Research Proposal [Part B2]

a State-of-the-Art and Objectives

Have elites played a major role in economic development? For a long time, history was devoted to the analysis and description of the elite's achievements - the great battles won by generals, the miracles of Saints, the conquests of kings and emperors, and the transformative inventions of geniuses. This view of the world started to change with the Enlightenment. Voltaire, in his *Histoire universelle*, followed the chronological succession of the dynasties as a guide, not a purpose. He did not want the reader to be so unfortunate as to read a book about the year a prince unworthy of being known succeeded a barbarous sovereign. Later on, in the nineteenth century, especially with the rise of Socialism, the attention shifted towards the achievements of the masses. Today, the weight which should be given to the role of the masses versus that of the elite remains actively contested in both science and politics.

An exemplary application of this tension concerns the role of human capital and, in particular, of upper-tail human capital (hereafter referred to as UTHC), in the emergence of the West through the humanistic, scientific and industrial revolutions. According to one extreme view, the key innovations were driven entirely by the UTHC – scientists and mathematicians pushing the envelope of propositional knowledge, which was then applied in the agricultural and industrial revolutions of the late eighteenth and nineteenth centuries. For example, for Mokyr (2002), a small group of a few thousand people were the main actors that paved the way for the Industrial Revolution. The other extreme view sees technical innovations as being driven entirely by the evolutionary development of applied knowledge, which improved over time through learning-by-doing and the diffusion of these improvements that were discovered largely by chance. From this perspective, formal and codified knowledge played no role in these advances (Epstein, 2013).

a.1. Strategic Objective: a European database of scholars (1088-1800) to weight the significance of the UTHC in generating the take-off to modern growth

This important debate on the weight and significance of the UTHC in generating the take-off to modern economic and social growth has so far been mostly qualitative and largely focused on specific places and sectors. **There are currently no global quantitative analyses of the issue because of lack of data and lack of a European perspective.** The strategic objective of this project is to take the debate to a new and unique level by conducting research in a more systematic and quantitative way. I will build and exploit a new database covering a large sample of university professors and members of scientific academies across Europe from the Middle Ages to the Industrial Revolution. I will use this new database to develop new empirics and theory in addressing the outstanding questions identified below.

With such a tool, grounded on individual data of scholars and literati, it will become possible to address questions which could not be addressed before, and **to investigate the role of scholars in opening the path to modern growth and to reveal how they interacted with practical knowledge and institutional improvements in doing so.** This can be achieved by exploiting the variations in the data along the various dimensions recorded in the database to determinate the nature and extent of the link between elite knowledge and economic development through time and space, and by field of study and quality of both persons and institutions involved. Before detailing what I intend to do, I will describe the current state-of-the-art knowledge in terms of existing theories and available data.

A priori, there can be four different types of (non-exclusive) answers to my research question.

(1) Elites generated the new scientific knowledge (scientific revolution & enlightenment), which, when applied, triggered the Industrial Revolution. For Jacob (2014), the marriage of industrial culture to scientific knowledge and technology was key. Musson and Robinson (1969) argued in favor of a central place for Science in the development of the Industrial Revolution, in particular by contributing to advances in engineering and chemistry. Wootton (2015) describes how the discoveries of Brahe, Newton, Toricelli, and others caused the Industrial Revolution and transformed the world. In terms of economic models, this view resembles innovation-driven endogenous growth models (Romer (1990) and Aghion and Howitt (1992)), but with doubtful applicability to the pre-industrial era, since legal protections for intellectual property (which are at the core of this class of models) only became widespread recently.

(2) Elite knowledge triggered a major cultural change which prepared the population for the modern world. This is the thesis defended in the recent book by Mokyr (2016). He suggests that the Enlightenment in the eighteenth century was pivotal in driving the economic growth in the nineteenth century, but that it was not a mass phenomenon. *"It was an Elite phenomenon, confined to intellectuals, scholars, ..."* This thesis on the emergence of a culture of growth resembles the theoretical approach based on threshold externalities (see Azariadis and Drazen (1990)), but in which the key variable triggering a change of regime would be the UTHC and not general human capital. Alternatively, the cultural change model of Bisin and Verdier (2001) can be used to think about this channel, if the UTHC plays a role in socializing the youth to the culture of the Enlightenment.
(3) Elite knowledge, by writing books, educating the population, and producing good citizens, made labor more open to the adoption of new techniques (Cipolla, 1969). Indeed, the economic take-off was preceded and accompanied by a rise in literacy. Allen (2009) also stresses that even though great inventors were not so frequently in contact with scientists, they were all very well educated and literate. In the growth literature, human capital accumulation is often perceived as central, in particular with the emergence of endogenous growth models (see Lucas (1988), Boucekkine, de la Croix, and Peeters (2007)) and unified growth theory (Galor and Weil (2000), Cervelatti and Sunde (2005), Galor (2011)). Its distribution and its upper tail, however, were not the focus of specific attention (except in Strulik and Werner (2014) and Squicciarini and Voigtlaender (2015), see below).
(4) Elite knowledge was in effect a luxury good, which played no role in the take-off to modern growth.

Beyond these four approaches, there is the view that the UTHC was a necessary but not a sufficient condition to trigger the industrial revolution. Allen (2011) writes: “Scientific discoveries were known across Europe, and upper-class enthusiasm for natural philosophy was universal. These cultural developments, therefore, cannot explain why the Industrial Revolution was British.” For Allen, the Industrial Revolution was due to the cheap price of energy in Britain, so that research and development was conducted there (by British engineers). Here, Science and human capital were necessary conditions for the take-off, but they were not sufficient in themselves. For Ferguson (2011), Science was one of the key components of the Rise of the West, but trade and competition mattered just as much.

I will develop a new quantitative approach to determining which of these alternatives is paramount. The specific research objectives of this project are

[1] to develop a new database that integrates the elements necessary for the study of the role of upper-tail human capital (namely scholars and professors, universities, academies, and books);

[2] to conduct an empirical analysis of the weight and significance of the UTHC in paving the way towards scientific, humanistic and industrial revolutions, either directly or through culture and literacy;

[3] to unravel the corresponding mechanisms which contributed to the take-off to modern growth;

[4] to develop new theories of the interface between elite knowledge and the adoption of better techniques and institutions,

[5] to establish a greater understanding of the key mechanisms behind these complementarities and how UTHC affected development by promoting a culture of growth.

The theoretical part [4] is important because most of the existing frameworks have been developed to understand the comparative growth experience of the last two centuries and can hardly be applied to the pre-industrial period. A further outcome of this project could be **to change thinking about the theory of growth and the development of a new theory in which individuals play a central role.**

a.2. The Mechanisms Involved: density of scholars, fields, contact time, and mobility of persons and ideas

If elites had an impact on development, either directly through technical progress, or indirectly through changing the culture and educating the population, then several mechanisms were involved. One is through an increase in density (number of scholars per inhabitant) and the concentration of upper tail-human capital in “crucible regions.” Places and periods with more actively engaged scholars are expected to have higher outcomes in terms of their economic development, technical progress (such as the adoption of the printing press, the steam engine, etc.), and the growth of cities. They might also display an improvement in the quality of governance and in democratization. This positive view of the role of the UTHC for economic and social development is in line with the two existing studies of the question at the country level: Squicciarini and Voigtländer (2015) show that the number of subscribers to the *Encyclopédie* predicts the rate of economic development one century later (the unit of observation is the *département*); Dittmar and Meisenzahl (2016) show that cities that established public goods institutions in the 1500s generated more UTHC and grew faster (the unit of observation is the city).

The composition of the UTHC in terms of field is also important. Some fields may be reservoirs of rent-seekers, who tend to hamper institutional innovation. Since the seminal paper of Murphy, Schleifer, and Vishny (1991) in favor of more engineers and fewer lawyers in developing countries, the case of law has been particularly controversial (see also Maloney and Caicado (2016) on the role of engineers in America). Economic development requires not being too far from the efficient allocation of talents across relevant fields.

However, the composition and density of upper-tail human capital are not the whole story. In a world where face-to-face communication was essential for both knowledge transmission and enhancement, the length of the elite's productive life was important to determining the extent of their impact on their cultural and economic environments. A formal link between productivity growth and longevity is implicitly provided by Lucas (2009). In his model, people pick up ideas from those whom they meet. If they live long, they have much greater chances of becoming excellent at what they do, and they also give far more opportunities to other people to learn from them. This effect of longevity on growth might quantitatively be important, and this is why several authors have tried to assess the extent and impact changes in the elite's longevity before the Industrial Revolution (Cummins (2014), de la Croix and Licandro (2015), see below).

A last mechanism whereby elites influenced development is both their national and international mobility. Mokyr (2005) measures the mobility of 1,185 "creative people" in Europe over the period 1450–1750, and shows that it was large, with 3.72 mean moves per person. Mobility promotes the diffusion of ideas, and also demonstrates the relative freedom of knowledge elites with respect to their king or government.

a.3. The Limitations of Current Theories and the specificities of pre-industrial human capital

One of the key questions that must be tackled is that of the complementarity between elite human capital and other potentially significant inputs, such as practical knowledge. **Most of the existing literature on human capital and education is of little use here as it cannot be directly applied to pre-industrial societies**. First, because masses are viewed as being educated through formal schooling, while, in fact, most of the knowledge that they gained was tacit. It was embodied in people rather than written in books. Elite knowledge (books, universities, and science) was not taught to the masses. Instead, it interacted in a more subtle way with artisanal knowledge, which was itself transmitted from person to person through apprenticeships. A few models have addressed this issue. In Strulik and Werner (2016), there are scientists and workers, both endowed with human capital, which improves through learning-by-doing. In their model, there is also a pre-industrial R&D sector in which only scientists intervene. Their model is useful in that it distinguishes between elite education and mass education, including cases in which elite education mostly concerns the low-ability elite. It provides a first step towards understanding the complementarities between education and economic growth both during and after the Industrial Revolution, and the interactions between R&D and learning-by-doing. However, **it does not really address the issue of the complementarity between both types of knowledge, science and techniques, in pre-industrial times.**

In Squicciarini and Voigtländer (2015), there is an illustrative model showing the link between the knowledge of entrepreneurs and technical progress (science). The latter grows exogenously. Yet the technical and operational knowledge of entrepreneurs helps them stay at the frontier. Their model does not enter into the detailed channels through which this operates, but it illustrates that *"First, more scientifically savvy entrepreneurs were more likely to know about the existence of new technologies, which reduced their search costs and raised the likelihood of adoption. Second, they could operate modern technology more efficiently because of having a better understanding of the underlying processes."*

Finally, de la Croix, Doepke, and Mokyr (2018) examine the role of apprenticeship institutions in stimulating economic growth in the pre-industrial era. They build a model of technological progress that emphasizes the person-to-person transmission of tacit knowledge from the old to the young (as in Lucas (2009) and Lucas and Moll (2014)). This makes it possible to go beyond the simplified representations of technological progress used in the models of pre-industrial growth, such as the two described above. Their model is mostly about the exploitation of practical knowledge, which is represented as the efficiency with which craftsmen perform tasks. While there is some scope for new innovation, the main engine of technological progress is in effect the transmission of productive knowledge from old to young workers. Young workers learn from their elders through a form of apprenticeship. There is an operational dissemination of acquired knowledge (or productivity) across workers, and when young workers learn from multiple old workers, they can adopt the best technique to which they have been exposed. The limitation in this explanation lies in the modelling of new knowledge, which applies an exogenous rate to the actual state of knowledge.

To conclude, although some advances have been made to model elite human capital as distinct from general human capital, **there is as yet no theory that provides an understanding of how it interacts with society, either in terms of new knowledge creation or for the diffusion of current best techniques and more supportive institutions.**

a.4. The Limitations of Existing Databases

Several authors have built databases in order to analyze the key characteristics of the elite, such as increased longevity and mobility. In a sense, economists and economic historians are now reviving the old tradition of prosopography, which collects and analyzes large quantities of biographical data about a well-defined group of individuals (in the elites in most cases) in order to reveal connections between them, and to draw the contours of a representative person (a survey of the state of this literature in France and Germany is provided by Joly (2008)). In order to better understand the strengths and additional capabilities of the proposed database that we intend to build to address the core research question, it is useful to compare its merits with the limitations of past attempts.

Cummins (2014) analyzes the longevity of European nobility and its link with the 'Rise of the West'. It is based on data collected by the Church of Jesus Christ of Latter-day Saints which has been expanded by several independent genealogists. It therefore extends the existing demographic studies of Europe's aristocracy considerably. All observations (>100k) of birth and death are geo-coded. The empirical challenge was to extract the time and spatial trends in the nobles' lifespans from the noisy data, while controlling for the changing selectivity of the sample. The main result was to show that the areas of North-West Europe where the Industrial Revolution took place had achieved greater longevity than the rest of Europe by 1000 CE, thus suggesting that the `Rise of the West' originated before the Black Death. **The main weakness of this analysis is that it relies on the study of noble families, which might not actually have been the prime holders of upper-tail human capital.**

The paper by de la Croix and Licandro (2015) builds a different database from the *Index Bio-bibliographicus Notorum Hominum (*IBN), which contains entries on famous people from about 3,000 dictionaries. It also contains information on multiple individual characteristics, including their place of birth and death, and their occupations. De la Croix and Licandro (2015) show that permanent improvements in longevity preceded the Industrial Revolution by at least a century. The longevity of famous people started to increase steadily for the generations born during the 1640-9 decade, reaching a total gain of around nine years over the following two centuries. The increase in longevity among the educated segment of society hence preceded industrialization, **lending credence to the hypothesis that upper tail human capital may have played a significant role in the process of industrialization and the take-off to modern economic growth.** Finally, they also find that the increase in longevity did occur almost everywhere in Europe, and it was not dominated by mortality reduction in any particular occupation. Compared to Cummins (2014), this study has the advantage of covering a broader swath of population than just the nobility, as it includes all the professions that can be thought to have played a role in the transition to modern economic growth: e.g. scientists, professors, writers, merchants, etc. Their study however suffers from two main weaknesses that the present proposal will be immune from. The selection into the sample is based on choices made by others (the IBN), hence it is impossible to know whether it was really a random sample drawn from the set of all famous people. Second, the age at which famous people became famous cannot be controlled for (for some of them, it might even be post-mortem), making impossible to compute properly their population at any point in time.

With the expansion of electronic resources, it has now become feasible to gather information on the web to study the place and role of notable people in history. Gergaud, Laouenan, and Wasmer (2016) build a database of people recorded in *FreeBase* and *Wikipedia*. The essential contribution of this approach is to link every individual to all the places mentioned in the corresponding Wikipedia entry. The final product comprises over one million people and seven million locations, but only thirty thousand of these have occupations related to education. Their research is probably less relevant for UTHC as a large part of the data come from athletes and singers, but their approach of geocoding the birth to death trajectories of people has inspired me to record similar information for European scholars, whose mobility was crucial to the dissemination of new knowledge.

Beyond these efforts to build global databases, there are some country-level initiatives focused on the UTHC. For Britain, Dowey (2016) quantitatively studies 'Knowledge Access Institutions' – such as learned societies, mechanics institutes, Masonic lodges, and public libraries – which reduced the cost of access to useful knowledge over the course of the eighteenth and early nineteenth centuries. For France, Roche (1978) gathers and analyzes a large database of academies and their members over the period 1680-1789. For Germany, the project "*Repertorium Academicum Germanicum* - The Graduate Scholars of the Holy Roman Empire between 1250 and 1550" focuses on university students and professors located on the territory of the Holy Roman Empire from 1250 to 1550. **Compared to these, our project is truly European, thus allowing us to consider cross-border interactions at the continental level. Our project also aims at covering all the periods thought to be relevant for the ultimate take-off, from the Middle Ages to the Renaissance, the Scientific Revolution and the Enlightenment (Mokyr, 1990).**

In addition to the "famous people" literature, there is one paper which looks quantitatively at the effect of universities on pre-industrial society. Cantoni 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 in the universities of Bologna, Paris, Padua, Orléans, Prague, Heidelberg, Cologne, and Erfurt. This data was collected from a variety of sources, most of them books published in the nineteenth century.

Beyond establishing a new database covering thousands of scholars and literati, the specific objective of this project compared to the literature is to link these data to universities and academies, to books published, and to a range of key fields. Creating these links is an essential step towards determining the nature and extent of the role of upper-tail human capital (UTHC) in the Rise of the West and the emergence of the Industrial Revolution.

b Methodology. Building the proposed database and exploiting its depth empiricially

Let me now describe the proposed methodology in more detail, from the construction of the new database and its subsequent exploitation to show how it will open up new horizons and opportunities for research.

b.1. The Key Features of the Proposed Core Database

As far as universities are concerned, we will focus the coverage of the new database to the 188 universities which confer doctoral degrees at some point before 1800 (from Frijhof 1996) and include all professors in these universities active before 1800. Later on, we may extend the database to other higher education institutions which were not universities. This still highlights the ambition of the project, as it is hard to tell how much time will be needed to gather a significant amount of data on at least half of the universe, which we estimate to include 170k persons (based on extrapolating the number of professors at Heidelberg listed by Drüll-Zimmermann (1991, 2002) and the number of members of the Leopoldina). I explain below how this risk will be mitigated.

The aim will be to achieve sufficient coverage to enable us to establish significant variability across places, time, and fields, and to identify mobility patterns. The value and interest of the UTHC database to economists, economic historians, and other researchers on cultural change will be significant. In addition to universities, we will incorporate data for the members of scientific societies (academies). Initiated in Florence, the movement for national academies gained momentum in Northern Europe with the creation of the Académie des Sciences (1666), the Royal Society of London (1662), and the Academia Leopoldina (1677). Including the academies will represent a high gain in terms of the quality of the picture of the scientific elite. The 100 important scientific societies (as listed in Mc Clelland III, 1985), both official and private, are represented in blue on the map. For the academies, building the list of their members is simple, as their list was often kept by the academies themselves. In some cases, it will be necessary to do more research to match the names with their vital dates, using other sources. For example, the *Leopoldina* does not report the vital dates, but these can be found in the *Deutsche biographie* (http://www.deutsche-biographie.de/).

For universities, building a comprehensive list of professors with the relevant supporting information (at least: name, birth, nomination year, field, and death or retirement) will not be as easy. We will essentially proceed in six steps. (a) Establish the list of relevant institutions (from Frijhof (1996) for universities, from Mc Cleland III (1985) for scientific societies), their activity period, a short history notice, and their GPS coordinates. In this step, we all also pay attention to their degree of autonomy with respect to religious or political authorities. (b) For each university, we will check whether there is an online historical database of professors. If there is, we will import the contents of the database. As example, consider Groningen University, for which the list of professors 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. This highlights that the proposed project could not only lead to the production of scientific knowledge, but could also serve a societal purpose by gathering information on the long history of European universities, and making it publicly available in an accessible format. (c) For those universities without such a database, we will check whether there are books of biographies of their professors. If there are, we will encode the contents of these books. This is, for example, the case for the University of Jena (Günther, 1858). Here too, it is highly feasible to code the information. For the scholars listed in the book but still alive in 1858, the relevant information can be added from the *Deutsche-biographie*. This allows solving the problem of right censoring (the fact that everyone is not observed until the end of their activity period). Similar compendia exist for Oxford (Emden 1957) and Cambridge (Emden 1963) and other universities. (d) For the remaining universities, we will check 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 will build up a representative sample of professors from this information and we will check national biographies and other databases to complete the information needed. In some cases, the *matriculum* itself is of little use as the quality 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 give a good coverage of the universe of professors there (with some selection bias). (e) Complementary strategies will also be used. For example, for Jesuit universities, there is a biographical dictionary by Sommervogel (1890) listing all Jesuits having published something; as they are classified by place of activity, we can associate the professors to the relevant universities. Moreover, for the late Middle Ages and the Renaissance, information can be retrieved from two recent projects, both aiming 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" mentioned above. The project "*Studium*" pursues a similar aim for the University of Paris from the twelfth century to the Renaissance. Both projects are currently under development.

In order to assess the feasibility of the data collection, I have launched two pilot studies. A first pilot aims to determine how far one can go with "low-hanging fruit." This pilot paper was written with two scholars in demography and designed to study improvements in the life expectancy of scholars (Stelter, de la Croix, Myrskylä, 2019). The sample is drawn from the universe of scholars in the Holy Roman Empire (within its 1648 borders) and in Holland (independent in 1581). It puts together the data directly available from the websites of universities and academies and that published in biographical books (steps (b) and (c) above). **Pilot study #1 shows that with "low-hanging fruit" in Germanic regions, we reached a sample of 10,857 scholars active before 1800, with their vital dates and their activity dates.** This has allowed us to study the influence of the Thirty Years' War on their life expectancy, but, more importantly, it shows that the whole project already benefits from a starting base of thousands of scholars.

With the adequate labor input, we can rapidly push the number of scholars to 30,000. Once this intermediary goal has been achieved, we will then proceed in two directions: [1] completing the population of the database. Many universities were created in Spain and Italy during the Middle Ages, but unlike the wealth of information which exists for the Netherlands and Germany, biographies on their professors are very scarce (hopefully Bologna seems well covered in Mazzetti (1847), and Alcala in Guttiérez Torrecilla et al. (2013)). [2] enriching it by matching it with other existing sources. Having reached this key intermediate stage may also require us to make adjustments to the project planning, by broadening or reducing the geographical scope of the project. **This risk is mitigated by the flexibility in the scalability of the project.** The scalability is not limited to the geographical dimension. We may also have to decide how deep we want to dig into the literature concerning a precise university in order to unravel all the very obscure scholars who worked there. If the data collection goes faster than expected, we may also then decide to include more ephemerous institutions like the Toledo School of

Translators (12-13th centuries) or the Gymnasium Vosagense (1500-1520), both of them having played their part in the accumulation of human capital in their regions. Another risk relates to the differences in the sampling rate across institutions. This risk will be mitigated by the inclusion of all people with some degree of notoriety, using biographical dictionaries of the 19th century (such as Michaud's masterpiece, *Biographie Universelle*).

The main data challenge arises from those universities where nothing has been done to record past professors. To better grasp how difficult it might be to obtain information for such places, I carried out the pilot #2 on the old university of Aix (Provence, France). While pilot #1 coverage a large territory and was limited to easily accessible resources, **pilot #2 is limited in scope and focuses on hard to get data**. The University of Aix was active from 1409 to 1793, but pre-existing schools of law and grammar were also taken into account in the analysis. We (de la Croix and Fabre, 2018) started from books on the history of the university and identified all mentioned professors. With the help of a dictionary of people from the French county where the university is located (Masson, 1931), we were able to complete the vital information for many of them. We also used the encyclopedia of Jesuits mentioned above to complete the information on the professors of the Collège Bourbon, which was run by Jesuits next to the university.

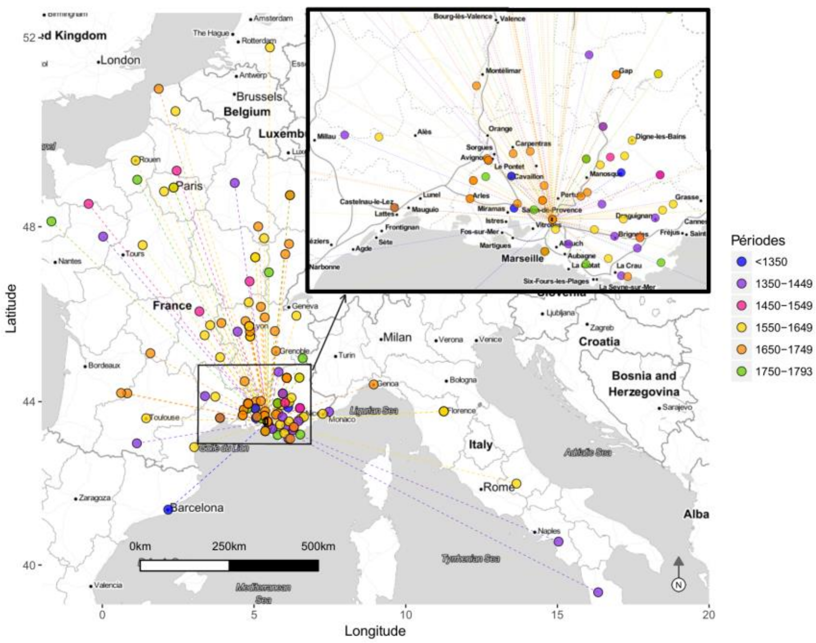

Figure 1. University of Aix. Origin of scholars

In total, we identified 476 scholars. The birth year is known for 31.5% of them. The place of birth is identified for 40.3%. Their field(s) is known for all but 9 persons. 12% have a wikipedia page, 19.5% produced writings still available in librairies today (through Worldcat service). Figure 2 shows the origin of the scholars involved in this university, by period. The mean distance from birth to Aix in 192km, the median distance is 92 km. We also measured the quality of the scholars with information from Worldcat and Wikipedia. The university reached a golden age in the sixteenth century, then declined, but probably not as much as is claimed in the literature based exclusively on qualitative approaches (see Guénée, 1978, page 3).

An important feature of the core database will be the inclusion of the field of study. When the first universities emerged, there were only four faculties, arts, law (canon and Roman law), medicine (including pharmacy and surgery), and theology. Later on, some universities expanded the realm of their expertise, while others did not, thus becoming more and more obsolete. Humanism, directly followed by Protestantism, induced an expansion of the faculty of arts. For example, when the new university of Marburg was created in 1529, it included ten chairs in arts: rhetoric (2), Greek, Hebrew, dialectics, grammar, poetry, history, physics, and mathematics, including astronomy (Pedersen, 1996). Faculties of arts, however, were very slow to cope with rapidly evolving fields, such as cartography and astronomy, which led major scientists to quit their universities before the end of their careers (Copernicus, Kepler, or Galileo). Encoding the field of scholars will enable us to quantify and map these changes in a precise way, also identifying the capability of universities to adjust to the needs of the changing world. Another consequence of the humanist revolution was the creation of national or specialist sectoral academies. Adding the members of these societies to the database and paying special attention to their field of research is indispensable to capturing the shifts in focus in universities following the humanistic revolution.

Another promising feature of the database is being able, for each institution, to compute the birthplace diversity of its members (following Alesina, Harnoss, and Rapoport 2016). The hypothesis is that the quality of the institution is positively correlated with the diversity of its members. Birthplace diversity indexes can help identify the best places in each period, and also how institutions rose and declined over time.

We also propose to **measure the quality of scholars and their impact within their respective fields by their book production**. Our main source will be Worldcat, which connects to the collections and services of more than 10,000 libraries worldwide. Complementary information will come from the data on books (titles and editions) collected and used by Buringh and van Zanden (2009) from various sources. They also consider books produced before the adoption of the printing press (data sources are available on the "global historical bibliometrics" website at http://www.iisg.nl/bibliometrics/). According to their panel data regression on the per capita production of manuscript books, the latter is correlated with the presence of universities and monasteries, and the degree of urbanization. Baten and van Zanden (2008) use the same data on book production as a proxy for upper-tail human capital. In addition to these data, there is the *Universal Short Title Catalogue (USTC)* database of St. Andrews (2012), which is designed as a universal catalogue of all known books printed in Europe between 1450 and 1600. This catalogue has been used recently by Dittmar and Seabold (2016), who measured the importance of religious ideas in these books.

b.2. Descriptive Analysis: how the composition, density, and quality of the UTHC correlate with development

Once the database has been established and populated, we will exploit the variation in the composition, density, and quality of the UTHC across time, space, fields, and the variation in longevity and migration of the UTHC to measure the correlation between the UTHC and different scientific, economic, and social outcomes. **Given that the data are collected at the individual level, we can build measures of the UTHC at different levels of aggregation, depending on the chosen outcome variable. The geodesic cell level of 0.1 deg x 0.1 deg will be our natural unit of analysis**, but we will also consider the city and the region levels. Several important works have used the city as a unit of analysis, but for our purpose it needs to be completed by a broader geographical unit (indeed, the development of the cities of Oxford and Cambridge will not tell us much about the English take-off, unless taken within a broader area, where their students were distributed). A key strength of our analytical approach will be the capability to observe where the scholars actually worked, which is not possible when you only know their places of birth and death. The outcomes to be correlated with the UTHC will include the adoption/dissemination of new techniques (such as the printing press and the steam engine), the establishment of better institutions, and the development of cities and regions. To measure these outcomes, we will utilize existing databases such as: Bairoch, Batou, and Chèvre (1988) and Bosker and Buringh (2013) who build a database of city population for almost all cities in Europe reaching populations of 5k before 1850. City growth is often used as the primary indicator of economic vitality. Dittmar (2011) compiles information from three different sources on the adoption of the printing press during its infancy (1450-1500). DeLong and Shleifer (1993) build an indicator on whether cities were free or subject to a prince's will. To measure regional development in terms of broad human capital, we can rely on numeracy indexes based on age heaping measures, as suggested by A'Hearn, Baten, and Crayen (2009) and Baten and Hippe (2018). Literacy in the pre-industrial period can be measured by signatures on marriage registers and such data are available for many countries at a regional level (see Maggiolo's survey for France in Fleury and Valmary, 1957). It has also been suggested that height is a good measure of income (Baten et al. 2010) and such measure is available at this level of disaggregation (see for example the variation in height across French regions in Komlos, Hau, and Bourginat, 2003).

Having linked scholars to institutions and to their output (published) books opens up the possibility of looking at peer effects. Along the lines suggested by Borowiecki (2013) for music composers, we aim to determine whether individual productivity depended on whether other scholars in the same field were located in the same university (or in nearby universities). We will also challenge the external validity of Waldinger's (2012) result, who found no evidence of such effects in twentieth century data, using the dismissal of scientists by the Nazi government in 1933 as a source of exogenous variation in the peer group of scientists who stayed in Germany.

b.3. Causal Inference: instruments and quasi-natural experiments

In exploiting the new database empirically, we need to be able to directly address the question of the exogeneity of the localization of human capital that many other researchers have faced before us. A correlation between the UTHC and development is not necessarily indicative of a causal effect. For example, if we believe that the presence of coal was key for the take-off to modern growth (as Pomeranz (2009) does), the UTHC might have been concentrated in the coal regions to meet a demand for education as a luxury good, leading to the false impression that the UTHC was key for the take-off. The current literature has adopted several strategies to deal with this issue. One is to use instrumental variable techniques to isolate causal links. For example, distance to Wittenberg has been used as an instrument to predict Protestantism (Becker and Woessmann 2009, Becker et al. 2010), distance to the first adoption of the steam engine has been used to predict further adoptions (Franck and Galor 2015), distance from Mainz has been used to predict the adoption of the printing press (Dittmar 2011) etc. **However, this distance instrument might not be the best** in our case though, as universities were not created in concentric circles around Bologna, Paris, or Oxford. Yet this may be true for each country separately. The exclusion restriction in this case would imply that being close to Oxford affected outcomes only through the creation and/or development of universities. This may hold in countries where university towns did not have any economic importance, which may be true for Oxford or Louvain, but not for a city like Paris.

A more promising instrumentation method that we will implement is catered to our particular problem**. We will build networks of individuals and universities, and exploit exogenous changes in their position in the network to instrument our measures of the UTHC**. The network of scholars will represent individuals as nodes. Edges (links between individuals) will be assumed when two scholars share the same institution during the same period. Alternatively, the network of universities will represent universities as nodes, and a link between two universities will be assumed when the same scholar held positions in both universities during his/her life. In these two networks, individuals and universities will be characterized by their centrality. We will focus on Eigenvector centrality (definition from Jackson (2008); the power of other notions will be investigated as well): nodes with high eigenvector centralities are those which are connected to many other nodes which are, in turn, connected to many others (and so on). After having designed the networks, we will look for sources of random variations, which modified the allocation of the UTHC without altering other unobserved variables. Such variations will affect the centrality of every node in both networks, providing instruments for the UTHC.

A clear exogenous shock to the network of universities occurred when the Protestant academies were closed in France after the revocation of the Edict of Nantes: Dié, Sedan, Saumur, Montauban, and Nîmes (the latter being transformed into a Catholic university). Those academies were not small negligible institutions. Instead, in their time, they were quite predominant in France (Bourchenin, 1882).

To illustrate how we can use exogenous changes in the network of universities, consider three individuals who can be found on the Post-Reformation Digital Library. Denis Godefroy was Prof. of Law, Geneva (1580-1589), Prof. of Law, Strassburg (1591-1600), and Prof. of Law, Heidelberg (1604-1621). Matthieu Beroald was Prof. of Hebrew, Orléans (1562-1568), Prof. of Chronology, Sedan (1573-1574), and Prof. of Philosophy, Geneva (1574-1576). Immanuel Tremellius was Prof. of Hebrew, Cambridge (1549-1553), Prof. of Old Testament & Hebrew, Heidelberg (1561-1577), and Prof. of Hebrew, Sedan (1577-1579).

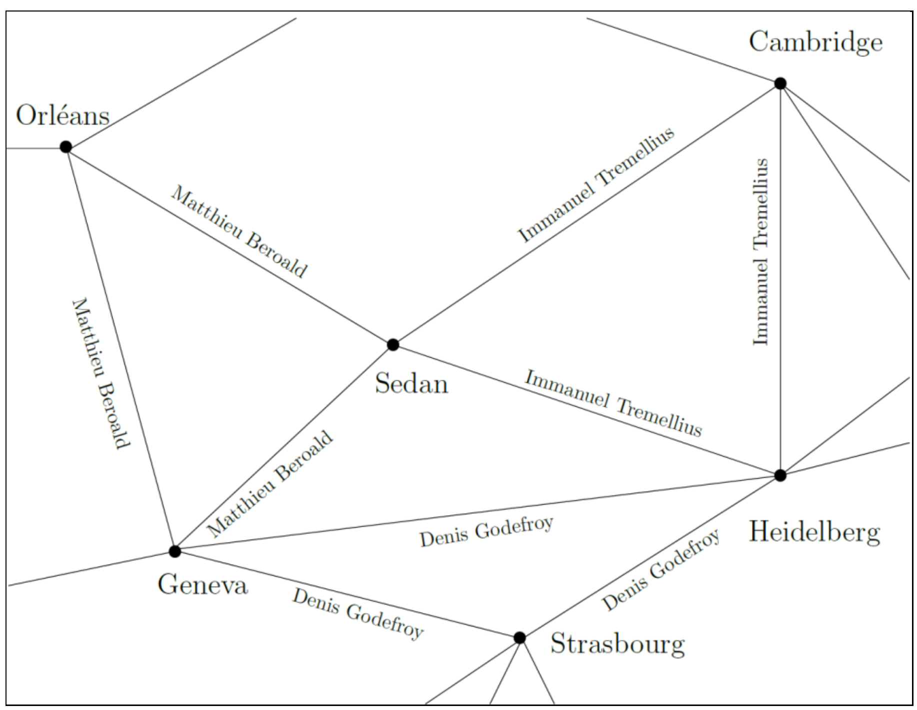

Figure 2. Three individuals forming a network of universities (16th century)

Accepting that these individuals created links between the universities they were appointed to, for example by promoting the mobility of students, books, and ideas between them, one obtains the network presented in Figure 2. Now remove Sedan from the map, following the ban on Protestantism by the King of France. Without Sedan, Geneva will remain connected to Cambridge in two steps, but Orléans loses connectedness. All the universities connected to Orléans also lose a possibly key position in the network, at least if they are not connected through other ways to Cambridge. The suppression of Sedan is expected to deteriorate the outcomes in the region of Sedan, but also in all the regions which lose centrality in the network. Using changes in the network generated by exogenous events will allow us to instrument the UTHC by removing the influence of endogenous scholarly network formation. **This simple example with just three people allows seeing the power of individual data to investigate aggregate outcomes, as well as the great interest of adopting a European-level point of view.** Those three people linked six universities in four different countries.

The creation of universities itself can be seen in some cases as a quasi-natural experiment. Why there was no university in London until the nineteenth century, and why universities were sometimes founded later in more important cities such as Brussels, Amsterdam, or Stockholm remains a mystery for historians (Rüegg, 1992). Looking into the history of each university will provide valuable information for the identification of the possible sources of exogenous variations. Persecution by the authorities is an important ingredient in the foundation of some universities. This is what happened in Cambridge, with masters and students fleeing Oxford following the execution of a few students on the orders of the mayor (Verger, 1992). The same pattern was repeated in Paris in 1229-31, leading to the creation of universities in Orléans and Angers. The great Schism between the Pope and the Emperor is considered as having played a major role in the creation of universities, and is treated as a natural experiment by Cantoni and Yuchtman (2014). One task in the project is accordingly to examine the history of each university looking for quasi-natural experiments, and to use them as a source of variation.

Beyond the creation of universities, political turmoil and the **persecution of minorities allow us to observe the exogenous disappearance of scholars from their origin university, and hence changes in the positions in the network of every individual**. A convincing (and inspiring) modern example is provided by Waldingen (2010). He shows how the rise of Nazism in pre-World War II Germany led to the dismissal of many Jewish and “politically unreliable” professors in mathematics and assesses how the loss in university quality impacted future student outcomes. Returning to our time frame, the religious conflicts between Catholics and Protestants in the sixteenth and seventeenth centuries also led to significant changes in the European university landscape (see Becker et al. 2016). Scoville (1953) describes two large waves of emigration: the first resulted from the expulsion of Protestants from the Low Countries in the latter part of the sixteenth century, while the second followed the revocation of the Edict of Nantes in the latter half of the seventeenth century. Scoville is essentially interested in how these migrations led to the diffusion of new techniques (for example in the textile industry), but they certainly also affected universities. For example, the decline of Louvain and the rise of Leiden in the Netherlands might have been witness to a brain drain fleeing the Spanish Low Countries. A famous example is Justus Lipsius (whom the building of the European Parliament is named after), who fled because of the war. The second wave of migration described by Scoville, the Huguenot diaspora and their migration to Prussia after the revocation of the Edict of Nantes, is a natural experiment used in the literature (Hornung, 2014). Finally, several members of the French academies left after this revocation, while still maintaining written exchanges with their former colleagues (see Pederson (1996)). With our database, we will identify migrations between universities and/or academies. A challenge will be to separate the effect of the UTHC migration from that related to the migration of skilled craftsmen.

Finally, there is a source of variation often used in the literature, which we will not be able to exploit: the expulsion of Jews and their persecution. Indeed, Jews were usually banned from attending and teaching at universities, with the exception of Padua and Leiden (Collins 2013).

We will also test whether it is possible to exploit exogenous variations in the activity of the Inquisition that affected the dynamism and orientation of universities. For Spain, Vidal-Robert (2011) shows that the Inquisition had significant and long-lasting negative effects on local economic development, in particular through delaying the adoption of new technologies (as measured by the number of patents by region). More generally, for many authors, **the Inquisition was an important factor behind the waning of innovation in Southern Europe and the displacement of the center of the Scientific Revolution toward Western and Northern Europe** (Young 2009). The feasibility of such an identification strategy will depend on the availability of data on Inquisition trials, and on whether the observed spatial variations can be seen as exogenous. If this appears infeasible, an alternative approach would be to identify the books published by those scholars who were prohibited by the church (*Index Librorum Prohibitorum,* see De Bujanda, 1996).

b.4. Demographic Analysis of the Population of Scholars

First, following Schich et al. (2014), we will identify the characteristic statistical patterns of the birth and migration of scholars. Taking inspiration from tools of network and complexity theory to describe the mobility of artists over the span of human history, we will provide **a macroscopic view of the history of scholars and universities in part of Europe, and document historical trends in the primacy of knowledge centers beyond the scope of specific events or the narrow time intervals that are usually provided.**

Second, given the large number of observations, as well as the knowledge of the age at which each scholar entered the population at risk (their age at nomination), we will be able to properly compute the life expectancy of scholars and also measure its standard error (by Monte Carlo simulations to the life table, see Andreev and Shkolnikov (2010)). This significantly improves on the existing literature in historical demography computing the life expectancy of small groups of people (noble families, cardinals, knights of the Golden Fleece, etc. See references in de la Croix and Licandro 2015. See also Dupâquier (2000) on the members of the French Academy). With our large sample, life expectancy can also be computed for different regions and time periods precisely and correlated to outcome variables. This would make it possible to further test the implications of the contact time model (see above) according to which knowledge transmission is facilitated when people live longer.

b.5. Mobility Analysis and the Impact of Positive Selection and Sorting on Scholarly Output

Beyond the effect of UTHC density, quality and longevity on outcomes, we will also learn from modelling the location choice of individuals**.** The mobility of students and professors has been a key aspect of universities since their foundation. Until the seventeenth century, all universities taught in Latin, which facilitated *peregrinatio academica*, the academic pilgrimage (Rydder-Symoens, 1992). With our database, we can identify the patterns of location for professors, far beyond what is currently only known for the most famous scholars (for example, Desiderius Erasmus tutored in Paris, Louvain, and Cambridge, before moving to Italy). Establishing these patterns matters for understanding the diffusion of knowledge. In particular, we will be able to measure the three key mechanisms stressed in the contemporaneous migration literature**, agglomeration, selection and sorting** (Grogger & Hanson (2010), McKenzie and Rapoport 2007)). In general, positive selection refers to the force that drives the increase in prevalence of advantageous traits. In the context of migration, positive (resp. negative) selection refers to the fact that high (resp. low) skilled workers are more likely to migrate. In the context of our university professors, it would imply that the best people are less sensitive to distance when choosing where to settle. Sorting appears when individuals with better attributes are concentrated in the region where returns are higher. In our context, there would be sorting if better people are more likely to settle in more prestigious universities and/or in more attractive cities. **Finding these mechanisms in our data would back the claim that there was a functioning academic market as early as the Middle Ages. The combination of market forces with bottom-up institutions such as universities is a strong combination to enhance knowledge production and diffusion (de la Croix, Mokyr, and Doekpe, 2018).** Our database will also be rich enough to see how this pattern changed over time, and across regions and fields.

Understanding mobility within the upper tail of the skill distribution in the pre-industrial era is of particular importance as the agglomeration of elites can enhance knowledge creation and diffusion. Understanding the "pull factors" attracting university professors allows us to unravel the conditions for successful economic effects in the origin and destination regions. In order to quantify the effect of selection and sorting on scientific output, we can proceed as follows. A distribution of scholars over space is predicted from the migration model (likely a multinomial logit). A counter factual distribution can be obtained by simply assuming scholars went to the closest university from their birthplace. Augmenting the migration model with a relationship between the quality of the university (the publications of its members) and the quality of each scholar (his publications), makes it possible to simulate what would have been the total scientific output if those people had stayed in the region where they were born. Suppose it would be lower than the observed output, one could then measure by how much the openness of European universities increased their scientific output.

Section c. New Theories of the Complementarity between Elites and the Society

Guided by the information gathered while building the database, we will develop two new theoretical frameworks: a growth model of the trickle down of the scientific revolution in which elite knowledge and techniques are complements; and a model of the competition between tradition and modernity within universities, and its effect on the adoption of "enlightened institutions". Unlike most of existing development theories, ours will incorporate key specificities of the pre-industrial period.

c.1. The Trickle Down of Sciencia to Ars and the Incentives to Produce Knowledge

Concerning the first mechanism, the economic literature reviewed above usually assumes substitutability between practical knowledge and science. In de la Croix, Doepke, and Mokyr (2018), apprentices acquire ideas both from their masters and exogenously (maybe from contacts with the elite), and they implement the best of the two. New ideas are then diffused by master-apprentice relationships. An example is the invention of the spiral-spring balance in watches in the seventeenth century (Kelly and Ó Gráda (2016)). The literature in the history of science, however, shows that the interface between upper-tail human capital and practical knowledge is more complex than just slowly adopting a new idea obtained randomly for free. More elaborate modelling is required to understand the incentives that underlie a fast adoption and diffusion. **We will accordingly model this interface by considering three layers. The first layer is theoretical knowledge, *sciencia*, mostly developed by intellectuals and generally codified in books. The second layer is codified practical knowledge, often in collections of recipes or almanacs. The third layer is *ars*, the knowledge of master craftsmen, which is mostly uncodified and is acquired through apprenticeship.** As an example of the different layers interacting, consider advances in beer brewing, especially those concerning hygiene and sterilization (from Leong (2017)). The *sciencia* layer corresponds to philosophers and physicians developing realistic views of the human body and ways to preserve health by regulating food and drink. An example for the second layer (codified practical knowledge) is Sir John Tracey's (died 1648) recipe for making ale, including the particular step of boiling water for three hours before adding malt. The inclusion of the boiling step reflects advancing theoretical views about health and water quality. The third practical layer in this example consists of brewers, whose knowledge was mostly tacit, but also influenced by recipe collections, and hence indirectly by science.

To guide modelling, another example of science trickling down into practice is provided by almanacs. An example of such a science here is astronomy (from Omodeo (2017) and Kremer (2017)). The practical realms benefitting from astronomy included navigation, agriculture, and time measurement. Early examples of practical codified knowledge influenced by astronomy are the almanacs, which served as working handbooks. These almanacs benefitted progressively from the development in science. The "Mariners new Kalender" is a powerful example. It was written by a "theoretician," student in mathematics Nathanael Colson, printed in London in 1729, and advertised as necessary for the ingenious mariner. Notice also that Kremer (2017) looks at the most prolific authors of incunable almanacs, and finds 13 professors in the top 20 authors. According to Long (2011), the proliferation of books on technical subjects allowed the skilled to acquired learning, and also the learned to acquired skills. One key question the model will address is **determining the incentives faced by the members of the three layers under which an economy relies on codified knowledge in addition to tacit knowledge, speeding up the diffusion of ideas, or tends to stick to the traditional way of learning through interpersonal contacts**.

Such incentives likely depended on the printing technology, density of population, literacy of the population, and protection of intellectual property. Patents and copyrights did not apply during the preindustrial period that we consider, since intellectual property was not formally protected (the first sign of modern copyright for authors is The Statute of Anne passed by the English Parliament in 1709, see Moore (2013)). **We thus need to consider mechanisms of innovation without monopoly rents**. The following structure allows for preserving incentives to write and print books. The process of production and reading of applied books involves three distinct stages. First, at some cost, authors (literate craftsmen, upper-tail human capital, and former students) can write a "recipe" with their knowledge, coming either from practice, or from the adoption of science. Second, "editors and publishers" buy these recipes. They compare many recipes in order to find the best one amongst them. This comparison is a useful way for new knowledge to replace old knowledge over time (technically, if the distribution of knowledge satisfies the maximum stability postulate, the dynamics of knowledge in which the best is retained can be determined analytically). In the third step, publishers produce recipe collections and almanacs in the form of printed books which could then be sold to readers. We assume that the final stage of production involves a very low marginal cost, i.e. increasing the number of book copies is almost free. This implies that books have a public good characteristic, as the use of books by different readers is non-rival. The negligible cost of book production is subject to a caveat: after a book has been first assembled, there is then a period during which only a limited number of copies is available. The initial delay in book production is crucial to generate scarcity rents (as in Boldrin and Levine (2008)), which provides the incentive to produce books even in an environment without copyright protection.

The new theory will thus feature two differences between tacit and codified ways of transmitting knowledge. First, the speed of reproduction is different: ideas can spread only to a few people every period through apprenticeship, but they can reach every worker in an economy (after the initial delay) through book production. For example, with our model, one can measure the productivity lost over time by banning printing, what the Ottoman Empire did for 250 years (Rubin (2017)). The second difference is the location of knowledge: whereas, in the case of apprenticeship, knowledge is not codified and resides only in the brains of workers, in the case of books, there is an external storage site for ideas. In that case, the contact time mechanism described above matters most.

The objective of this formal analysis is **to identify those channels through which economic conditions affect the choice and intensity of the mode of knowledge transmission and the overall rate of technological progress**. The explicit structure of this model will yield testable implications directly regarding the relationship between upper-tail human capital and technological progress. The empirical part will require to relate our data on the UTHC to existing data on innovations at the dawn of the Industrial Revolution. Patent data are available for England by year and sector (see Sullivan 1989), but for other countries as well, such as Prussia (Cinnirella and Streb, 2017). When patent data are not available, a rich source of information to track the rise of innovations is provided by individual data from exhibits and world fairs (see Moser (2011) for the 1851 French exhibition – those data are geolocalized). Insights on the link between science and applications can thus be drawn combining the relevant subset of our database with the readily available information on innovations in the 19th century. The fact that our data on scholars precedes that on innovations by one century or more is not sufficient to guarantee exogeneity, and instrumentation strategies based on exogenous changes in scholarly networks can also be applied here.

c.2. Complementarity between Elites and Enlightened Institutions

Before analyzing the relation between elites and the adoption of enlightened institutions, we should assess why universities were created in the first place. We will start from the idea that the dominance of the nuclear family in Europe created a need early on for organizations that cut across family lines. Universities were such institutions; monasteries, guilds, and independent cities were others. Indeed, in contrast to the rest of the world, the nuclear family came to dominate in Europe. By 1500, extended families or clans had become less visible there, especially in the Western part (Shorter 1975, p. 284). Hence, earlier institutional developments may have made the establishment of universities in Europe much more attractive compared to clan-based societies (see Greif and Tabellini (2012) for a similar argument about corporations in Europe). A test of this idea can be performed by matching our database with Todd (1985 and subsequent work) to a measure of family structure. In Todd, each European region falls into three categories: nuclear, stem, and extended family (to simplify). With our data, we can determine whether universities had a higher probability of emerging in a nuclear family region, and, more importantly, whether their professors were more likely to be born in nuclear family regions.

Once universities were in place, they influenced the society around them, including the oligarchy in charge of the city. To guide modelling, we know cases in which universities fought against novelty: according to Cantoni (2012), "Ziegler (2008) hypothesises that the German territories with universities had a more conservative attitude towards the Reformation, both because they had advanced further in the creation of a state bureaucracy trained in formal law (which thus had a vested interest in the status quo), and because they were naturally skeptical of the new theological teaching coming from the most recent of all universities, Wittenberg." However, Cantoni did not find any significant effect of universities on the adoption of Protestantism in his regression. A theoretical way to model Ziegler's insight is proposed by Acemoglu (2008). In his model, an oligarchic institution may initially enjoy a high rate of growth, but oligarchies also tend to extract rents and establish barriers to entry. Over time, innovation inevitably moves from one location to the next, so that members of a sitting oligarchy do not remain at the frontier, leading to the prediction that oligarchies will eventually stagnate. Acemoglu's prediction has been tested on a sample of 169 European cities by Stasavage (2013), who finds strong support in favor of the theory. In other cases, universities and academies favored modernity. When Kepler (1571-1630), a professor at Graz University, advised the Emperor, or when Euler (1707-1783), a member of the Academy in Berlin, taught philosophy and physics to Frederik II's niece, he plead in favor of freedom and enlightenment. On the whole, there was competition within universities between conservative forces (leading to raising barriers to entry) and modernity forces. The influence on society depended critically on which of the two was winning. In some cases, progress was achieved by the emergence of new universities (like Halle and Göttingen, which allowed for the foundation of *Wissenschaft* – the empirical approach to knowledge – in the eighteenth century Holy Roman Empire; see Ashby (1963)). The debate on the merits and drawbacks of universities resembled the one on medieval guilds. Traditionally relegated by an earlier literature to a set of conservative, rent-seeking clubs, a revisionist literature has tried to rehabilitate craft guilds as agents of progress and technological innovation (Epstein (2013)). The same trend can be observed in the literature on the role of universities in the Scientific Revolution (Porter (1996)).

An essential ingredient of our model of universities will be **viewing them as multiproduct firms, producing a variety of goods (new knowledge - fields)**. Each good requires specific human capital (scholars) to be developed and transferred to society. Investing in a new product line (like introducing Newtonian physics) helps the university remain at the frontier, but hurts the vested interests of its scholars, as they will lose their investment in their old field and/or cannot themselves switch to this new field. Unlike the approach of Bénabou, Ticchi, and Vindigni (2015), who model the interaction between science and religion and in which the government may censor innovations, the resistance to change comes from inside universities, which seems more appropriate to us, at least as far as Northern Europe is concerned. A second ingredient of the proposed new model consists in describing the influence of adopting new fields on the society. The state of the society will be described by a stock of modernity, which may represent the share in the population of people with an enlightened view of the world (or their share among the Prince's advisors). The last essential ingredient consists in identifying the way a more modern society helps universities more easily expand the variety of products they offer, by adopting new fields of research**.** Describing such a new model of the dynamic interactions between conservative and modern forces within universities and learned societies would enable us to derive the conditions under which one of the two forces prevailed, and to use the richness of our database to examine where and when it did so.

Finally, our database will allow us to differentiate human capital transmission within families of scholars from nepotism. Our pilot study on Aix has already identified 10 father-son pairs of professors at the same university. With more than one thousand such pairs in the whole database, a very clear identification strategy emerges to distinguish nepotism from the intergenerational transmission of skills. For each son and each father, we will have measured their publications. Nepotism can thus be identified by comparing the distribution of publications among all sons with the distribution of publications among all fathers. This will tell us whether sons were on average worse than fathers. With the help of a structural model, we will be able to quantify the size of nepotism. As for human capital transmission, it will be identified by the usual correlation between fathers and sons, and in some cases, between grandfathers and grandsons. Once identified, those features can be related to the characteristics of universities/academies such as Protestant vs Catholic, law vs medicine, and by period. The field dimension directly relates to the previous point: was there less nepotism in fields such as new sciences, and at more recent universities?

Section d. Further Dissemination

Many more theoretical and empirical issues can benefit from the establishment of the proposed new database. Its main strength lies in linking individual people to the places where they worked and to the outputs that they produced. Once completed, our database will be open for use in a variety of ways by the scientific communities in economics, demography, and prosopography. The database will also be made available online for use by the civil society. Indeed, there is a large interest in many European universities in more systematically recording the history of the university, as attested to by many university websites. Regarding ownership rights, although UCLouvain would keep the ownership of the structure of the database according to the law in force, it will be my academic choice to make the database available online for free to other researchers, as well as to a wider audience.

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