*** (0.002)	0.025*** (0.002)	0.017*** (0.001)
ψ_1 (low)				0.646*** (0.015)
ψ_2				0.612*** (0.011)
ψ_3				0.609*** (0.010)
ψ_4 (high)				0.624*** (0.008)
FE	yes	yes	yes	yes
N. Obs.	23,044	30,586	23,044	23,044
Log Likelihood	-51,437	-44.761	-50,419	-50,918

Notes. In the mixed logit, the six variance parameters are estimated as well, four of them exhibit a variance that significantly differs from zero (variance of the coefficients of d_{ik} , D_{kt} , $d_{ik}q_i$, and $Q_{kt}q_i$).

Table 5: Multinomial logit regressions: robustness analysis

techniques. We report our benchmark results in col. (1). Then, col. (2) shows the results obtained when assuming that all identified scholars from unknown origin are locals. This increases the sample size by one third. Assuming obscure scholars are locals reinforces the positive selection and gravity effects; the agglomeration terms and positive sorting are not much affected. These results suggest that if we had observed the whole universe of scholars, which contains many more unknown people born locally, positive selection would appear stronger while leaving sorting unaffected. Hence, our benchmark estimates might give a lower bound on selection.

In col. (3), we relax the assumption of independent career choices for multi-destination scholars. In a multinomial logit, we cannot include individual fixed effects since they would not affect the probability that a university k dominates another university k' . However, we can estimate a mixed logit model with individual-specific vectors of coefficients drawn from a normal distribution. In such a setup, we account for individual unobserved preference factors that are common to all career spells. The agglomeration, selection, and sorting mechanisms are preserved. Although the mixed logit entails six additional parameters (the s.e. of the six coefficients - not reported), a likelihood ratio test would reject the benchmark formulation in favor of the mixed logit formulation. The mixed logit has a disadvantage though: the estimates are obtained by simulation, while in the multinomial logit, a likelihood function is maximized. In addition, the results depend on the assumption regarding the distribution of the random parameters.

Finally, in col. (4), we estimate the nested logit model to mitigate endogeneity concerns about q_i . Our nests are defined as groups of universities sharing similar levels of notability. Compared to the benchmark, the effects of agglomeration are weakened but still positive and highly significant; part of the agglomeration force is likely to be captured by the nest-specific error term. The selection coefficient is slightly greater. Sorting is weakened but remains highly significant and important compared to the agglomeration effect: when q_i is around 10, positive sorting increases the gains from settling in a more prestigious university by a factor of 3. Note that we reject the assumption of no nests, either through a likelihood ratio test (lr=1039.09), or by testing whether the correlations within nests are zero, or equivalently $\psi_m = 1 \forall n$ (Wald=2481). We also marginally reject that the degree of correlation inside each nest is the same, $\psi_m = \psi_{\tau(i)} \forall m$ (Wald=8.08, p-val=0.028).

In Table 6, we separately estimate the multinomial logit (a) for five sub-periods (i.e. 1000 to 1526, 1200 to 1617, 1348 to 1685, 1450 to 1733, and 1527 to 1800), (b) after excluding one field at a time (i.e. Theology, Law, Medicine, and Science), and (c) after excluding one region of origin at a time (i.e. Benelux, Germany, France, Italy, and the United Kingdom/Ireland). Our 14 sub-samples include smaller numbers of observations. In each of these sub-samples, the portfolio of possible universities differs. For example, when we exclude scholars born in Germany, some German universities cannot be included in the estimation as only German scholars worked there during their existence.

The effect of distance is always negative and highly significant. As far as agglomeration forces

	Distance		Agglomeration		Selec	Sorting	Nb of obs.
	d_{ik}	$Q_{ik\tau(i)}$	$P_{ik\tau(i)}$	$D_{ik\tau(i)}$	$d_{ik}q_i$	$Q_{ik\tau(i)}q_i$	
Benchmark	-1.373***	0.173***	0.289***	0.261*	0.024***	0.021***	23,044
	By sub-period						
1000-1526	-1.294***	0.262***	-0.103***	0.462***	0.034***	0.004	7,017
1200-1617	-1.335***	0.247***	0.100***	0.411***	0.031***	-0.001	11,777
1348-1685	-1.380***	0.135***	0.526***	0.372***	0.026***	0.009***	14,597
1450-1733	-1.428***	0.158***	0.562***	0.229	0.033***	0.014***	14,783
1527-1800	-1.420***	0.084***	0.366***	0.183	0.028***	0.039***	15,905
	By field						
W/o Theology	-1.367***	0.190***	0.404***	0.331***	0.026***	0.018***	18,694
W/o Law	-1.388***	0.155***	0.262***	0.138***	0.016***	0.028***	15,499
W/o Medicine	-1.358***	0.181***	0.296***	0.276***	0.021***	0.020***	19,140
W/o Sciences	-1.393***	0.185***	0.290***	0.265***	0.030***	0.017***	20,551
	By region						
W/o Benelux	-1.359***	0.166***	0.301***	0.245***	0.023***	0.021***	21,757
W/o Germany	-1.335***	0.186***	0.201***	0.274***	0.021***	0.015***	17,040
W/o France	-1.325***	0.190***	0.308***	0.322***	0.014***	0.020***	20,208
W/o Italy	-1.380***	0.147***	0.340***	0.082	0.022***	0.031***	14,987
W/o UK/Irl	-1.369***	0.171***	0.278***	0.250***	0.033***	0.018***	22,094

Table 6: Multinomial logit regressions: heterogeneous effects

are concerned, the notability of the university is always positive and significant with the exception of the last period. The attracting effect of city size is always positive, with the exception of the first period, when local democracy seems dominant. The effect of communal freedom, which is found to be important in general by Serafinelli and Tabellini (2017) in their study of the migration patterns (from birth to death) of creative people, is found to be significant in most sub-samples. The estimates by region show that Italy is key to identifying this effect, as communal freedom stops being significant when one removes Italian scholars from the sample. Looking at the estimations per period, it is the first five that allow us to identify its effect. This echoes the study of Buonanno et al. (2019) who show that territories with communal freedom in the Middle Ages display more positive features and attitudes today than territories without such freedom. As for positive selection, the effect is positive and significant in all cases. Finally, the sorting term is positive and significant in all cases as well. Despite smaller numbers of observations, our results are fairly robust across sub-samples.

The results by period can be used to consider the effect of Protestantism on the academic market. The period 1000-1526 ends with the creation of the first Protestant university, Marburg. The period 1527-1800 covers a divided world, where many scholars had to change religions if they wanted to keep their positions, while others decided to migrate to a region where

their religion was accepted. Others converted voluntarily and this changed their approach to science.¹⁸

	Benchmark	(2)	(3)	(4)	(5)
$1 - \delta$	0	0.98 ^T	0	0	0
σ	2	2	1.2	2	2
ω	1	1	1	0	1
Incl.	≥ 10	≥ 10	≥ 10	≥ 10	≥ 20
d_{ik}	-1.373***	-1.376***	-1.373***	-1.377***	-1.380***
Q_{kt}	0.173***	0.162***	0.174***	0.188***	0.172***
P_{kt}	0.289***	0.283***	0.283***	0.313***	0.287***
D_{kt}	0.261***	0.221***	0.264***	0.162***	0.264***
$d_{ik}q_i$	0.024***	0.025***	0.024***	0.025***	0.024***
$Q_{ik\tau(i)}q_i$	0.021***	0.014***	0.020***	0.020***	0.023***
FE	yes	yes	yes	yes	yes
Log likelihood	-51,437	-51,533	-51,428	-51,174	-49,978
N. Obs.	23,044	23,044	23,044	23,044	22,741

Table 7: Multinomial logit regressions: Robustness to identifying assumptions

In the period before the Reformation, the agglomeration force attracting all scholars to the most notable universities is very strong (coefficient of $Q_{ik\tau(i)}$ around 0.198). Positive sorting seems negligible then. In the post-Reformation period, it is the opposite. The agglomeration force disappears (the coefficient even becomes negative but very small), but sorting is strong, indicating that the ability of top universities to attract professors became confined to top scholars. It is as if the Reformation slowed down the mobility of average scholars. This is confirmed by the increase in the coefficient associated with cost distance.

In Table 7, we assess the robustness of our results to four identifying assumptions. The benchmark results are repeated in col. 1. Then, col. 2 accounts for some persistency of past notability, i.e. we assume a depreciation rate of 2% per year. This assumption makes new universities less attractive, while there is some persistence in the notability of declining universities. Under this hypothesis, the variables involving the notability of universities are a bit weaker. In col. 3, we decrease σ from 2 to 1.2 (i.e. a stronger complementarity between top-5 scholars in the notability equation). This does not change the estimation results much (but this might be important for the simulations). In col. 4, we set $\omega = 0$, counting each multi-destination scholar as contributing in full to the notability of their universities of destination. In col. 5, we restrict our working sample to universities with at least 20 scholars (instead of 10 in the benchmark). Our empirical results are highly robust to these changes.

¹⁸An example is Nicolas Steno (from Table 3). Born to a Lutheran family and known for his groundbreaking contributions to geology, he converted to Catholicism and moved away from the natural sciences to embrace theology.

5 Agglomeration of Scholars and the Scientific Revolution

Firstly, we assess the estimated effect of the determinants of location decisions (x_{ikt}) on individual choice probabilities by comparing simulated outcomes with counterfactual experiments. We focus on the role of agglomeration, positive selection, and positive sorting for two scholars who were born in the same region in the first period (the period with the smallest choice set), but who exhibit different levels of human capital. We first consider Thomas Aquinas (1225-1274), who was born in Roccasecca and taught theology at Paris for twenty years (1252-1272) and at Naples. Thomas Aquinas belongs to the very top of the ability distribution (ranked 8th, $q = 11.03$). Aquinas's choice set consists of 22 universities. We then consider Roffredus Beneventanus (1170-1243), who was born in Benevento, taught law at Naples (1170-1243), and is in the middle of the distribution ($q = 2.84$). As he was born 50 years before Thomas Aquinas, Roffredus Beneventanus's choice set consists of just 17 universities. In Table 8, we compare the predicted location probabilities of the full specification of Table 4, with those of a restricted model in which the coefficients of the selection and sorting terms are set to zero. For both scholars, the set of universities is ranked by decreasing order of the predicted probability generated by the full specification.

Unsurprisingly, positive selection implies a broader menu of effective options, whereas agglomeration forces and positive sorting increase the attractiveness of famous universities. The effects are balanced by the extent of each scholar's notability. Our estimated model shows that the most likely locations for Thomas Aquinas are Bologna (38.5%), Naples (22.2%), Padova (10.7%) and Paris (9.1%). Neutralizing the positive selection term increases the probability of choosing a good location closest to his birthplace (Naples) to the detriment of Bologna and Paris (+9, -2.9, and -2.7 percentage points, respectively). Neutralizing the positive sorting and agglomeration term drastically decreases the attractiveness of Paris (by 5.2 and 6.0 percentage points, respectively). Overall, the basic gravity model predicts a low probability of choosing Paris (0.7%). The combination of agglomeration, selection, and positive sorting increases this probability by a factor of 13, and increases the probability of choosing Bologna by a factor of 3.

For Roffredus Beneventanus, who has less human capital (q_i), the selection and sorting effects are weaker. Our estimated model shows that the most likely location is Naples (38%). Compared to Thomas Aquinas, Roffredus Beneventanus is more sensitive to distance, and less sensitive to the notability of the university or to agglomeration effects. Removing the sorting effect or the agglomeration effect increases the probability of choosing Padua, Salerno, and Pisa, at the expense of Bologna, Montpellier, and Paris. When removing the selection effect, similar changes are obtained. The basic gravity model also predicts that Naples and Padua are the two most attractive universities, for both Roffredus Beneventanus and Thomas Aquinas, and that the probability of choosing Paris or Bologna, the best universities in this period, are

similar for both (a bit higher in fact for Beneventanus, because his choice set is more limited, i.e. 17 universities against 22 for Thomas Aquinas). However, unlike for Thomas Aquinas, the combination of agglomeration, positive selection, and positive sorting increases the probability of choosing Paris and Bologna by a factor of 5.1 to 2.5 only.

	Estimated	No agglom	No selec.	No sorting	Basic Gravity
Thomas Aquinas ($K_i=22$)					
Ubologna-1088	38.5%	23.2%	35.6%	22.6%	9.6%
Unapoli-1224	22.2%	25.4%	31.2%	28.5%	35.1%
Upadua-1222	10.7%	15.4%	10.2%	16.0%	16.9%
Uparis-1200	9.1%	3.1%	6.4%	3.9%	0.7%
Umontpellier-1289	5.0%	4.8%	4.0%	3.7%	2.2%
Upavia-1361	2.9%	5.9%	2.6%	7.8%	10.7%
Usiena-1246	2.1%	2.7%	2.1%	2.2%	2.2%
Other (15)	9.5%	19.5%	8.0%	15.2%	22.6%
Beneventanus Roffredus ($K_i=17$)					
Unapoli-1224	38.0%	38.0%	40.4%	39.7%	40.2%
Ubologna-1088	24.3%	12.8%	23.0%	20.7%	9.9%
Upadua-1222	13.8%	17.3%	13.1%	15.0%	17.2%
Usalerno-1231	8.9%	12.9%	9.8%	9.7%	14.7%
Uparis-1200	3.6%	1.1%	3.1%	2.8%	0.7%
Umontpellier-1289	3.0%	2.5%	2.8%	2.8%	2.0%
Upisa-1343	1.7%	3.6%	1.7%	2.2%	4.1%
Other (10)	6.7%	11.7%	6.1%	7.1%	11.1%

Table 8: Role of selection and sorting: two examples

Secondly, we go beyond individual cases by using our estimated model to simulate the contribution of agglomeration, positive selection, and positive sorting to total university output by period. We construct a proxy for the total output of university k for period τ , denoted by $Y_{k\tau}$, which is an aggregation of the human capital of all scholars predicted to work there. $Y_{k\tau}$ is defined as a CES (constant elasticity of substitution) combination of the ability levels of its predicted members:

$$Y_{k\tau} = \left(\sum_i \hat{p}_{ik\tau(i)} q_i^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \quad (12)$$

where $\hat{p}_{ik\tau(i)}$ is the weight given to professor i at university k in period $\tau(i)$. We set it equal to the simulated probability that i goes to k from the multinomial logit model – like the probabilities shown in Table 8 for two cases. Parameter σ represents the elasticity of substitution between academic scholars' human capital in production.

The simulated output $Y_{k\tau}$ should be interpreted as including advancement to knowledge, quality

of teaching, and service to society (such as supplying cautious physicians, rigorous lawyers to the local courts, or well-educated priests and pastors to parishes). Then, we compare the total simulated output

$$Y_\tau = \sum_k Y_{k\tau}$$

in the benchmark (normalized to 100) with the predicted output obtained after neutralizing the agglomeration, positive selection, and sorting terms. Hence, the important point here is not the level of Y_τ in itself, but the gap between Y_τ with and without market forces.

When the elasticity of substitution tends to infinity ($\sigma = \infty$), we have perfect substitutability between scholars. The total output is the sum of individual human capital, independent of location (represented by the $\hat{p}_{ik\tau(i)}$):

$$\lim_{\sigma \rightarrow \infty} Y_\tau = \sum_k \sum_i \hat{p}_{ik\tau(i)} q_i = \sum_i q_i.$$

By contrast, when σ is finite, there is a complementarity relationship between academic scholars. The smaller σ , the greater the knowledge gain from agglomerating high-ability scholars at the same university, and the agglomeration of the highest ability scholars leads to output gains. In our benchmark regressions and simulations, we use a CES production function with $\sigma = 2$, in line with the definition of the notability of the university in Eq. (3).

Table 9 shows the results obtained with the benchmark model (i.e. standard multinomial logit model with $\sigma = 2$) in the top panel, with the nested logit variant in the middle panel, and with the high-complementarity variant (i.e. standard multinomial logit model with $\sigma = 1.2$) in the bottom panel. In the nested logit variant, we use the estimates provided in col. (4) of Table 5. The high-complementarity variant relies on col. (3) of Table 7. In each panel, col. (2) to (4) give the total output obtained after neutralizing the effect of agglomeration, positive selection, and positive sorting. In col. (5), we neutralize these three mechanisms jointly, while keeping the distance term and the university fixed effects (i.e. basic gravity).

In line with our empirical findings, col. (3) shows that positive selection hardly influences the total simulated output. We have seen in Table 8 that positive selection tends to scatter talents across universities by increasing the menu of options for the highest ability scholars, but the total effect of this increased dispersion is small. On the other hand, cols. (2) and (4) show that agglomeration and positive sorting play an important role, especially in the earlier periods, when there are few universities. Under the benchmark and nested-logit variants, agglomeration and sorting increase the total output of Europe by about 50% before the Black Death (32 universities), by about 35% before the invention of the printing press (48 universities), and by 35% before the rise of Protestantism (72 universities).

It is worth noticing that sorting and agglomeration do not always increase total simulated output. Their joint effect on output depends on the correlation between the notability of universities and the level of city/university amenities (captured, in our regressions, by the

university fixed effect and the attractiveness of the city). When the correlation is high, the effects of notability and amenities point in the same direction; the best scholars agglomerate in the best universities. When the correlation is lower, agglomeration and sorting can result in the concentration of talent in second-best universities, which reduces total academic output. This is at least the case if the intensity of agglomeration and sorting forces is limited.

The effects of agglomeration and sorting become weaker after 1618. They increase total output by less than 20% over this period. Overall, we find that agglomeration and sorting are more likely to reduce academic output when the individual choice set is large. For this reason, their effect on academic output diminished in the late 16th and in the 17th centuries, when the number of universities almost doubled. What is specific to periods 5-7 is the presence of many universities with a large number of scholars having published something ($q_i > 0$) which was not highly influential. Shutting down agglomeration redistributes superstars to the advantage of these less prestigious universities, thus increasing the level of the many average people there.

To further understand the role of market forces, Figure 2 maps the winners (in green) and losers (in red) due to market forces in the period 1618-1685. The surface of each circle represents the difference in simulated output between the benchmark case and the basic gravity case. An easily understandable case is Lund vs Copenhagen. With market forces, scholars born in Sweden are more likely to locate in Copenhagen which has a high notability ($Q_6 = 6.2$) rather than in Lund, which is just average ($Q_6 = 3.8$), while without agglomeration and sorting forces, they are content with Lund. We also note that Rinteln is a big loser in Germany, being surrounded by many good universities such as Leipzig and Jena. It is also noteworthy that the South of Europe is not doing so poorly, although the bigger gains are in the North. Renowned Southern universities still attract talents (Salamanca, Padua, Bologna, and Rome). In a sense, without market forces, the fate of the South would be worse.

When looking at universities which were permanently closed down over the period 1700-1900, many of them were losers from the market in the last 3 periods. Altdorf (closed in 1809), Bamberg (closed in 1803), Cahors (closed in 1751), Cervera (closed in 1821), Dorpat (closed in 1710), Harderwijk (closed in 1811), Pont-à-Mousson (closed in 1768), Rinteln (closed in 1809), Siguenza (closed in 1807), and Valence (closed in 1793) are in this category. A few winners were closed too: Erfurt (closed in 1816) and Frankfurt (Oder) (closed in 1811).

Overall, our results show that agglomeration and sorting effects in the academic market contribute to fostering university output. The size of the agglomeration and sorting effects before the middle of the 16th century are quantitatively significant. Without these effects, university output would be reduced by 50%. As we do not model any cumulative effect of knowledge creation, this 50% should be understood as a lower bound.

Several economic historians claim that labor markets were relatively complete and competitive in Medieval Europe: “Given the low reproductive success of the urban population there had to be a constant flow of labor from the country to the city (Clark 2008). The records of a 1292

	No agglom.	No selection	No Sorting	Basic Gravity
Benchmark ($\sigma = 2$)				
1000-1199	83.3	98.1	91.1	78.0
1200-1347	61.2	97.2	78.3	52.8
1348-1449	72.0	97.8	90.4	65.8
1450-1526	71.6	99.3	91.1	64.2
1527-1617	68.6	97.4	87.4	60.6
1618-1685	86.0	98.7	91.6	82.5
1686-1733	90.8	99.3	93.7	86.5
1734-1800	95.3	99.1	94.4	90.9
Nested logit ($\sigma = 2$)				
1000-1199	82.0	96.6	88.2	74.4
1200-1347	63.2	96.5	75.7	52.7
1348-1449	74.6	97.0	89.2	67.1
1450-1526	75.0	98.7	90.2	66.7
1527-1617	74.0	96.6	87.3	65.1
1618-1685	89.5	98.4	92.0	84.1
1686-1733	92.8	99.2	93.8	87.3
1734-1800	94.7	98.7	93.9	88.9
High complementarity ($\sigma = 1.2$)				
1000-1199	33.1	89.5	67.2	21.3
1200-1347	13.1	88.8	48.5	6.1
1348-1449	27.8	92.6	74.3	19.9
1450-1526	30.8	97.4	81.3	22.5
1527-1617	20.6	89.3	67.9	12.1
1618-1685	45.2	90.7	71.7	42.1
1686-1733	67.2	93.4	80.7	58.2
1734-1800	77.6	95.7	74.9	60.8

Table 9: Effect of agglomeration, selection, and sorting on academic output (100=benchmark)

Gainers and losers in Period 6

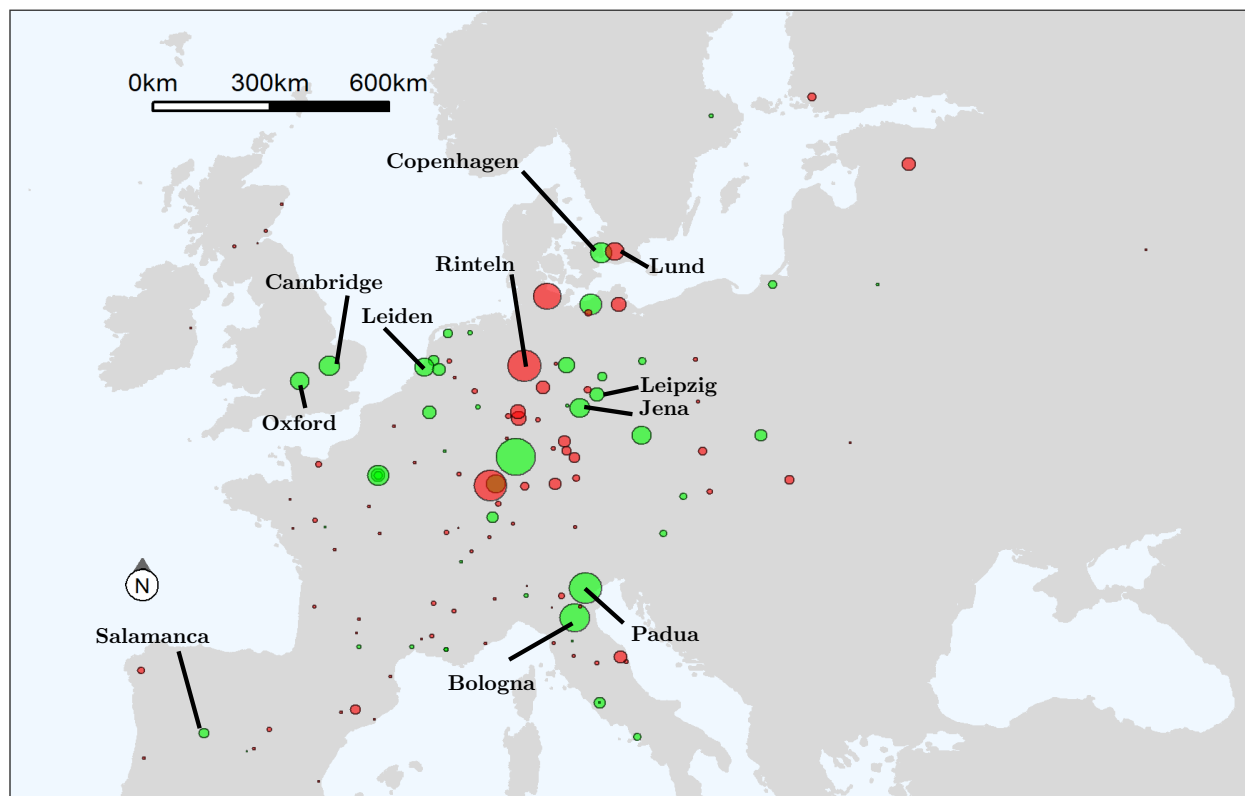


Figure 2: Winners (green) and Losers (red) from Market Forces in 1618-1685

tax levied by Philip the Fair on the commoner households of Paris show that 6 percent were foreigners: 2.1 percent English, 1.4 percent Italian, 0.8 percent German, 0.7 percent Flemish, 0.6 percent Jewish, and 0.4 percent Scottish” (Clark 2008, Sussman 2006). We can compare these numbers with the origin of the scholars of Paris University in the first two periods of our sample (1000-1347). Based on the 194 persons with known origin, we obtain that 54% of the scholars were born in France (in its 2020 limits), 14% are British, 5% are from Germany and 6% are from the Low Countries – the data for this period are mostly based on (Courtenay 1999). Although the mobility of ordinary people seems quite high already, the mobility of university scholars is higher by an order of magnitude.

The importance of market forces seem particularly relevant in the periods preceding and coinciding with the dawn of the Scientific Revolution, a period commonly defined as spanning Copernicus’s and Newton’s times, i.e. 1543-1687 (Applebaum 2003). In the last two centuries before the Industrial Revolution, these effects decrease significantly or even become non-existent. Hence, although we provide no causal evidence of such a link, our simulations lend credence to the hypothesis that universities might have been key to triggering the rise of this new science. This view is corroborated by the analysis of the gains from the market at the local level. In our simulations, the universities gaining the most from agglomeration and

sorting forces in the period 1450-1526 are Rome, Bologna, Padua, Paris, and Louvain. In the period 1527-1617, one can add Cambridge and Leiden to the list. Those were indeed leading universities for the Scientific Revolution.

Our results are conditional on the value of σ . As stated above, all these effects would disappear if we had taken $\sigma = \infty$, as the allocation of scholars (represented by the $\hat{p}_{ik\tau(i)}$) across places would not matter. By contrast, the positive and negative effects of agglomeration and sorting are magnified under the high-complementarity variant with $\sigma = 1.2$. The benefits of sorting exceed those obtained in the benchmark. Nevertheless, the effect of agglomeration varies a lot across periods. In the first five periods, the concentration of the highest ability scholars multiplies simulated output by at least five. By contrast, in the last three periods, the gains from agglomeration in the top universities are compensated for by losses in average- and low-quality universities, leading to a smaller total effect on total university output. When combining all these mechanisms, agglomeration and sorting increase the simulated output at least fivefold in the earlier periods, while their effect is less than twofold in the last three periods.

6 Conclusions

In European universities, students were educated by a plurality of masters, and schools were open to students and scholars from all parts of Europe. In this paper, we map the European academic market in the medieval and early modern times. We build an original database of thousands of scholars from university sources to study the location pattern of scholars over the period 1000-1800. The quality of scholars is measured using information provided by Worldcat and Wikipedia. Using a multinomial logit, we show that scholars tend to agglomerate in the best universities, and that this phenomenon is more pronounced within the upper tail of the talent distribution: better scholars are more sensitive to the quality of the university (positive sorting), and migrate over greater distances (positive selection). Agglomeration and sorting patterns influenced the distribution of upper-tail human capital across Europe, and contributed to fostering university output at the dawn of the Scientific Revolution. By contrast, positive selection tended to scatter talents across universities and barely influenced the aggregate production of knowledge.

Agglomeration, sorting, and selection testify to market forces at work. They appear when there is a competition between universities to attract scholars, or among scholars to land the best positions available. This contrasts with a common but mistaken view that markets are a modern phenomenon, but our findings are in line with the qualitative evidence put forward by historians such as Denley (2013) who describes the emergence in Italy of “an efficient and sometimes cut-throat academic market, with its own ‘transfer season,’ clearly defined hierarchies, rocketing salaries for the top players, and a mentality of academic celebrity that fed off it.” At the European level, two features may have helped the academic market to develop. First, political fragmentation, together with competition between church and state, prevented a centralized

control by the political sphere of universities. Second, the use of Latin as a *lingua franca*, which persisted late into the early modern period, allowed scholars to teach anywhere at low cost.

Our simulations suggest that the presence of a functioning academic market in Europe helped universities to produce more at the dawn of European primacy. This might have paved the way for the Enlightenment, humanistic, and scientific revolutions. We thus provide some quantitative support to the views developed by historians, such as Huff (2017)'s approach to the Scientific Revolution, comparing the West to China and the Islamic World. Huff suggests that the origins of the stronger support given to scientific inquiry in the West during the early modern period can be traced back to the medieval period when European institutions were reconstructed. In this context, he sees the rise of European universities in the Middle Ages and their long-run contribution to the Scientific Revolution as highly significant.

References

- Abowd, John, Francis Kramarz, and David Margolis. 1999. "High wage workers and high wage firms." *Econometrica* 67 (2): 251–333.
- Abramitzky, Ran, Leah Platt Boustan, and Katherine Eriksson. 2012. "Europe's tired, poor, huddled masses: Self-selection and economic outcomes in the age of mass migration." *American Economic Review* 102 (5): 1832–56.
- . 2014. "A nation of immigrants: Assimilation and economic outcomes in the age of mass migration." *Journal of Political Economy* 122 (3): 467–506.
- Abramitzky, Ran, and Fabio Braggion. 2006. "Migration and human capital: self-selection of indentured servants to the Americas." *Journal of Economic History* 66 (4): 882–905.
- Addy, George M. 1966. *The Enlightenment in the University of Salamanca*. Duke University Press.
- Agrawal, Ajay, Devesh Kapur, John McHale, and Alexander Oettl. 2011. "Brain drain or brain bank? The impact of skilled emigration on poor-country innovation." *Journal of Urban Economics* 69 (1): 43–55.
- Akcigit, Ufuk, Salomé Baslandze, and Stefanie Stantcheva. 2016. "Taxation and the international mobility of inventors." *American Economic Review* 106 (10): 2930–2981.
- Albrecht, Helmuth. 1986. *Catalogus professorum der Technischen Universität Caroli-Wilhelmina zu Braunschweig*. Die Universität.
- Andreev, A Yu, and DA Tsygankov. 2010. *Imperatorskiy Moskovskiy universitet, 1755-1917: entsiklopedicheskiy slovar [Imperial Moscow University, 1755-1917: Encyclopedic Dictionary]*. Moscow: ROSSPeN.
- Antonetti, Guy. 2013. *Les professeurs de la faculté des droits de Paris 1679-1793*. Paris: Editions Pant'éon-Assas.
- Applebaum, Wilbur. 2003. *Encyclopedia of the scientific revolution: from Copernicus to Newton*. Routledge.
- Arabeyre, Patrick, Jean-Louis Halpérin, and Jacques Krynen. 2007. *Dictionnaire historique des juristes français (XIIe-XXe siècle)*. Paris: Presses Universitaires de France.
- Arteaga, Enrique Esperabé. 1917. *Historia pragmática é interna de la Universidad de Salamanca: maestros y alumnos más distinguidos*. Imp. y Lib. de Francisco Núñez Izquierdo.
- Astro.uu.se. 2011. "History of astronomy in Uppsala." <http://www.astro.uu.se/history/>.
- Astruc, Jean. 1767. *Mémoires pour servir à l'histoire de la faculté de médecine de Montpellier, par feu M. Jean Astruc, ... revus et publiés par M. Lorry, ...* P.-G. Cavelier.
- Bairoch, Paul, Jean Batou, and Chevre Pierre. 1988. *Population des villes européennes de 800 à 1850: banque de données et analyse sommaire des résultats*. Librairie Droz.

- Bamberg, Universitätsarchiv. 2019. “Bamberger Professorinnen- und Professorenkatalog.” mimeo.
- Barbot, J. 1905. *Les chroniques de la faculté de médecine de Toulouse*. Toulouse: Dirion.
- Barjavel, Casimir François Henri. 1841. *Dictionnaire historique, biographique et bibliographique du département de Vaucluse*. Devillaris.
- Bauer, Johannes Joseph. 1957. *Zur Frühgeschichte der Theologischen Fakultät der Universität Freiburg (1460-1620)*. Freiburg: Albert.
- Beine, Michel, Frederic Docquier, and Caglar Ozden. 2011. “Diasporas.” *Journal of Development Economics* 95 (1): 30–41.
- Belin, Ferdinand. 1896. *Histoire de l'ancienne université de Provence, ou Histoire de la fameuse univesité d'Aix: période. 1409-1679*. A. Picard et fils.
- . 1905. *Histoire de l'ancienne université de Provence, ou Histoire de la fameuse univesité d'Aix: d'après les manuscrits et les documents originaux*. A. Picard et fils.
- Beltrán Tapia, Francisco J, and Santiago de Miguel Salanova. 2017. “Migrants’ self-selection in the early stages of modern economic growth, Spain (1880–1930).” *Economic History Review* 70 (1): 101–121.
- Bénézet, Brigitte. 2003. *L’Université d’Avignon: naissance & renaissance, 1303-2003*. Actes sud.
- Benzing, Josef. 1986. *Verzeichnis der Professoren der alten Univerität Mainz*. Mainz: Universitätsbibliothek Johannes Gutenberg-Unviersität.
- Berger-Levrault, Oscar. 1890. *Catalogus professorum Academicarum et Universitatum alsaticarum XVI-XVIII seculi, editore Oscar Berger-Levrault*. Impr. de Berger-Levrault.
- Bertoli, Simone, and Jesús Fernández-Huertas Moraga. 2015. “The size of the cliff at the border.” *Regional Science and Urban Economics* 51:1–6.
- Bertoli, Simone, and Ilse Ruysen. 2018. “Networks and migrants’ intended destination.” *Journal of Economic Geography* 18 (4): 705–728 (03).
- Bianco, Franz Joseph von. 1974. *Die alte Universität Köln und die spätern Gelehrten-Schulen dieser Stadt: nach archivarischen und anderen zuverlässigen Quellen*. Aalen: Scientia-Verlag.
- Bimbenet, Jean Eugène. 1853. *Histoire de l’Université de lois d’Orléans*. Dumoulin.
- Bogart, Dan. 2011. “Did the Glorious Revolution contribute to the transport revolution? Evidence from investment in roads and rivers 1.” *Economic History Review* 64 (4): 1073–1112.
- Boissonade, Prosper. 1932. *Histoire de l’université de Poitiers: passé et présent (1432-1932)....* Poitiers: Imprimerie moderne, Nicolas, Renault & cie.

- Borjas, George J. 1987. "Self-selection and the earnings of immigrants." *American Economic Review* 77 (4): 531–553.
- Bosker, Maarten, Eltjo Buringh, and Jan Luiten Van Zanden. 2013. "From Baghdad to London: Unraveling urban development in Europe, the Middle East, and North Africa, 800–1800." *Review of Economics and Statistics* 95 (4): 1418–1437.
- Bourchenin, Pierre Daniel. 1882. *Étude sur les académies protestantes en France au XVIe et au XVIIIe siècle*. Grassart.
- Boutier, Jean. 2017. "Accademia Fiorentina - liste des membres." EHESS, Marseilles.
- Brants, Victor. 1906. *La faculté de droit de l'Université de Louvain à travers cinq siècles <1426-1906>*. Louvain: Ch. Peeters.
- Breschi, Stefano, and Francesco Lissoni. 2009. "Mobility of skilled workers and co-invention networks: an anatomy of localized knowledge flows." *Journal of Economic Geography* 9 (4): 439–468.
- Brun-Durand, Justin. 1901. *Dictionnaire biographique et biblio-iconographique de la Drôme, contenant des notices sur toutes les personnes de ce département qui se sont fait remarquer par leurs actions ou leurs travaux, avec l'indication de leurs ouvrages et de leurs portraits*. H. Falque et F. Perrin.
- Bumblauskas, Alfredas, B Butkeviciene, Sigita Jegelevičius, Paulius Manusadžianas, Vygintas Pšibilskis, Eligijus Raila, and Dalia Vitkauskaitė. 2004. *Universitas Vilnensis, 1579–2004*. Vilnius, Spauda.
- Buonanno, Paolo, Matteo Cervellati, Sara Lazzaroni, and Giovanni Prarolo. 2019. "Political Institutions, Culture and Cooperation: Medieval Social Contracts and their Legacy." Mimeo, University of Bologna.
- Cabeza de León, Salvador, and Enrique Fernández-Villamil. 1947. *Historia de la Universidad de Santiago de Compostela*. Peón,.
- Cantoni, Davide, and Noam Yuchtman. 2014. "Medieval universities, legal institutions, and the commercial revolution." *Quarterly Journal of Economics* 129 (2): 823–887.
- Capeille, Jean. 1914. *Dictionnaire de biographie rousillonnaises*. J. Comet.
- Cardell, N Scott. 1997. "Variance components structures for the extreme-value and logistic distributions with application to models of heterogeneity." *Econometric Theory* 13 (2): 185–213.
- Carmignani, Paul. 2017. *L'Université de Perpignan: L'une des plus anciennes universités d'Europe*. Presses universitaires de Perpignan.
- Casellato, Sandra, and Luciana Sitran Rea. 2002. *Professori e scienziati a Padova nel Settecento*. Padua: Antilia.
- Chenon, Emile. 1890. *Les anciennes Facultés des droits de Rennes (1735-1792)*. H. Caillière.

- Chiquiar, Daniel, and Gordon H Hanson. 2005. "International migration, self-selection, and the distribution of wages: Evidence from Mexico and the United States." *Journal of Political Economy* 113 (2): 239–281.
- Cinnirella, Francesco, and Jochen Streb. 2017. "The role of human capital and innovation in economic development: evidence from post-Malthusian Prussia." *Journal of Economic Growth* 22 (2): 193–227.
- Clark, Gregory. 2008. *A farewell to alms: a brief economic history of the world*. Princeton University Press.
- Collège de France. 2007. "Liste des professeurs depuis la fondation du Collège de France en 1530." Affaires culturelles et relations extérieures, Paris.
- Conrad, Ernst. 1960. "Die Lehrstühle der Universität Tübingen und ihre Inhaber (1477-1927)." Eberhard Karls Universität Tübingen.
- Čornejová, Ivana, and Anna Fechtnerová. 1986. *Životopisný slovník Pražské Univerzity: Filozofická a Teologická Fakulta 1654 - 1773*. 1. vyd. Praha: Univ. Karlova.
- Cottini, Elena, Paolo Ghinetti, and Simone Moriconi. 2019. "Higher Education Supply, Neighbourhood Effects and Economic Welfare." CESifo Working Paper.
- Courtenay, William J. 1999. *Parisian scholars in the early fourteenth century: a social portrait*. Volume 41. Cambridge University Press.
- Covarrubias, Matías, Jeanne Lafortune, and José Tessada. 2015. "Who Comes and Why? Determinants of Immigrants Skill Level in the Early XXth Century US." *Journal of Demographic Economics* 81 (1): 115–155.
- Croissant, Yves. 2012. "Estimation of multinomial logit models in R: The mlogit Packages." available from R-Forge.
- Dahl, Gordon B. 2002. "Mobility and the return to education: Testing a Roy model with multiple markets." *Econometrica* 70 (6): 2367–2420.
- De Caro, Luigi. 1961. *Discipline e maestri dell'Ateneo Pavese: Nel Sesto Centenario dello Studium Generale Pavese (1361-1961)*. Università di Pavia.
- De la Croix, David, Matthias Doepke, and Joel Mokyr. 2018. "Clans, Guilds, and Markets: Apprenticeship Institutions and Growth in the Preindustrial Economy." *Quarterly Journal of Economics* 133 (1): 1–70.
- De la Croix, David, and Alice Fabre. 2019. "A la découverte des professeurs de l'ancienne université d'Aix, de ses origines à 1793." *Annales du midi*.
- De la Croix, David, and Omar Licandro. 2015. "The longevity of famous people from Hammurabi to Einstein." *Journal of Economic Growth* 20 (3): 263–303.
- De la Croix, David, and Fabio Mariani. 2015. "From Polygyny to Serial Monogamy: A Unified Theory of Marriage Institutions." *Review of Economic Studies* 82 (2): 565–607.

- De Lens, Louis. 1880. *Université d'Angers, du Xve siècle à la Révolution française*. Angers: Germain et Grassin.
- Deloume, Antonin. 1890. "Personnel de la Faculté de droit de Toulouse depuis la fondation de l'Université de Toulouse au XIIIe siècle." manuscript.
- Denéchère, Yves, and Jean-Michel Matz. 2012. *Histoire de l'Université d'Angers du Moyen Age à nos jours*. Presses universitaires de Rennes.
- Denley, Peter. 2013. "'Medieval', 'Renaissance', 'modern'. Issues of periodization in Italian university history." *Renaissance Studies* 27 (4): 487–503.
- de Pontville, Michel. 1997. "Histoire de l'Académie de Caen." manuscript.
- Deuster, Christoph, and Frédéric Docquier. 2019. "International Migration and Human Capital Inequality: A Dyadic Approach." In *Global Education Monitoring Report*, 1–41. UNESCO.
- Dittmar, Jeremiah. 2019. "Economic Origins of Modern Science: Technology, Institutions, and Markets." London School of Economics.
- Dittmar, Jeremiah, and Ralf Meisenzahl. 2019. "Public goods institutions, human capital, and growth: evidence from German history." *Review of Economic Studies*, 02.
- Dorsman, Leen. 2011. "Catalogus Professorum Academiae Rheno-Traiectinae." <http://profs.library.uu.nl/index.php/info/project>.
- Dowey, James. 2017. "Mind over matter: access to knowledge and the British Industrial Revolution." Ph.D. diss., The London School of Economics and Political Science (LSE).
- Drüll, Dagmar. 1991. *Heidelberger Gelehrtenlexikon: 1652–1802*. Berlin, Heidelberg: Springer Berlin Heidelberg.
- . 2002. *Heidelberger Gelehrtenlexikon 1386–1651*. Berlin, Heidelberg: Springer Berlin Heidelberg and Imprint and Springer.
- Duhamel, Leopold. 1895. "Liste des primiciers de l'Université d'Avignon." Archives du Vaucluse.
- Duijnste, Marguerite. 2010. "L'enseignement du droit civil à l'université d'Orleans du début de la guerre de Cents ans (1337) au siège de la ville (1428)." Ph.D. diss., Institute of Private Law, Faculty of Law, Leiden University.
- Dulieu, Louis. 1975. *La médecine à Montpellier, vol I: Le Moyen Âge*. Avignon: Les presses universelles.
- . 1979. *La médecine à Montpellier, vol II: La Renaissance*. Avignon: Les presses universelles.
- . 1983. *La médecine à Montpellier, vol III: L'âge classique*. Avignon: Les presses universelles.

- Ebel, Wilhelm, ed. 1962. *Catalogus professorum Göttingensium: 1734 - 1962*. Göttingen: Vandenhoeck & Ruprecht and Niedersächsische Staats- und Universitätsbibliothek.
- Eloy, Nicolas FJ. 1755. *Dictionnaire Historique De La Médecine: Contenant Son Origine, Ses Progrès, ses Révolutions, ses Sectes & son Etat chez différents Peuples*. Bassompierre.
- Emden, Alfred Brotherston. 1959. *A Biographical Register of the University of Oxford to AD 1500*. Volume 3. Clarendon Press.
- Facciolati, Jacopo. 1757. *Fasti Gymnasii Patavini Jacobi Facciolati studio atque opera collecti: Fasti gymnasii Patavini Jacobi Facciolati opera collecti ab anno 1517 quo restitutae scholae sunt ad 1756*. Volume 1. typis Seminarii.
- Feenstra, Robert, Margreet Ahsmann, and Theo Johannes Veen. 2003. *Bibliografie van hoogleraren in de rechten aan de Franeker Universiteit tot 1811*. Amsterdam: Koninklijke Nederlandse Akademie van Wetenschappen.
- Feret, Pierre. 1904. *La faculté de théologie de Paris et ses docteurs les plus célèbres*. Picard.
- Ferté, Patrick. 1975. *L'université de Cahors au XVIIIe siècle: 1700-1751*. Saint-Sulpice-la-Pointe: Ferté.
- Fink, Carsten, Ernest Miguelez, and Julio Raffo. 2013. "The global race for inventors." mimeo.
- Fischer, Karl Franz Adolf. 1978. "Jesuiten-Mathematiker in der deutschen Assistenz bis 1773." *Archivum Historicum Societatis Iesu* 47:159–224.
- Flessa, Dorothee. 1969. "Die Professoren der Medizin zu Altdorf von 1580 - 1809." Ph.D. diss., Universität Erlangen-Nürnberg.
- Fleury, Georges, and Auguste Dumas. 1929. *Histoire de l'ancienne Université d'Aix de 1730 à 1793: d'après des documents inédits*. Nicollet.
- Fournier, Marcel. 1892. *Histoire de la science du droit en France*. Librairie du recueil général des lois et des arrêts et du journal du palais.
- Fourquet, Émile. 1929. *Les hommes célèbres et les personnalités marquantes de Franche-Comté: du IVe siècle à nos jours*. Laffitte.
- Franzoni, Chiara, Giuseppe Scellato, and Paula Stephan. 2012. "Foreign Born Scientists: Mobility Patterns for Sixteen Countries." *Nature Biotechnology* 30 (12): 1250–1253.
- Frijhoff, Willem. 1996. "Patterns." Chapter 2 of *A History of the University in Europe. Vol. II: Universities in Early Modern Europe (1500–1800)*, edited by Hilde de Ridder-Symoens. Cambridge University Press.
- Frova, Carla, Giuliano Catoni, and Paolo Renzi. 2001. "Maestri e scolari a Siena e Perugia 1250-1500." <http://www3.unisi.it/docentes/index.html>.
- Gallin, Joshua Hojvat. 2004. "Net migration and state labor market dynamics." *Journal of Labor Economics* 22 (1): 1–21.
- Galor, Oded. 2011. *Unified growth theory*. Princeton University Press.

- Galor, Oded, and Omer Moav. 2002. "Natural Selection and the Origin of Economic Growth." *Quarterly Journal of Economics* 117 (4): 1133–1191.
- Gaullieur, Ernest. 1874. *Histoire du Collège de Guyenne d'après un grand nombre de documents inédits*. Paris: Sandoz et Fischbacher.
- Gergaud, Olivier, Morgane Laouenan, and Etienne Wasmer. 2017. "A Brief History of Human Time. Exploring a database of 'notable people'." mimeo.
- Gibson, John, and David McKenzie. 2014. "Scientific mobility and knowledge networks in high emigration countries: Evidence from the Pacific." *Research Policy* 43 (9): 1486–1495.
- Gleixner, Ulrike. 2019. "Professorenkatalog." <http://uni-helmstedt.hab.de/index.php>.
- González, Serafin Vegas. 1998. *La Escuela de Traductores de Toledo en la historia del pensamiento*. Toledo: Ayuntamiento de Toledo.
- Grant, Alexander. 1884. *The story of the University of Edinburgh during its first three hundred years*. Volume 2. Longmans, Green, and Company.
- Greif, Avner. 2006. "Family Structure, Institutions, and Growth: The Origins and Implications of Western Corporations." *American Economic Review* 96 (2): 308–312.
- Grendler, Paul F. 2009. *The University of Mantua, the Gonzaga, and the Jesuits, 1584–1630*. Baltimore: John Hopkins University Press.
- Grogger, Jeffrey, and Gordon H Hanson. 2011. "Income maximization and the selection and sorting of international migrants." *Journal of Development Economics* 95 (1): 42–57.
- . 2015. "Attracting talent: location choice of foreign-born PhDs in the United States." *Journal of Labor Economics* 33 (S1): 5–38.
- Groningen, Rijksuniversiteit. 2014. "Catalogus Professorum Academiae Groninganae." <https://hoogleraren.ub.rug.nl/>.
- Grünblatt, Serge. 1961. "Les chirurgiens de l'Hôtel-Dieu de Nantes sous l'ancien régime: Esquisse d'histoire de la médecine à Nantes au 18ème siècle." Ph.D. diss., Nantes.
- Guerau de Montmajor, Gaspar. 1999. *Breu descripció dels mestres que anaren a besar les mans a sa majestat del rei don Felip al Real de la ciutat de València a 8 de febrer any 1586*. València: Universitat de València.
- Gundlach, Franz, and Inge Auerbach. 1927. *Catalogus professorum academiae Marburgensis; die akademischen Lehrer der Philipps-Universität in Marburg*. Veröffentlichungen der Historischen Kommission für Hessen und Waldeck, 15. Marburg <Hessen>: N. G. Elwert'sche Verlagsbuchhandlung G. Braun.
- Günther, Johannes. 1858. *Lebensskizzen der Professoren der Universität Jena seit 1558 bis 1858*. Jena: Friedrich Mauke.
- Hänsel, Willy. 1971. *Catalogus Professorum Rintelensium*. Rinteln: Verlag.
- Harris, Jonathan. 1995. *Greek emigres in the West 1400-1520*. Porphyrogenitus.

- Haupt, Herman, and Georg Lehnert. 1907. *Chronik der Universität Giessen, 1607 bis 1907*. Verlag von Alfred Töpelmann.
- Hazon, Jacques Albert, and Thomas-Bernard Bertrand. 1778. *Notice des hommes les plus célèbres de la Faculté de Médecine en l'Université de Paris, depuis 1110, jusqu'en 1750 (inclusivement)*. chez Benoît Morin.
- Heiss, Florian, et al. 2002. "Structural choice analysis with nested logit models." *Stata Journal* 2 (3): 227–252.
- Herbermann, Charles George. 1913. *The Catholic Encyclopedia*. New York: Encyclopedia Press, Incorporated.
- Herzog, Johann Werner. 1780. *Adumbratio eruditorum basiliensium meritis apud exteros olim hodieque celebrium : apendicis loco Athenis Rauricis addita*. Basel: Serinus.
- Hoisl, Karin. 2007. "Tracing mobile inventors—the causality between inventor mobility and inventor productivity." In *A Study of Inventors*, 65–119. Springer.
- Huff, Toby E. 2017. *The rise of early modern science: Islam, China, and the West*. Cambridge University Press.
- Izarn, Pierre. 1991. "La faculté de médecine de Perpignan au XVIIIe siècle." *Bulletin mensuel de l'Académie des sciences et lettres de Montpellier* 22:81–107.
- Jagielloński, Uniwersytet. 2019. "Corpus Academicum Cracoviense." <http://www.archiwum.uj.edu.pl/corpus-academicum-cracoviense1>.
- Jaussaud, Philippe, and Édouard-Raoul Brygoo. 2004. *Du Jardin au Muséum en 516 biographies*. Paris: Publications scientifiques du Muséum national d'histoire naturelle.
- Junius Institute. 2013. "Post Reformation Digital Library – Scholastica." www.prdl.org.
- Keane, Michael P, and Kenneth I Wolpin. 1997. "The career decisions of young men." *Journal of Political Economy* 105 (3): 473–522.
- Kedar, Benjamin. 1995. "Benvenutus Grapheus of Jerusalem, an Oculist in the Era of the Crusades." *Korot* 11:14–41.
- Kerr, Sari Pekkala, William Kerr, Çağlar Özden, and Christopher Parsons. 2016. "Global talent flows." *Journal of Economic Perspectives* 30 (4): 83–106.
- . 2017. "High-skilled migration and agglomeration." *Annual Review of Economics* 9:201–234.
- Kerr, Sari Pekkala, William R Kerr, and William F Lincoln. 2015a. "Firms and the economics of skilled immigration." *Innovation Policy and the Economy* 15 (1): 115–152.
- . 2015b. "Skilled immigration and the employment structures of US firms." *Journal of Labor Economics* 33 (S1): S147–S186.
- Kerr, William R. 2008. "Ethnic scientific communities and international technology diffusion." *The Review of Economics and Statistics* 90 (3): 518–537.

- Kindleberger, Charles P. 1996. *World economic primacy: 1500-1990*. Oxford University Press.
- Københavns Universitet. 2017. “Universitetshistorie – Rektorer.” available from <https://universitetshistorie.ku.dk/>.
- Köbler, Gerhard. 2019. “Zentrissimum integrativer europäischer Legistik - Rechtsfakultäten.” <http://www.koeblergerhard.de/Rechtsfakultaeten.htm>.
- Kohnle, Armin, and Beate Kusche. 2016. *Professorenbuch der theologischen Fakultät der Universität Wittenberg: 1502 bis 1815/17*. Leipzig: Leucorea-Studien zur Geschichte der Reformation und der Lutherischen Orthodoxie.
- Krones, Franz Xaver. 1886. *Geschichte der Karl Franzens-Universität in Graz*. Verlag der Karl Franzens-universität.
- Krüger, Kersten. 2019. “Catalogus Professorum Rostochiensium.” <http://cpr.uni-rostock.de/>.
- Kurrus, Theodor. 1977. *Die Jesuiten an der Universität Freiburg im Br. 1620 – 1773*. Volume 2. Alber.
- Lackner, Franz. 1976. *Die Jesuitenprofessoren an der philosophischen Fakultät der Wiener Universität (1712-1773)*. Volume 1. VWGÖ, Verb. d. Wissenschaftl. Gesellschaften Österreichs.
- Lamberts, Emiel, and Jan Roegiers. 1990. *Leuven University, 1425–1985*. Leuven: Leuven University Press.
- Lamothe-Langon, Etienne-Léon. 1823. *Biographie toulousaine, ou Dictionnaire historique des personnages qui... se sont rendus célèbres dans la ville de Toulouse, ou qui ont contribué a son illustration*. Volume 2. Michaud.
- Landes, David S. 1998. *The wealth and poverty of nations: Why are some so rich and others so poor*. New York: WW Norton.
- Laudel, Grit. 2003. “Studying the brain drain: Can bibliometric methods help?” *Scientometrics* 57 (2): 215–237.
- Laval, Victorin. 1889. *Histoire de la Faculté de Médecine d’Avignon. Ses origines, son organisation et son enseignement, 1303–1791*. Avignon: Seguin Frères.
- Leiden, Universitaire Bibliotheken. 2019. “Leidse hoogleraren vanaf 1575.” <https://hoogleraren.leidenuniv.nl/>.
- Lladonosa, Josep. 1969. *La Facultat de Medicina de l’antiga Universitat de Lleida*. Barcelona: Rafael Dalmau.
- . 1970. *L’Estudi General de Lleida del 1430 al 1524*. Institut d’Estudis Catalans.
- Maddison, Angus. 2007. *The world economy volume 1: A millennial perspective volume 2: Historical statistics*. Academic Foundation.

- Manning, Alan, and Barbara Petrongolo. 2017. “How local are labor markets? Evidence from a spatial job search model.” *American Economic Review* 107 (10): 2877–2907.
- Manuel, Frank E. 1968. *A portrait of Isaac Newton*. Cambridge MA: Harvard Univ. Press.
- Martin, Eugène. 1891. *L’Université de Pont-à-Mousson (1572-1768)*. Berger-Levrault.
- Masson, Paul R. 1931. *Les Bouches-du-Rhône: encyclopédie départementale, Dictionnaire biographique des origines à 1800*. Archives départementales des Bouches-du-Rhône.
- Mazzetti, Serafino. 1847. *Repertorio di tutti i Professori antichi e moderni della famosa Università, e del celebre Istituto delle Scienze di Bologna*. Bologna: tipografia di San Tommaso d’Aquino.
- McFadden, Daniel. 1974. “Conditional logit analysis of qualitative choice behavior.” In *Frontiers in Econometrics (Chapter 2)*, 65–119. P. Zarembka, Academic Press: New York.
- . 1978. “Modeling the choice of residential location.” *Transportation Research Record*, no. 673.
- McKenzie, David, and Hillel Rapoport. 2007. “Network effects and the dynamics of migration and inequality: theory and evidence from Mexico.” *Journal of Development Economics* 84 (1): 1–24.
- Méchin, Édouard. 1890. “L’Enseignement en Provence avant la Révolution.” *Annales du collège royal Bourbon d’Aix, depuis les premières démarches pour sa fondation jusqu’au 7 ventôse an III*, vol. 3.
- Michaud, Joseph-François. 1811. *Biographie universelle ancienne et moderne, 45 vols*. Paris: Bureau de la Biographie Universelle.
- Miguelez, Ernest, and Rosina Moreno. 2013. “Do Labour Mobility and Technological Collaborations Foster Geographical Knowledge Diffusion? The Case of European Regions.” *Growth and Change* 44 (2): 321–354.
- Mokyr, Joel. 2010. *The Enlightened economy: an economic history of Britain 1700-1850*. Yale University Press.
- . 2016. *A culture of growth: the origins of the modern economy*. Princeton University Press.
- Monroe, Paul. 2000. *Encyclopaedia of History of Education*. New Delhi: Cosmo.
- Nadal, Joseph Cyprien. 1861. *Histoire de l’Université de Valence, et des autres établissements d’instruction de cette ville, etc*. Impr. E. Marc Aurel.
- Napjus, J. W., and Gerrit Arie Lindeboom. 1985. *De hoogleraren in de geneeskunde aan de Hogeschool en het Athenaeum te Franeker*. Nieuwe Nederlandse bijdragen tot de geschiedenis der geneeskunde en der natuurwetenschappen. Amsterdam: Rodopi.
- Naragon, Steve. 2006. “Kant in the Classroom: Materials to Aid the Study of Kant’s Lectures.” Manchester College. <http://www.manchester.edu/kant/Home/index.htm>.

- Navarro-Brotons, Victor. 2006. "The Cultivation of Astronomy in Spanish Universities in the Latter Half of the 16th Century." In *Universities and Science in the Early Modern Period*, 83–98. Springer.
- Neal, Derek. 1999. "The complexity of job mobility among young men." *Journal of Labor Economics* 17 (2): 237–261.
- Nève, Félix. 1856. *Mémoire historique et littéraire sur le Collège des trois-langues à l'Université de Louvain, en réponse a la question suivante: Faire l'histoire du collège des trois-langues a Louvain,[...]*. Hayez.
- Nowicki, Michał. 2011. "Działalność oświatowa i naukowa Akademii Lubrańskiego w XVII i XVIII wieku." Uniwersytet im. Adama Mickiewicza w Poznaniu Wydział Studiów Edukacyjnych.
- of Amsterdam, University. 2007. "Album Academicum." <http://www.albumacademicum.uva.nl/>.
- Origlia Paolino, Giovanni Giuseppe. 1754. *Istoria dello studio di Napoli*. Torino: nella stamperia di Giovanni di Simone.
- Ortega, Francesc, and Giovanni Peri. 2013. "The effect of income and immigration policies on international migration." *Migration Studies* 1 (1): 47–74.
- Özak, Ömer. 2010. "The voyage of homo-economicus: Some economic measures of distance." Department of Economics, Brown University.
- . 2018. "Distance to the pre-industrial technological frontier and economic development." *Journal of Economic Growth* 23 (2): 175–221.
- Pery, Guillaume Marie Auguste Georges. 1888. *Histoire de la Faculté de Médecine de Bordeaux et de l'enseignement médical dans cette ville 1441-1888: Publié sous les auspices du Conseil général des Facultés de Bordeaux*. Paris: O. Doin.
- Pesenti, Tiziana. 1984. *Professori e promotori di medicina nello studio di Padova dal 1405 al 1509*. Trieste: Lint.
- Pierson, Alice Sharp, and Peter Cotgreave. 2000. "Citation figures suggest that the UK brain drain is a genuine problem." *Nature* 407 (6800): 13.
- Pietrzyk, Zdzisław, and Jadwiga Marcinek. 2000. *Poczet rektorów Uniwersytetu Jagiellońskiego 1400-2000*. Krakow: Uniwersytetu Jagiellońskiego.
- Piñero, José M López. 2006. "The Faculty of Medicine of Valencia: Its Position in Renaissance Europe." In *Universities and science in the early modern period*, 65–82. Springer.
- Prezziner, Giovanni. 1810. *Storia del pubblico studio e delle società scientifiche e letterarie di Firenze*. Firenze: Carli.
- Raggi, A. 1879. Memorie e documenti per la storia dell'Università di Pavia e degli uomini piu illustri che vi insegnarono.

- Ram, Pierre François Xavier de. 1861. *Les quatorze livres sur l'histoire de la ville de Louvain du docteur et professeur en théologie Jean Molanus: Historiae lovaniensium*. Collection de chroniques belges inédites. Bruxelles: Hayez.
- Rangeard, Pierre, and Albert Lemarchand. 1868. *Histoire de l'Université d'Angers*. E. Barassé.
- Rashdall, Hastings. 1895. *The Universities of Europe in the Middle Ages*. Clarendon Press.
- Renardy, Christine. 1981. *Les maîtres universitaires du diocèse de Liège: répertoire biographique, 1140-1350*. Paris: Société d'Édition "Les Belles Lettres".
- Renazzi, Filippo Maria. 1803. *Storia dell'Università degli studi di Roma: detta comunemente la sapienza, che contiene anche un saggio storico della letteratura romana, dal principio del secolo XIII sino al declinare del secolo XVIII*. nella stamperia Pagliarini.
- Revelt, David, and Kenneth Train. 1998. "Mixed logit with repeated choices: households' choices of appliance efficiency level." *Review of Economics and Statistics* 80 (4): 647–657.
- Rodríguez San Pedro Bezares, Luis Enrique. 2004. *Historia de la Universidad de Salamanca*. Salamanca: Ediciones Universidad de Salamanca.
- Rubio y Borrás, Manuel. 1914. *Historia de la Real y Pontificia Universidad de Cervera, dos volúmenes*. Barcelona: Verdager.
- Sanz Serrulla, Francisco Javier. 1985. *Historia de la Facultad de Medicina de la Universidad de Sigüenza*.
- Sarrias, Mauricio, et al. 2016. "Discrete choice models with random parameters in R: The Rchoice Package." *Journal of Statistical Software* 74 (10): 1–31.
- Schmutz, Benoit, and Modibo Sidibe. 2019. "Frictional Labour Mobility." *Review of Economic Studies* 86 (4): 1779–1826.
- Schwinges, Rainer Christoph, and Christian Hesse. 2019. "Repertorium Academicum Germanicum." <https://en.rag-online.org/>.
- Serafinelli, Michel, and Guido Tabellini. 2017. "Creativity over time and space." mimeo.
- Serangeli, Sandro. 2010. *I docenti dell'antica Università di Macerata:(1540-1824)*. G. Giapichelli.
- Sergescu, Petre. 1939. "Les mathématiques à Paris au moyen-âge." *Bulletin de la Société Mathématique de France* 67:27–42.
- Slottved, Ejvind. 1978. *Lærestole og lærere ved Københavns Universitet 1537-1977*. Samfundet for dansk Genealogi og Personhistorie.
- Sommervogel, Carlos. 1890. *Bibliothèque de la Compagnie de Jésus*. Brussels: Oscar Schepens.
- Spitzer, Yannay, and Ariell Zimran. 2018. "Migrant self-selection: Anthropometric evidence from the mass migration of Italians to the United States, 1907–1925." *Journal of Development Economics* 134:226–247.

- Squicciarini, Mara P, and Nico Voigtländer. 2015. “Human capital and industrialization: evidence from the age of enlightenment.” *Quarterly Journal of Economics* 130 (4): 1825–1883.
- Stephan, Paula E., and Sharon G. Levin. 2001. “Exceptional contributions to US science by the foreign-born and foreign-educated.” *Population Research and Policy Review* 20 (1-2): 59–79.
- Sussman, Nathan. 2006. “Income inequality in Paris in the heyday of the commercial revolution.” Technical Report, DEGIT (Dynamic Economics, Growth, and International Trade).
- Svatoš, Michal, and Ivana Čornejová. 1995. *Dějiny Univerzity Karlovy: 1348-1990*. Karolinum.
- Taisand, Pierre. 1721. *Les vies des plus celebres jurisconsultes de toutes les nations, tant anciens que modernes, savoir, latins ou romains, francois, espagnols, italiens, allemans, anglois, hollandois*. Sevestre.
- Tersmeden, Fredrik. 2015. “Rektoratet vid Lunds universitet - några historiska glimtar.” Rektorsinstallation Lunds universitet 28 januari 2015.
- Teule, E. 1887. *Chronologie des docteurs en droit civil de l’universite d’Avignon (1303-1791)*. Lechevalier.
- Torrecilla, Luis Miguel Gutiérrez, Manuel Casado Arboniés, and Pedro L Ballesteros Torres. 2013. *Profesores y estudiantes: biografía colectiva de la Universidad de Alcalá (1508-1836)*. Universidad de Alcalá, Servicio de Publicaciones.
- Toselli, Jean-Baptiste. 1860. *Biographie niçoise ancienne et moderne*. Imprimerie de la Société typographique.
- Trippel, Michaela. 2013. “Scientific mobility and knowledge transfer at the interregional and intraregional level.” *Regional Studies* 47 (10): 1653–1667.
- van Epen, Didericus Gysbertus. 1904. *Album studiosorum Academiae gelro-zutphanicae MDCXLVIII-MDCCCXVIII*. The Hague: Jacobum Hoekstra.
- Venn, John. 1922. *Alumni Cantabrigienses: a biographical list of all known students, graduates and holders of office at the University of Cambridge, from the earliest times to 1900*. Cambridge University Press.
- Volbehr, Friedrich, and Richard Weyl. 1956. *Professoren und Dozenten der Christian-Albrechts-Universität zu Kiel: 1665 - 1954. Mit Angaben über d. sonstigen Lehrkräfte u.d. Universitäts-Bibliothekare u.e. Verz. d. Rektoren*. 4. Aufl., bearb. von Rudolf Bülck, abgeschlossen von Hans-Joachim Newiger. Volume N.F., Nr. 7 of *Veröffentlichungen der schleswig-holsteinischen Universitätsgesellschaft*. Kiel: Hirt.
- Von Bahr, Gunnar. 1945. *Medicinska fakulteten i Uppsala*. Stockholm: Almqvist & Wiksell International.
- von Hehl, Ulrich, and Thomas Riechert. 2017. “Catalogus professorum lipsiensium.” <https://research.uni-leipzig.de/catalogus-professorum-lipsiensium/>.

- Wachter, Clemens. 2009. *Philosophische Fakultät, Naturwissenschaftliche Fakultät*. Erlanger Forschungen Sonderreihe. Erlangen: Universitätsbibliothek Erlangen and Universitätsbund Erlangen-Nürnberg.
- Walker, Thomas Alfred. 1927. *A Biographical Register of Peterhouse Men*. Cambridge: Cambridge University Press.
- Walter, Ludwig K. 2010. *Dozenten und Graduierte der Theologischen Fakultät Würzburg 1402 bis 2002*. Volume 63 of *Quellen und Forschungen zur Geschichte des Bistums und Hochstifts Würzburg*. Würzburg: Schöningh.

A Coverage

To show the current coverage of the database, Figure 3 displays the origin of all identified scholars over the whole period. Because information about the history of universities is less developed in France and Spain, the database is slightly undersampled there.

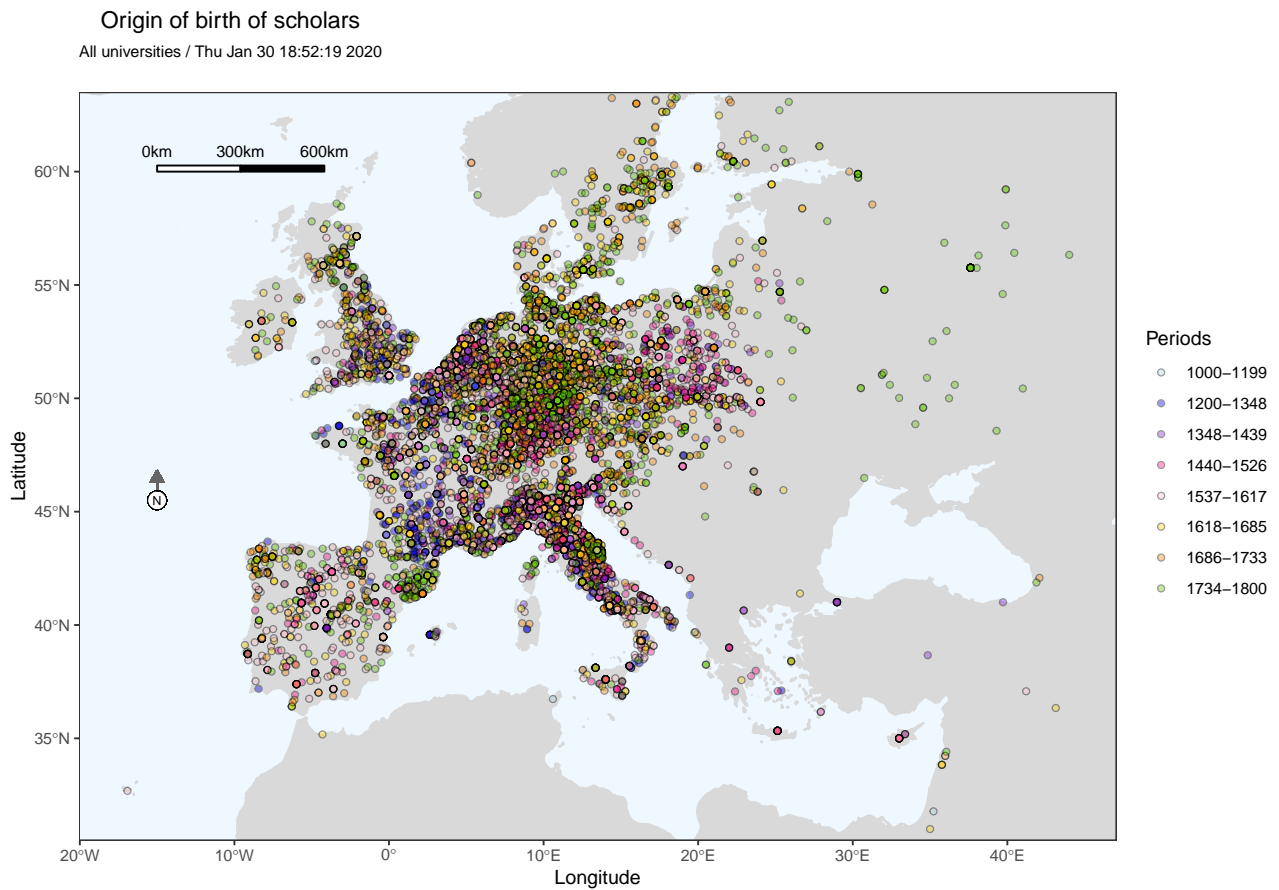


Figure 3: Coverage of the database: places of birth of scholars

B Barycenters

Figure 4 shows the barycenter, with coordinates R . If each scholar i is born in space with coordinates r_i , the barycenter is such that:

$$\sum_i (r_i - R) = 0.$$

It gives equal mass to each scholar. The figure shows that the barycenter moves East then North as time passes.

Figure 5 shows the quality adjusted barycenter, with coordinates R_q . It solves:

$$\sum_i q_i (r_i - R) = 0.$$

where q_i is the human capital of each scholar i . Adjusting for quality does not change the qualitative changes seen in the previous figure, but amplifies the movement towards the North.

barycenter of places of birth

All universities / Thu Jan 30 18:52:19 2020

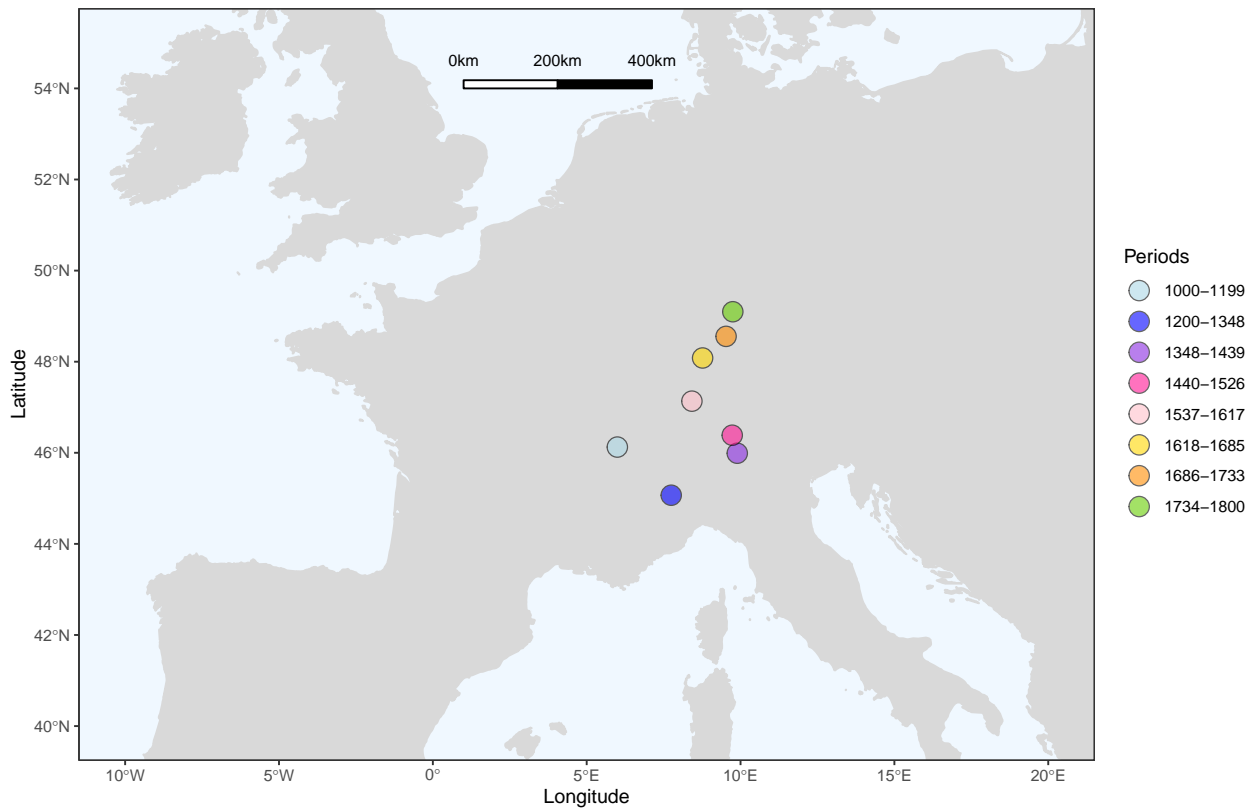


Figure 4: Barycenter of places of birth, by period

barycenter of places of birth

All universities / Thu Jan 30 18:52:19 2020

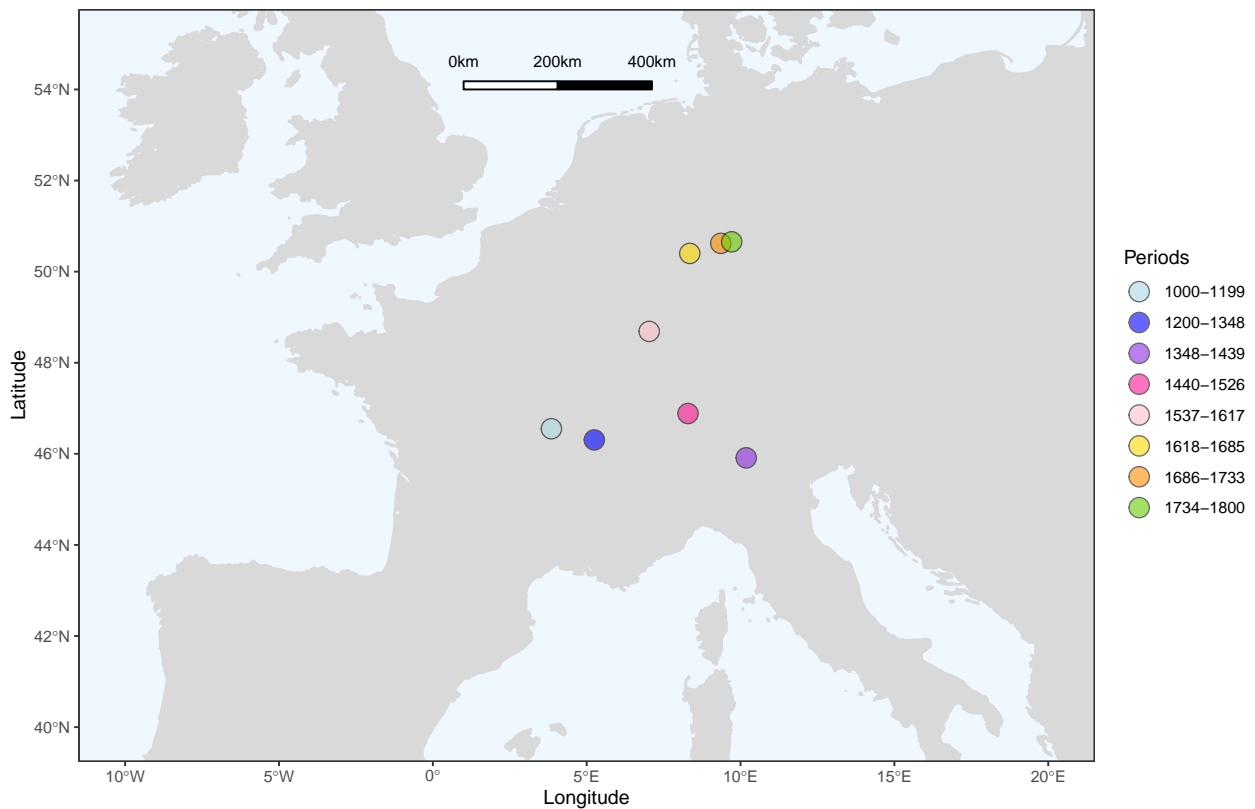


Figure 5: Barycenter of places of birth, quality weighted, by period

C Allocation of academic scholars by field

Our classification of academic scholars by scientific field is mostly based on teaching. A scholar may act in more than one “field”.

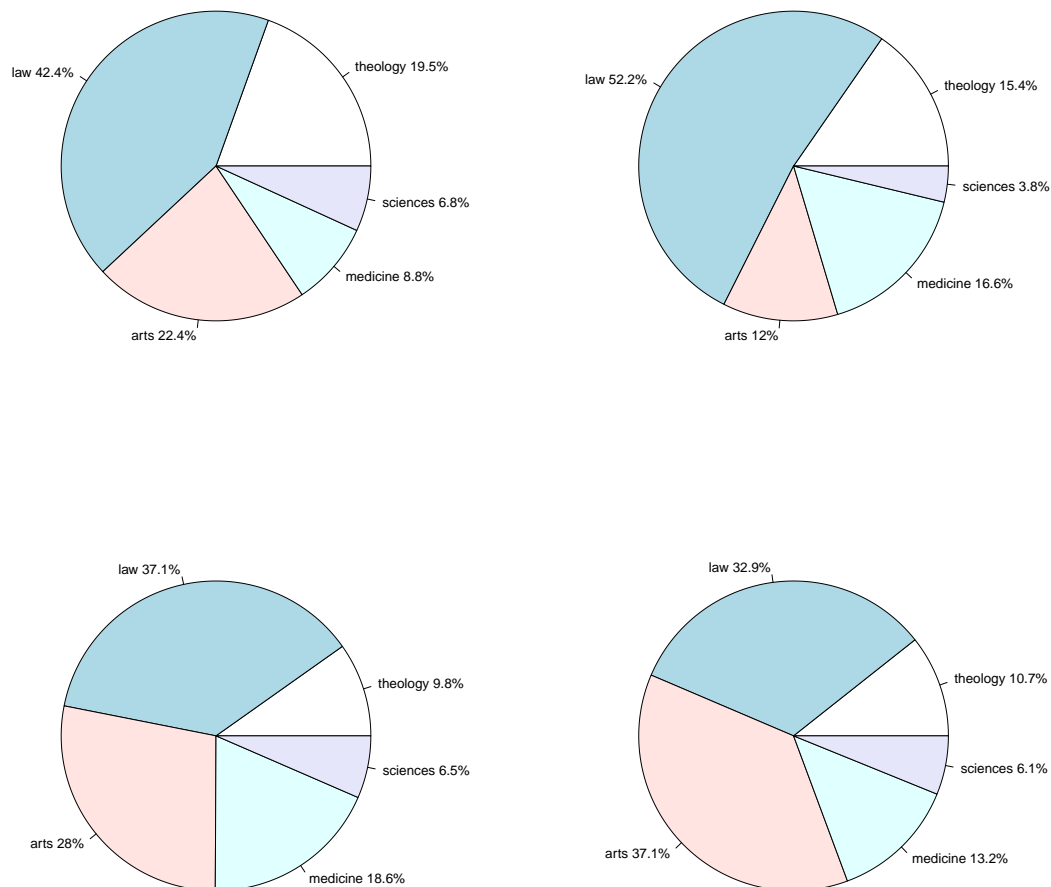


Figure 6: Fields, periods 0 to 3

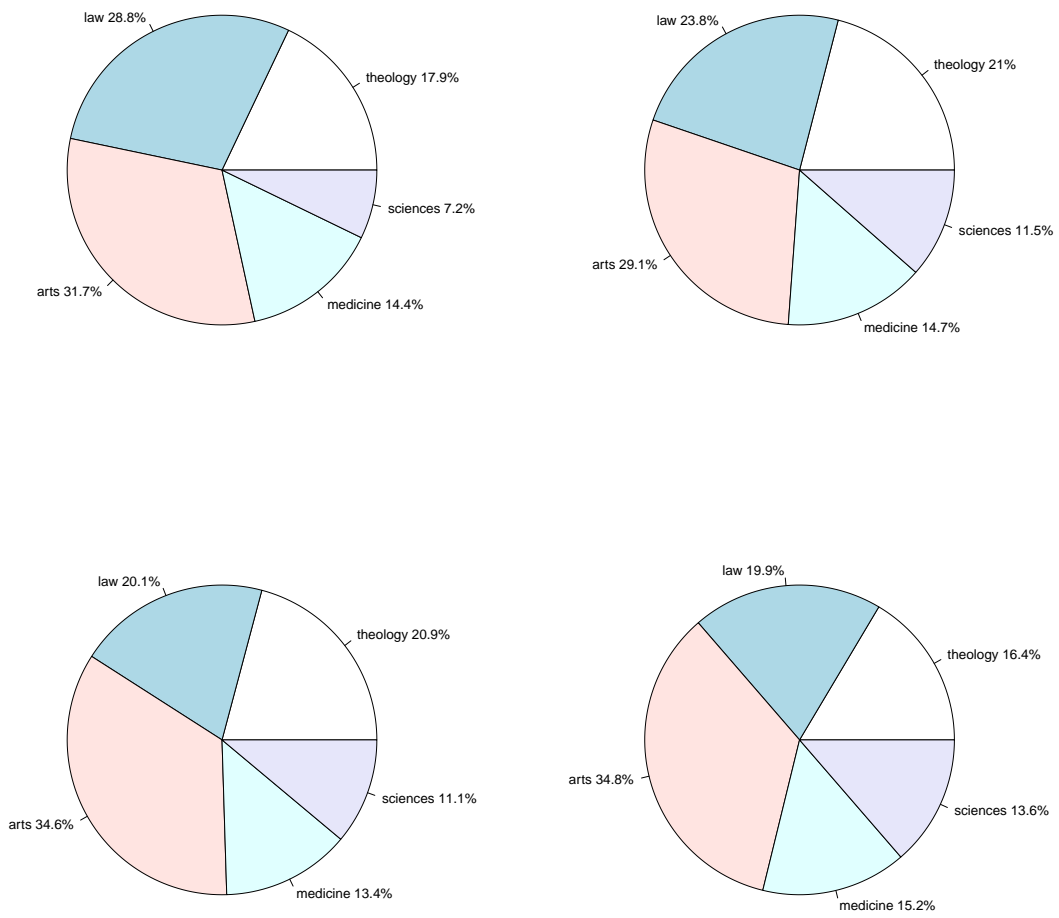


Figure 7: Fields, periods 4 to 7

D Universities: notability indexes and sources

University (k)	Obs	Q_{k0}	Q_{k1}	Q_{k2}	Q_{k3}	Q_{k4}	Q_{k5}	Q_{k6}	Q_{k7}	Main sources
Ubologna-1088	3001	6.9	6.8	4.9	5.4	7.3	5.0	5.6	6.4	Mazzetti (1847)
Upadua-1222	1524		2.6	5.2	5.1	6.8	6.5	4.8	6.1	Pesenti (1984), Casellato and Rea (2002), Facciolati (1757)
Upavia-1361	1503		0.1	2.8	5.7	6.5	4.0	1.7	6.2	Raggi (1879), De Caro (1961)
Uheidelberg-1386	1151			3.1	4.0	6.2	5.5	4.9	4.6	Drüll (1991), Drüll (2002)
Umacerata-1540	683					2.3	1.9	1.7	2.5	Serangeli (2010)
Uparis-1200	603	6.5	8.1	7.3	6.2	7.4	5.2	5.5	7.0	Antonetti (2013), Courtenay (1999), Hazon and Bertrand (1778)
										Hazon and Bertrand (1778), Feret (1904)
Uroma-1303	558		0.1	6.9	7.8	7.1	4.8	5.6	5.7	Renazzi (1803)
Uracow-1364	538			3.3	4.8	3.9	3.8	2.5	4.3	Pietrzyk and Marcinek (2000), Jagielloński (2019)
Ulouvain-1425	406			0.6	5.3	6.5	5.9	4.5	4.5	Ram (1861), Nève (1856), Schwinges and Hesse (2019), Brants (1906), Lamberts and Roegiers (1990)
Unapoli-1224	388		3.3	2.7	3.6	3.1	3.0	2.4	6.2	Origlia Paolino (1754)
Usalamanca-1218	350			1.7	5.8	6.5	5.2	5.7	5.3	Addy (1966), Rodríguez San Pedro Bezares (2004), Arteaga (1917)
Umarburg-1527	346					5.7	5.3	4.1	5.3	Gundlach and Auerbach (1927)
Utubingen-1476	331			0.0	5.1	6.2	5.2	4.7	5.8	Conrad (1960)
Ujena-1558	327					5.0	5.9	5.2	9.2	Günther (1858)
Uperugia-1308	314		1.1	2.4	5.1	3.0	1.9	0.1	0.4	Frova, Catoni, and Renzi (2001)
Uprague-1348	299			5.2	2.6	4.2	6.6	3.6	5.2	Svatoš and Čornejová (1995)
										Čornejová and Fechtnerová (1986)
Umontpellier-1289	294	1.2	5.7	5.2	1.3	4.5	3.5	3.0	5.9	Astruc (1767), Dulieu (1975, 1979, 1983)
Urostock-1419	285			0.0	0.4	5.2	5.2	4.1	4.0	Krüger (2019)
Ugiessen-1607	282					2.1	4.6	4.9	4.9	Haupt and Lehnert (1907)
Uhelmstedt-1575	279					4.8	5.4	4.9	5.3	Gleixner (2019)

Table 10: Universities: notability indexes and sources (1/7)

University (k)	Obs	Q_{k1}	Q_{k1}	Q_{k2}	Q_{k3}	Q_{k4}	Q_{k5}	Q_{k6}	Q_{k7}	Main sources
Uoxford-1200	277	2.4	5.8	5.3	5.2	6.1	7.2	7.1	6.6	Emden (1959)
Uvienna-1365	251			4.8	2.5	3.1	3.2	2.5	6.4	Lackner (1976)
Ustrasbourg-1621	248					6.6	5.5	4.6	5.7	Berger-Levrault (1890)
Ucambridge-1209	234		0.9	1.9	2.4	7.0	7.2	7.8	6.9	Walker (1927), Venn (1922)
Ubamberg-1648	232					0.0	2.1	2.6	3.6	Bamberg (2019)
Ugöttingen-1734	231								7.8	Ebel (1962)
Uleiden-1575	231					6.7	7.2	5.2	6.1	Leiden (2019)
Uavignon-1303	222		1.7	3.2	2.6	3.5	2.8	1.6	3.0	Laval (1889), Teule (1887), Fournier (1892) Bénézet (2003), Barjavel (1841), Duhamel (1895)
Ugreifswald-1456	213				1.3	4.0	4.0	3.9	6.1	Wikipedia
Ukonigsberg-1544	202					4.5	3.5	3.9	6.5	Naragon (2006)
Uwurzburg-1402	200			0.3	0.3	5.4	2.9	2.0	4.4	Walter (2010)
Ucologne-1388	199	0.9	1.5	3.0	5.8	4.8	3.2	1.9	2.3	Bianco (1974), Schwinges and Hesse (2019)
Ucervera-1714	182							0.7	3.4	Rubio y Borrás (1914)
Uleipzig-1409	182			0.1	1.6	4.6	5.0	5.4	6.3	von Hehl and Riechert (2017)
Ukiel-1652	182						2.1	4.4	6.4	Vollbeh and Weyl (1956)
Uwittenberg-1502	178				3.7	7.4	5.5	5.4	5.6	Kohnle and Kusche (2016)
Utoulouse-1229	173		4.0	3.3	1.0	5.2	2.6	3.2	4.0	Deloume (1890), Barbot (1905), Lamothe-Langon (1823)
CollegeFr-1530	170					6.7	5.2	6.8	6.7	Collège de France (2007), Hazon and Bertrand (1778)
Ucopenhagen-1475	166				0.1	4.9	6.1	6.2	6.6	Københavns Universitet (2017), Slottved (1978)
Uuppsala-1477	165					4.4	5.9	5.5	7.0	Von Bahr (1945), Astro.uu.se (2011)
Umainz-1476	163				0.4	4.4	3.2	1.5	4.6	Benzing (1986)

Universities: notability indexes and sources (2/7)

University (k)	Obs	Q_{k0}	Q_{k1}	Q_{k2}	Q_{k3}	Q_{k4}	Q_{k5}	Q_{k6}	Q_{k7}	Main sources
Urinteln-1620	156				0.5	4.1	3.0	3.9	Hänsel (1971)	
Ufreiburg-1457	153			4.2	5.2	2.4	2.4	4.6	Bauer (1957), Kurrus (1977)	
Uingolstadt-1459	151			3.8	6.4	3.2	3.7	4.2	Sommervogel (1890), Köbler (2019)	
Usiena-1246	148	4.2	1.5	1.4	3.3	0.2	1.1	0.6	Frova, Catoni, and Renzi (2001)	
Ubasel-1460	147			2.7	6.8	5.7	5.2	5.6	Herzog (1780), Schwinges and Hesse (2019)	
Upisa-1343	143	0.0	1.1	1.4	4.3	3.4	3.6	5.4	Boutier (2017)	
Ufraneker-1585	140				2.4	5.6	5.6	5.4	Feenstra, Ahsmann, and Veen (2003), Napjus and Lindeboom (1985)	
Uaix-1409	136	0.4	1.1	1.0	2.0	3.0	3.1	4.7	Belin (1896), Belin (1905), Fleury and Dumas (1929), Masson (1931), De la Croix and Fabre (2019)	
Uerlangen-1742	127							5.8	Wachter (2009)	
Ufrankfurt-1506	116			2.7	5.0	4.2	4.8	6.0		
Utrecht-1636	114					5.9	4.8	5.3	Dorsman (2011)	
Ugraz-1585	109					2.5	4.6	4.3	Krones (1886)	
Uferrara-1391	102		1.5	3.5	5.6	1.9	1.6	1.3		
Uharderwijk-1647	101					4.8	4.7	5.2	van Epen (1904)	
Upoitiers-1431	97		0.1	3.1	2.3	2.9	0.3	0.9	Boissonade (1932)	
Umoscow-1755	95							6.0	Andreev and Tsygankov (2010)	
Uorleans-1235	94	1.0	4.4	2.5	0.6	2.6	1.0	3.9	Bimbenet (1853), Duijnstee (2010), Fournier (1892)	
U groningen-1612	92					1.4	3.9	4.2	Groningen (2014)	
Uerfurt-1379	90			1.2	3.8	4.4	3.6	3.4	Schwinges and Hesse (2019)	
StudFlorence-1321	89	0.1	6.4	4.6	5.2	4.8	4.8	4.9	Prezziner (1810), Boutier (2017)	

Universities: notability indexes and sources (3/7)

University (k)	Obs	Q_{k0}	Q_{k1}	Q_{k2}	Q_{k3}	Q_{k4}	Q_{k5}	Q_{k6}	Q_{k7}	Main sources	
Uangers-1250	87	4.7	0.4	0.3	0.8	2.9	0.1	1.3	2.0	Rangeard and Lemarchand (1868), De Lens (1880), Denéchère and Matz (2012)	
Tubraunschweig-1745	87								5.5	Albrecht (1986)	
Uhalle-1694	85							6.3	6.8		
Uolmutz-1570	84					0.1	0.9	1.3	3.2		
Cpoznan-1519	83				0.1	1.4	1.9	1.7	1.6	Nowicki (2011)	
Ulund-1666	81						2.7	3.8	5.3	Tersmeden (2015)	
Udillingen-1553	79					4.2	4.2	1.3	3.5	Fischer (1978)	
Jplantes-1635	79						5.0	5.7	8.6	Jaussaud and Brygoo (2004)	
Uabo-1640	78					0.3	3.4	4.1	6.2		
Aamsterdam-1632	72						5.5	6.0	5.5	of Amsterdam (2007)	
Uaixbourbon-1603	72						3.1	2.8	3.8	Méchin (1890)	
Umolsheim-1617	70					0.0	1.2	0.6	1.4	Berger-Levrault (1890)	
Ualcala-1499	67				0.6	5.7	1.8	0.2	1.2	Torrecilla, Arboniés, and Torres (2013)	
Utorino-1404	67		0.0	0.1	1.2	3.6	0.0	0.1	4.8		
Uedinburgh-1582	67					0.3	3.9	4.2	6.7	Junius Institute (2013), Grant (1884)	
Ucompostella-1526	66					0.9	0.5	0.1	0.1	Cabeza de León and Fernández-Villamil (1947)	
Uvalence-1452	65				0.0	4.4	1.6	0.5	2.3	Brun-Durand (1901), Nadal (1861)	
Udouai-1559	61					3.3	4.6	0.4	3.3	Fischer (1978), Sommervogel (1890)	
Umantua-1625	54						1.1	0.1	0.5	Grendler (2009)	
Udorpat-1632	52						2.8	3.3			
Ugeneve-1559	51					4.5	4.0	4.5	5.1	Junius Institute (2013)	
Ualtdorf-1578	51					4.4	4.6	4.1	4.2	Flessa (1969)	
Ubordeaux-1441	51				0.0	0.0	4.1	2.1	0.7	0.3	Gaullieur (1874), Pery (1888)

Universities: notability indexes and sources (4/7)

University (k)	Obs	Q_{k0}	Q_{k1}	Q_{k2}	Q_{k3}	Q_{k4}	Q_{k5}	Q_{k6}	Q_{k7}	Main sources
Uparma-1412	49			1.2	0.1	0.2	3.6		2.9	
Ucoimbra-1308	46					4.3	2.2	0.2	4.1	
Uglasgow-1451	43				0.2	0.7	3.6	3.7	5.5	
Usedan-1599	39					1.8	6.0	0.0		Bourchenin (1882)
Uvalencia-1500	38				0.1	3.5	1.7	0.2	3.7	Piñero (2006), Guerau de Montmajor (1999)
Udole-1422	36					3.1	1.7	0.1		Fourquet (1929)
Uperpignan-1350	36					0.8	0.8	0.4	4.4	Carmignani (2017), Capeille (1914), Izarn (1991)
Usalerno-1231	34	5.8	2.7	0.1	0.2	2.2				
Ubourges-1464	34				0.4	3.6	0.7	0.2	0.2	
Udublin-1592	33					0.7	3.8	2.3	4.7	
Ustandrews-1411	31			0.2		3.2	3.1	0.1	3.3	Junius Institute (2013)
UromaGregoriana-1556	30					4.4	3.1	0.1	0.6	
Ubutzow-1760	30								2.3	
Ucaen-1432	30			0.0	0.5	0.6	0.5	1.0	2.2	de Pontville (1997)
Utrnava-1635	30					0.1	0.1	0.4	3.3	Sommervogel (1890)
Ebern-1528	29					3.1	1.6	1.8	3.7	Junius Institute (2013)
Uaberdeenold-1495	29				0.0	1.0	3.8	1.7	5.1	
Ubreslau-1702	28						1.2	1.4	0.9	Fischer (1978)
Cmadrid-1625	26					0.3	3.7	0.6	1.3	Sommervogel (1890)
Ucahors-1332	26		0.1	0.0	0.7	3.1	1.4	0.2	0.0	Ferté (1975)
Uduisburg-1654	26					0.2	2.2	2.8	3.1	Junius Institute (2013)
Ufermo-1585	24					0.2	0.1	0.1	1.7	
Uinnsbruck-1668	24						0.1	1.2	3.4	

Universities: notability indexes and sources (5/7)

University (k)	Obs	Q_{k0}	Q_{k1}	Q_{k2}	Q_{k3}	Q_{k4}	Q_{k5}	Q_{k6}	Q_{k7}	Main sources
Ulerida-1300	23		0.4	0.4	0.1	0.2	0.2		0.1	Lladonosa (1969), Lladonosa (1970)
Ulausanne-1537	23					4.6	0.1	0.0	2.4	Junius Institute (2013)
Czurich-1525	23					5.8	0.6	2.4	4.5	Junius Institute (2013)
Umонтаuban-1598	22					1.3	2.5	0.1		
Ureims-1548	22					2.7	0.6	0.1	1.7	
Uvilnius-1578	22					0.1	4.8		3.7	Bumblauskas et al. (2004)
Usiguena-1489	21					1.7		0.1	0.4	Sanz Serrulla (1985)
Aherborn-1584	21					1.2	3.8	1.0	2.0	Junius Institute (2013)
Urennes-1735	21								2.5	Chenon (1890)
Unantes-1460	20							0.0	2.3	Chenon (1890), Grünblatt (1961)
Upontamousson-1572	19					2.3	4.2		0.8	Martin (1891)
Ctoledo-1126	19	5.7	4.7							González (1998)
Ulwow-1661	18						1.3		4.8	Sommervogel (1890)
Ufulda-1732	18						0.0	0.0	0.6	
Unimes-1539	17					2.1	2.6			Bourchenin (1882)
Ubarcelona-1450	16					2.0	0.1	0.4	0.1	
Umilano-1556	16				0.2	0.8	0.3	0.2	1.6	
Ukassa-1657	16							0.1	0.5	
Upalermo-1578	15					0.1	1.9	0.2	0.4	
Umessina-1548	15					1.1	0.7	0.5	0.0	
Eliege-1000	14	4.7								Renardy (1981)
Ugrenoble-1339	14		0.0			1.5				
Usaumur-1596	14					0.0	5.3	0.1		Bourchenin (1882)

Universities: notability indexes and sources (6/7)

University (k)	Obs	Q_{k0}	Q_{k1}	Q_{k2}	Q_{k3}	Q_{k4}	Q_{k5}	Q_{k6}	Q_{k7}	Main sources
Udie-1601	14				0.0	2.4	0.0			Bourchenin (1882)
Unijmegen-1655	14					3.0	0.8			
Uevora-1558	13				1.6	0.1			0.1	
Ubesancon-1691	11						0.0	3.1		Fourquet (1929)
Unice-1559	10						0.2			Toselli (1860)
Echartres-1000	10	6.2								
Emallorca-1330	10		0.2	2.2	0.1					
Ufreiberg-1765	10								4.7	

Universities: notability indexes and sources (7/7)