

# Early Modern Academies, Universities and Growth\*

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## Abstract

Knowledge production is vital to modern progress, but what about the past? Pre-industrial European academic institutions are often assumed to have been flawed, with misallocated talents and resources. In this paper, I examine the role of academies, dynamic and scientifically oriented institutions that emerged between 1650 and 1800. Using new data on historical European academia and advanced difference-in-difference methods, I find that academies contributed to long-term urban growth. Exploiting individual-level data on scholars, I further show that literary academies had no long-term effect, whereas scientific academies led to persistent growth. Finally, I demonstrate that academies had positive spillover effects, both on the growth of neighboring cities and on the quality of pre-existing universities. Altogether, I provide the first empirical evidence of the pivotal role scientific academies played in Europe's economic growth.

**Keywords:** Academies, universities, human capital, growth, science

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\* You can find the most recent version of the paper here: [https://chiarazanardello.github.io/files/zanardello\\_jmp.pdf](https://chiarazanardello.github.io/files/zanardello_jmp.pdf).

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# 1 Introduction

Today, we recognize the value of knowledge: human capital and innovation lead entire societies to grow and progress (Nelson & Phelps, 1966), and high-level innovation skills are essential in modern economies (Barro, 1991, 2001; Cohen & Soto, 2007; Hanushek & Woessmann, 2008). However, questions linger about the contribution of human capital to the major technological advances of the past due to mixed results and a lack of historical data (Bosker, Buringh, & Van Zanden, 2013). We have precise, extensive data that we can use to analyze the short-term impact of contemporary higher educational institutions (Bianchi & Giorcelli, 2020), but we cannot measure the long term effects of current investments in human capital. Still, we can use historical data to project how such investments might unfold in the future, based on patterns observed from the past (Cantoni & Yuchtman, 2014; de la Croix, Docquier, Fabre, & Stelter, 2023; Dittmar & Meisenzahl, 2022; Squicciarini & Voigtlaender, 2015). Early Modern educational institutions, such as academies and universities, aggregated high-level human capital and allocated their talents to benefit local societies. Nevertheless, already at the end of the 17<sup>th</sup> century, institutional flaws in this allocation of resources were pointed out (Boissier, 1907; Murphy, Shleifer, & Vishny, 1991). In this debate, academies are often overlooked for their historical role to growth and innovation.

Using new empirical evidence, I examine the proposal that a few, most skilled people were crucial for European development before the Industrial Era (Mokyr, 2005a; Mokyr & Voth, 2009). Specifically, in this paper I study innovative and experimental academies, and their interaction with more traditional educational institutions – universities. Firstly, I investigate whether academies contributed to the Early Modern economic growth of European cities. I aim to understand how these institutions allocated productive knowledge: if they wasted it, or if they were actually linked to higher economic growth. I do so by extending a unique database of scholars active in European educational institutions between 1000 and 1800 (de la Croix, 2021). Secondly, I explore the connections between these innovative academies and traditional universities to unravel possible complementarities, studying how universities leveraged the presence of academies to modernize their structures and curricula.

Between the 16<sup>th</sup> and 18<sup>th</sup> century European culture underwent significant change. New scientific methods and thinking emerged: scientific truths and procedures no longer relied on past authorities such as Aristotle or Ptolemy, but were constantly proved, reviewed, and challenged (Mokyr, 2016). Intellectuals throughout Europe brought their curiosity and academic methods under an umbrella of more dynamic and scientifically-oriented institutions known as *academies* (Applebaum, 2000; McClellan, 1985). These new organizations were alternatives to traditional universities, which were created from the 12<sup>th</sup> and 13<sup>th</sup> century (Applebaum, 2000; McClellan, 1985). Indeed, academies were committed to testing observed facts, empirically based on longitudinal data, and to advocating more dynamic, accurate, and empirical research, which

could lead to more practical discoveries and inventions (McClellan, 1985), a concept Mokyr refers to as “useful knowledge” (Mokyr, 2005a, p.287). These institutions were devoted to the betterment of the local society, trying to solve everyday problems. While they did not ignore the wider world, their primary focus was improving the living standards of the hosting cities. Nevertheless, I also investigate the possibility that the impact of these institutions could reach locations outside the hosting urban area, consistent with models of technology being a non-rival good (Romer, 1990). By 1800, nearly every nation and urban center in Europe either hosted an academy or felt the influence of the academy movement and the spread of experimental thinking (McClellan, 1985). As robustness, I also present detailed sensitivity analyses to assess the impact of certain units of analysis that may influence the results, given their large involvement with the academy movement.

I assess the economic roles of academies across time and space: my data comes from a novel database on academicians and university professors, which is detailed in de la Croix (2021). This database, to which I contributed, covers the universe of scholars active in European Academia during the Early Modern Era. We collected micro-level information for every scholar. We tracked their movement through their appointments in different institutions, and from their birthplace to their place of death. We also defined their field of study, so that I can distinguish between scientific and literary institutions. I enlarge the database and improved the coverage of academies that used a scientific approach and appeared in McClellan (1985). The current database encompasses over seventy-nine thousand scholars from more than 370 institutions (de la Croix, 2021).<sup>1</sup>

My main outcome variable is population at the city level (Buringh, 2021), which is usually taken as a proxy for historical economic development, as in the Malthusian model by Ashraf and Galor (2011). I use a difference-in-differences (DID) design to accurately study the economic impact of academies’ scientific approach. Including population data up to 1900,<sup>2</sup> I first employ dynamic Two-Way Fixed Effects (TWFE) regressions to study the effects before and after the establishment of academies. Nevertheless, traditional dynamic TWFE estimators may be biased when the event is staggered, occurring in different time periods in different cities (De Chaisemartin & D'haultfoeuille, 2023; Goodman-Bacon, 2021; Roth, Sant'Anna, Bilinski, & Poe, 2023). In my context, academies were created in different centuries, introducing possible estimation biases. To address this concern, I employ advanced DID estimators. My primary findings are based on Sun and Abraham (2021), although I also present results using estimators developed by Callaway and Sant'Anna (2021) and by De Chaisemartin and d'Haultfoeuille (2024).<sup>3</sup> The parallel trends assumption holds between 1500 and 1900, the relevant period for my

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<sup>1</sup> Access the database at the following link: <https://shiny-lidam.sipr.ucl.ac.be/scholars/>

<sup>2</sup> Population data at the city level are available every 50 years.

<sup>3</sup> I also used earlier versions of similar estimators like De Chaisemartin and d'Haultfoeuille (2022); De Chaisemartin and d'Haultfoeuille (2020) which produce very similar results.

analysis (i.e., cities with an educational institution would have grown as cities without any educational institution), which already reduces reverse causality concerns. However, questions remain about the exogeneity of the events' timing. Indeed, there could be factors influencing both the creation of academies and urban growth at the same time. Hence, I gathered extensive information on the history of these innovative institutions, including their organizational and financial structures, along with the biographies of their founders. The history of the origins of these academies support the notion that the great majority were established by eminent scholars who mainly aimed to revitalize scientific studies, which were seen as crucial for societal advancement. Only later local lords, bishops, and some kings also recognized the importance of these institutions and advocated for their creation. In this paper, I do not claim that these institutions are entirely exogenous. Instead, I use a step-by-step empirical strategy designed to progressively reduce concerns about endogeneity, such as reverse causality. Additional concerns may arise from unobserved variables that affect both city growth and the creation of these institutions. However, I include city and time fixed effects to —at least partially— mitigate concerns related to omitted variables.

I find that cities with academies initially experience a slower population growth rate with respect to cities without academies, followed by an increase in the urban growth rate of 10% in the subsequent century that more than compensates for the initial relative downturn. Leveraging the individual-level information in the database, I show that the scholars' field of study is crucial for understanding where this pattern originates from: cities that establish academies with more than 50% of members specializing in scientific subjects exhibit around a 15% higher growth rate after 100 years, compared to cities without scientific academies. By contrast, cities creating literary academies with over half of their members focusing on humanities subjects experience negative effects for the initial 50 years, with a population growth rate that is 10-4% slower compared to cities without literary academies. While this effect appears to diminish over the following 50 years, its initial impact is still noteworthy. Murphy et al. (1991) already demonstrates the critical role that talent allocation plays in economic growth. My findings suggest that scientific academies direct resources towards economically beneficial activities, whereas literary academies divert human capital into low-return projects. This interpretation aligns with recent literature exploring the inhibitory effects of religion and law on economic progress. For instance, Squicciarini (2020) shows that regions with a stronger emphasis on religious education tend to be less innovative and less industrially developed. Similarly, Curtis and de la Croix (2023b) find a negative correlation between regional income and individuals dedicated to the study of law.

In addition, creating an academy in cities with existing universities might trigger different interactions and complementarities that yield benefits other than direct economic growth. There are several channels of interest, when it comes to the positive influence of academies on local urban areas. There is

some historical evidence documenting how universities reformed and updated their organization and curricula towards the end of the eighteen century: the presence of academies provided a strong push to these innovations (Applebaum, 2000; McClellan, 1985). Exploiting the features of our database, I can investigate whether and how much universities reformed. I use the university quality index based on de la Croix et al. (2023) as a dependent variable, and I show a significant positive effect of creating a purely scientific academy on university quality after 50 years. Universities in cities with a science-focused academy improve their quality by 40% on average, compared to universities in cities without scientific academies. Literary academies do not prompt universities to innovate. Both the sign and the timing of these findings align with the historical academic context and evidence that experimental and scientific academies prompted reforms within universities. The presence of experimental and scientific academies pushed these traditional institutions to innovate and adopt the modern structures that persist to the present day. To the best of my knowledge, my paper is the first to empirically assess this impact (Applebaum, 2000; McClellan, 1985).

This paper contributes to three main fields of research. First, in Economic History, it advances the measurement of the upper tail of human capital distribution in Europe during the pre-industrial era (Mokyr, 2005b; Mokyr & Voth, 2009), a time when the foundations of the Scientific Revolution and the Enlightenment were being framed (Mokyr, 2016; Ó Gráda, 2016). I construct a novel micro-level database by manually collecting biographical information on all academicians active in Europe before 1800. In addition to documenting individual members (de la Croix, 2021), I systematically gather data on the origins of these academies, including their founders, motivations, governance and financial structures. This allows for new classifications and a richer qualitative understanding of these institutions. Furthermore, my research speaks to the broader literature on the long-run impact of educational institutions (Becker & Woessmann, 2009; Cantoni & Yuchtman, 2014; Cinnirella & Streb, 2017; Dittmar & Meisenzahl, 2022; Koschnick, Hornung, & Cinnirella, 2022; Squicciarini & Voigtländer, 2015). Indeed, at the aggregate level, universities have mostly been used to represent high-level human capital in long-run empirical studies. de la Croix et al. (2023) determine the strength of universities' quality and professors' skills in moving and locating high-level knowledge across Europe during the Middle Ages, until the eve of the Industrial Revolution. I highlight the role of academies as key producers of "useful knowledge", emphasizing their experimental approach (Applebaum, 2000; Gage, 1938; McClellan, 1985; Mokyr, 2003). The intuition I rely on is that to initiate the Industrial Revolution and the technological breakthroughs, what mattered most was the scientific method and experimental approach. As far as I am aware, the sole study exploring the newly emerging societies at the end of the 18<sup>th</sup> century is that of Koschnick et al. (2022), which centers on German economic societies exclusively. I argue that a distinctive subset of academies, not just the

economically-oriented ones but all those institutions moved by the new Baconian reasoning and focused on the betterment of local societies, exerted a notable influence on the economic growth of European cities during the first technological breakthroughs. Additionally, while much of the literature focuses on single-country case studies, my research adopts a pan-European perspective (Benos, Conti, Papazoglou, & Tsoumaris, 2024; Bosker et al., 2013; de la Croix et al., 2023), offering a broader view of the economic impact of high-level human capital on the eve of the Industrial Revolution (de la Croix et al., 2023; Serafinelli & Tabellini, 2022). Second, this paper contributes to the Economics of Innovation by examining the importance of scientific knowledge before the Industrial Revolution (Abramitzky & Sin, 2014; Almelhem, Iyigun, Kennedy, & Rubin, 2023; Curtis & de la Croix, 2023b; Dittmar, 2019; Dittmar & Seabold, 2019; Hanlon, 2022; Koschnick, 2025; Mokyr, 2003, 2005a, 2010, 2016). I show that scientific academies, more than literary academies, were strongly associated with higher city growth and university quality, reinforcing their role in fostering innovation and economic development. My paper points in the same direction of a recent work by Dittmar and Meisenzahl (2022), who finds positive and significant effects of German universities on innovations and scientific activity from the early 1800s, but only after research activities and more practical curricula were implemented. Finally, this paper speaks to the Economics of Education by exploring the complementarities between higher educational institutions. To the best of my knowledge, this is the first study to analyze how academies influenced universities, pushing them to innovate and improve their quality. This suggests that academies contributed to societal progress through a distinct channel beyond urban growth, shaping the evolution of higher education in pre-industrial Europe.

The rest of this paper is organized as follows: in Section 2, I provide historical context regarding the establishment of experimental academies, first by outlining their differences and interactions from more traditional universities, and then by presenting their characteristics in detail. In Section 3, I detail the data I use. I briefly outline my empirical strategy in Section 4, followed by the interpretation of my findings in Section 5. In Section 6 I explore university quality as a different channel of growth. In Section 7 I develop sensitivity and spillover effects analyses.

## 2 Historical and institutional context

### 2.1 Universities and academies

Universities constituted the initial wave of higher educational institutions in Medieval and Early Modern Europe.<sup>4</sup> Academies and learned societies came

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<sup>4</sup>Universities are among the first higher educational institutions with multiple masters. Before there were cathedral and monastic schools which usually had only one master and the training provided mostly focused on one specific subject (Pixton, 1998). Nevertheless, in some cases the depth and popularity of the teaching attracted many students, also from abroad, as in the case of the School of Laon (Luscombe, 1969).

later, in the 1650s, marking a significant shift in the European educational system. These organizations were important because they bridged two distinct approaches to education: the traditional, university-based model and the modern method of scientific knowledge dissemination, which gained prominence in the 19th century (McClellan, 1985). Academies represent the origins of this “extraordinary educational breakthrough” (Schütte, 2007, p.545) which continued and evolved over the whole 19th century.<sup>5</sup> Europe represents a unique case regarding higher educational institutions, which were predominantly found on the European continent at that time. In China, emphasis was placed on kinship institutions, such as the clan, which were oriented not toward improving living standards but toward fostering stability and security (Chen & Ma, 2022). In the Middle East and North Africa, the madrasa was the most important higher educational institution (Bosker et al., 2013); however, it was more similar to a specialized high school than to a university in the European sense. Figure 1 shows the cumulative number of institutions used in my analyses between 1500 and 1800.

The advent of academies highlighted shortcomings in the institutional structure and cultural updating process of universities. Universities were often slow to accept new thinking, especially in the approach to natural philosophy. They valued ancient textual authorities and resisted updating their curricula.<sup>6</sup> Mathematics and sciences taught at universities focused on qualitative conclusions, neglecting empirical and quantitative applications. Most universities taught primarily in Latin well into the 18th century, reinforcing their reputation for resistance. Academies played a pivotal role in promoting innovation and reform in universities. Initially the relationship between the two types of institutions was strained. For example, the Society of Haarlem, founded in 1752, was not officially approved until 1761, after the University of Leiden (located about 40 km away) accepted that the Society did not intend to offer lectures, and to publish in Latin but exclusively in Dutch (Bierens de Haan, 1952). Despite some initial tensions, it became evident that universities retained their role as *teaching* institutions, providing lectures and degrees (in Latin), and focusing on the pursuit of knowledge for its intrinsic value (Applebaum, 2000; McClellan, 1985; Pepe, 2008). Academies assumed a distinct role of *research* institutions, offering scholars a space for discussions and the promotion of the experimental approach. Their goal was to generate and disseminate “useful knowledge” that could enhance the quality of life in local communities (Applebaum, 2000; McClellan, 1985; Mokyr, 2005a, 2016). The interactions between these two types of institutions led universities to update their thinking, curricula, and organizational structure towards the end of the Scientific Revolution (Applebaum, 2000).

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<sup>5</sup>The academies considered in this paper did not involve students, but with their focus on practical research, they paved the way for technical colleges and universities of applied sciences in various European countries, like German *Fachschulen* (Pahl & Ranke, 2019) and Danish *tekniske skoler* (Rasmussen, 1969).

<sup>6</sup>Universities were teaching some sciences within the *Quadrivium*, which included arithmetic, geometry, astronomy, and music (Applebaum, 2000).

I use the city of Turin to exemplify the influence of scientific thinking within academies, and elucidate the disparities and interactions between these two types of institutions.<sup>7</sup> Table 1 contains a summary of these distinctions. In Turin, education was notably low prior to the establishment of the university. In 1404, Prince Ludovico D'Acaia founded the university, which received papal recognition the following year (Vallauri, 1875). The university's history is closely tied to enlightened rulers who implemented laws and reforms to strengthen academic pursuits. This trajectory is illustrated in Figure B1, which traces the university's quality over time (further details on quality measures are provided in Section 3). The initial pre-1600 peaks are attributed to three key figures: Amedeo VII, his successor Ludovico, and Duke Emanuele Filiberto. In 1424, Amedeo revitalized the university by enacting reforms that attracted students from Piedmont and beyond, while reducing taxes to just 10 silver marks. His heir, Ludovico, continued this approach and restored the university to Turin after it had been temporarily relocated to nearby cities due to the Black Death. This epidemic is responsible for the downturns in the university's lifecycle, as seen in Figure B1. The year 1572 marked a peak since the university's inception, largely due to Duke Emanuele Filiberto's reforms, which mandated that young scholars return to Turin to resume their studies. However, the 17th century presented significant challenges for Piedmont, including wars and unstable regencies. Only at the start of the 18th century did Vittorio Amedeo II refocus on the university, centralizing higher education in Turin and introducing a meritocratic system for appointing faculty chairs (Vallauri, 1875; Zanardello, 2022). Despite these efforts, scientific fields and experimental methods were given comparatively little attention. In 1757, three students of university professor Giovanni Battista Beccaria (Mondovì 1716 – Turin 1781) created the Scientific Academy. Inspired by Beccaria's progressive vision, Giuseppe Luigi Lagrange (Turin 1736 – Paris 1813), Giuseppe Francesco Cigna (Mondovì 1734 – Turin 1790), and Giuseppe Angelo Saluzzo (Saluzzo 1734 – Turin 1810) established a platform for the dissemination of "useful knowledge." King Vittorio Amedeo III of Savoy officially recognized the academy more than 25 years later, in 1783, transforming it from a private society into an official institution. Guided by the motto *veritas et utilitas*, the academy sought both truth (*veritas*) and its practical application (*utilitas*), organizing public competitions to address everyday challenges (Accademia delle Scienze di Torino; de la Croix and Zanardello (2021)). The inaugural competition in 1788 aimed to identify alternative employment opportunities for workers in the local silk-textile industry who were affected by a mulberry-picking crisis. Subsequent competitions led to innovations such as public lighting for the city and the development of advanced agricultural machinery (Accademia delle Scienze di Torino; de la Croix and Zanardello (2021)). Figure B1 compellingly illustrates the surge in university quality during the latter half of the 18th century, following the academy's establishment. The advances are reflected in the

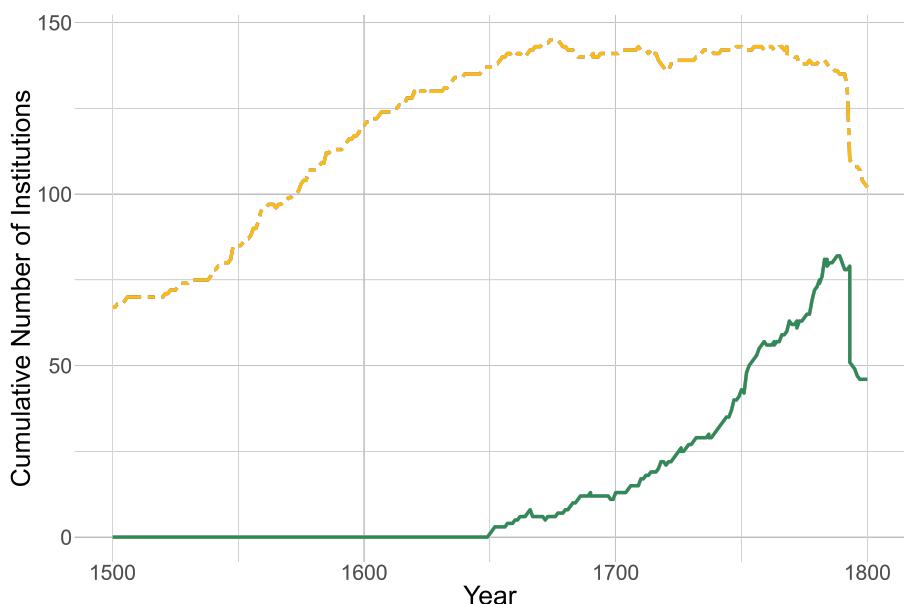
<sup>7</sup>For more examples, refer to the *Repertorium Eruditorum Totius Europae*: <https://ojs.uclouvain.be/index.php/RETE/index>.

increase in the number of publishing scholars<sup>8</sup> and the arrival of prominent professors, such as Carlo Danina (Ravello 1731 – Paris 1813).

**Table 1** Main differences between universities and academies

|          | <b>UNI</b>  | <b>ACAD</b>   |
|----------|---|---|
| When     | From 12 <sup>th</sup> -13 <sup>th</sup> century             | From mid-17 <sup>th</sup> century                                   |
| How      | traditional approach<br>mostly <i>teaching</i> institutions | experimental approach<br>mostly <i>research</i> institutions        |
| Why      | learning for its own sake                                   | creating “useful knowledge”<br>(Mokyr, 2005a, p.287)                |
| What     | theology, law,<br>logic, and medicine                       | science, maths, medicine,<br>agriculture, and philosophy            |
| Language | mostly Latin  | mostly Vernacular   |
| Finance  | Municipality,<br>student fees,<br>Church                    | Private donations,<br>memberships fees,<br>only a few public funded |

Source: Applebaum (2000); McClellan (1985); Mokyr (2005b)



**Fig. 1** Cumulative number of institutions over time, considering both the openings and the closing. The dashed, yellow line represents universities; while the solid, green line represents academies.

<sup>8</sup>A publishing scholar refers to an individual with a documented footprint in Wikipedia or the VIAF catalogue, more details in Section 3.

## 2.2 Academies' characteristics

Having outlined the differences between universities and academies, in this section I describe the main characteristics of the latter type of institutions across European countries.

Overall European trends show that many academies were inspired by the ideas of the Scientific Revolution and the “New Science,” with a strong emphasis on experimental research and the use of empirical data. The institutional shift towards this “New Science” can be traced to the founding of the *Accademia del Cimento* in 1657 in Florence. As one of the first Renaissance academies driven by scientific research and experiments, it paved the way for modern and innovative institutions (McClellan, 1985). Afterwards, many establishments recognized the importance of applying scientific knowledge to practical problems related to agriculture, industry, commerce, and the betterment of society. Often these academies originated in the private homes of enlightened individuals who offered their spaces for discussions and experiments. Initially, they invited a small circle of intellectual friends, gradually expanding to more formal meetings and structured organizations. To reach this last step, royal patronage (i.e., official recognition) was a significant factor in the establishment and development of many academies in Europe, particularly in France, Italy, Germany, and Sweden. Additionally, through correspondence and exchange of publications, academies created global networks that facilitated the spread of scientific knowledge. This likely created spillover effects, impacting areas outside the local seats of academies (Section 7.3 investigates these spillovers).

Appendix E.1 presents the main characteristics of the official recognition, topics of study, memberships and meetings, general governance, and financing of academies by modern country. The study of this historical context indicates that France was a highly centralized system, with French academies generally receiving prompt royal recognition and respecting a hierarchical structure similar to the Paris Academy. Italy and Germany had variable governance structures, with some institutions more dependent from papal and patronage support, respectively. In Great Britain, academies were mostly informal, emphasized experimental science, and the government financial support was rarer.

In addition, I also collected micro-level data on the founders of these academies. Analyzing the personal differences between those who established the institutions and those who were affiliated later provides interesting details, which are highly relevant to the origins of these academies. I managed to collect information for about 90 out of 99 academies in my sample. Four academies (out of the nine with missing information) were created directly by kings and will not appear in the statistics, such as the academy of Göttingen established by King George II of Great Britain and Ireland and the academy of Naples established by King Ferdinand IV of Bourbon. Excluding these four academies and the few others for which our sources do not list the founders,

I am able to select a total of 413 founders (an academy can have more than one founder). Table B1 shows the differences between these founders and the rest, the not-founders. Founders seem to have slightly higher individual quality but once I consider year fixed effects the average difference with the quality of not-founders is not statistically significant (see Section 3 for the quality measurement). The individuals in the two groups seem to die and be appointed at approximately the same age. Founders remain active in the academy for a longer period but again when considering year fixed effects the difference is not significant. Interestingly, founders are much more local (they are born closer to the academy seat) and static (they die closer to where they were born).

In Appendix E.2, I list each academy individually, providing a brief history of their establishment.

### 3 Data

To establish whether the presence of an academy affected economic growth in cities, I use data on population, academic institutions, scholars, university quality and fields of study. I describe these data below.

**Population data.** Population size is often used as a measure of economic development for pre-industrial societies. This lies on the hypothesis that the economy followed a Malthusian regime, meaning that the higher the technological progress, the larger the population (Ashraf & Galor, 2011). Economic prosperity was strongly and positively correlated with the number of inhabitants. Furthermore, the lack of GDP data at city level during the pre-industrial era leads me to follow the previous literature in using population size to capture economic growth (Acemoglu, Johnson, & Robinson, 2005; Bairoch, 1988; Bosker et al., 2013; DeLong & Shleifer, 1993; Dittmar, 2011; Serafinelli & Tabellini, 2022; Squicciarini & Voigtländer, 2015). I use Buringh (2021) as a source for population data for cities that reached 5,000 inhabitants at least once in the period between 700 and 2000. This is an updated version of Bairoch, Batou, and Pierre (1988). Buringh (2021) includes 2262 cities over a longer time frame: Buringh (2021) covers the period 700 - 2000, while Bairoch et al. (1988) have data between 800 and 1850. Buringh (2021) systematically imputes missing population data considering specific city and time characteristics and corrects previous miscalculations thanks to both new data collection and his new imputation algorithm. However, errors are still possible especially in the earlier centuries of the sample period (for more details, see Buringh (2021)). Nevertheless, given that my main dependent variable represents the creation of *academies* that spread from the 1650s; I will focus on the period after 1500, to also reduce possible measurement errors in population data.

I focus on Europe given its unique features when it comes to educational institutions, and I exclude those countries that were part of the Ottoman

Empire - I remove 161 cities in 11 countries.<sup>9</sup> There are also five cities that were initially independent settlements but later agglomerated into larger urban centres. To avoid missing values and ensure comparable estimates, I sum the inhabitants of these smaller settlements to the population of the main city.<sup>10</sup> Finally, I have population data for 2096 cities over 19 time periods, between 700 and 2000 (every century until 1400, every 50 years from 1500). Appendix B.1 presents some descriptive statistics.

**Academies and Universities.** Population data is my main dependent variable, while the main independent variables capture the presence of higher educational institutions and, hence, the role of high-level knowledge in a specific city. I have access to a new and unique database on scholars described in de la Croix (2021), which I have expanded to better account for scientific academies. It lists information about individual quality (referred to as “*human capital*”) and mobility characteristics, such as year and place of birth and death, of more than seventy-nine thousand scholars active in European universities and academies between 1000 and 1800. The database also includes affiliation data. The scholars can be affiliated to a university, an academy, or both. With this information, I can track when a professor worked in both a university and an academy in the same city. I mainly consider aggregate data; therefore, my main independent variable is the dummy capturing the presence of an academy (ACAD), and as controls and additional analyses I also define similar dummies to indicate the presence of a university (UNI) or both institutions (ACADxUNI). This last case is what I call *interaction* (ACADxUNI): the dummy variable takes value 1 when both institutions operated at the same time in the same city, 0 otherwise. The database is continuously updated and every covered institution with more than 100 scholars is (or will be) summarized in the *Repertorium Eruditorum Totius Europae*.<sup>11</sup>

The reach of this database is both large and delicate, so I decided to select a subset of the most representative institutions. For universities, I consider those listed in “*A History of the University in Europe*” written by Frijhoff (1996). As a general rule, I include only institutions classified as a “typical” university and exclude those defined as convent-university, collegium, seminar-university, or those that never functioned.<sup>12</sup> I collect data about the location, the creation and the end date. I usually consider the information exactly as written in Frijhoff (1996), but for some cases I used additional and more precise sources.<sup>13</sup>

<sup>9</sup>I exclude the countries listed in the following link: [https://en.wikipedia.org/wiki/Outline\\_of\\_the\\_Ottoman\\_Empire](https://en.wikipedia.org/wiki/Outline_of_the_Ottoman_Empire) (accessed in June 2023), but retain Hungary and Slovakia because only partially conquered by the Ottomans.

<sup>10</sup>Specifically, I sum the population size of Barmen and Elberfeld into Wuppertal (Germany), Rheydt became part of Mönchengladbach, Deptford is now part of London (Buringh, 2021), and Pest merged with Buda to become Budapest in 1873.

<sup>11</sup><https://ojs.uclouvain.be/index.php/RETE/index>

<sup>12</sup>I also exclude the *Angelicum* university in Rome founded in 1727, as it seems to be a minor institution in a city where there are other two relevant universities; and the university of Camerino founded in 1727 because the sources we consulted described it as marginal without mentioning any professor (Brizzi, 2001).

<sup>13</sup>The only case is for the University of Modena: I use the website of the university itself (<https://www.unimore.it/ateneo/cennistorici.html>) to include a more accurate creation date.

Individual data for university professors are already well-covered by the original database. I add to it information about scholars active in academies.<sup>14</sup> I consider the academies listed in McClellan (1985)'s “*Science reorganized: Scientific societies in the eighteenth century*” because it includes only academies working with an experimental approach. Under this approach, I exclude Renaissance academies because they were based on the same traditional perspective as universities.<sup>15</sup> I examine both official and private academies from McClellan (1985) and exclude those for which there was no source or record of anyone having been a member.<sup>16</sup> For the creation and end dates, I use the exact information found in McClellan (1985) except in cases where more precise sources were available.<sup>17</sup>

In cities with more than one academy or university, I generally consider the oldest. For universities, this occurs in only four cities: Aberdeen in Scotland, Aix-en-Provence and Nimes in France, and Rome in Italy. For academies the situation is more complex: many cities had more than one academy and some cities had more than two, like Bologna, Edinburgh, Florence, Naples and Venice had three, and London had four academies. In these cases I also consider the oldest, but for Bologna, Caen and Florence I consider those that lasted the longest (the other academies in those cities operated for only a few years, with few members).

Figure 2 shows the geographical distribution of these educational institutions between 1000 CE and 1800 CE. The yellow bubbles represent universities as classified in Frijhoff (1996) and the green triangles academies from McClellan (1985). At the aggregate level, I define an interaction as the presence of an academy and a university in the same city, represented by yellow bubbles overlapping green triangles. By 1800, almost every European city either had an academy or felt the effect of the academy movement and the experimental perspective (McClellan, 1985).<sup>18</sup> It is a pooled set, meaning that the figure only shows where the institution is created but not whether the institution closed before 1800. To illustrate the time dimension, two figures in Appendix B show

<sup>14</sup>I mainly use secondary sources, but for the Academy of Nimes we obtained the first handwritten registers.

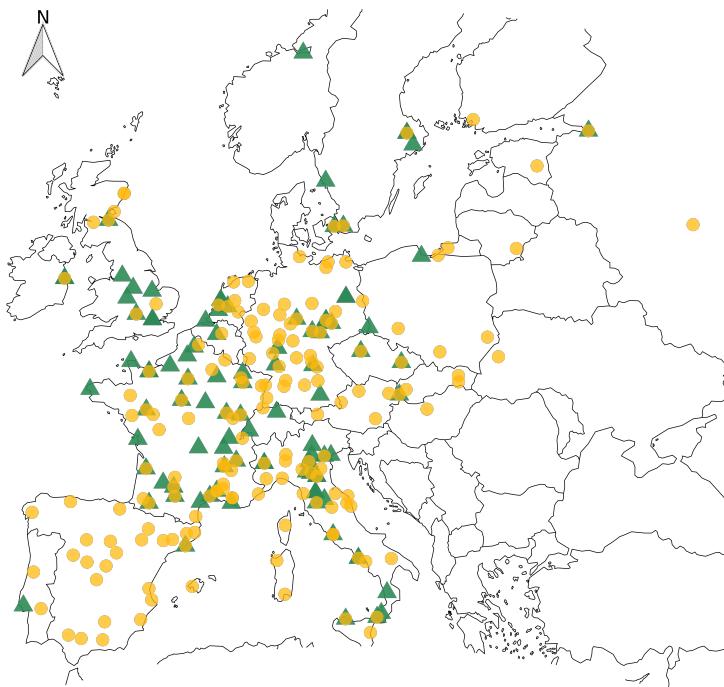
<sup>15</sup>In general, I cannot exploit ‘Renaissance’ academies in my analyses also because of more technical reasons: we only track 57 ‘Renaissance’ academies and 40 of them are in Italy, 12 in France, while the other countries like Germany, Croatia, UK, Spain and Poland only have one ‘Renaissance’ academy each. 42/57 are created before 1650 making them not comparable with the academies listed in McClellan (1985). Finally, they all lasted only a few years, only 25 academies were active for more than 50 years.

<sup>16</sup>This is the case only in the list of McClellan (1985, p. 281) entitled “Notable Private and Semi-Private Scientific Societies: 1660 - 1793”. Hence, I do not consider the Academy *Fisico-matematica* and *dell'Arcidiacono* in Bologna (Italy), the Society in Breman (Germany), the Society in Cuneo (Italy), the Academy *Clelia de' Vigilanti* in Milan (Italy), and the *Temple Coffee House Botany Club* of London (UK). Additionally, I merged the two academies in Mannheim (Germany): the *Societas Meteorologicae Palatinæ* created in 1780 with the *Academia Electoralis Scientiarum et Elegantiorum Literarum Theodoro-Palatina* created in 1763 (Cassidy, 1985).

<sup>17</sup>This is especially the case for creation dates. If the academy is considered as *official* by McClellan (1985), I use the year when it actually became *official* or when it was authorized/endowed by the local or ministerial power. However, when there is reliable evidence of strong activity even before that date, I use the foundation year of the society, even if it remained only a *private* entity for a while.

<sup>18</sup>Spain has only one academy in Barcelona, I investigate it in section 7.1

the creation dates and the end dates (Figure B2 and B3, respectively). Figure B2 shows that universities have a more heterogeneous creation period than academies. This heterogeneity over time is relevant for my empirical strategy. Figure B4 (in the Appendix) also illustrates the establishment of new universities and academies in every 50 year period between 1500 and 1800. I note the measurement error in the data: I only observe institutions that left some record, either by still being open today or by being sufficiently relevant to be recorded in historical sources.



**Fig. 2** Locations of higher educational institutions (1000 - 1800 CE): yellow bubbles represent universities, green triangles represent academies. When the two institutions are created in the same city there is an interaction, which is captured by the overlapping of the two shapes. Countries borders are those in the year 2000.

**Scholars.** The database also contains information on individual scholars' Virtual International Authority File (VIAF), which includes the alternative names, countries, publishers, and titles for each individual. Information from scholars' Wikipedia pages, such as their length (i.e., number of characters in the Wikipedia entry) and languages available, is collected as well. These data are used by de la Croix et al. (2023) to compute a quality index referred to as "human capital". The authors employ a principal component analysis to

obtain a unique indicator of human capital (for the combination of weights see Curtis and de la Croix (2023a)). On this point, it should also be noted that a present bias affects this output measure of human capital since both VIAF and Wikipedia only reflect the modern-day importance of scholars. This means we are tracking only the quality of scholars whose works have survived to the present, rather than capturing the actual importance each scholar held during their active period. In addition, there may also be language or national biases when a specific language or nation is better covered than others for endogenous reasons, in a non-random way. This would only be a problem if one language or nation systematically improved its own coverage, but there is no evidence of that for the countries considered.

The database also has details about scholars' age at death, age at appointment, period of activity in any institution, and the distance they travelled from their birthplace to the institutions where they were active, from their birthplace to their place of death, and from their institution to their place of death. Table 2 shows some descriptive statistics at the individual level. It is evident that the sample of scholars affiliated with academies (Column 1) is entirely different from the sample of university professors (Column 2).<sup>19</sup> Interestingly, for the 'age at death' I find similar results to Stelter, de la Croix, and Myrskylä (2021), who show that scholars of scientific academies experienced lower mortality than their contemporaries in universities. In the sample of 32,112 university professors, I only include scholars active from 1600 onwards. I exclude all the Medieval professors for a better comparison. Column 3 shows the mean for the sample of scholars who were members of at least an academy and a university at the same time at least once in their life time. I present the statistical differences between this group of scholars and those affiliated only with an academy in Column 4 and only with a university in Column 5. This 'interaction' group differs significantly from the other two subsets of scholars. There are only two similarities between the interaction group and university professors: the interaction group seems to die, on average, at the same distance from the institution as university professors, and to be born at the same distance from their death place as professors do on average. Finally, it is important to notice that year fixed effects are always included to control for possible time trends. Additionally, there is the possibility that scholars are active in multiple academies and universities at the same time, when this happens I consider the mean of the various statistics and I only count them once in the number of scholars.

**University quality.** Using the individual data on quality, I compute the aggregate level of quality for universities. I adopt the index from de la Croix et al. (2023), who employ the human capital indicator of the top five professors who had been working in the institution during the 25 years before the year when the quality index of the institution is computed (for more details see

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<sup>19</sup>I did not add the coefficients (and SE) for these two samples because the difference is clearly significant, as confirmed by the p-values that are all at 0.000.

**Table 2** Summary statistics for members of only Academies (1), only Universities (2), and members of both Academies and Universities at the same time at least once over their lifetime (3). The coefficients in columns (4) and (5) indicate the significance of the differences between groups (3) and (1), and between groups (3) and (2), respectively, and consider year fixed effects.

| No. of scholars         | (1)<br>ACAD<br>16002 | (2)<br>UNI<br>32112° | (3)<br>ACADxUNI<br>1166 | (4)<br>vs ACAD | (5)<br>ACADxUNI<br>vs UNI |
|-------------------------|----------------------|----------------------|-------------------------|----------------|---------------------------|
|                         | $\mu$                | $\mu$                | $\mu$                   |                | p-value                   |
| Quality                 | 2.31                 | 1.01                 | 3.34                    | 0.000          | 0.000                     |
| Age at Death            | 67                   | 63                   | 68                      | 0.007          | 0.000                     |
| Age at Appointment      | 38                   | 31                   | 30                      | 0.000          | 0.000                     |
| Activity Years°         | 15                   | 10                   | 30                      | 0.000          | 0.000                     |
| Dist. Birth-Institution | 338                  | 186                  | 257                     | 0.000          | 0.000                     |
| Dist. Institution-Death | 428                  | 188                  | 196                     | 0.000          | 0.504                     |
| Dist. Birth-Death       | 380                  | 269                  | 247                     | 0.000          | 0.770                     |
| Year FE*                |                      |                      |                         | YES            | YES                       |

Note:

\* p<0.1; \*\* p<0.05; \*\*\* p<0.01

°) UNI profs are included only if active after 1600.

°) When interpreting the statistics on activity years, it is important to consider that if there is no precise time frame of activity in the database, academicians are considered active at the academy for their entire lifetime, whereas university professors are considered active for only 8 years (unless they pass away before the end of this period).

\*) Year FE are relative to the initial year of activity of the scholar.

de la Croix et al. (2023)). I take the average of this index for every 50 years as dependent variable in Section 6.

**Fields of study.** Universities and academies also differ in their fields of study as classified in our database (de la Croix & Zanardello, 2022). This distinction is illustrated in Figure B5, which displays the number of institutions by main field of study (i.e., the subject studied by the majority of their members). Universities mainly focused on the humanities, including history, literature, philosophy, ethics, rhetoric, Greek, poetry, theology and law, as depicted in Figure B5b. However, medicine was also important in their curricula. Academies mainly focused on the sciences, although 30 of them also had members working in the humanities. This is shown in Figure B5a. Figure B6 shows the partition in fields by country for academies (Figure B6a) and for universities (Figure B6b). Table B2 presents some descriptive statistics for size, activity years and fields of study at the aggregate level, differentiating between academies and universities.

## 4 Empirical strategy

In my analysis I focus specifically on academies that adopted an experimental approach, which took place in the period from 1500 to 1900. For this reason, I study nine 50-year periods due to city data, which includes approximately five periods before and three periods after the creation of an academy. It is

important to include periods after 1800 to track what happens after the initial establishment of higher education institutions.

My empirical strategy proceeds step-by-step. I use simple Ordinary Least Squares (OLS) regressions for different city samples, providing preliminary correlations (Section 5.1). Then I use a difference-in-differences (DID) design to mitigate endogeneity concerns. In Section 5.2, I use dynamic two-way fixed effects (TWFE) regressions to visualize panel event studies, treating the creation of a higher educational institution as the event of interest. This approach allows for the examination of pre- and post-event estimates to assess the presence of possible pre-trends and anticipation effects. Indeed, for the event-study estimates to be reliable, three key assumptions must hold: the *parallel trends assumption* (which posits that cities with an academy would have experienced the same growth rate evolution as cities without academies, if the academy was never created), the *no anticipation effect assumption* (which suggests that no significant changes in the growth rate occurred immediately before the creation of an academy in treated cities), and the *Stable Unit Treatment Value Assumption* (SUTVA), which assumes that the population growth rate of one city does not depend on the growth rate of another city. The results using the dynamic TWFE specification are presented in Appendix F, confirming the first two assumptions. There is more analysis in Section 7.2 assessing the validity of the SUTVA assumption and investigating whether the observed effects reflect local impacts (Berkes & Nencka, 2021; Butts, 2021).

However, since this is a staggered setting with the event occurring at different periods in different cities, there may be heterogeneity across time. The traditional TWFE estimator does not recognize heterogeneity and computes the average treatment effect with wrong weights, leading to biased estimates (Goodman-Bacon, 2021). Therefore, it is necessary to account for heterogeneity in the treatment effects (Goodman-Bacon, 2021; Roth et al., 2023). As a result, advanced DID estimators developed by Sun and Abraham (2021) (Section 5.3), by De Chaisemartin and d'Haultfoeuille (2024), and by Callaway and Sant'Anna (2021) (Appendix H) are employed to construct more appropriate counterfactuals and a more precise weighting process. I also discuss the main differences between these estimators.

I then study the historical evidence that claims a positive effect of creating an academy on the quality of universities. In Section 6, I present the analysis using university quality as the outcome variable. This offers further insight into the interaction between these two types of higher educational institutions.

Finally, in Section 7 I present additional analyses testing the Stable Unit Treatment Value Assumption (SUTVA) – to assess whether the effects I see in cities hosting an academy depend only on their own characteristics and not on the status of nearby cities. I also conduct sensitivity analyses by excluding one sample unit from the study and perform spillover effect analyses to examine whether the effects extend beyond the local urban areas.

Overall, this comprehensive approach aims to provide a robust understanding of the relationship between the presence of academies and population growth of European cities in Early Modern time.

## 5 Results

### 5.1 OLS results

Table 3 presents the panel estimations obtained using ordinary least squares (OLS). The table shows the correlation between the natural logarithm of population and the presence of an academy, while controlling for the presence of a university in a European city during the period of analysis (i.e., 1500–1900).

Table 3 reports the estimates for the entire sample of 2,096 cities as in Buringh (2021), while Table C4 (Appendix) presents the results for a subset of 633 large cities as defined by Bosker et al. (2013).<sup>20</sup> In my preferred specification, Column 2, I include city fixed effects (city FE) and time fixed effects (time FE). By considering the whole sample of Buringh (2021), I also capture the effects in smaller urban areas. However, there are no additional controls available for all the cities and periods covered in this analysis. To mitigate omitted variable bias, I include city FE in Columns 1 and 2 to control for time-invariant city-specific characteristics, although time-varying characteristics cannot be accounted for. Nonetheless, in Appendix C, I argue that including city and time FE already accounts for the most relevant information. I demonstrate this using the sample of big cities for which I have access to time-varying controls as in Bosker et al. (2013). Table C4 shows that including only city and time FE provides similar results as adding time-varying determinants.

Table 3 shows that the coefficients associated with the presence of either an academy or a university in the city are positive and statistically significant. The magnitude of the ACAD coefficient is consistently larger than the coefficient for universities, providing initial evidence of the importance of these research-driven institutions. However, in Column 2, the interaction term between universities and academies is not significant. Interestingly, the coefficient for the interaction term (ACADxUNI) has a negative sign, suggesting that adding an academy to a city with an existing university does not increase the link with the economic conditions of the local area. If anything, creating an academy appears to have a crowding out effect in cities that already have a university. Nonetheless, the total correlation of having both educational institutions remains positive and significant. The results in Table C4 exhibit a similar pattern. Specifications without city FE, but including country and time FE (Column 3 in Table 3, and Column 2 in Table C4), yield stronger coefficients, but they do not control for city-specific characteristics, as reflected in the lower R-squared values.

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<sup>20</sup>In Bosker et al. (2013), cities are included if they exceed the threshold of 10,000 inhabitants at least once between 800 and 1800 (633 European cities). In my sample, I include all cities that exceed the threshold of 5,000 inhabitants at least once between 700 and 2000 (2,096 cities).

**Table 3** Results: OLS estimator.

ACAD indicates the presence of an Academy in a specific city and time, UNI indicates the presence of a University in a specific city and time, ACADxUNI indicates the presence of both a University and an Academy in the same city at the same time. The dependent variable is log of population at the city level between 1500 and 1900, and has a frequency of 50-year as in (Buringh, 2021).

| Dependent Variable: ln pop in 1500-1900 |                                       |                    |                      |
|---|---------------------------------------|--------------------|----------------------|
|   | Obs.: ALL cities as in Buringh (2021) |                    |                      |
|   | (1)                                   | (2)                | (3)                  |
| <b>ACAD</b>                             | 0.308**<br>(0.118)                    | 0.316**<br>(0.130) | 1.757***<br>(0.226)  |
|   |                                       | 0.142**<br>(0.056) | 1.089***<br>(0.077)  |
| <b>UNI</b>                              |                                       |                    |                      |
| <b>ACADxUNI</b>                         |                                       | -0.055<br>(0.225)  | -1.005***<br>(0.323) |
|   |                                       |                    |                      |
| Obs.                                    | 2096                                  | 2096               | 2096                 |
| R <sup>2</sup>                          | 0.806                                 | 0.806              | 0.442                |
| <i>city</i> FE                          | YES                                   | YES                | NO                   |
| <i>time</i> FE                          | YES                                   | YES                | YES                  |
| <i>country</i> FE                       | NO                                    | NO                 | YES                  |

Note: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01

Standard errors in parenthesis clustered at city level.

In Table 4, I look more specifically at the link between the population of cities in Buringh (2021) and academies, providing a heterogeneity analyses with respect to their field of study (as described in Section 3). Table 4 shows only the first evidence which will be confirmed by the main results: scientific academies drive the positive effects seen in the general case as in Table 3. Only the coefficients associated with the presence of academies focusing mostly on science, applied science, and medicine are positive and highly significant (Column (1) and (3)). On the other hand, literary academies focusing mainly on humanities, theology, law, and social sciences, do not report any significant coefficient (Column (2) and (4)). About the interaction between the presence of a university and an academy either scientific or literary, the results are similar as in Table 3 showing again a negative sign and no significance.

## 5.2 Dynamic TWFE results

To reduce endogeneity concerns,<sup>21</sup> I first use dynamic two-way fixed effects (TWFE)<sup>22</sup> estimation and visualize the results using panel event studies

<sup>21</sup> As discussed in the introduction, I can only partially mitigate issues of reverse causality. By using a DID approach, I am able to address endogeneity related to the location of educational institutions. However, there may still be factors that simultaneously influence both the establishment of educational institutions and urban growth. Based on the data I collected, I can assume that academies were mostly founded and managed by enlightened scholars who had little to no direct influence over the local urban population.

<sup>22</sup> Appendix D presents the static TWFE estimates.

**Table 4** Results: OLS estimator by ACAD fields.

$\text{ACAD}_{\text{Science}}$  indicates the presence of a scientific academy in a specific city and time,  $\text{ACAD}_{\text{Literary}}$  indicates the presence of a literary academy in a specific city and time,  $\text{ACAD}_{\text{Science}} \times \text{UNI}$  (or  $\text{ACAD}_{\text{Literary}} \times \text{UNI}$ ) indicates the presence of both a university and a scientific (or literary) academy in the same city at the same time. The dependent variable is log of population at the city level between 1500 and 1900, and has a frequency of 50-year as in (Buringh, 2021).

| <b>Dependent Variable: ln pop in 1500-1900</b> |                    |                  |                     |                   |
|--|--------------------|------------------|---------------------|-------------------|
| Obs.: <b>ALL cities</b> as in Buringh (2021)   |                    |                  |                     |                   |
|  | (1)                | (2)              | (3)                 | (4)               |
| <b>ACAD</b> <sub>Science</sub>                 | 0.417**<br>(0.190) |                  | 0.505***<br>(0.190) |                   |
| <b>ACAD</b> <sub>Literary</sub>                |                    | 0.182<br>(0.128) |                     | 0.118<br>(0.163)  |
| <b>UNI</b>                                     |                    |                  | 0.156***<br>(0.056) | 0.151*<br>(0.072) |
| <b>ACAD</b> <sub>Science</sub> <b>xUNI</b>     |                    |                  | −0.219<br>(0.354)   |                   |
| <b>ACAD</b> <sub>Literary</sub> <b>xUNI</b>    |                    |                  |                     | −0.102<br>(0.258) |
| Obs.   | 2096               | 2096             | 2096                | 2096              |
| R <sup>2</sup>                                 | 0.806              | 0.806            | 0.805               | 0.805             |
| city FE  | YES                | YES              | YES                 | YES               |
| time FE  | YES                | YES              | YES                 | YES               |

*Note:*

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

*Standard errors in parenthesis clustered at city level.*

(Bhalotra, Clarke, Gomes, & Venkataramani, 2023; Clarke & Tapia-Schytte, 2021; Jacobson, LaLonde, & Sullivan, 1993). I use this to estimate the effect of the *EVENT* (i.e., the creation of an academy) occurring at different times across different cities. I divide the cities into two main groups: in the treated group are cities that experienced the creation of at least one academy, while cities in the control group did not. The outcome variable used for this dynamic analysis is the growth rate of the natural logarithm of city population, denoted as  $\Delta \ln POP_{ct}$ , where  $c$  represents the city and  $t$  denotes the time period. The event-study specification is expressed as follows:

$$\begin{aligned} \Delta \ln POP_{ct} = \beta_0 + \sum_{l=2}^5 \beta_l^{lead} EVENT_c \times \mathbf{1}\{lead_t = l\} + \\ \sum_{k=0}^3 \beta_k^{lag} EVENT_c \times \mathbf{1}\{lag_t = k\} + \\ \mu_c + \lambda_t + \epsilon_{ct} \end{aligned} \quad (1)$$

In equation 1,  $\mu_c$  represents city fixed effects (city FE),  $\lambda_t$  represents time fixed effects (time FE), and  $\epsilon_{ct}$  is the unobserved error term. There are no

time-varying controls. The variable  $l$  denotes the number of leads (pre-event estimates), and  $k$  denotes the number of lags (post-event estimates) used to capture the impact of the events. The first lead is omitted as the baseline reference for comparing differences between treated and untreated cities.

It is important to note that, by design, the event-study approach assumes absorbing states, meaning that once an academy is created, it remains open until the end of the period considered. Consequently, the analysis focuses on the intention-to-treat (ITT) effect, examining the impact on local economic prosperity between 1500 and 1900 in cities where an academy was created before 1800. It is important to notice that I consider absorbing states in all my analyses, also in Section 5.3 and Section H.<sup>23</sup>

### 5.3 Main findings: Interaction-weighted DID

Recent literature on difference-in-differences (DID) designs has highlighted potential biases in classical dynamic Two-Way Fixed Effects (TWFE) estimates when events occur at different times in different cities, leading to heterogeneous effects (Goodman-Bacon, 2021; Roth et al., 2023). In my context, it is reasonable to expect that the impact of creating an academy in Oxford in 1651 is different from creating one in Turin in 1757. Heterogeneity across cities is evident, and the dynamic estimates presented in Appendix F suggest heterogeneity across periods as well.

In simple contexts, when the event happens only once (2x2 DID), there is no heterogeneity across time, which eliminates one of the main concerns of having negative weights, as explained below. I present these simple event studies in Appendix G, where I plot the coefficients of dynamic TWFE regressions, selecting only one period at a time for the creation of an academy. As expected, the post-event effects are not constant over time and vary according to the year of creation, implying heterogeneity.

In more complex settings, where events occur in multiple periods across multiple units, the issue of heterogeneity becomes more pronounced. This is because dynamic TWFE estimates incorporate a weighted sum of all simple 2x2 DID estimates, sometimes with “wrong/negative” weights (Goodman-Bacon, 2021). These negative weights primarily arise in the 2x2 DID estimates between later- and earlier-treated units (Jakiela, 2021). I formally identify this issue by calculating the proportion of negative weights for the *ACADEMY* event, and it is reassuring that it does not exhibit negative weights.

---

<sup>23</sup>I always consider absorbing treatment due to data constraints. I want to include post-treatment periods up to 1900, given that most of the academies in my sample were founded in the 18th century. However, I do not have their closure dates after 1800, and collecting this data would require accounting for the complexity of historical events happening from the beginning of the 19th century (e.g., Napoleon), which led many institutions to close and reopen only a few years later. In most cases, these periods of closure did not exceed half a century, making it difficult to precisely track them in my analyses.

Nevertheless, using heterogeneity-robust estimators for staggered timing is a valuable approach to address possible biases in the dynamic TWFE estimator and obtain more reliable average treatment effect estimates in the presence of heterogeneity across time and space, even when negative weights are not a significant concern (De Chaisemartin & D'haultfoeuille, 2023). In my analysis, I employ four of the new heterogeneity-robust estimators: Sun and Abraham (2021), De Chaisemartin and d'Haultfoeuille (2022), De Chaisemartin and d'Haultfoeuille (2020), and Callaway and Sant'Anna (2021). In brief, these estimators control for heterogeneity by constructing the counterfactual in more robust ways than the dynamic TWFE, leading to a more appropriate weighting procedure.

I am interested in the dynamic effects of creating an educational institution. Specifically, I want to determine the average effect on a city of opening an academy, in each period after its creation. In other words, I seek a coefficient for the effect on city population for each cohort of cities, where a cohort is defined as a group of cities where an academy was created in a specific period of time.

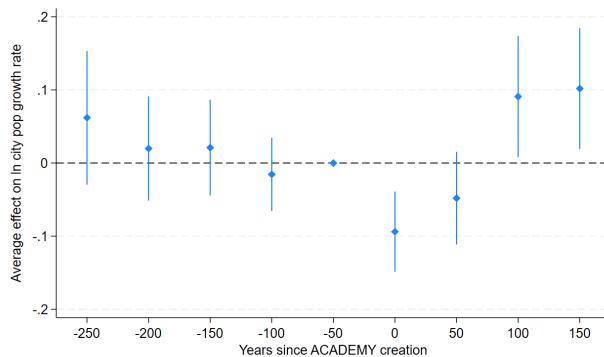
My main results are derived using the “interaction-weighted” estimator (IW estimator) developed by Sun and Abraham (2021). The authors propose a new regression-based approach in which they estimate a weighted average of the cohort-specific average treatment effect on the treated (CATT) for each period relative to the initial treatment. They provide interpretable and robust non-negative weights. The method is termed the “*interaction-weighted*” estimator because it interacts relative period  $l$  indicators with cohort  $e$  indicators. Once the control cohort is defined, the coefficient estimator consistently estimates CATTe,  $l$  via a two-way fixed effects specification. After estimating the reasonable weights as shares of sample cohorts  $e$  in relevant  $l$  periods, Sun and Abraham (2021) construct the IW estimator by taking the weighted average of the estimated CATTe,  $l$ .

I define the group of cities that never hosted an academy - the never-treated cohorts - as the control group in the event study. I include outcome variables up to 1900 to ensure enough post-event periods, which is possible under the assumption that once a unit is treated, it remains treated (e.g., Intention To Treat). However, including the nineteenth century in the analysis increases the number of outliers—cities with a population growth rate higher than 200%—which I exclude from my event studies to obtain more conservative estimates.<sup>24</sup> This reduces the total number of observations to 2,056, with 152 universities and 82 academies, as Saint Petersburg, with its university and academy, is one of the outliers.

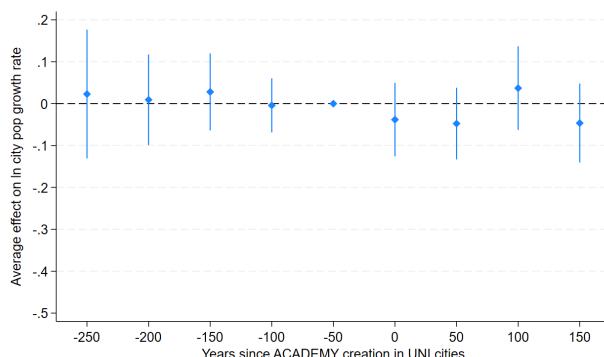
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<sup>24</sup>Out of 40 outliers, only Bekescsaba (HUN), Cacares (ESP), Chaves (PRT), Kronslot (RUS), Le Creusot (FRA), Montceau-les-Mines (FRA), Orel (RUS), Rochefort (FRA), Saint Petersburg (RUS), Tameside (UK), Valletta (MLT), and Versailles (FRA) grew above 200% before (and including) 1800.

Figure 3 presents the average treatment effect of creating an academy between 1500 and 1800. The plotted coefficients are relative to five periods prior and three periods after the creation, allowing for the estimation of effects on a sufficiently balanced number of units for each period. The first lead is omitted as the baseline period. The pre-trends assumption holds, and I observe an immediate negative impact ( $-9.4\%$ , p-value: 0.005), which is more than compensated for in the following century. Cities with an academy experience faster economic growth compared to cities without academies: from 100 years after their establishment, cities hosting an academy grow around 10% faster (pre-treatment stats:  $\mu 0.2$ ,  $sd 0.3$ ).

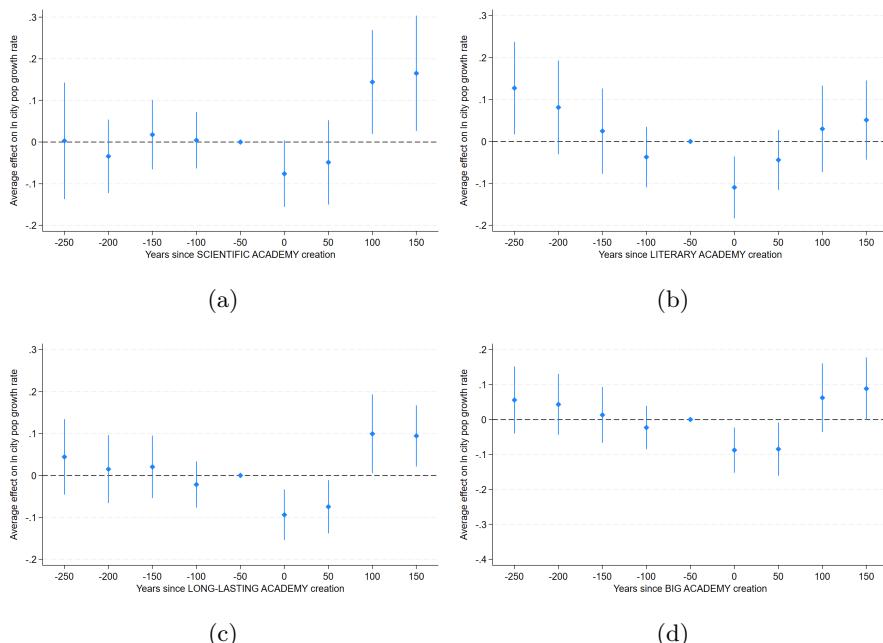


**Fig. 3** Effect of creating an academy between 1500 and 1900 estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: city population growth rate in logarithm. No. of clusters 2056. Adj.  $R^2$  0.186



**Fig. 4** Effect of creating an academy between 1500 and 1900 in cities that hosted a university at least once estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: city population growth rate in logarithm. No. of clusters 151, Adj.  $R^2$  0.289.

To investigate the interaction between universities and academies, I select only cities that had a university at at least one point in time, and I apply Sun and Abraham (2021) to estimate the average effect of creating an academy in those cities. The sample reduces to 151 cities, decreasing the statistical power as well. Indeed, Figure 4 shows that there is no significant change in the economic growth of cities that hosted a university when an innovative academy is created, compared to cities that had only a university at least once. Again, there is a downward trend, implying a negative marginal effect of creating an academy in a city with a more traditional university. Only one coefficient (after 100 years) remains slightly positive but with an effect not significantly different from zero.



**Fig. 5** Effect of creating (a) a scientific academy, (b) a literary academy, (c) a long-lasting academy (with more than 30 years of activity), and (d) a big academy (with more than 30 members) between 1500 and 1900 estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: city population growth rate in logarithm. No. of clusters 2056. Adj. R<sup>2</sup>: (a) 0.185, (b) 0.185, (c) 0.186, (d) 0.185.

As with the dynamic TWFE in Appendix F, I further analyze the *ACADEMY* event by studying the field, the length of the activity period, and the size of the academies created. Figure 5 shows the estimated coefficients using Sun and Abraham (2021) for scientific, literary, long-lasting,<sup>25</sup> and big academies,<sup>26</sup> respectively. In each case, I consider five pre-periods and three

<sup>25</sup>Recall that *long-lasting* academies are those that lasted more than 30 years.

<sup>26</sup>Recall that *large* academies are those with more than 30 members.

post-periods to balance the frequencies and ensure consistency. The same pattern as in the general case is observed for long-lasting academies (Figure 5c), while big academies (Figure 5d) show less significance.

More interestingly, the field of study is the key factor. Figure 5b shows the average effect of creating a literary academy, with no anticipation effect. The visualization of the placebo estimates may indicate the presence of some pre-trends, however it is reassuring that only the last placebo coefficient is significant and the jointly they are not significant, as presented in the appendix H.1. The immediate negative effect in cities that created a literary academy is striking—those cities experience a lower growth rate of between 11% and 4.4% (pre-treatment stats:  $\mu 0.2$ ,  $sd 0.3$ ) during the first 50 years relative to cities without a literary academy. This negative effect disappears in the next 50 years, with coefficients slightly positive but not statistically different from zero. While this result is challenging to interpret, it seems to support the idea presented by Murphy et al. (1991), suggesting that some occupations may be rent-seeking, using resources without generating economic returns, leading to a negative overall effect. Recent empirical literature also suggests that regions more involved in Catholic traditions grow more slowly than their counterparts due to a more religious and less technical education system (Squicciarini, 2020). Similarly, Curtis and de la Croix (2023b) shows that income per capita is negatively influenced by the presence of scholars studying law in the region.

It seems that scientific subjects are the ones that truly matter for long-term growth. When studying the creation of scientific academies in Figure 5a, I show that cities where more than 50% of academy members studied science, applied science, and medicine experienced faster economic growth—by 14.4% (p-value: 0.057) after 100 years relative to cities without a scientific academy. This faster growth persists until the end of the sample period, with cities growing 16.5% faster 150 years after a scientific academy is established in the city (pre-treatment stats:  $\mu 0.21$ ,  $sd 0.31$ ). These findings align with the event study estimates, showing that the field of study of an academy—whether scientific or literary—has a significant impact on population growth rates. Scientific academies have a positive effect, while literary academies have a negative effect, at least in the short term. Moreover, these results highlight the importance of collecting micro-level data on the field of study to precisely assess the impact of high-level human capital before the Industrial Revolution. This is further confirmed in Section 6 where I explain the connection between the creation of academies and the quality of universities.

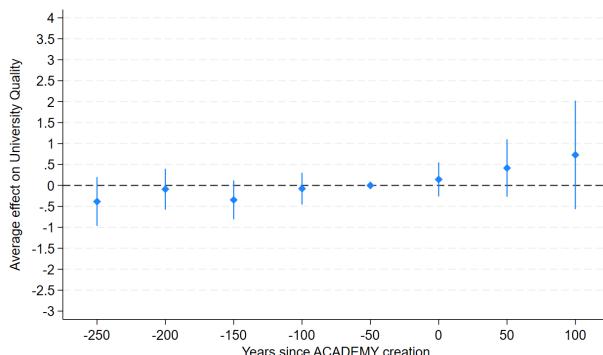
In the appendix, I present alternative DID estimators following Callaway and Sant'Anna (2021), De Chaisemartin and d'Haultfoeuille (2020), and De Chaisemartin and d'Haultfoeuille (2022) as robustness checks. All the main results are confirmed, see Appendix H for details.

## 6 Quality of Universities

In this section, I examine historical evidence for the role of academies in fostering university innovations and reforms. I can use my data to measure university quality over time, within the same period considered in Section 5.3. Thus, I can apply the same identification strategy and use a DID design.

While exploring the connection between university quality and the establishment of academies provides insights into the direction of the effect, it does not fully resolve the underlying endogeneity issue. Nevertheless, defining the relationship between innovative academies and university quality remains of significant interest: it offers valuable insights into the process that ultimately transformed European universities into modern, professionally-oriented institutions by the 19th century.

The computation of a university's quality is based on the aggregated quality of the top five professors who taught there in the preceding 25 years (for technical specifics, refer to de la Croix et al. (2023)). Using the information available in the database, I calculate the average university quality for every 50-year interval up to 1800. Using this approach I can replicate the same DID design I used in the previous section. Here, I present results using my preferred DID estimator Sun and Abraham (2021). I consistently include only two lags in the analyses to balance event frequencies, as university quality data is available only up to 1800. The last dynamic effects would otherwise imprecisely estimate the relative coefficients, considering only the first academy, the *Accademia degli Investiganti*, was exactly founded in 1650.



**Fig. 6** Effect of creating an academy between 1500 and 1800 in cities that hosted a university at least once estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: quality of universities. No. of clusters 151, Adj. R<sup>2</sup> 0.658.

Figure 6 illustrates the impact of establishing an academy on university quality. The pre-trends are consistent, with no significant negative leads but I also observe no significant effects after an academy is established. The creation of an academy in cities that already have a university does not appear

to improve the quality of the universities compared to cities with universities but without academies.

The effect becomes evident only with the creation of purely scientific academies, as shown in Figure 7a. The effect is significant and positive after 50 years: the establishment of a scientific academy increases university quality by a coefficient of 1.33 (p-value: 0.06), representing an average increase of almost 40% compared to pre-treatment statistics ( $\mu = 3.27$ ,  $sd = 2.35$ ). Thus, considering both the main results and those presented in this section, I demonstrate that the creation of a scientific academy has a significant impact on university quality in cities compared to those where a university, but not a scientific academy, was established.

In contrast, literary academies show no significant positive effects. While the pre-trend is still confirmed, the average treatment effect on the treated cities is negative but not statistically significant. This suggests that the creation of a literary academy does not lead to an improvement in university quality, which aligns with the findings in the main text.

Finally, event studies examining long-lasting<sup>27</sup> and large academies<sup>28</sup> do not really suggest any positive influence on university quality. Figure 7c and Figure 7d contain the respective results.

## 7 Additional analyses

In this section, I provide sensitivity analyses to better understand the specific effects of certain units of analysis. In Section 7.1, I examine the impact of excluding major cities such as London and Paris, as well as entire countries that host a large number of innovative academies, including France, Italy, Germany, and the UK. I also present the results of excluding Spain, a country with only one academy, which could rise concerns about the actual variation exploited in the analysis given it mainly affects the construction of the counterfactual.

In Section 7.2 I explore the potential for spillover effects from nearby cities. The creation of an academy in one city could be influenced not only by the characteristics of that specific urban area but also by those of nearby cities, which could bias the DID estimator. I show that this is not a concern, demonstrating the coefficients for the unbiased local effect.

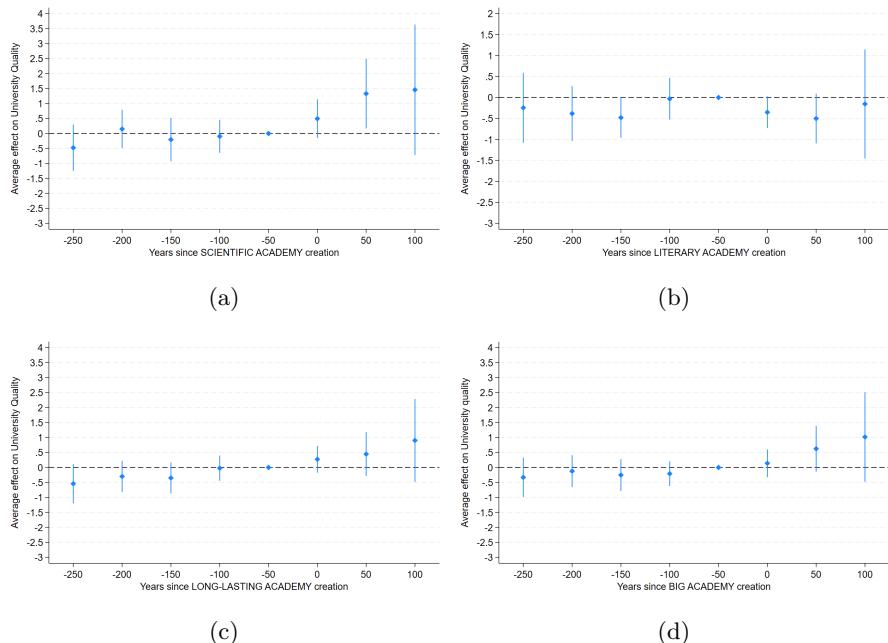
Finally, in Section 7.3 I present the spillover effects obtained through “donut” regressions, where I allow for the influence of academies to extend beyond the immediate urban center. These results reveal interesting dynamics, which again depend on the academic fields at the institution.

### 7.1 Sensitivity analyses: leave-one-out

Maintaining a European perspective has the advantage of offering a comprehensive and general analysis. However, it is possible that specific units of

<sup>27</sup>Long-lasting academies are those that have been active for more than 30 years.

<sup>28</sup>Large academies are those with more than 30 members.



**Fig. 7** Effect of creating (a) a scientific academy, (b) a literary academy, (c) a long-lasting academy (with more than 30 years of activity), and (d) a big academy (with more than 30 members) between 1500 and 1800 estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: quality of universities. No. of clusters 151. Adj. R<sup>2</sup>: (a) 0.659, (b) 0.653, (c) 0.661, (d) 0.659.

analysis may heavily influence the results. For instance, cities hosting the most prominent academies, such as London and Paris, could disproportionately drive the findings. This could also occur at the country level, where one nation might dominate the outcomes. In this case the effects could not be attributed to all of Europe, but rather to a specific unit. I use sensitivity analysis to determine whether certain cities or countries are driving my results.

I begin by excluding London and Paris, followed by the four countries with the largest number of academies: France, Italy, Germany, and the UK. I exclude each unit one at a time to assess its individual impact, comparing the results to my main findings using the *IW* estimator from Sun and Abraham (2021).

Excluding London does not affect the results, as the coefficients from the event studies on academy creation remain largely unchanged, regardless of the type of academy analyzed. The same is true when Paris is excluded from the sample, where the coefficients slightly increase in magnitude but show no change in significance. Appendix I.1 and I.2 provide graphical representations of these results. Overall, the main findings remain consistent even when excluding the most renowned centers of scientific knowledge and innovation. This not only demonstrates the robustness of the analysis but also reduces concerns about endogeneity.

Maintaining a European perspective throughout the paper allows me to exclude an entire country while retaining enough statistical power to assess its relative importance compared to the entire sample. I begin by excluding France, which hosts the largest number of academies, followed by Italy, Germany, and the UK. France significantly affects the results, as it contains the most academies (30 out of 83) and universities (34 out of 153). In the main event studies, excluding France slightly reduces the significance of the negative coefficient found immediately after an academy's establishment.<sup>29</sup> Excluding France also increases the positive effect observed at the 100-year mark; excluding French urban areas, cities hosting academies show a population growth rate 17.5% higher (p-value: 0.01) compared to cities without academies (previously 9% with a p-value of 0.04). Overall, excluding France only slightly alters the results, primarily by amplifying the positive impact of academy creation. Figure I22 displays these results. This effect can be explained by France's unique history: excluding the country removes the negative shocks it experienced during the 18th century. In 1793, the French Revolutionary Convention sought to sever all cultural ties with the *Ancien Régime*. On August 8th, 1793, the National Convention decreed the "suppression of all academies and literary societies licensed or endowed by the nation" (Taillefer, 1984). The second article of this decree mandated the closure of academies and the confiscation of all their materials, including "books, manuscripts, medals, machines, tables, and other objects," which were placed in storage. The buildings were also seized and sold as national property in the subsequent years (Taillefer, 1984).

Regarding other outcomes, I find similar effects with or without France when analyzing the creation of academies in cities that have ever hosted a university (Figure I22c) or when examining the impact of *ACAD* on university quality (Figure I22b).

The most challenging results to interpret arise when analyzing specific academies after excluding France, including purely scientific, literary, long-lasting, and large academies. Without France, the creation of scientific academies no longer has a negative impact on population growth within the first 50 years. Moreover, excluding French cities leads to a 22% faster growth rate for cities with scientific academies 100 years after their creation—a larger magnitude compared to the baseline. However, when testing the influence of scientific academies on university quality, excluding France lowers statistical significance while keeping the magnitude unchanged, suggesting that the regression's statistical power is insufficient to fully interpret the results (Figure I23a and I23b).<sup>30</sup> For literary academies, excluding France affects the results on population growth, increasing the magnitudes of the coefficients in the first 50 years (Figure I23c). As for university quality, the effect of literary academies in the rest of Europe remains non-significant, similar to the main findings (Figure I23d). Excluding France increases the positive impact of long-lasting

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<sup>29</sup>With France, the coefficient was -9.4% (p-value: 0.005); without France, the magnitude remains at -11%, but the p-value rises to 0.015.

<sup>30</sup>France hosts 11 out of the 37 scientific academies in the sample.

academies on population growth after 100 years<sup>31</sup>, without altering the results on university quality, which remain insignificant (Figures I23e and I23f). For large academies, excluding France has minimal impact on the results (Figure I23g and I23h).

Excluding other countries does not affect the results in the same way as excluding France. Removing Italy decreases the significance of the results: the *ACAD* event shows no strong positive effect, with only a slightly significant coefficient 100 years after academy creation (Figure I24a). However, the results on university quality remain unchanged. The main findings also hold when looking at the types of academies created: without Italy, scientific academies still have a significant positive effect after 100 years (+15.4%), increasing to 21% by the end of the sample period compared to cities without scientific academies (Figure I25a). These effects remain strong for university quality as well (Figure I25b). Appendix I.4 presents all event studies.

Excluding Germany delays the positive impact of the *ACAD* event (Figure I26a). This is driven by scientific, long-lasting, and large academies: when German cities are excluded, the positive effects of these academies become highly significant only after 150 years, rather than 100. This delay is explained by the fact that German academies were established around 1755, while the average creation date for the whole sample is 1741. Although the difference is only 15 years, it aligns with the cut-off point for sample periods, shifting the results by 50 years. All other findings, including those related to university quality, remain unchanged. The graphs for this are in Appendix I.5.

Excluding the UK does not significantly alter the baseline results on population growth: the *ACAD* event shows an immediate negative effect that is more than offset after 100 years. The analyses regarding field of study, academy size, and years of activity remain unchanged, as do the findings when university quality is used as the outcome variable. Appendix I.6 contains all relevant results.

Finally, I exclude Spain from the sample, and the results are in Appendix I.7. Spain hosts only one academy in Barcelona since 1764 and 21 universities. Therefore, when analyzing the primary *ACAD* event, the treated group would not be significantly affected by the exclusion of only one city. However, the untreated group would undergo significant changes, possibly affecting the estimates. Leaving Spain out allows us to address potential concerns about the variation exploited in the entire analysis. It is reassuring that all the main results remain mostly unaffected: the entire sample of academies only delays to 150 years the positive and significant effects (Figure I30a), also scientific academies still increase the population growth rate by 16% (p-value: 0.056) after 150 years from their creation (Figure I31a). Literary academies again have an immediate negative impact of around 10% for their first 50 years

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<sup>31</sup>With France, long-lasting academies foster growth by 10%, while without France the effect rises to 19%.

(Figure I31c). The results on university quality do not vary significantly either: the general sample of *ACAD* does not improve the quality of universities (Figure I30b). In cases where the academy is scientific, the increase is significant and positive (Figure I31b), while academies with a literary focus do not yield significant coefficients (Figure I31d). As before, long-lasting and big academies do not significantly enhance the quality of universities in the same city where they are established (Figure I31f and I31h, respectively). Therefore, the consistent results when excluding Spain from the sample demonstrate the robustness of the overall analysis and the presence of sufficient variation even when excluding this specific country.

## 7.2 Local effects

I assume that the main event studies capture only the local effect of creating an academy. However, the influence of such institutions may extend beyond the boundaries of a single municipality, potentially affecting nearby cities. In this case, the treatment effects could violate the Stable Unit Treatment Value Assumption (SUTVA)—a key assumption for unbiased event studies. SUTVA requires that the effects depend solely on the status of treated cities and not on neighboring cities. To address this, a common strategy is to exclude nearby cities, to account for potential spatial spillovers Butts (2021). This approach refines the construction of the counterfactual, ensuring that cities indirectly impacted by spillovers are excluded from the sample. Such analysis can provide a more accurate estimate of the local effect of creating an innovative academy within a particular city. The resulting estimator will yield unbiased coefficients, provided that all nearby cities potentially affected by the treatment are excluded from the sample.

Following the methodology of Johnson, Thomas, and Taylor (2023), who examine spatial spillovers for a historical period similar to the one considered in this paper, I exclude cities within a 50, 100, and 150 km radius of an academy, while keeping the hosting city.<sup>32</sup> If the primary results hold after this adjustment, the effects identified can be considered the unbiased local effects of creating an academy in a specific urban area.

When excluding cities within a 50 km radius of the nearest academy, the results remain consistent in terms of population growth rates. As expected, the significance diminishes due to the reduced sample size (now 1,642 cities, down from 2,056). However, excluding cities within 100 and 150 km produces slight changes: the magnitude of negative coefficients increases within the first 50 years, while the magnitude of positive coefficients—found after 100 years—diminishes until they are no longer relevant. Despite this, the positive coefficients related to university quality persist, although they are not statistically significant, as they are in the baseline results. These findings are displayed in Figure J32.

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<sup>32</sup>I do not extend the radius beyond 150 km in order to maintain sufficient statistical power.

Figure J33 shows the event studies for academy creation in cities that previously hosted a university. Once again, the trends are consistent with the main results.

In the analysis of spatial spillovers for specific types of academies—scientific, literary, long-lasting, and large academies—I exclude cities located near the respective academy type. I find no substantial variations compared to the main results when excluding cities within a 50, 100, or 150 km radius. Excluding cities within 50km, Scientific academies (Figure J34) exhibit a positive effect on population growth rates from 100 years after their creation, reaching a 17.3% increase after 150 years, and they also enhance university quality by around 80% on average (pre-treatment stats:  $\mu$  1.70,  $sd$  2.17) within the first 50 years. Similar patterns are seen also when excluding cities within 100km and 150km. Literary academies (Figure J35) reduce population growth by around 11% immediately but have no significant effect on university quality within the same city. The results for long-lasting and large academies align with the main findings (Figure J36 and Figure J37, respectively): both types of academies initially have a negative impact on population growth in the first 50 years but show a recovery in the following century, resized according to the lower statistical power.

### 7.3 Spillover effects

In this section, I examine potential spatial spillover effects from the creation of different types of academies. This complements the previous section, where I estimated the local effect. Now, I assess the impact on cities located further away from the treated cities, applying a standard spatial analysis technique (Butts, 2021; Keller & Shiue, 2021). Specifically, I create “donuts” around the treated city—the academy-hosting city—using cities within these donuts as treated groups and those further away as controls. To focus on spillover effects, the treated city itself is excluded. Due to statistical power constraints, the maximum radius for these donuts is 25 kilometers: I analyze areas 0-25 km, 25-50 km, and 50-75 km from the treated city.<sup>33</sup>

I find a consistent pattern for cities within the 0-25 km donut: while cities further away experience no immediate effects (with no significant coefficients at time 0), they show a positive and significant impact roughly 50 years after the academy’s creation. This positive effect, however, trends downward over time, with coefficients ceasing to be significant by 100 years and eventually becoming negative (though still not significant) in later periods.<sup>34</sup>

This pattern—significant positive effects at 50 years followed by a decline—persists, particularly for scientific and larger academies. Focusing on scientific academies, cities up to 75 km seem to benefit earlier (after 50 years) compared to the host cities, which only see positive effects 100 years after the

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<sup>33</sup>I explored spillovers up to 150 km, but beyond 100 km the results became non-significant due to limited statistical power.

<sup>34</sup>Note that for the last lag, I used fewer frequencies, which should be considered when interpreting the results.

academy's creation. However, while the hosting cities retain long-term benefits, the positive effect fades for the surrounding cities. This might reflect the hosting cities absorbing the upfront costs of establishing the academy, while nearby cities benefit from spillover effects without incurring those costs. In the long run, however, the hosting cities continue to benefit while the spillover effects dissipate in surrounding areas.

Apart from the case of scientific academies, I find no evidence of positive spillovers for cities within the 25-50 km and 50-75 km donuts. After excluding the nearest cities (i.e., those hosting academies and those within 25 km or 50 km, respectively), these cities do not experience significant impacts within the first 50 years. Over time, they show a slightly significant negative effect, with the 25-50 km donut exhibiting more significant results than the 50-75 km one. This suggests that cities may bear some costs of not having an academy close enough. This pattern is most evident for larger academies, while for scientific academies, the effects in these two donuts remain flat.

For long-lasting academies, there is no significant spillover effect; the general pattern holds.

The results for literary academies differ. For the 0-25 km donut, statistical power is insufficient to draw robust conclusions.<sup>35</sup> However, in the 25-50 km and 50-75 km donuts, a progressively negative impact emerges: cities within the 25-50 km donut experience slower growth, with a 4% reduction initially and an 11% reduction after 100 years. A similar but slightly more significant effect is observed for cities in the 50-75 km donut.

As discussed in the main analysis, literary academies negatively impact host cities during the first 50 years. However, the negative effect on surrounding cities appears to persist over time. This could be explained by resource allocation toward low-return activities: resources drawn from surrounding areas may slow growth locally, while the benefits of producing capable professionals, like lawyers or historians, are confined to the hosting cities. Thus, while these cities eventually recover, the surrounding cities continue to experience diminished growth.

## 8 Conclusions

In this paper I show the long-term role of Early Modern Academies in the economic growth of European cities. At the heart of this study there is a unique dataset of academicians active between 1500 and 1800, and a robust DID design used to analyze the establishment and evolution of these educational institutions. Evaluating economic growth directly through population growth rates, I find that academies had a positive effect. Science-focused academies exhibited a stronger and more persistent positive impact. In contrast, literary academies had a temporary negative effect on population growth during the first 50 years. Also when examining the impact of these academies on the quality of local

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<sup>35</sup>The maximum number of frequencies for the first donut is 58, compared to 186 and 388 for the other two.

universities, I observe a strong positive effect from the establishment of purely scientific academies.

These results contribute to explain the complex relationship between human capital, science, and economic dynamics in historical contexts. I emphasize the importance of the experimental approach and practical research in driving economic growth also in pre-industrial times, consistent with the literature on “useful knowledge” (Mokyr, 2005b). The analysis of historical interactions between academies and universities opens the possibility for further research on the origin of the modern educational system.

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## References

- Abramitzky, R., & Sin, I. (2014). Book translations as idea flows: The effects of the collapse of communism on the diffusion of knowledge. *Journal of the European Economic Association*, 12(6), 1453–1520.
- Académie de Béziers (2024). *Tricentenaire Academie Beziers 1723 - 2023*. Retrieved from <https://tricentenaire-beziers.fr/historique/> (Consulted in April 2024)
- Académie de Cherbourg (2024). *Historique*. Retrieved from <https://academiedecherbourg.wordpress.com/la-societe-nationale-academique-de-cherbourg/> (Consulted in April 2024)
- Académie des sciences, des lettres et des arts d'Amiens (1901). *Tome XLVIII. Mémoires de l'Académie des sciences, agriculture, commerce, belles-lettres et arts du département de la Somme*. Imprimerie Yvert et Tellier.
- Académie des Sciences, Lettres et Arts d'Arras (2024). *Histoire de l'Académie d'Arras*. Retrieved from <https://academie-arras.fr/histoire> (Consulted in March 2024)
- Académie des Sciences Lettres et Arts de Marseille (2024). *Histoire de l'Academie depuis 1726*. Retrieved from <https://www.academie-sla-marseille.fr/pages/l-academie-de-marseille/histoire-de-l-academie-depuis-1726-1720124475.html> (Consulted in April 2024)
- Académie Royale de Marine (2024). *250 ans d'histoire*. Retrieved from <https://www.academiedemarine.com/250ans.php> (Consulted in March 2024)
- Académie Royale des sciences (2024). *Histoire de l'Académie des sciences*. Retrieved from <https://www.academie-sciences.fr/fr/Histoire-de-l-Academie-des-sciences/histoire-de-l-academie-des-sciences.html> (Consulted in February 2023)
- Académie Royale des Sciences, belles-lettres et arts de Lyon (2024). *Histoire de l'Académie*. Retrieved from <https://academie-sbla-lyon.fr/Academie/histoire> (Consulted in April 2024)
- Accademia delle Scienze di Torino (2023). *Oggi si chiamano brevetti, nel passato privilegi industriali*. Retrieved from <https://accademiadellescienze.it/brevetti> (Consulted in June 2023)

Accademia Nazionale di Scienze, Lettere e Arti di Modena (2023). *I soci storici*. Retrieved from <https://www.accademiasla-mo.it/it> (Consulted in February 2023)

Accademia Peloritana dei Pericolanti (2024). *Storia dell'Accademia*. Retrieved from <https://www.accademiapeloritana.it/storia.html> (Consulted in March 2024)

Accademia Roveretana degli Agiati di Scienze, Lettere ed Arti (2024). *Storia*. Retrieved from <https://agiati.org/storia> (Consulted in March 2024)

Acemoglu, D., Johnson, S., Robinson, J. (2005). The rise of Europe: Atlantic trade, institutional change, and economic growth. *The American Economic Review*, 95(3), 546–579.

Allombert, F. (1899). *Annales de la Societe d'Emulation et Agriculture (Lettre, Science, et arts) de l'Ain*. (Bourg-en-Bresse)

Almelhem, A., Iyigun, M., Kennedy, A., Rubin, J. (2023). Enlightenment ideals and belief in progress in the run-up to the industrial revolution: A textual analysis.

Applebaum, W. (2000). *Encyclopedia of the scientific revolution: from Copernicus to Newton*. Routledge.

Ashraf, Q., & Galor, O. (2011). Dynamics and stagnation in the Malthusian epoch. *American Economic Review*, 101(5), 2003–2041.

Bairoch, P. (1988). *Cities and economic development: from the dawn of history to the present*. University of Chicago Press.

Bairoch, P., Batou, J., Pierre, C. (1988). *Population des villes européennes de 800 à 1850: banque de données et analyse sommaire des résultats (la)*. Librairie Droz.

Barro, R.J. (1991). Economic growth in a cross section of countries. *The quarterly journal of economics*, 106(2), 407–443.

Barro, R.J. (2001). Human capital and growth. *American Economic Review*, 91(2), 12–17.

Bayerische Akademie der Wissenschaften (2024). *Chronik der Akademie*. Retrieved from <https://badw.de/geschichte/chronik.html> (Consulted in May 2024)

Becker, S.O., & Woessmann, L. (2009). Was Weber wrong? A human capital theory of Protestant economic history. *The quarterly journal of economics*, 124(2), 531–596.

Benos, N.N., Conti, M., Papazoglou, M., Tsoumaris, S. (2024). The Rise of Universities and Economic Development in Medieval and Early Modern Europe (700–1800). *SSRN* <http://dx.doi.org/10.2139/ssrn.4967505>.

Berkes, E., & Nencka, P. (2021). Knowledge access: The effects of Carnegie libraries on innovation. Available at SSRN 3629299.

Berry, H.F. (1915). *A history of the royal dublin society*. Longmans, Green and Co. (London)

Bhalotra, S., Clarke, D., Gomes, J., Venkataramani, A. (2023). Maternal mortality and women's political participation. *Forthcoming at the Journal of the European Economic Association*.

Bianchi, N., & Giorcelli, M. (2020). Scientific education and innovation: from technical diplomas to university stem degrees. *Journal of the European Economic Association*, 18(5), 2608–2646.

Bierens de Haan, J.A. (1952). *De Hollandsche Maatschappij der Wetenschappen, 1752-1952*. (Haarlem)

Böhme-Käßler, K. (2005). *Gemeinschaftsunternehmen Naturforschung : Modifizierung und Tradition in der GNF zu Berlin 1773 - 1906*. Franz Steiner Verlag GmbH. (Stuttgart)

Bois, J.-P. (2021). *Histoire de L'Académie Royale des Belles-Lettres d'Angers, 1685-1793*. Le Coudray-Macouart, Saint-Léger Editions. (Angers)

Boissier, G. (1907). *La Suppression des Académies en 1793*. Revue des Deux Mondes (1829-1971). (5e période, Vol. 40, No.4, pages 721-751)

Bosker, M., Buringh, E., Van Zanden, J.L. (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.

- Brizzi, G.P. (2001). *L'antica Università di Fermo*. Milano-Fermo, Silvana.
- Buringh, E. (2021). The Population of European Cities from 700 to 2000: Social and Economic History. *Research Data Journal for the Humanities and Social Sciences*, 1(aop), 1–18.
- Butts, K. (2021). Difference-in-differences estimation with spatial spillovers. *arXiv preprint arXiv:2105.03737*.
- Callaway, B., & Sant'Anna, P.H. (2021). Difference-in-differences with multiple time periods. *Journal of Econometrics*, 225(2), 200–230.
- Campori, G. (1887). *La società filopatria di Torino*. Giornale Storico della Letteratura Italiana. (Torino)
- Cantoni, D., & Yuchtman, N. (2014). Medieval universities, legal institutions, and the commercial revolution. *The Quarterly Journal of Economics*, 129(2), 823–887.
- Cassidy, D.C. (1985). *Meteorology in Mannheim: The Palatine Meteorological Society, 1780-1795*. Franz Steiner Verlag Wiesbaden GmbH. (Stuttgart)
- Chen, Z., & Ma, C. (2022). Prioritizing Stability over Productivity: How Confucianism Facilitated Population Growth in Preindustrial China. *SSRN*.
- Cinnirella, F., & Streb, J. (2017). The role of human capital and innovation in economic development: evidence from post-Malthusian Prussia. *Journal of economic growth*, 22, 193–227.
- Clarke, D., & Tapia-Schythe, K. (2021). Implementing the panel event study. *The Stata Journal*, 21(4), 853–884.
- Cohen, D., & Soto, M. (2007). Growth and human capital: good data, good results. *Journal of economic growth*, 12(1), 51–76.

*Complete list of the members and officers of the Manchester Literary and Philosophical Society, from its institution on February 28th, 1781 to April 28th, 1896.* (1896). (Manchester)

Courteault, P. (1912). *Listes des membres: 1712-1912, Actes de l'Académie nationale des sciences, belles-lettres et arts de Bordeaux, 1912*, p. 327-357. Académie nationale des sciences, belles-lettres et arts de Bordeaux. (Bordeaux)

Curtis, M., & de la Croix, D. (2023a). Measuring Human Capital: from WorldCat Identities to VIAF. *Repertorium Eruditorum Totius Europae*, 10, 17–22.

Curtis, M., & de la Croix, D. (2023b). *Seeds of Knowledge: Premodern Scholarship, Academic Fields, and European Growth* (Tech. Rep.). CEPR Press Discussion Paper No. 18321.

de la Croix, D., & Zanardello, C. (2021). Scholars and Literati at the Academy of Sciences of Turin (1757–1800). *Repertorium Eruditorum Totius Europae*, 5, 43–51.

de la Croix, D., & Zanardello, C. (2022). Scholars at the Royal Academy of Sciences in Paris (1666–1793). *Repertorium Eruditorum Totius Europae*, 9, 1–10. Retrieved from 10.14428/rete.v9i0/ASc

De Candolle, A. (1885). *Histoire des sciences et des savants depuis deux siècles: précédée et suivie d'autres études sur des sujets scientifiques en particulier sur l'hérédité et la sélection dans l'espèce humaine*. Georg.

De Chaisemartin, C., & d'Haultfoeuille, X. (2022). *Difference-in-differences estimators of intertemporal treatment effects* (Tech. Rep.). National Bureau of Economic Research.

De Chaisemartin, C., & d'Haultfoeuille, X. (2024). Difference-in-differences estimators of intertemporal treatment effects. *Review of Economics and Statistics*, 1–45.

De Chaisemartin, C., & d'Haultfoeuille, X. (2020). Two-way fixed effects estimators with heterogeneous treatment effects. *American Economic Review*, 110(9), 2964–2996.

- De Chaisemartin, C., & D'haultfoeuille, X. (2023). Two-way fixed effects and differences-in-differences estimators with several treatments. *Journal of Econometrics*, 236(2), 105480.
- de Colonjon, H. (1866). *Société Académique Et Patriotique De Valence, Bulletin De La Société Départementale D'archéologie Et De Statistique De La Drome*. Imprimerie De Chenevier Et Chayet. (Valence)
- Defrasne, J., Maurat, J.-P., Lordereau, M., Lassus, F. (2002). *Deux cent cinquantième anniversaire de l'académie de Besançon*. (Besançon)
- de la Croix, D. (2021). Scholars and Literati in European Academia before 1800. *Repertorium Eruditorum Totius Europae*, 5, 35–41.
- de la Croix, D., Docquier, F., Fabre, A., Stelter, R. (2023). The Academic Market and the Rise of Universities in Medieval and Early Modern Europe (1000–1800). *Journal of the European Economic Association*, jvad061.
- de la Croix, D., & Doraghi, M. (2021). Scholars and literati at the Saint Petersburg Academy of Sciences (1724–1800). *Repertorium eruditorum totius Europae*, 5, 17–26.
- de la Croix, D., Eisfeld, T., Ganterer, M. (2021). Scholars and literati at the royal prussian academy of sciences (1700–1800). *Repertorium eruditorum totius Europae*, 3, 1–9.
- DeLong, J., & Shleifer, A. (1993). Princes or Merchants? City Growth before the Industrial Revolution. *Journal of Law and Economics*, 36(2), 671–702.
- de Pontville, M. (1997). *Histoire de l'Académie de Caen*.
- des Barres, C. (1851). *Discours de M. le Président sur l'histoire des anciennes Sociétés littéraires et scientifiques à Auxerre. Bulletin de la société des sciences historiques et naturelles de l'Yonne*. Perriquet. (Auxerre)
- Deutsche Akademie der Naturforscher Leopoldina (2024). *History of the Academy*. Retrieved from <https://www.leopoldina.org/en/about-us/about-the-leopoldina/history/the-history-of-the-leopoldina/> (Consulted in April 2024)

- Dittmar, J. (2011). Information technology and economic change: the impact of the printing press. *The Quarterly Journal of Economics*, 126(3), 1133–1172.
- Dittmar, J. (2019). The economic origins of modern science: technology, institutions, and markets. *London School of Economics*.
- Dittmar, J., & Meisenzahl, R. (2022). The research university, invention, and industry: Evidence from german history.
- Dittmar, J., & Seabold, S. (2019). New media and competition: printing and europe's transformation after gutenberg.
- Dulieu, L. (1975). *La médecine à Montpellier, Tome 1, Le Moyen-Age*. Les presses universelles.
- Emerson, R.L. (1981). *The Philosophical Society of Edinburgh 1748-1768*. Cambridge University Press. (Cambridge)
- Ercolani, G.B. (1881). *Accademia delle scienze dello Istituto di Bologna dalla sua origine a tutto il MDCCCLXXX*. Nicola Zanichelli. (Bologna)
- Flouret, J. (2009). L'académie de La Rochelle, ses activités, ses membres, de 1732 à nos jours. *Actes des congrès nationaux des sociétés historiques et scientifiques*. (Bordeaux)
- Forestié, E. (1888). *La société Littéraire et l'ancienne Académie de Montauban*.
- Frijhoff (1996). *A History of the University in Europe*.
- Gage, A. (1938). *A history of the Linnean Society of London*. Taylor and Francis. (London)
- Gertz, O. (1940). *Kungl. Fysiografiska Sällskapet I Lund 1772-1940*. Häkan Ohlssons Boktryckeri. (Lund)
- Goodman-Bacon, A. (2021). Difference-in-differences with variation in treatment timing. *Journal of Econometrics*, 225(2), 254–277.

- Gordin, M. (2000). The Importation of Being Earnest - The Early St. Petersburg Academy of Sciences. *The University of Chicago Press on behalf of The History of Science Society*, 91:1, 1 - 31.
- Gosseaume, M. (1985). *Précis Analytique Des Travaux De L'académie Royale Des Sciences, Belles - Lettres Et Arts De Rouen*. P.Periaux. (Rouen)
- Gunther, R.T. (1925). *Early Science in Oxford - VOL IV - The Philosophical Society*. (Oxford)
- Hanlon, W.W. (2022). *The rise of the engineer: Inventing the professional inventor during the Industrial Revolution* (Tech. Rep.). National Bureau of Economic Research.
- Hanushek, E.A., & Woessmann, L. (2008). The role of cognitive skills in economic development. *Journal of economic literature*, 46(3), 607–68.
- Hasquin, H. (2009). *L'académie impériale et royale de Bruxelles, ses académiciens et leurs réseaux intellectuels au XVIII siècle*. Académie Royale de Belgique. (Bruxelles)
- Histoire et mémoires de la société des sciences physiques de Lausanne. Tome Second. Années 1784, 1785 & 1786.* (1789). Mourer. (Hombourg-ez-Monts)
- Hollandsche Maatschappij der Wetenschappen (2024). *Geschiedenis*. Retrieved from <https://khw.nl/> (Consulted in April 2024)
- Jacobson, L.S., LaLonde, R.J., Sullivan, D.G. (1993). Earnings losses of displaced workers. *The American Economic Review*, 685–709.
- Jakiela, P. (2021). Simple diagnostics for two-way fixed effects. *arXiv preprint arXiv:2103.13229*.
- Johnson, N.D., Thomas, A.J., Taylor, A.N. (2023). The impact of the black death on the adoption of the printing press. *Working Paper*.
- Karlberg, G. (1977). *Royal Society of Sciences of Uppsala, Catalogue of Publications 1716-1967*. Kungl. Vetenskaps-societeten i Uppsala. (Uppsala)

- Keller, W., & Shiue, C.H. (2021). *The economic consequences of the opium war* (Tech. Rep.). National Bureau of Economic Research.
- Kiefer, J. (2004). *Bio-bibliographisches Handbuch der Akademie Gemeinnütziger Wissenschaften zu Erfurt: 1754–2004*. Akad. Gemeinnütziger Wiss. zu Erfurt. (Erfurt)
- Knowles Middleton, W. (1971). *The Experimenters: a study of the Accademia del Cemento*. The John Hopkins Press. (Baltimore and London)
- Koschnick, J. (2025). *Teacher-directed scientific change: The case of the English Scientific Revolution* (Tech. Rep.).
- Koschnick, J., Hornung, E., Cinnirella, F. (2022). Flow of Ideas: Economic Societies and the Rise of Useful Knowledge.
- Kostlán, A. (1996). *Societas Incognitorum - První Učená Společnost V Českých Zemích*. Archiv Akademie věd České Republiky. (Prague)
- Krahnke, H. (2001). *Die Mitglieder der Akademie der Wissenschaften zu Göttingen 1751-2001*. Vandenhoeck & Ruprecht. (Göttingen)
- Kungliga Vetenskapsakademien (2024). *Akademiens historia*. Retrieved from <https://www.kva.se/om-oss/akademiens-historia/> (Consulted in May 2024)
- Königlich-Preußische Akademie der Wissenschaften (2024). *Akademiegeschichte*. Retrieved from <https://www.bbaw.de/die-akademie/akademie-historische-aspekte> (Consulted in May 2024)
- Lauzun, P. (1900). *La société académique d'Agen (1776-1900)*. Alphonse Picard et Fils. (Paris)
- Lettres Patentées*. (1790). Imprimerie Royale. (Grenoble)
- Lieburg, M.J. (1985). *Het Bataafsch Genootschap der Proefondervindelijke Wijsbegeerte te Rotterdam (1769-1984). Een bibliografisch en documenterend overzicht*. Editions Rodopi. (Amsterdam)
- Lomholt, A. (1950). *Det Kongelige Danske Videnskabernes Selskab 1742-1942*.
- Luscombe, D.E. (1969). The School of Laon. In *The school of peter abelard: The influence of abelard's thought in the early scholastic period* (p. 173–182). Cambridge University Press.

- Maggiolo, A. (1983). *I soci dell'Accademia patavina dalla sua fondazione (1599)*. Accademia Patavina delle Scienze Lettere ed Arti. (Padova)
- Maylender, M. (1930). *Storia delle accademie d'Italia* (Vol. 1-5). L. Cappelli.
- McClellan, J.E. (1985). *Science reorganized: Scientific societies in the eighteenth century*. Columbia University Press.
- Menu, H. (1869). *Notes historiques sur la Société Littéraire et sur la Société des Sciences Arts et Belles Lettres de Chalons sur Marne 1750-1792*. Le Roy. (Chalons-sur-Marne)
- Milsand, P. (1871). *Notes et documents pour servir à l'histoire de l'Académie des sciences, arts et belles-lettres de Dijon*. Auguste Aubry. (Dijon)
- Mokyr, J. (2003). The gifts of Athena: Historical origins of the knowledge economy. Princeton University Press.
- Mokyr, J. (2005a). The intellectual origins of modern economic growth. *The Journal of Economic History*, 65(2), 285–351.
- Mokyr, J. (2005b). Long-term economic growth and the history of technology. *Handbook of economic growth* (Vol. 1, pp. 1113–1180). Elsevier.
- Mokyr, J. (2010). *The Enlightened economy an economic history of Britain 1700-1850*. Yale University Press.
- Mokyr, J. (2016). A Culture of Growth. Princeton University Press.
- Mokyr, J., & Voth, H.-J. (2009). Understanding growth in early modern Europe. *Cambridge Economic History of Europe*, 1, 7–42.
- Murphy, K.M., Shleifer, A., Vishny, R.W. (1991). The allocation of talent: Implications for growth. *The quarterly journal of economics*, 106(2), 503–530.
- Mège, F. (1884). *L'académie des sciences, belles lettres et arts de Clermont Ferrand, Ses origines et ses travaux*. Ferdinand Thibaud. (Clermont Ferrand)
- Nelson, R.R., & Phelps, E.S. (1966). Investment in Humans, Technological Diffusion, and Economic Growth. *The American Economic Review*, 56(1/2), 69–75.

- Nicolas, M. (1854). *Histoire Litteraire de Nimes et des localites voisines qui forment actuellement le departement du Gard.* Chez Ballivet et Fabre, imprimeurs.
- Nicolas, M. (1908). *Mémoires de la société d'agriculture, sciences belles-lettres et arts d'Orléan.*
- Niedersächsische Akademie der Wissenschaften zu Göttingen (2024). *Über die Akademie.* Retrieved from <https://adw-goe.de/ueber-uns/uebersicht/> (Consulted in April 2024)
- Oberlausitzische Gesellschaft der Wissenschaften (2024). *Geschichte - Von der Gründung bis zum Ende des 18. Jahrhunderts.* Retrieved from <https://www.olgdw.de/gesellschaft/geschichte/> (Consulted in April 2024)
- Ó Gráda, C. (2016). Did science cause the industrial revolution? *Journal of Economic Literature*, 54(1), 224–239.
- Pahl, J.-P., & Ranke, H. (2019). *Von der höheren fachschule zur fachhochschule. entstehung und etablierung einer institution* (Vol. 28) (No. 1).
- Pepe, L. (2008). Les milieux savants en italie dans la deuxième moitié du 18 e siècle. *Dix-huitième siècle*(1), 211–228.
- Pixton, P.B. (1998). The misfiring of german cultural leadership in the twelfth century: The evidence from the cathedral schools. *Paedagogica historica*, 34(2), 346–363.
- Programme de la Société patriotique de Hesse-Hombourg, pour l'encouragement des connaissances et des moeurs.* (1777). Société Patriotique. (Hombourg-ez-Monts)
- Ramankutty, N., Foley, J.A., Norman, J., McSweeney, K. (2002). The global distribution of cultivable lands: current patterns and sensitivity to possible climate change. *Global Ecology and biogeography*, 11(5), 377–392.
- Rasmussen, W. (1969). De tekniske skolers historie. *Årbog for dansk skolehistorie*, 3, 7–41.

- Real Academia de Ciencias Exactas, Físicas y Naturales de España (2024). *Nuestra Historia*. Retrieved from <https://rac.es/sobre-nosotros/nuestra-historia/1582/> (Consulted in October 2024)
- Reial Acadèmia de Ciències i Arts de Barcelona (2024). *Història de la RACAB*. Retrieved from <https://www.racab.cat/historia/> (Consulted in April 2024)
- Roche, D. (1964). La diffusion des Lumières. Un exemple : l'académie de Châlons-sur-Marne. *Annales. Economies, sociétés, civilisations.*(5), 887-922. Retrieved from <https://doi.org/10.3406/ahess.1964.421231>
- Romer, P.M. (1990). Endogenous technological change. *Journal of political Economy*, 98(5, Part 2), S71–S102.
- Roth, J., Sant'Anna, P.H., Bilinski, A., Poe, J. (2023). What's trending in difference-in-differences? A synthesis of the recent econometrics literature. *Journal of Econometrics*.
- Royal Irish Academy (2024). *History of the Academy*. Retrieved from <https://www.ria.ie/about/history-of-the-academy/> (Consulted in April 2024)
- Rübel, E. (1947). *Geschichte der Naturforschenden Gesellschaft in Zürich auf das Jahr 1947*. Kommissionsverlag Gebr. Fretz AG. (Zurich)
- Schmidt, O. (1960). *Det kongelige norske videnskabers selska: Matrikkel 1760-1960*. Det Kongelige Norske Videnskabers Selskab. (Trodheim)
- Schofield, R.E. (1963). *The Lunar Society of Birmingham: A Social History of Provincial Science and Industry in Eighteenth Century England*. Clarendon Press. (Oxford)
- Schumann, E. (1893). *Geschichte der Naturforschenden Gesellschaft in Danzig 1743 — 1802*. Commissions-verlag von Wilhelm Engelmann. (Danzig)
- Schütte, F. (2007). Jahrzehnt der Neuordnung 1890-1901. Die Reform des technischen und allgemeinen Bildungssystems in Deutschland. Berufspädagogische Anmerkungen zu einem bildungshistorisch-disparaten’Forschungsfeld. *Zeitschrift für Pädagogik*, 53(4), 544–561.

- Serafinelli, M., & Tabellini, G. (2022). Creativity over time and space. *Journal of Economic Growth*, 27(1), 1–43.
- Singels (1923). *Gedenkboek van het Provinciaal Utrechtsch genootschap voor kunsten en wetenschappen 1773-1923. Uit de geschiedenis van het P.U.G. (Provinciaal Utrechtsch Genootschap) 1773-1923*. Utrecht / A. Oosthoek. (Utrecht)
- Société Royale des Sciences (2024). *Histoire résumée de l'Académie des Sciences et Lettres de Montpellier*. Retrieved from <https://www.ac-sciences-lettres-montpellier.fr/academie/histoire> (Consulted in April 2024)
- Squicciarini, M.P. (2020). Devotion and development: religiosity, education, and economic progress in nineteenth-century france. *American Economic Review*, 110(11), 3454–3491.
- Squicciarini, M.P., & Voigtländer, N. (2015). Human capital and industrialization: Evidence from the age of enlightenment. *The Quarterly Journal of Economics*, 130(4), 1825–1883.
- Stanislas, A. (2024). *Historique*. Retrieved from <https://www.academie-stanislas.org/historique-general/> (Consulted in April 2024)
- Stelter, R., de la Croix, D., Myrskylä, M. (2021). Leaders and laggards in life expectancy among European scholars from the sixteenth to the early twentieth century. *Demography*, 58(1), 111–135.
- Sturges, P. (1978). *The Membership of the Derby Philosophical Society, 1783–1802* (Vols. 4, Issue 3). Midland History. (Birmingham)
- Sun, L., & Abraham, S. (2021). Estimating dynamic treatment effects in event studies with heterogeneous treatment effects. *Journal of Econometrics*, 225(2), 175–199.
- Tabarrini, M. (1856). *Degli Studi e delle vicende della Reale Accademia dei Georgofili - nel primo secolo della sua esistenza*. M. Cellini & Co., Firenze.
- Taillefer, M. (1984). *L'Académie des sciences, Inscriptions, et Belles lettres de Toulouse au XVIIe siècle*. CNRS.

Teixeira Rebelo da Silva, J.A. (2015). *A Academia Real das Ciências de Lisboa (1779-1834): ciências e hibridismo numa periferia europeia.* (Thesis, Universidade de Lisboa)

The Royal Society (2024). *History of the Royal Society.* Retrieved from <https://royalsociety.org/about-us/who-we-are/history/> (Consulted in January 2024)

Vallauri, T. (1875). *Storia delle università degli studi del Piemonte.* Stamperia reale di GB Paravia.

Zacek, J.F. (1968). The “Virtuosi” of Bohemia: The Royal Bohemian Society of Sciences. *East European Quarterly - Periodicals Archive Online*, 2, 147 – 159.

Zanardello, C. (2022). Scholars and Literati at the University of Turin(1404 – 1800). *Repertorium Eruditorum Totius Europae*, 7, 31–38.

Zeeuwssch Genootschap der Wetenschappen (2024). *Historie.* Retrieved from <https://kzgw.nl/kzgw/historie/> (Consulted in April 2024)

## Appendix A Marat's pamphlet

English translation: **Modern Charlatans, or Letters on Academic Charlatanism**

"It [i.e., the Academy of Sciences] took a radiant sun as her symbol and this modest epigraph as its motto: *Invenit et perfecit*, not that it ever made any discovery or that it has never perfected anything, because all that came out of its heart was a heavy collection of aborted memoirs, which sometimes serve to fill a void in the great libraries. On the other hand, it has assembled 11,409 times, it has published 380 praises, it has given 3,965 approvals, both on new recipes for makeup, hair pomades, plasters for corns, ointments for bedbugs, as well as on the most advantageous form of false toupees, wig heads, syringe cannulas, and on a thousand other objects of similar importance; glorious works, well done to console us for the immense sums it costs us annually.[6] Taken collectively, it must be regarded as a society of vain men, very proud to gather together twice a week, to chat at ease over the fleur-de-lys, or, if you like it better, as a brotherhood of mediocre men, knowing very little and believing they know everything, mechanically given over to the sciences, judging on their word, incapable of delving into anything, attached by self-esteem to old opinions and almost always at odds with common sense."

[6] The budget of the Academy of Sciences, in 1790, amounted to 83,458 pounds.

Original version: **Les charlatans modernes, ou Lettres sur le charlatanisme académique**

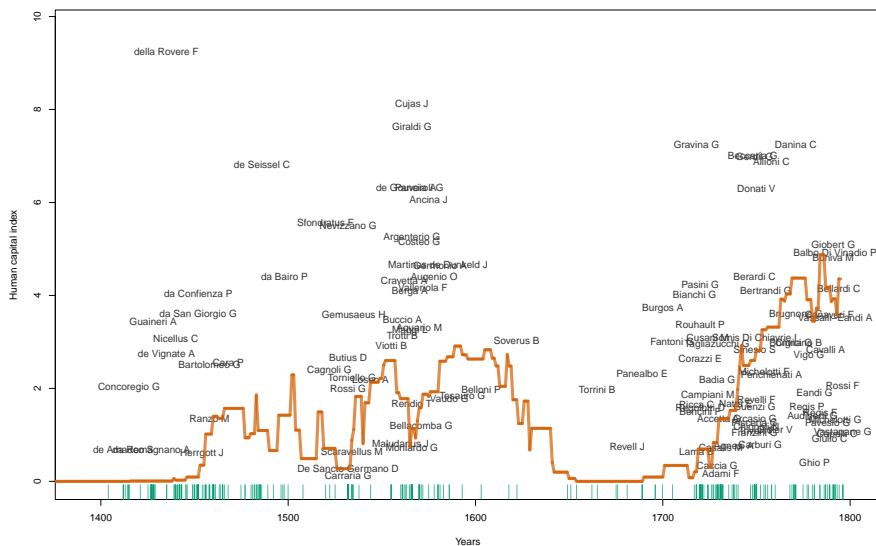
"Elle [Académie des Sciences] a pris, dit-il, pour symbole un soleil radieux et pour devise cette modeste épigraphe : *Invenit et perfecit*, non qu'elle ait jamais fait aucune découverte ou qu'elle ait jamais rien perfectionné, car il n'est sorti de son sein qu'une lourde collection de mémoires avortés, qui servent quelquefois à remplir un vide dans les grandes bibliothèques. En revanche, elle s'est assemblée 11 409 fois, elle a publié 380 éloges, elle a donné 3 965 approbations, tant sur de nouvelles recettes de fard, de pommades pour les cheveux, d'emplâtres pour les cors, d'onguens pour les punaises, que sur la forme la plus avantageuse des faux toupet, des têtes à perruque, des canules de seringues, et sur mille autres objets de pareille importance ; travaux glorieux, bien faits pour nous consoler des sommes immenses qu'elle nous coûte annuellement.

[6] Prise collectivement, elle doit être regardée comme une société d'hommes vains, très fiers de se rassembler deux fois par semaine, pour bavarder à l'aise sur les fleurs de lys, ou, si tu l'aimes mieux, comme une confrérie d'hommes médiocres, sachant fort peu de choses et croyant tout savoir, livrés machinalement aux sciences, jugeant sur parole, hors d'état de rien approfondir, attachés par amour-propre aux anciennes opinions et presque toujours brouillés avec le bon sens."

[6] Le budget de l'Académie des Sciences, en 1790, montait à 83 458 livres.

Source: Boissier (1907), p.725-726

## Appendix B Descriptive Statistics



**Fig. B1** Ordinary member at the University of Turin with a non-negative individual quality index. Vertical green lines show their distribution over time considering also scholars with a zero quality index. The orange like displays the dynamic of the aggregate quality of the university. Figure taken from Zanardello (2022).

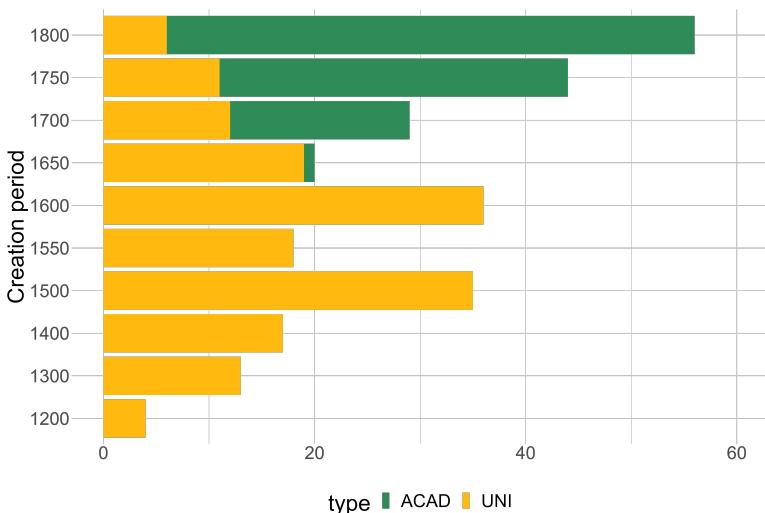
**Table B1** Summary Statistics ACAD Founders (1) VS not Founders (2) indicating the averages of each group. The coefficients in column (3) indicate the significance of the differences between averages of group (1) and (2), considering year fixed effects.

| Obs.               | (1)<br>Founders | (2)<br>Not<br>Founders | (3)<br>t-test |
|--------------------|-----------------|------------------------|---------------|
|                    | 413<br>$\mu$    | 16860<br>$\mu$         | p-value       |
| Quality            | 2.67            | 2.41                   | 0.426         |
| Age at death       | 68              | 67                     | 0.189         |
| Age at Appointment | 36.7            | 37.3                   | 0.611         |
| Activity Years     | 19.5            | 16                     | 0.338         |
| Dist. Birth-ACAD   | 220             | 344                    | 0.003         |
| Dist. ACAD-Death   | 317             | 421                    | 0.260         |
| Dist. Birth-Death  | 248             | 368                    | 0.074         |
| Year FE*           |                 |                        | YES           |

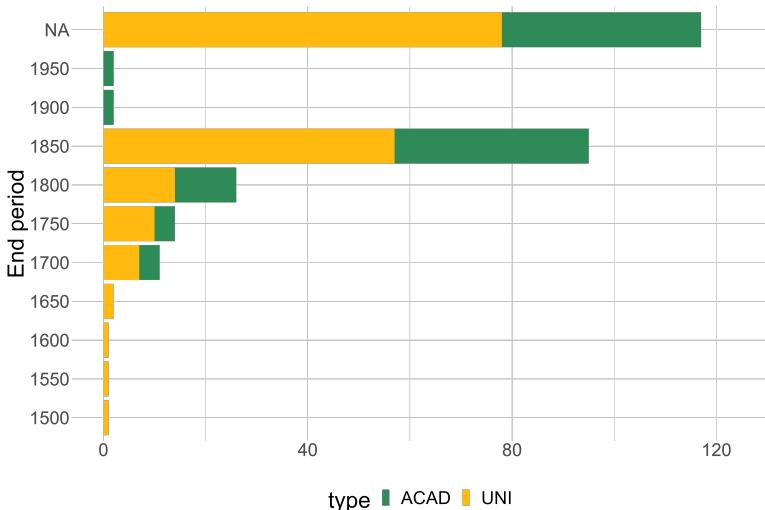
Note:

\* p<0.1; \*\* p<0.05; \*\*\* p<0.01

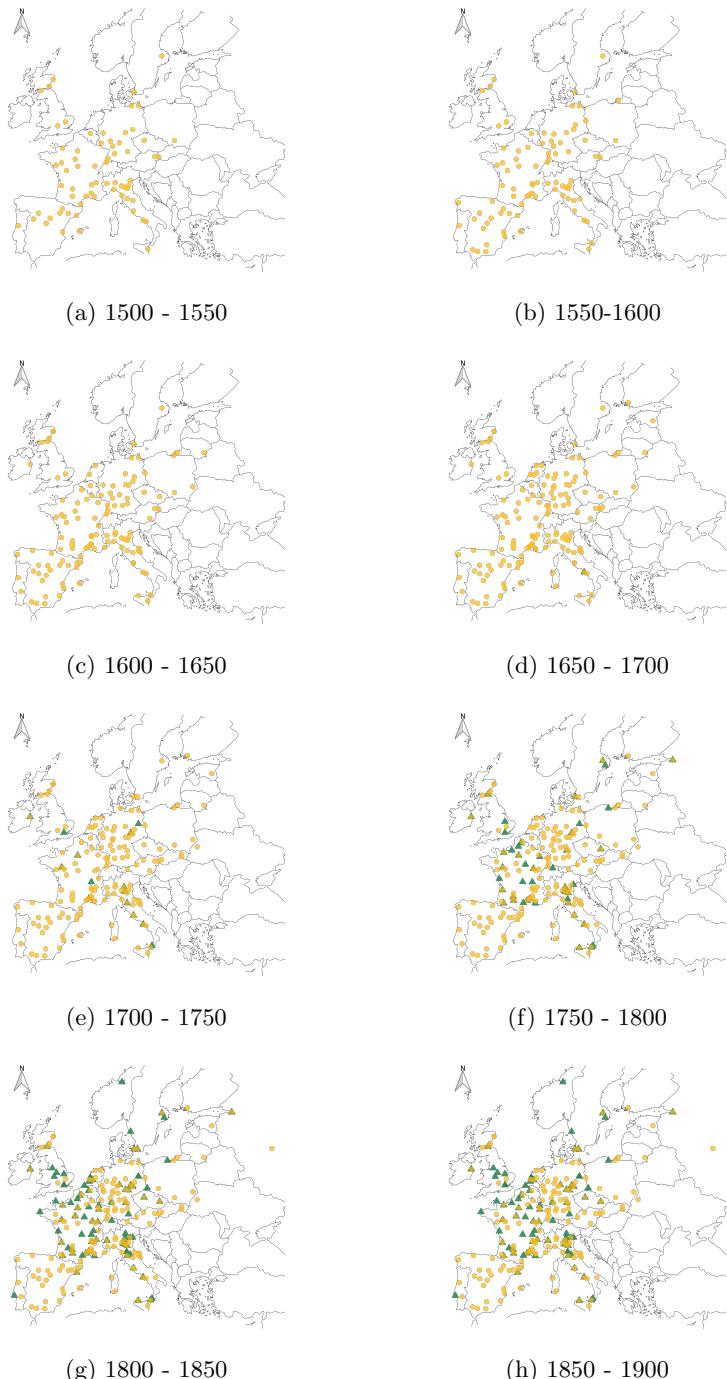
\*) Year FE are relative to the initial year of activity of the scholar.



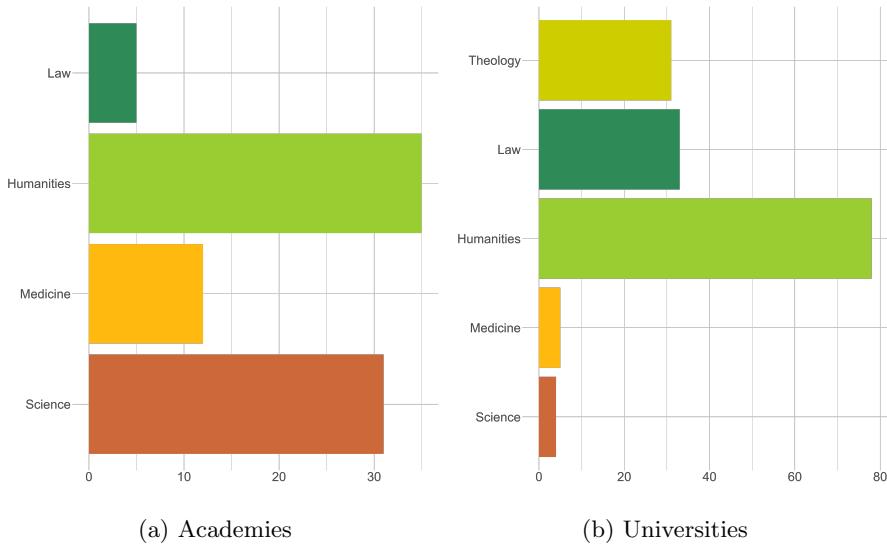
**Fig. B2** Number of institutions created in the period before the year indicated in the y-axis. It shows that universities have a more heterogeneous creation dates compared to academies: universities were created since the 11<sup>th</sup> century, while academies started to spread from the second half of the 17<sup>th</sup> century.



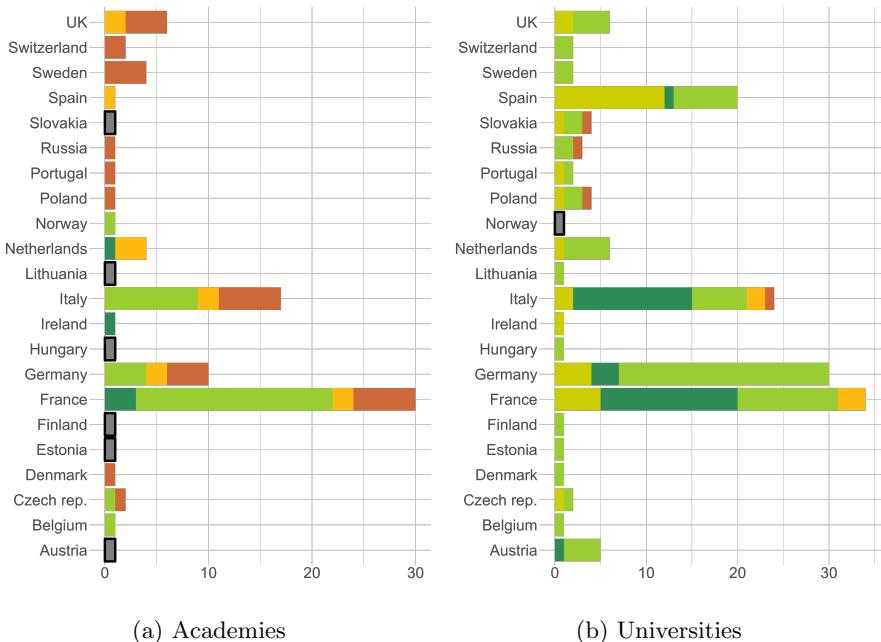
**Fig. B3** Number of institutions closed in the 50 years before the year indicated in the y-axis. NA indicates institutions that never closed. It is clear that most institutions remained open before 1800, many closes between 1800 and 1850 but most of them are still open today.



**Fig. B4** Educational institutions location (1500 - 1900 CE): yellow bubbles represent universities, green triangles represent academies. When the two institutions are created in the same city there is an interaction, which is captured by the overlapping of the two shapes. Countries borders as in 2000.



**Fig. B5** Number of institutions by main field of study – *main field of study* being the field studied by the majority of members in the institution.



**Fig. B6** Number of institutions by major field of study per country. For major field of study, I mean the field most studied in the institution, without considering any specific threshold. Science is in red, Medicine is in gold, Humanities are in light green, Law is in dark green, Theology is in lime. Countries without a specific institution are represented in grey and highlighted by a solid black line.

**Table B2** Summary statistics at aggregate level, divided by academies and universities

|                          | ACADEMIES |       |       |        | UNIVERSITIES |       |       |       |        |     |
|--------------------------|-----------|-------|-------|--------|--------------|-------|-------|-------|--------|-----|
|                          | Mean      | Med   | Min   | Max    | Obs          | Mean  | Med   | Min   | Max    | Obs |
| Total activity years     | 137       | 81    | 2*    | 372**  | 101          | 366   | 356   | 3*    | 936*** | 171 |
| Creation Date            | 1740      | 1750  | 1650  | 1793   | 101          | 1517  | 1548  | 1088  | 1781   | 171 |
| End Date                 | 1877      | 1794  | 1667  | 2024   | 101          | 1883  | 1811  | 1460  | 2024   | 171 |
| <b>Total size</b>        | 137       | 57    | 1†    | 1622‡  | 101          | 155   | 70    | 0†    | 1958§  | 171 |
| % SCIENCE                | 53.2%     | 53.0% | 0.0%  | 100.0% | 101          | 20.7% | 19.1% | 0.0%  | 100.0% | 171 |
| % LITERARY               | 43.1%     | 43.1% | 0.0%  | 100.0% | 101          | 74.7% | 76.9% | 0.0%  | 100.0% | 171 |
| % UNKNOWN                | 2.4%      | 0.0%  | 0.0%  | 28.7%  | 101          | 2.8%  | 0.0%  | 0.0%  | 31.3%  | 171 |
| <b>Size in 1650-1700</b> | 238       | 49    | 2     | 1622‡  | 16           | 91    | 50    | 12    | 246°   | 12  |
| % SCIENCE                | 58%       | 56.4% | 19.6% | 100.0% | 16           | 20.8% | 19.2% | 0.0%  | 40.0%  | 12  |
| % LITERARY               | 39.3%     | 41.8% | 0.0%  | 73.9%  | 16           | 74.3% | 75.5% | 60.0% | 84.4%  | 12  |
| % UNKNOWN                | 2.6%      | 0.0%  | 0.0%  | 14.0%  | 16           | 4.9%  | 1.7%  | 0.0%  | 16.7%  | 12  |
| <b>Size in 1700-1750</b> | 142       | 70    | 4     | 873⊕   | 33           | 65    | 26    | 1     | 354⊕   | 11  |
| % SCIENCE                | 49.1%     | 47.4% | 0.0%  | 100.0% | 33           | 28.8% | 19.1% | 0.0%  | 67.8%  | 11  |
| % LITERARY               | 49.5%     | 51.7% | 0.0%  | 100.0% | 33           | 69.6% | 81.0% | 19.4% | 100.0% | 11  |
| % UNKNOWN                | 1.4%      | 0.0%  | 0.0%  | 12.9%  | 33           | 1.6%  | 0.0%  | 0.0%  | 12.9%  | 11  |
| <b>Size in 1750-1800</b> | 103       | 52    | 1†    | 480•   | 52           | 27    | 20    | 1     | 71•    | 6   |
| % SCIENCE                | 54.4%     | 54.3% | 0.0%  | 100.0% | 52           | 34.2% | 33.6% | 0.0%  | 80.0%  | 6   |
| % LITERARY               | 42.6%     | 42.1% | 0.0%  | 100.0% | 52           | 65.5% | 65.7% | 20.0% | 100.0% | 6   |
| % UNKNOWN                | 3%        | 0.0%  | 0.0%  | 28.7%  | 52           | 0.2%  | 0.0%  | 0.0%  | 1.4%   | 6   |

\* Refer to *Accademia della Traccia* in Bologna (ITA, 1665), and to *Corte University* in France (1765).

\*\* Refer to *Leopoldina Academy* in Halle (DEU, 1652), and to the *University of Bologna* in Italy (1088).

† Refer to *Naturforschende Gesellschaft* in Jena (DEU, 1793), and to the universities for which we did not find any member yet in Burgo-de-Osma (ESP, 1555), Genova (ITA, 1471), and Palma (ESP, 1483).

‡ Refer to the *Royal Society* in London (UK, 1660), and to the *University of Cambridge* in UK (1209).

◦ Refer to the *University of Lund* in Sweden (SWE, 1666).

⊕ Refer to the *Prussian Academy* in Berlin (DEU, 1700), and to the *University of Göttingen* in Germany (1734).

• Refer to the *Erfurt Academy* in Germany (DEU, 1754), and to the *University of Moscow* in Russia (1755).

## B.1 Statistics on city population

Table B3 presents descriptive statistics including the median and third quantile, for population levels in different subsets of cities. These subsets consist of cities that ever had a university (columns 3 and 4) or an academy (columns 5 and 6) for at least one period, compared to the entire sample of cities (columns 1 and 2) and cities with no higher educational institutions at all (columns 7 and 8). The city samples remain constant over time. The results indicate that even prior to the relevant period of analysis (1000-1400), cities with higher educational institutions were experiencing faster population growth. Specifically, when comparing larger cities in the general sample (column 2) to the median city with a university at a certain point in time (column 3), it becomes evident that while the general sample did not experience significant growth after 1200, cities that had universities showed continuous growth over time. This pattern is even more pronounced when examining cities with an academy at a certain point in time (column 5). This table reveals that higher educational institutions were established in cities that were experiencing faster growth prior to the Black Death, and although the difference temporarily diminished afterward, it began to grow again towards the end of the period considered.

**Table B3** Descriptive statistics of city population

| cities<br>N. cities | <b>ALL</b><br>2096 |            | <b>UNI</b><br>153 |            | <b>ACAD</b><br>83 |            | <b>NO INST.</b><br>1902 |            |
|---------------------|--------------------|------------|-------------------|------------|-------------------|------------|-------------------------|------------|
|                     | (1)<br>Med         | (2)<br>75% | (3)<br>Med        | (4)<br>75% | (5)<br>Med        | (6)<br>75% | (7)<br>Med              | (8)<br>75% |
| 1000                | 1                  | 2          | 2                 | 5          | 3                 | 6.5        | 1                       | 2          |
| 1100                | 1                  | 2          | 3                 | 7          | 3                 | 8.5        | 1                       | 2          |
| 1200                | 2                  | 3          | 4                 | 10         | 5                 | 12         | 1                       | 3          |
| 1300                | 2                  | 3          | 7                 | 15         | 8                 | 18         | 2                       | 3          |
| 1400                | 1                  | 3          | 5                 | 12         | 6                 | 17         | 1                       | 2          |
| <b>1000 - 1400</b>  | <b>1</b>           | <b>3</b>   | <b>4</b>          | <b>10</b>  | <b>5</b>          | <b>11</b>  | <b>1</b>                | <b>2</b>   |
| 1500                | 2                  | 4          | 7                 | 17         | 9                 | 25         | 2                       | 4          |
| 1600                | 3                  | 6          | 11                | 25         | 16                | 39.5       | 3                       | 5          |
| 1700                | 4                  | 6          | 13                | 27         | 20                | 41.5       | 4                       | 6          |
| 1800                | 6                  | 10         | 19                | 33         | 30                | 73.5       | 6                       | 9          |
| 1900                | 16                 | 33         | 54                | 108        | 85                | 295.5      | 15                      | 28         |
| <b>1500 - 1900</b>  | <b>5</b>           | <b>10</b>  | <b>15</b>         | <b>33</b>  | <b>24</b>         | <b>55</b>  | <b>5</b>                | <b>9</b>   |

Note: Inhabitants in 000-s in every column. The sample of cities do not change over the time periods.

Med is the median, 75% is the third quantile.

## Appendix C Additional OLS results: time-varying controls

In the main text (Section 5.1), I consider the whole sample of cities in Buringh (2021) for which I do not have time-varying controls. This arises omitted variable concerns. Therefore in this section, I prove that city and time FE already provide the most important piece of information by showing that results do not change by adding time-varying controls.

I can do this only for the sample of big cities for which I have time-varying controls until 1800 from Bosker et al. (2013). I first select the time variant characteristics from Bosker et al. (2013) by looking at the dynamic of every independent variable available in the dataset. It is clear that many cities had been *plundered* different number of times depending on the year considered. In addition, Bruges (Belgium) and Seville (Spain) stopped having a direct access to the *sea* between 1500 and 1900, some cities became/ceased to be a *bishop*, an *archbishop* or a *capital* in this period. Again, *Muslim* and *Christian urban potential* (defined as in Bosker et al. (2013) to be a “distance-weighted sum of the size of all other Muslim or Christian cities” (p.1423), for the formula check p.1423 in Bosker et al. (2013).) changes for most cities over the period. Granada ceased to host a *Madrasa* between 1500 and 1600 (*Madrasa* being a higher educational institution in the Arab world). Finally, some cities became or ceased to be influenced by *Muslim* religion. All the other determinants present a stable dynamic: distances to Rome, to Mecca, to Byzantium, the quality of the soil,<sup>36</sup> the logarithm of the elevation above the see in meters, the logarithm of the standard deviation of the elevation of the terrain in a 10km radius in meters, having direct access to a river, to a Roman road, or to more than two Roman roads, and being a Christian holy city.

City FE will certainly capture these time-invariant characteristics but they may not consider the information provided by time-varying controls. Nonetheless, this is not a concern here, given that the OLS estimates do not vary much when I include time-varying determinants in Table C4: any of the coefficients in Column (3) and (4) is not significant, and only the coefficient associated with the presence of the university change sign but also remains very close to zero - all the other coefficients have the same sign with (Column 3) or without (column 4) time-varying controls.

In Table C4, Columns (1) and (2) complements results presented in the main text in Table 3 and it shows very similar trends.

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<sup>36</sup>Bosker et al. (2013) utilize the composite indicator of Ramankutty, Foley, Norman, and McSweeney (2002). For more details refer to p.1422 in Bosker et al. (2013).

**Table C4** OLS estimator - BIG cities as in Bosker et al. (2013)

|                        | ln pop in 1500-1900 |                     | ln pop in 1500-1800 |                   |
|------------------------|---------------------|---------------------|---------------------|-------------------|
|                        | (1)                 | (2)                 | (3)                 | (4)               |
| <b>ACAD</b>            | 0.346**<br>(0.163)  | 1.252***<br>(0.256) | 0.190<br>(0.127)    | 0.177<br>(0.157)  |
| <b>UNI</b>             | 0.102*<br>(0.061)   | 0.708***<br>(0.084) | 0.005<br>(0.063)    | -0.05<br>(0.061)  |
| <b>ACADxUNI</b>        | -0.235<br>(0.213)   | -0.481<br>(0.329)   | -0.048<br>(0.173)   | -0.104<br>(0.206) |
| Obs.                   | 633                 | 633                 | 633                 | 633               |
| R <sup>2</sup>         | 0.742               | 0.464               | 0.795               | 0.752             |
| $\Delta time$ controls | NO                  | NO                  | YES                 | NO                |
| <i>city</i> FE         | YES                 | NO                  | YES                 | YES               |
| <i>time</i> FE         | YES                 | YES                 | YES                 | YES               |
| <i>country</i> FE      | NO                  | YES                 | NO                  | NO                |

Note: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01

Standard errors in parenthesis clustered at city level.

Time varying ( $\Delta time$ ) controls are having direct access to the sea, having a bishop or an archbishop, being a capital city, having a madrasa, being plundered n. times, Muslim or Christian urban potential, and being a Muslim city.

## Appendix D Static TWFE

In this section, I present the estimate of a traditional static Two-Way-Fixed-Effects specifications as follows:

$$\ln POP_{ct} = \beta_0 + \beta_1 EVENT_{c}xPost_{ct} + \mu_c + \lambda_t + \epsilon_{ct} \quad (\text{D1})$$

where  $\mu_c$  and  $\lambda_t$  are city and time FE respectively, and  $\epsilon_{ct}$  is the unobserved error term.  $\ln POP_{ct}$  is the logarithm of the population size of city  $c$  at time  $t$ , and it is the outcome variable in these specifications.  $Post_{ct}$  is an indicator variable taking value 1 the periods after the creation of an ACAD or a UNI in city  $c$  (e.g.,  $EVENT_{ct}$ ). The coefficient of interest is  $\beta_1$  and should identify the average increase in cities' population size after the creation of an academy relative to cities with no academies. Static TWFE models shows conservative estimates because they underweight long-run effects favouring short-run effects. Nonetheless, I cannot claim the main assumption of homogeneity across time and space, which makes the identification through static TWFE not possible. I present the single coefficient estimates only for completeness, while more robust dynamic TWFE and new DID estimators are also presented in the main text.

**Table D5** Effect of creating an academy (ACAD), a scientific academy ( $ACAD_{science}$ ), or a literary academy ( $ACAD_{literary}$ ) on log city population between 1500 and 1900.

|                                       | ln pop in 1500-1900 |                     |                     |
|---------------------------------------|---------------------|---------------------|---------------------|
|                                       | (1)                 | (2)                 | (3)                 |
| <b>ACAD x Post</b>                    | 0.202**<br>(0.083)  |                     |                     |
| <b>ACAD<sub>science</sub> x Post</b>  |                     | 0.297**<br>(0.119)  |                     |
| <b>ACAD<sub>literary</sub> x Post</b> |                     |                     | 0.093<br>(0.111)    |
| <b>Constant</b>                       | 1.291***<br>(0.009) | 1.291***<br>(0.009) | 1.291***<br>(0.009) |
| Obs.                                  | 2056                | 2056                | 2056                |
| within R <sup>2</sup>                 | 0.641               | 0.641               | 0.640               |
| city FE                               | YES                 | YES                 | YES                 |
| time FE                               | YES                 | YES                 | YES                 |

Note: \* p<0.1; \*\* p<0.05; \*\*\* p<0.01

Standard errors in parenthesis clustered at city level.

## Appendix E Academies: historical context

### E.1 Academies' characteristics by country

In this Section, I list the main characteristics of the official recognition, topics of study, memberships and meetings, general governance, and financing of academies by modern country:

- France

**Official Recognition.** Generally, French academies received official recognition from the King relatively quickly, often within 10 years of their informal foundation. For example, the *Académie des Sciences, belles lettres et arts in Besançon* received official recognition in 1752, just a few years after it was formed in 1748 (Defrasne, Maurat, Lordereau, & Lassus, 2002). The first meeting of the academy of Nancy was held on December 28, 1750, and the patent letters arrived exactly one year later, on December 27, 1751 (Stanislas, 2024). Most academies received these patent letters, signifying both royal approval and often some form of financial support either from the Royal Court or from local authorities (e.g., lords and bishops).

**Topics of Study.** French academies covered a wide range of subjects, including natural sciences, humanities, arts, and practical issues related to local regions. The emphasis on applied science and knowledge for the betterment of society was particularly evident in academies like those in Châlons-sur-Marne and Cherbourg. In Châlons-sur-Marne, the academy's motto was “*L'Utilité*” (literally “The Utility”, (Roche, 1964)), signalling a focus on improving the living standards of the local community. The *Société Académique* in Cherbourg organized local competitions to incentivize young researchers in hydrography (Académie de Cherbourg, 2024). The experimental approach and the influence of the “New Science” were significant factors, as is clear from the creation of the *Académie Royale des Sciences* in Paris. The latter was officially founded by the minister Colbert “to advance scientific knowledge and promote the practical application of scientific research” (de la Croix & Zanardello, 2022, p.1).

**Memberships and Meetings.** French academies typically had three membership categories: ordinary members, who usually resided in the city of the academy; honorary members, who were influential personalities who brought fame and reputation to the institutions without advancing knowledge themselves, and correspondents, often foreign, who did not reside permanently in the city but sent letters with their thoughts and findings to be read by the ordinary members during meetings. There was often an upper limit on the number of ordinary members, explicitly written in the *Statutes* and varying according to the academy, but there was no limit on correspondents and honorary members.<sup>37</sup>

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<sup>37</sup>Sometimes honorary members were also limited to a specific number, but for this category, exceptions were applied more regularly than the rule itself.

Meetings were generally regular, often weekly or bi-weekly, with meeting days written into the *Statutes* of the academies.

**Governance.** Most French provincial academies had a hierarchical structure very similar to the Paris Academy, with directors, secretaries, treasurers, librarians, and often a protector (usually a high-ranking figure like the King, or a local noble or bishop).<sup>38</sup> The directors or presidents of the academy were elected members and held office for a certain number of months. Secretaries and librarians were also elected members but usually stayed in their roles permanently. Treasurers were often also the vice-directors, but for this role, there was more variability among the provincial academies.

**Finances.** Finances often came from a combination of royal support, member fees, private donations, and sometimes bequests. Some academies received annual subsidies from the King (e.g. the Paris Academy, Boissier (1907)), others only at the beginning of their activities, while others relied on private contributions to achieve some independence from the central power.

- Italy

**Official Recognition.** Italian academies were often established informally before receiving official recognition from local rulers or the Pope. Official recognition was sometimes delayed, with some academies operating for several decades before receiving official status. For instance, it was 26 years before the King of Savoy recognized the Academy of Sciences in Turin. While many Italian academies were recognized by local rulers, the Pope's authority was significant, particularly for institutions like the *Istituto delle Scienze* in Bologna, which relied heavily on Pope Benedict XIV's donations.

**Topics of Study.** Italian academies were inspired by the “New Science” and its experimental approach, particularly in the early period, thanks to the influence of scholars like Galileo Galilei and his followers. Academies such as the *Accademia del Cimento* in Florence (founded by two students of Galileo) (Knowles Middleton, 1971; Maylender, 1930) and the *Accademia degli Investiganti* in Naples (Maylender, 1930) are examples of early Italian institutions focused on experimental research. Italian academies frequently focused on natural philosophy, physics, mathematics, and astronomy, but also explored literature, history of the homeland, and practical issues like agriculture. In Florence, the Georgofili Academy worked closely with local authorities to reduce the impact of famines in 1791/1792, giving advice which proved to be beneficial and thus gaining credibility (Tabarrini, 1856).

**Memberships and Meetings.** Italian academies had various membership categories, including ordinary members, honorary members, and foreign correspondents, but in a much less centralized manner than their French provincial counterparts. The *Statutes* of Italian academies rarely contain rules about the maximum number of members. Meeting frequency varied significantly depending on the academy, with some meeting only once a month.

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<sup>38</sup>From here on, when I use the term ‘hierarchical’ structure, I am referring to the French-like organization, where specific figures are either elected or appointed for life or for a set term.

**Governance.** Governance structures were diverse, ranging from the more to less democratic. Some academies were overseen by a patron, while others had elected leaders and committees. The *Accademia ducale dei Dissonanti* of Modena had in its name the word “ducale” (i.e., literally “of the Duke”), explicitly indicating the Ducal patronage and his high level of influence over academic matters (Accademia Nazionale di Scienze, Lettere e Arti di Modena, 2023).

**Finances.** Italian academies had various sources of funding, mainly from patronage and member fees, but also from private donations and sometimes subsidies from the local or provincial church. Royal patronage was particularly important for some institutions, as mentioned above, but its generosity varied significantly.

- Germany

**Official Recognition.** For German academies, official recognition did not follow any specific pattern. It could come from local rulers or patrons, with variations in the timing and type of recognition. For example, the academy of Göttingen was directly established as a “Royal Society” by King George II of Great Britain and Ireland, and Elector of Hanover (Niedersächsische Akademie der Wissenschaften zu Göttingen, 2024). The city of Mannheim hosted two academies,<sup>39</sup> thanks to the Elector Palatine of Bavaria, Karl Theodor (Cassidy, 1985). Not obtaining recognition often meant more independence, as in the case of the academy of Görlitz, which did not obtain any official recognition, and remained a private society from its foundation in 1779 (Oberlausitzische Gesellschaft der Wissenschaften, 2024).

**Topics of Study.** German academies covered a wide range of subjects, including natural sciences, humanities, and applied sciences. There was a strong emphasis on experimental research and the use of empirical data, as seen in academies like the *Gesellschaft Naturforschender Freunde* in Berlin and the *Naturforschende Gesellschaft* in Jena. The former focused on producing original research on natural history thanks to their own data collections (Böhme-Käßler, 2005). The latter aimed to supplement university lessons with more empirical applications through their collection of instruments and their own laboratory (Böhme-Käßler, 2005).

**Memberships and Meetings.** German academies had a mix of ordinary members, honorary members, and sometimes foreign correspondents. Meetings were generally regular, with weekly or bi-weekly gatherings being common.

**Governance.** Unlike France, governance structures in Germany were diverse, ranging from more informal and democratic to more hierarchical and patron-driven.

**Finances.** Finances were typically derived from a combination of member fees and donations, with patron support and government subsidies both being

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<sup>39</sup>The *Accademia Electoralis Scientiarum et Elegantiorum Literarum Theodoro-Palatina* created in 1763 and the *Societas Meteorologicae Palatinæ* founded in 1780.

important sources. Patronage was particularly important in Germany, and the stability of the academy was highly dependent on it.

- Great Britain

**Official Recognition.** British academies were mostly informal, with only the Royal Society of London and the academy of Edinburgh obtaining official recognition. The timing differed significantly between the two: the Royal Society was recognized in 1662, about two years after its creation, while Edinburgh waited 52 years to obtain its royal charter in 1783.<sup>40</sup>

**Topics of Study.** British academies were primarily devoted to natural philosophy and scientific experimentation, taking the *Royal Society* as a model. Its motto “*nullius in verba*” (which translates “into take nobody’s word for it”) is a clear statement of the will to use the experimental perspective to test and verify every fact and conclusion (The Royal Society, 2024). The experimental approach was central to their work, as demonstrated by institutions like the *Lunar Society* of Birmingham, which focused on applied science and its relevance to industry, with members like James Watt (a mechanical engineer who worked on steam engines), Erasmus Darwin (natural philosopher, poet, and grandfather of Charles), and Richard Lovell Edgeworth (grandfather of Francis Ysidro)<sup>41</sup> (Schofield, 1963).

**Memberships and Meetings.** British academies typically had various membership categories, including ordinary fellows, honorary members, and foreign correspondents. However, for many British academies, including the Royal Society, it is impossible to distinguish between ordinary and correspondent members, as all members are called “fellows” in their records. In our database, the category is identified only for specific years for which we know the list of foreign members as detailed in De Candolle (1885).

Meetings were generally regular, often weekly, with specific days designated for gatherings.

**Governance.** Most academies had a hierarchical structure, with presidents, secretaries, treasurers, and sometimes other elected officials.

**Finances.** British academies had very similar finances to those in other countries, with a combination of member fees and donations. Patron support and subsidies were rarer in Great Britain.

- Rest of Europe

- **Russia.** The only Russian academy in my analysis is the one in Saint Petersburg. It was created under the direct patronage of Tsar Peter the Great, who fully financed and controlled it by retaining the right to

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<sup>40</sup>Edinburgh presents a complex case: the 52 years are calculated from the founding of its predecessor, the “*Philosophical Society of Edinburgh*”. Although it was inactive for a period, it later resumed with only minor changes in its membership, which is why we regard both societies as a single academy, established in 1731.

<sup>41</sup>Francis Ysidro is considered the pioneer of utility theory with his development of indifference curves and the Edgeworth box.

approve new memberships. This academy was devoted to advancing Russia through the study of sciences and mathematics, along with history and humanities. The educational aspect was much more significant for this academy than for those in the rest of Europe.

- **North Europe.** In the Netherlands, Sweden, Ireland, Belgium, Denmark, and Norway, official recognition was much more widespread than in the rest of Europe, with only a few informal or private academies. Nevertheless, the timing of granting recognition could vary from almost no wait to 19 years. This was the case for the Royal Dublin Society, which originated from a previous society in 1731 and obtained its royal charter only on April 2, 1750 (Berry, 1915). The topics of research were very similar to the rest of Europe, ranging from natural science to practical applications to improve local society.
- **East Europe.**<sup>42</sup> In the Czech Republic both of the academies, in Prague and Olomouc, received official recognition, while in Switzerland the academies were mostly private societies (Kostlán, 1996; Zacek, 1968). Olomouc stood out for its open-minded atmosphere, where Catholics and Protestants collaborated and helped each other (Kostlán, 1996). The topics of study focused on natural history and improving the efficiency of agriculture, which was especially important for Switzerland (Rübel, 1947).
- **South Europe.** Both Spain and Portugal had one scientific academy each,<sup>43</sup> and both were officially recognized a year after their creation. Patronage was an important source of finance for these societies as well (Teixeira Rebelo da Silva, 2015). The topics were similar, focusing on the advancement of the local region.

## E.2 Academies' establishments

- **Acad Agen.** The “*Société des Sciences, arts et belles lettres*” was created in Agen (FRA) on January 1, 1776 and officially recognized in 1788. The main goal was to provide a forum for intellectual discussion. It was focused on advancing knowledge in various fields, including arts, sciences, and belles-lettres (Lauzun, 1900).
- **Acad Amiens.** The “*Académie des Sciences, belles lettres et arts*” was founded in Amiens (FRA) in February 1746 and officially recognized in 1750. It was initiated by Chauvelin German Louis (lawyer), Gresset Jean-Baptiste (poet), and d'Albert d'Ailly Michel Ferdinand (governor and scientist). It

<sup>42</sup> McClellan (1985) does not include any academy in Poland; however, the "Warsaw Society of Friends of Science" (*Towarzystwo Przyjaciół Nauk*) was established in 1800 and remained active until 1832. It is the earliest scientific academy recorded in Poland. Nevertheless, I will not include it in the analysis, as data collection has only recently begun.

<sup>43</sup> I refer to the list in McClellan (1985), which includes only one Spanish and one Portuguese academy. However, we recently found two other scientific academies in Madrid. The oldest is *Real Academia de Matemáticas de Madrid* created in 1582 and hence out of the academy movement I study in this paper. However, it may be argued that it contributed to its origins. The other is the Royal Spanish Academy, founded in Madrid in 1713 and dedicated to the study of all sciences (Real Academia de Ciencias Exactas, Físicas y Naturales de España , 2024). Despite this, I cannot include these academies in my analysis, given we only started the search for reliable sources and data.

aimed to cultivate the spirit and shape taste through perfecting language, art, and knowledge. It had a structured governance with a hierarchy and specific tasks for its members (*Académie des sciences, des lettres et des arts d'Amiens*, 1901).

- **Acad Angers.** The “*Académie des sciences, belles lettres et arts d'Angers*” was founded in Angers (FRA) on March 31, 1684, and received official recognition through patent letters from Luis XIV in June 1685. It was established under the proposition of the mayor of Angers, Jacques Charlot (Bois, 2021).
- **Acad Arras.** The “*Académie Royale de belles lettres*” was founded in Arras (FRA) on May 22, 1737, but received official recognition with patent letters in 1773. It was founded by the writer Pierre Antoine de La Place, the military engineer Victor-Hyacinthe d'Artus, and the counsellor Galhaut de Lassus. The academy sought to advance knowledge in literature and the arts. It had a structured governance with different categories of members and a protector. Maximilien de Robespierre joined the Academy of Arras in 1783, highly increasing the academy reputation (Académie des Sciences, Lettres et Arts d'Arras, 2024).
- **Acad Arezzo.** The “*Accademia Aretina*” was established in Arezzo (ITA) in 1787. It was founded by a group of 22 scholars to revitalize the intellectual atmosphere that was lacking scientific and literary discussions following the closure of two previous academies (Maylender, 1930, Vol 1). It is still active today.
- **Acad Auxerre.** The “*Académie des Sciences, arts et belles lettres*” was founded in Auxerre (FRA) in April 1749 with the permission of the King and support from M. de Caylus, the bishop of Auxerre. The academy aimed to advance knowledge in various fields, including ecclesiastical, civil, and natural history, physics, and agriculture. Arts and literature were also included in their pursuits. It had a director and a perpetual secretary, similar to the Paris Academy (des Barres, 1851).
- **Acad Barcelona.** The “*Reial Acadèmia de Ciències i Arts de Barcelona*” was founded in Barcelona (ESP) on January 18, 1764, and officially recognized on December 17, 1765. It was established by 15 founders, led by Francesc Subiràs i Barra, the first director. The academy sought to spread scientific and technical knowledge to the city. It is still active today (Reial Acadèmia de Ciències i Arts de Barcelona, 2024).
- **Acad Berlin.** The “*Gesellschaft Naturforschender Freunde zu Berlin (GNF)*” was founded in Berlin (DEU) on July 9, 1773. It was established by the doctor and natural scientist Friedrich Heinrich Wilhelm Martini. The academy aimed to recruit and train young scientists, popularize science, and enhance the experimental study of natural history. It has a structured governance, including ordinary, honorary, and extraordinary members, and is still active today. The Prussian State was financing its activities (Böhme-Käßler, 2005).
- **Acad Besançon.** The “*Académie des Sciences, belles lettres et arts*” was founded in Besançon (FRA) in 1748, and in 1752 officially recognized with

patent letters from Luis XV. It was established by Pourroy de Quinsonas (president of the Franche-Comte Parliament), the duc de Tallard (governor of Comte du Bourgogne), and Moreau de Beaumont (intendant of Franche-Comte). The academy sought to create a lasting and organized forum for advancing knowledge in the sciences and arts. It had a structured governance with a protector and 40 titular members (Defrasne et al., 2002).

- **Acad Beziers.** The “*Académie des Sciences et belles lettres*” was founded in Beziers (FRA) on August 19, 1723, and became a Royal Academy in 1766 with the receipt of patent letters. It was established by the lawyer Antoine Portalon, the physicist Dortous de Mairan, and the doctor Jean Bouillet (Académie de Béziers, 2024).
- **Acad Birmingham.** The “*Lunar Society of Birmingham*” was founded in Birmingham (GBR) in 1766, following the ”Lunar Circle” that formed in 1765. It primarily focused on science, both pure and applied, particularly as it related to industrial problems. Its members were mainly ”provincial manufacturers and professional men.” (Schofield, 1963, p.3) The academy did not have a structured governance. It was known for its monthly meetings held near the full moon (Schofield, 1963).
- **Acad Bologna.** The “*Istituto delle Scienze di Bologna*” was founded in Bologna (ITA) in 1714, although it had informal roots dating back to 1711 and a predecessor, the Inquieti Academy, established in 1690. The academy was founded by Count Luigi Ferdinando Marsili and Eustachio Manfredi, with papal patronage. It was established to foster reforms within the University. The academy’s focus was on experimental sciences, medicine, physics, chemistry, and mathematics. It was the first Italian academy to have academicians employed and paid by public funds (Ercolani, 1881).
- **Acad Traccia.** The “*Accademia della Traccia*” was founded in Bologna (ITA) in 1666. It was established by Abate Carlo Sampieri, following the influence of Geminiano Montanari, a professor at the University of Bologna and a corresponding member of the Cimento Academy. The academy was created as an imitation of the Cimento Academy and focused on experimental physics (Maylender, 1930, Vol 5).
- **Acad Bordeaux.** The “*Académie royale des sciences, belles-lettres et arts*” was founded in Bordeaux (FRA) in 1712, through letters patent issued on September 5th. The academy’s aim was to advance knowledge across a spectrum of disciplines, including belles-lettres, sciences, and arts. Natural history gained prominence with the establishment of the Société d’Histoire Naturelle in 1796. It had a structured governance with ordinary members, associate members, directors, secretaries, and a treasurer (Courteault, 1912).
- **Acad Bourg-en-Bresse.** The “*Académie des Sciences, belles lettres et arts*” in Bourg-en-Bresse (FRA) was initially established in 1755 and then reconstructed in 1783. It was founded by a group of notables to foster intellectual pursuits and the exchange of knowledge. The society focused on science, agriculture, letters, and social issues. It had a structured governance, with a Director, Vice-Director, and a perpetual Secretary (Allombert, 1899).

- **Acad Brest.** The “*Académie Royale de Marine*” was founded in Brest (FRA) in 1750 and officially recognized on July 30, 1752. It received royal status in 1769. It was founded by Sébastien Bigot de Morogues, a naval officer and scholar. The academy sought to study everything related to the navy, including naval officer training, shipbuilding techniques, research in mathematics, physics, arts, and natural history, and the compilation of a ”Dictionary of Marine.” It had a structured governance with honorary academicians, free/associate academicians, correspondents, ordinary academicians, and adjunct academicians (Académie Royale de Marine, 2024).
- **Acad Bruxelles.** The “*Académie Royale et Imperiale des Sciences et belles lettres*” was founded in Bruxelles (BEL) in 1769 as an informal society and officially recognized as a society with patent letters from Maria Theresa in 1772. It was founded by Count Cobenzl, who was inspired by the advice of Professor Schoëfflin. The academy aimed to revive interest in literature in the Austrian Netherlands, which was seen as declining. It had a structured governance with honorary members and ordinary academicians (Hasquin, 2009).
- **Acad Caen 1.** The “*Académie de physique de Caen*” was founded in Caen (FRA) in 1652, but received patent letters in 1705. It was established by Moisant de Brieux, de Grentemesnil, de Prémont, Halley, Vicquemand, and Bochart. The academy’s initial focus was on literature and philosophy, but shifted to scientific matters after the creation of the Royal Society and the Academy of Sciences. It had a structured governance, with a director, a secretary, and a permanent reader (de Pontville, 1997).
- **Acad Caen 2.** The “*Académie des arts et belles lettres*” was founded in Caen (FRA) in 1662. It was never officially recognized by the King but the ministry Colbert expressed the royal approval. It was established by Pierre-Daniel Huet, who was inspired by the mostly literary works of other academies. The academy focused on physical and mathematical sciences. It had a structured governance and a clear set of objectives for its research (de Pontville, 1997).
- **Acad Châlons-en-Champagne.** The “*Académie des Sciences, arts et belles lettres*” was founded in Châlons-en-Champagne (FRA) in 1750, officially recognized in 1753, and received patent letters in 1775. Its motto was “L’Utilité,” emphasizing practical applications of knowledge. It sought to cultivate belle-lettres, arts, sciences, and research in natural history. It had a structured governance with honorary academicians, titular academicians, “Agrégés pour les Arts,” and associate free members (Menu, 1869).
- **Acad Cherbourg.** The “*Société Académique*” was founded in Cherbourg (FRA) on January 14, 1755, and officially recognized in 1775. It was established by Jean-François Delaville and other 5 scholars to share knowledge and improve the reputation of the city. It was focused on the history of the local region and archeology, and naval matters also entered into its discussions.

It had a structured governance similar to the Paris Academy (Académie de Cherbourg, 2024).

- **Acad Cimento.** The “*Accademia del Cimento*” was founded in Firenze (ITA) in 1651 as an informal society and officially established in 1657. It was founded by Grand Duke Ferdinando II and his brother Leopoldo, who advocated for the free application of the “New Science.” The academy focused on experimental physics, meteorology, and astronomy. It was considered innovative in its methodology (Knowles Middleton, 1971).
- **Acad Florence 2.** The “*Accademia Botanica*” was founded in Firenze (ITA) in 1733 and officially recognized in 1739. It was established by Vincenzo Capponi as secretary of the earlier Botanic Society. It focused on scientific research and studies, with a particular interest in botany and the management of the botanic gardens in Florence (Maylender, 1930, Vol 1).
- **Acad Florence 3.** The “*Reale accademia dei Georgofili*” was founded in Firenze (ITA) in 1753. The creation of the academy was prompted by an essay by Abbot Ubaldo Montelatici, who also incorporated the previous Botanic Academy of Florence in 1783. It was established to promote research in agronomy, especially to address issues with famine and food shortages in Italy. It had a structured governance (Tabarrini, 1856).
- **Acad Clermont Ferrand.** The “*Académie des Sciences, arts et belles lettres*” was founded in Clermont-Ferrand (FRA) in 1747, officially recognized in 1750, and granted patent letters in 1780. The academy was established by Rossignol, Dufraisse de Vernines, and Queriau, with the aim of promoting science and society through research in natural history and literature. The academy had a structured governance (Mège, 1884).
- **Acad Copenhagen.** Founded in Copenhagen (DNK) on November 13, 1742, and granted royal status in 1743, the “*Det Konelige Danske Videns-sakernes Selskab*” was established by Johan Ludvig Holstein, Hans Gram, Erik Pontoppidan, and Henrik Henrichsen. The academy aimed to strengthen the position of science in Denmark and promote interdisciplinary understanding. It had a structured governance with a president and a secretary (Lomholt, 1950).
- **Acad Cosenza.** The “*Accademia dei Pescatori Cratilidi*” was founded in Cosenza (ITA) in 1753, inaugurated in 1756, and officially approved in 1758. It was established by Gaetano Greco, who wanted to create a new academy following the decline of the previous “Cosentina” academy. The academy’s name derived from the Crati river and its motto was “Grandia ab exiguo” (i.e., “from small to large”) (Maylender, 1930, Vol 4).
- **Acad Dantzig.** The “*Danziger Naturforschenden Gesellschaft*” was founded in Danzig (POL) on January 2, 1743. It was established during an informal gathering, with Daniel Gralath proposing the idea. The academy aimed to advance the understanding of natural phenomena through empirical investigation. It had a structured governance with different types of members and a permanent location (Schumann, 1893).

- **Acad Derby.** The “*Derby Philosophical Society*” was founded in Derby (GBR) in February 1783. It’s heavily implied that Erasmus Darwin was a driving force behind the society, he was also member of the Lunar Society of Birmingham. The academy aimed to promote knowledge and discussion of natural philosophy and provide access to scientific literature through its library (Sturges, 1978).
- **Acad Dijon.** The “*Académie des Sciences, Arts et Belles-Lettres de Dijon*” was founded in Dijon (FRA) in 1725, established through the will of Hector-Bernard Pouffier (dean of the Parliament of Burgundy) and officially recognized by the King in 1740. It primarily focused on scientific subjects like medicine, natural sciences, and applied sciences, but also included a quarter of its members working in the humanities. It had a structured governance and was supported by the regional State of Burgundy (Milsand, 1871).
- **Acad Dublin.** The “*Philosophical Society and Medica-Philosophical Society*” in Dublin (IRL) evolved from a previous academy and became the RDS (Royal Dublin Society) on June 25, 1731. It received royal recognition on April 2, 1750. The Dublin Society focused on improving the economy and the lives of the Irish people by promoting husbandry, manufactures, and useful arts. It had a structured governance with ordinary, honorary, and life members, and received funding through member subscriptions and parliamentary grants (Berry, 1915).
- **Acad Irish.** The “*Royal Irish Academy*” was founded in Dublin (IRL) in 1785 and granted a royal charter in 1786. This academy, the first in Ireland to balance research in both sciences and humanities, aimed to promote and investigate the sciences, polite literature, and antiquities. It had a structured governance with scientific and literary members, plus a rotating president (Royal Irish Academy, 2024).
- **Acad Edinburgh.** The “*Royal Society of Edinburgh*” was officially founded in Edinburgh (GBR) in 1783, with its first meeting on June 23, 1783. It received a Royal Charter on March 29. Many members of the earlier Philosophical Society became members of the RSE. It aimed to advance learning and useful knowledge, focusing on natural philosophy and literature. It had a structured governance (Emerson, 1981).
- **Acad Erfurt.** The “*Academia electoralis moguntina scientiarum utilium*” was founded in Erfurt (DEU) on July 19, 1754. Its creation was supported by its patron, the Elector of Mainz, Johann Friedrich Carl. The Academy aimed to promote useful sciences, like including natural sciences, mathematics, law, history, and the arts (Kiefer, 2004).
- **Acad Gorlitz.** The “*Oberlausitzischen Gesellschaft der Wissenschaften*” was founded in Gorlitz (DEU) on April 21, 1779. It was established by Karl Gottlob Anton, who proposed the idea to Adolf Traugott von Gersdorf. The academy aimed to promote the study of natural science and history in Upper Lusatia and foster scientific research and scholarship (Oberlausitzische Gesellschaft der Wissenschaften, 2024).

- **Acad Goteborg.** The “*Kungl. Vetenskaps-och Vitterbets Samhallet*” was founded in Goteborg (SWE) in the 1770s and obtained the royal title from King Gustav III in 1778. It was established by Johan Rosen, a schoolmaster, and later by Martin Georg Wallenstrale and Carl Fredrik Scheffer. The society aimed to promote scientific exchange among different disciplines and to foster the study of sciences for the benefit of the local community.
- **Acad Göttingen.** The “*Akademie der Wissenschaften zu Göttingen*” was established in Göttingen (DEU) in 1752 as the “*Königliche Societät der Wissenschaften*” (Royal Society of Sciences). It was founded under the patronage of King George II of Great Britain and Elector of Hanover. The academy aimed to advance learning and knowledge (Krahnke, 2001).
- **Acad Grenoble.** The “*Académie Delphinale*” was founded in Grenoble (FRA) in 1772, received patent letters in 1780, and formally adopted its name in March 1789. It was established by a group of enlightened and noble men who purchased books following the death of the bishop of Grenoble. The academy focused on enhancing humanities like history, letters, and arts, but also included sciences and technical matters (*Lettres Patentes*, 1790).
- **Acad Haarlem.** The “*Hollandsche Maatschappij der Wetenschappen*” was founded in Haarlem (NLD) in 1752. It was established by seven leading citizens of Haarlem with the aim of promoting science. The academy has a twofold structure, with social members (representing society’s interest in science) and scientific members (a group of scientists). It is still active today (Hollandsche Maatschappij der Wetenschappen, 2024).
- **Acad Tweede.** The “*Teylers Tweede Genootschap*” was founded in Haarlem (NLD) in 1756 and officially opened in 1778. It was established based on the will of Pieter Teyler van der Hulst. The academy aimed to promote science and the arts through discussion and prize competitions.
- **Acad Bad-Homburg.** The “*Société patriotique de Hesse-Hamburg pour l’encouragement des connaissances et des moeurs*” was founded in Bad-Homburg (DEU) in 1775, with statutes adopted in 1777. The academy aimed to promote “knowledge and morals” (from the name of the academy) and therefore focused on intellectual and ethical development (1777).
- **Acad Investiganti.** The “*Accademia degli Investiganti*” was founded in Napoli (ITA) in 1650 by Cornelio Tommaso and di Capua Leonardo. It was inspired by the Lincei academy in Rome, and sought to study and investigate “things of nature.” It primarily focused on natural philosophy before 1735 and on literary matters after that (Maylender, 1930, p.369, Vol3).
- **Acad Naples.** The “*Reale Accademia della Scienze e Belle-Lettere*” was founded in Napoli (ITA) in 1778 and officially established in 1780. It was established by King Ferdinando IV of Borbon to advance public education, progress, and human conviction. It had a structured governance with a president, vice-president, treasurer, fiscal lawyer, and secretary, and received financial support from a royal annuity (Maylender, 1930, Vol 5).
- **Acad Jena.** The “*Naturforschende Gesellschaft zu Jena*” was founded in Jena (DEU) in 1793 by August Johann Georg Karl Batsch. The academy

aimed to support members in choosing a career through natural-historical studies and to contribute to their moral advancement (Böhme-Käßler, 2005).

- **Acad La Rochelle.** The “*Académie Royale des Belles lettres*” was founded in La-Rochelle (FRA) in 1730 and officially recognized in 1744. It was founded by Jean-Jacques Franc de Pompignan, who was considered the soul of the academy. The academy focused on the study of literature and eloquence, specifically poetry. It had a structured governance with a director and a permanent secretary (Flouret, 2009).
- **Acad Lausanne.** The “*Société des sciences physiques*” was founded in Lausanne (CHE) on March 10, 1783. It aimed to cultivate interest in natural history and to study all that concerns the sciences, arts, agriculture, industry, commerce, and the local patrimony 1789.
- **Acad Leipzig.** The “*Fürstlich Jablonowskische Gesellschaft*” was founded in Leipzig (DEU) in 1768. Further sources have been asked to the current academy.
- **Acad Leopoldina.** The “*Deutsche Akademie der Naturforscher Leopoldina*” was founded in Halle (DEU) on January 1, 1652, and officially recognized by the Emperor Leopold I in August 1677. It was established by four physicians: Bausch, Fehr, Metzger, and Wohlfahrth. The academy aimed to explore nature for the glory of God and the good of mankind. It had a structured governance and received special privileges from the Emperor Leopold I (Deutsche Akademie der Naturforscher Leopoldina, 2024).
- **Acad Halle.** The “*Gesellschaft der Naturforschenden Freunde*” was founded in Halle (DEU) in 1779 by some theology students with the support of Friedrich-Wilhelm von Leysser, who became the first president. The academy aimed to increase acceptance and interest in natural history among students (Böhme-Käßler, 2005).
- **Acad Lisbon.** The “*Academia real das ciencias de Lisboa*” was founded in Lisboa (PRT) in 1779 and officially recognized by the King in 1780. It was established by the Duke of Lafões, who provided significant financial support. The academy aimed to promote scientific knowledge and cultural development within Portugal. It had a structured governance and was primarily funded through royal patronage and private donations (Teixeira Rebelo da Silva, 2015).
- **Acad Lund.** The “*Kungl Fysiografiska Sällskapet*” was founded in Lund (SWE) in 1772, and officially recognized by King Gustav III in 1788. It was established by Theologian Hesselen, doctor in Medicine Barfort, and Magistrat Retzius. The academy aimed to encourage a passion for science in youth and to associate those who shared this passion to produce useful findings for the general public. It was devoted to natural history and economics (Gertz, 1940).
- **Acad Lyon.** The “*Académie Royale des Sciences, belles-lettres et arts de Lyon*” was founded in Lyon (FRA) in 1700, and officially recognized with patent letters in 1724. It was established by Claude Brossette and other notable citizens, aiming to promote the advancement of science, art, and

literature in Lyon and the region. It had a structured governance with a director and a vice-director (Académie Royale des Sciences, belles-lettres et arts de Lyon, 2024).

- **Acad Manchester.** The “*Literary and philosophical society*” was founded in Manchester (GBR) in 1781. The academy was established by Thomas Percival and a group of men who sought to improve the living standards of the city, especially for the working class. It aimed to improve the local society and bring it towards more unity and progress (1896).
- **Acad Mannheim 1.** The “*Academia Electoralis Scientiarum et Elegantiorum Literarum Theodoro-Palatina*” was founded in Mannheim (DEU) on October 15-20, 1763. The academy was established by Karl Theodor, the Elector Palatine of Bavaria, after the advice of Johann Daniel Schopflin. The academy aimed to promote science and the humanities. It had a structured governance with honorary members (Cassidy, 1985). There was another academy, the “*Societas Meteorologicae Palatinæ*”, that was also founded in Mannheim (DEU) on September 5, 1780. It was also established by the same Karl Theodor. The academy focused on meteorology, aiming to connect international meteorological stations with similar instruments to compare measurements. It had a structured governance with members and received financial support from Karl Theodor (Cassidy, 1985). I consider these two academies as a unique one (Cassidy, 1985).
- **Acad Mantua.** The “*Accademia Virgiliana*” was founded in Mantova (ITA) in 1686. It took the name “*Royal Academy of Sciences, Lettres, and Arts*” in 1768. It was established by the co-regnant Maria Teresa and Giuseppe II, with the aim of continuing intellectual development in the Austrian Lombardy. It initially focused on theology and letters, but later expanded to include sciences useful to society. It had a structured governance with members and a patron (Maylender, 1930, Vol 5).
- **Acad Marseille.** The “*Académie des belles-lettres, sciences et arts*” was founded in Marseille (FRA) in August 1726 and officially recognized by King Luis XV with patent letters in 1766. The academy’s primary goal was to promote French language and literature in the region. It had a structured governance (Académie des Sciences Lettres et Arts de Marseille, 2024).
- **Acad Messina.** The “*Accademia Peloritana dei Pericolanti*” was founded in Messina (ITA) in 1728. It was established by Paolo Aglioti and others, following the death of Pietro Guerriera who had initially pushed for a similar academy. The academy focused on Letters, Moral and Natural Philosophy but also on Mathematics, Geography, and Duel and Knights subjects. After 10 years of activity, it focused primarily on scientific matters. It had a structured governance (Accademia Peloritana dei Pericolanti, 2024).
- **Acad Metz.** The “*Société Royale des Sciences et Arts*” was founded in Metz (FRA) in April 1757 and received patent letters in July 1760. The Marshal-Duke Charles Louis Auguste Fouquet de Belle-Isle was its founder and protector. The academy aimed to advance sciences, letters, and arts to make them useful to the local society of Metz.

- **Acad Middelburg.** The “*Zeeuwsch Genootschap der Wetenschappen*” was founded in Vlissingen (NLD) in 1765 and officially founded in 1769. It was established to provide a local organization for scientific practice and to promote the ideas of the Enlightenment (Zeeuwsch Genootschap der Wetenschappen, 2024).
- **Acad Modena.** The “*Accademia ducale dei Dissonanti di Modena*” was founded in Modena (ITA) in 1680 and formally active in 1684. It was established by the citizens of Modena to ask for the reopening of the University and the creation of the Academy. The academy was initially active only in humanities and letters, but added a scientific section in 1790 (Accademia Nazionale di Scienze, Lettere e Arti di Modena, 2023).
- **Acad Rangoniana.** The “*Accademia Rangoniana*” was founded in Modena (ITA) in 1783. It was established by Gherardo Aldobrandino Rangone, who was already financing and hosting scientific experiments of Michele Rosa, who worked on blood transfusions among animals. The academy focused on scientific experiments, mechanics, and physics (Maylender, 1930, Vol 4).
- **Acad Montauban** The “*Académie des belles lettres*” was founded in Montauban (FRA) in 1730 and officially recognized in 1744. The soul of the academy was Jean-Jacques Franc de Pompignan. The academy focused on literary subjects, particularly poetry and letters (Forestié, 1888).
- **Acad Montpellier** The “*Société Royale des Sciences*” was founded in Montpellier (FRA) in 1706. The King wanted to reassure his domain into the Mediterranean coast during the Spanish Succession. It was initially focused on mathematics, anatomy, chemistry, botany, and physics. It played a role in compiling the Encyclopédie of Diderot and d'Alembert (Dulieu, 1975; Société Royale des Sciences, 2024).
- **Acad Munich** The “*Bayerische Akademie der Wissenschaften*” was founded in Munchen (DEU) on October 12, 1758 and officially recognized on June 25, 1759. It was established by Johann Georg von Lori and aimed to advance all useful sciences in Bavaria (Bayerische Akademie der Wissenschaften, 2024).
- **Acad Nancy** The “*Société des Sciences et belles lettres - Académie Stanislas*” was founded in Nancy (FRA) on December 28, 1750, and received patent letters on December 27, 1751. It was founded by Stanislas Leszczynski, the king of Poland and duke of Lorraine and Bar. It aimed to enhance the study of sciences and literature and culture. It created a public library too (Stanislas, 2024).
- **Acad Nimes** The “*Academie Royale de Nimes*” was founded in Nimes (FRA) on March 28, 1682, and received patent letters in August 1682 from Luis XIV. It was established by Jules de Fayn, and aimed to enhance the local patrimony by studying antiquities and the local language (Nicolas, 1854).
- **Acad Nuremberg** The “*Cosmographical Society*” was founded in Nurnberg (DEU) in 1747.

- **Acad Olmouc.** The “*Societas Eruditorum Incognitorum*” was founded in Olomouc (CZE) in 1747 by Josef Pettrash, who had traveled the world as a soldier and poet. The academy aimed to free higher education from the influence of Jesuits. It sought to cultivate the fine sciences and liberal arts (Kostlán, 1996).
- **Acad Orleans.** The “*Académie Royale des Sciences, arts et belles lettres*” was founded in Orleans (FRA) on April 23, 1781, and received patent letters on March 20, 1784. The academy was established by a group of 10 scholars. It aimed to promote physics and natural sciences (Nicolas, 1908).
- **Acad Oxford.** The “*Oxford Philosophical Society*” was founded in Oxford (GBR) in 1645 as an informal society and formally established in 1651 by John Wilkins and other natural philosophers. It was inspired by the London group of natural philosophers, and the remnants of William Harvey’s circle at Oxford. The academy focused on magnetic experiments, dissections, antiquities, astronomy, and geometry (Applebaum, 2000; Gunther, 1925).
- **Acad Padua.** The “*Accademia dei Ricovrati/Accademia di Scienze, lettere ed Arti*” was founded in Padova (ITA) in 1599, which is still considered a Renaissance Academy (McClellan, 1985). It became the “*Accademia di Scienze, lettere ed Arti*” in 1779, when the Venetian Senate ordered its fusion with the *Accademia di Arte Agraria*. It was founded by Federico Cornaro, and Galileo was a founding member of the earlier Ricovrati Academy. The academy aimed to promote the study of humanities and science via the experimental approach (Maggiolo, 1983). The academy enter into my analysis only from 1779.
- **Acad Palermo.** The “*Accademia Palermitana*” was founded in Palermo (ITA) in 1718, though it only received recognition in 1752. It was established by Pietro Filangieri and other enlightened men. The academy aimed to tell Sicily’s story and advance letters and sciences (Maylender, 1930, Vol 1).
- **Acad Palma.** The “*Accademia Boreiana*” was founded in Palmi (ITA) in 1673 by Gio. Alfonso Borelli. It focused on physics and natural history, especially on the respiration moto (Maylender, 1930, Vol 1).
- **Acad Pau.** The “*Académie Royale des Sciences et beaux arts*” was founded in Pau (FRA) in 1718.
- **Acad Prussia.** The “*Königlich-Preußische Akademie der Wissenschaften*” was founded in Berlin (DEU) on July 11, 1700, and immediately officially recognized. It was established by Gottfried Wilhelm von Leibniz, with sponsorship from the noble Hohenzollern family. The academy aimed to advance both humanities and natural sciences (de la Croix, Eisfeld, & Ganterer, 2021; Königlich-Preußische Akademie der Wissenschaften, 2024).
- **Acad Prague.** The “*Regia Societas Scientiarum Bohemica*” was founded in Praha (CZE) in 1769 and officially recognized in 1790. The academy was established by count Frantisek Josef Kinsky and Ignac Born. It aimed to diffuse the experimental approach and critical thinking but also Bohemian History (Zacek, 1968).

- **Acad Reggio d’Emilia.** The “*Accademia degli Ipocandriaci*” was founded in Reggio-Emilia (ITA) in 1746. It was established by Achille Crispi, the captain of the Duke Francesco III. The academy had a structured governance (Maylender, 1930, Vol 3).
- **Acad Roma.** The “*Accademia di Fisico-Mathematica*” was founded in Roma (ITA) on July 6, 1677. It was established by Giovanni Giustino Ciampini, who provided the academy with tools and machines for scientific experiments. The academy focused on natural sciences and experiments, including anatomy, physics, mathematics, and mechanics (Maylender, 1930, Vol 3).
- **Acad Rotterdam.** The “*Battafsch Genootschap der Proefonderwindelijke Wijsbegeerte*” was founded in RotterdamNLD on May 14, 1769 (Lieburg, 1985).
- **Acad Rouen.** The “*Académie Royale des Sciences, belles lettres et arts*” started informally in Rouen (FRA) in 1736 and formally with patent letters from Luis XV on June 17, 1744. It was established by Fontanelle and Le Cornier de Cideville, and focused on botany (Gosseame, 1985).
- **Acad Rovereto.** The “*Imperiale Regia Accademia degli Agiati*” was founded in Rovereto (ITA) in 1750, officially recognized in 1753. It was established by Giuseppe Valeriano Vannetti and other four important local scholars. The academy was initially focused on letters, history, and science, but later expanded to include agricultural research (Accademia Roveretana degli Agiati di Scienze, Lettere ed Arti, 2024).
- **Acad Paris.** The “*Académie Royale des Sciences*” was founded in Paris (FRA) in the spring of 1666. The academy was established by Minister Colbert under Luis XIV, who fully funded its creation and operations. The academy was a symbol of royal patronage. Its focus was on natural philosophy, mathematics, and the application of the laws of nature to practical reforms (Académie Royale des sciences, 2024).
- **Acad Siena.** The “*Reale Accademia della scienze di Siena*” was founded in Siena (ITA) in 1690. It was established by Pirro Maria Garieli, a professor at the University of Siena. The academy focused on natural science, philosophy, medicine, and poetry (Maylender, 1930, Vol 3).
- **Acad Stockholm.** The “*Kungliga Vetenskapsakademien*” was founded in Stockholm (SWE) on June 2, 1739. It was modelled after the Royal Society of London and the Académie Royale des Sciences in Paris. The academy was created as an independent, non-governmental scientific society. It was primarily focused on natural sciences and mathematics (Kungliga Vetenskapsakademien, 2024).
- **Acad St Petersburg.** The “*Academia Scientiarum Imperialis Petropolitanae*” was founded in Saint-Petersburg (RUS) in 1724. It was established by Peter the Great, who was inspired by academies in Europe. The academy aimed to bring the Russian Empire into the modern era. It was initially focused on mathematics, physical sciences, and humanities, and included training in scientific subjects (de la Croix & Doragli, 2021; Gordin, 2000).

- **Acad Toulouse.** The “*Académie Royale des Sciences, inscriptions et belles lettres*” was founded in Toulouse (FRA) in 1640-1645/1665-1685 as an academic conference and officially recognized in 1746. It was established by Sage Antoine, Carrière, and Gouazé Pierre. The academy aimed to advance sciences, inscriptions, and belles-lettres. It had a structured governance (Taillefer, 1984).
- **Acad Trondheim.** The “*Det Kongelige Norske Vienskabers Selskab*” was founded in Trondheim (NOR) in 1760 and received royal recognition in 1767. It was established by Bishop Johan Ernst Gunnerus, rector Gerhard Schonning, and councilor Peter Friderich Suhm to create an institutional space for enhancing and spreading the New Science (Schmidt, 1960).
- **Acad Turin.** The “*Accademia delle scienze di Torino*” was founded in Torino (ITA) in 1757 and officially recognized in 1783. It was founded by Joseph-Louis Lagrange, Giuseppe Francesco Cigna, and Giuseppe Angelo Saluzzo. The academy aimed to advance scientific research that could not find enough space within the university of the city (Accademia delle Scienze di Torino, 2023).
- **Acad Filopatria.** The “*Accademia Filopatria*” was founded in Torino (ITA) on July 2, 1782. It was established by a group of enlightened men in the city of Turin. The academy focused on antiquities and the history of the homeland, including letters, poetry, and moral values but also on public economics, and sciences (Campori, 1887).
- **Acad Uppsala.** The “*Societatis Regiae Scientiarum Upsaliensis*” was founded in Uppsala (SWE) in 1710. It was reorganized in 1719, and received royal recognition on November 11, 1728. It was founded by the librarian Eric Benzelius. The academy initially focused on scientific discussions and later established a scientific journal (Karlberg, 1977).
- **Acad Uppsala.** The “*Cosmographiska sällskapet*” was founded in Uppsala (SWE) in 1758 by Anders Åkerman and other enlightened men. The academy focused on cosmography, constructing globes for the earth and the sky.
- **Acad Utrecht.** The “*Provinciaal Utrechtsh genootschap van Kunsten en Wetenschappen*” was founded in Utrecht (NLD) in 1773 and officially founded in 1778. It was established by Mr. J. van Haeften and L. Praalder. The academy aimed to preserve local heritage, modern art, and publications, as well as to develop and improve science (Singels, 1923).
- **Acad Valence.** The “*Société Académique et Patriotique*” was founded in Valence (FRA) in 1784, receiving King’s Letters Patent in December 1786. The academy aimed to advance sciences, arts, and belles-lettres. It had a structured governance and it organized 3 prizes every year (de Colonjon, 1866).
- **Acad Venice.** The “*Accademia dei Planomaci*” was founded in Venezia (ITA) circa 1740. It was established by the abate D. Meodoro Rossi. The

academy published the “*Novelle Letterarie*,” a journal of reviews and critiques of new works. It had a structured governance with a protector (Maylender, 1930, Vol 4).

- **Acad Verona.** The “*Societa Italiana delle Scienze*” was founded in Verona (ITA) in 1766 and officially established in 1782. It was founded by Antonio Mario Lorgna. The academy focused on scientific matters and published the periodical “*Memorie accademiche*” (Maylender, 1930, Vol 1).
- **Acad Zurich.** The “*Naturforschende Gesellschaft*” was founded in Zurich (CHE) in 1745 and formally established in 1746. It was established by Johannes Gessner. The academy aimed to provide a space for students and personalities who studied abroad to return home and share their knowledge. It had a structured governance and relied heavily on member contributions (Rübel, 1947).
- **Royal Society.** The “*Royal Society of London*” was founded in London (GBR) in 1660 and officially established in 1662. It was established by John Wilkins and other polymaths. The academy focused on natural philosophy and experiments, including trade, manufacture, and crafts, as well as scientific experiments. It had a structured governance with a president, a treasurer, and two secretaries (The Royal Society, 2024).
- **Acad Botanical.** The “*Botanical Society*” was founded in London (GBR) in 1721. It was established by Johann Jakob Dillen and John Martyn to increase knowledge of and spread interest in minerals, plants, and animals.
- **Acad Linnaus.** The “*Linnean Society of London*” was founded in London (GBR) in 1788 by James Edward Smith, Samuel Goodenough, and Thomas Marsham. The academy was named after Carl Linnaeus, who is considered the father of taxonomy. The academy was devoted to natural history, focusing on the evolution theory and biological taxonomy.

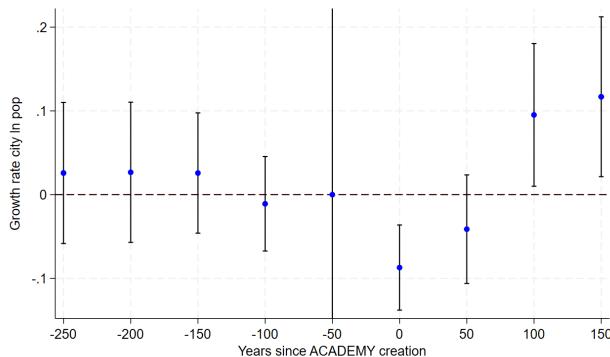
## Appendix F Dynamic TWFE results

In the following discussion, I focus on the results using dynamic TWFE estimations and address the two main assumptions of parallel trends and no anticipation effect. Section 7.2 provides further analyses to assess the validity of the SUTVA assumption and investigate possible spatial spillover effects (Berkes & Nencka, 2021; Butts, 2021).

Figure F7 presents the main event study analysing the impact of the creation of an academy between 1500 and 1900. Each period represents a 50-years interval. The first two assumptions (no pre-trends and no anticipation effect) hold.<sup>44</sup> The results indicate a downward trend in the first 50 years and a positive effect in the following century that compensate the initial negative impact. This indicates that cities with academies should grow faster than cities without academies after 100 years from the establishment.

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<sup>44</sup>To be noted that looking at possible pre-trends is only a partial test for the parallel trends assumption.



**Fig. F7** Event Studies for the creation of (a) an academy or (b) a university between 1500 and 1900. No. of clusters 2056. Within R<sup>2</sup>: (a) 0.189, (b) 0.189.

To investigate the interaction between universities and academies, I focus on cities that hosted a university at least once and analyze the impact of the *ACADEMY* event on this subset of cities. Furthermore, since it is likely that the university was established before the academy, this subset accounts for more similar cities allowing to better investigate the direction of the interaction term, *ACADxUNI*. However, this sample has a much lower statistical power than the main one given it includes only a subset of cities. Figure F8 displays the results for the period 1500-1900. The parallel trend assumption holds, but there are no significant effects observed after the creation of an academy in cities that had a university at least once. Interestingly, the lag periods exhibit a downward trend in both panels, which aligns with the negative sign found in the OLS results presented in Table 3.

In order to further investigate the *ACADEMY* event, I examine specific groups of academies based on their field of study, period of activity, and size.

First, I distinguish between literary and scientific academies based on the composition of their members. Academies are defined as scientific when more than 50% of their members studies science, applied science, and medicine.<sup>45</sup> Academies are defined as literary when more than 50% of their members deals with literary disciplines (history, letters, poetry, arts) but also deals with theology, law and social sciences (e.g. economics and political science). In Figure F9, Panel (a) presents the event study for scientific academies. The results show a positive and highly significant effect on the population growth rate of the city after 100 years, persisting for the rest of the period considered. Specifically, the growth rate increases by 28% (p-value: 0.000) after 150 years in cities with a scientific academy with respect to cities without scientific academies. Hence there is a positive and significant impact of creating a scientific academy. In Panel (b) of Figure F9, I present the event study for literary academies.<sup>46</sup> Interestingly, there is a negative and significant impact observed in the first 50

<sup>45</sup> It is the case of 43 academies in my sample.

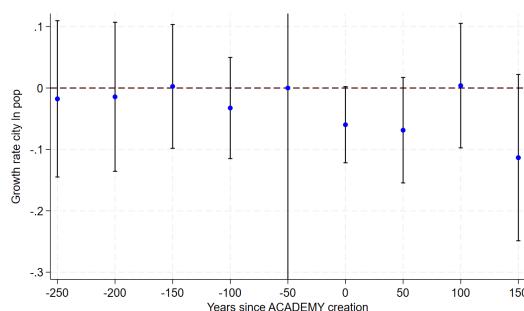
<sup>46</sup> It is the case of 39 academies in my sample.

years after the creation of a literary academy. The growth rate of the population decreases by 13% (p-value: 0.005) immediately after the establishment of a literary academy with respect to cities without literary academies.

Then, I also analyze the creation of big academies, defined as those with more than 30 members,<sup>47</sup> as shown in Figure F10a. However, the size of the academy does appear to have an immediate negative impact on the population growth rate of the city and only after 150 years there is a positive and significant effect (+14% p-value: 0.03). Next, I explore the event study for long-lasting academies, defined as those active for more than 30 years.<sup>48</sup> Figure F10b indicates that the duration of the academy's activity period does affect negatively the population growth rate: only the first two lag are negative and significant.

These findings suggest that micro-level data about the field of study of scholars are very important. It is the subject dealt at academies, rather than their size or duration that plays a crucial role in their impact on the population growth rate of cities. Scientific academies positively contribute to economic prosperity, while literary academies initially have a negative effect before stabilizing around a zero-effect in the long term. It appears clear that the experimental approach and innovative thinking have the strongest effect when linked to scientific subjects.

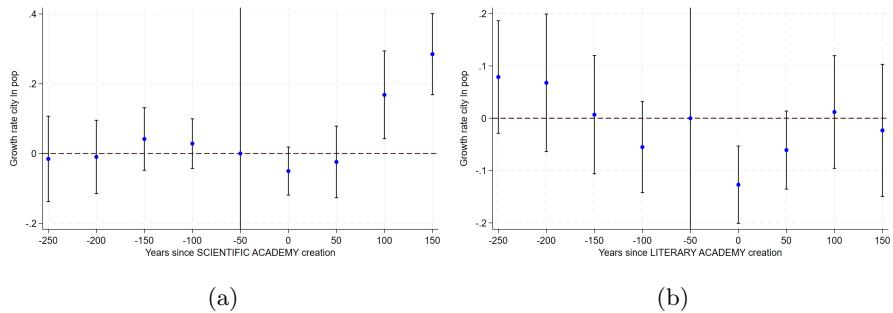
Nonetheless, event study estimates require not only the parallel trends and no anticipation effect hypothesis to hold, but also the Stable Unit Treatment Value Assumption - SUTVA. To test for it I build buffer zones of 50, 100 and 150 km around the cities with an academy, excluding them from the sample. The results do not change, implying that the estimates capture the local unbiased effect. In Section 7.2 I show that these results are confirmed, implying that the SUTVA holds and showing the unbiased local effect of having an academy in the city.



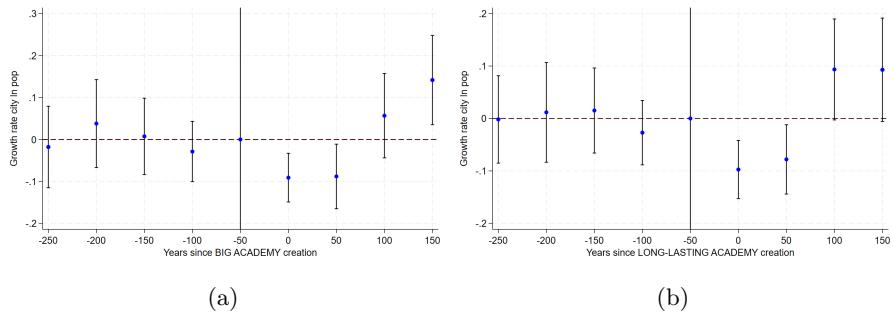
**Fig. F8** Event Studies for the creation of an academy between 1500 and 1900 in cities that hosted a university at least once. No. of clusters 151. Within R<sup>2</sup> 0.311.

<sup>47</sup>It is the case of 62 academies in my sample.

<sup>48</sup>It is the case of 69 academies in my sample.

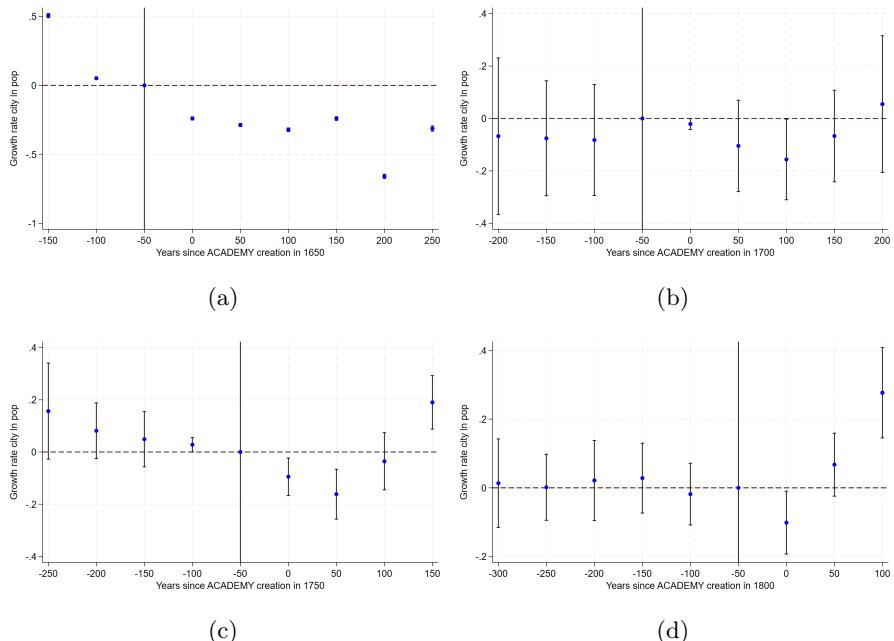


**Fig. F9** Event Studies for the creation of (a) a scientific academy or (b) a literary academy between 1500 and 1900. No. of clusters 2056. Within  $R^2$ : (a) 0.190, (b) 0.189.



**Fig. F10** Event Studies for the creation of (a) a big academy or (b) a long-lasting academy between 1500 and 1900. No. of clusters 2056. Within  $R^2$ : (a) 0.189, (b) 0.189.

## Appendix G 2x2 Event Studies



**Fig. G11** Event Studies for the creation of an academy in a specific period of time. Note that (a) in 1650 only Investiganti Academy in Naples was created. (b) In 1700 13 academies were opened. (c) In 1750 29 academies were created and (d) in 1800 40 academies were opened. No. of clusters 2056. Within R<sup>2</sup>: (a) 0.189, (b) 0.189, (c) 0.190, (d) 0.191.

## Appendix H Alternative DID estimators

### H.1 *CSDID* results

As in Sun and Abraham (2021), also Callaway and Sant'Anna (2021) focuses on the average treatment effect for cohorts, i.e. groups of cities  $g$  experiencing the creation of an academy for the first time at time  $t$ . *CSDID* estimator by Callaway and Sant'Anna (2021) is pretty similar to the *IW* estimator by Sun and Abraham (2021) which I use to obtain my main findings in Section 5.3.

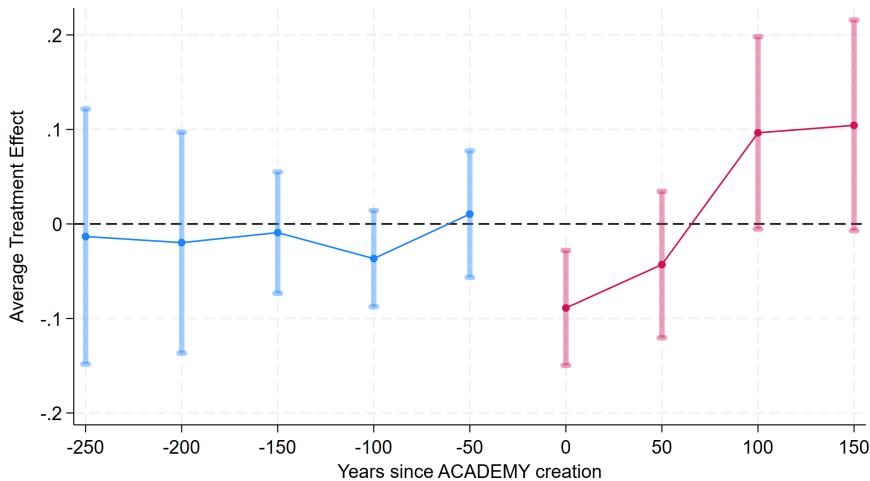
Callaway and Sant'Anna (2021) is more general and flexible, it allows for different types of average treatment effects' aggregations. It also allows to use not-yet-treated cities as controls (i.e., cities that will experience the creation of an academy only after time  $t$ ). However, these alternative ways to represent and compute the estimates are less of interest in my setting given and I prefer to focus on balancing the frequencies through the event-studies specifications proposed by Sun and Abraham (2021). Nonetheless, given the similarities between the two estimators, I present the results obtained with Callaway and Sant'Anna (2021) as a robustness check.

Figure H12 presents the event-study specifications plotting the dynamic effects of creating an academy. It visualizes how the effect of creating an academy (Figure H12) changes depending on the amount of periods the institution has been created. I show the specification with balanced time frame, with five pre- and three post-periods, to be consistent with the main results.

When studying the creation of an academy, Figure H12 shows statistic significant coefficients at 90% level, with a general dynamic similar to Sun and Abraham (2021). Callaway and Sant'Anna (2021) also allow to compute the pre-treatment average effect to partially test for pre-trends being this coefficient not significant ( $-1.4\%$ , p-value: 0.44). However, when looking at the average treatment effect on the treated, I find it not significant and close to zero, with a coefficient of 0.017 (p-value 0.6). This implies that the results on creating an academy may not be that strong and when using Callaway and Sant'Anna (2021) there is no relevant difference in the population growth rate of cities experiencing the creation of an academy with respect to cities without any academy.

In addition, *CSDID* allows the interpretation of every single calendar time effects. In Naples (the only city experiencing the creation of an academy in 1650), the population growth rate is estimated to be 23.9% (p-value: 0.000) lower on average between 1650 and 1700 than it would have been if the academy was not been created. It is only after 1900 that a positive and significant change in the population growth of 21% (p-value: 0.000) on average is seen, with respect to a situation where no academy was created.

Figure H13 plot the event-study specification visualizing the dynamic effects of creating an academy in cities that had a university at least once. This allows the investigation of the interaction between universities and academies, which follows the same dynamic found in Figure 4. There are no pre-trends



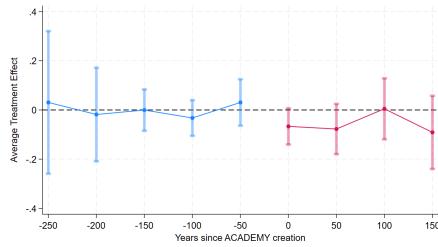
**Fig. H12** Dynamic average effects of creating an academy between 1500 and 1900 estimated with Callaway and Sant'Anna (2021). Control group: never-treated. Dependent variable: city population growth rate in logarithm.

(0.2%, p-value: 0.95), but also no statistically significant post-treatment effect on average ( $-5.8\%$ , p-value: 0.16).

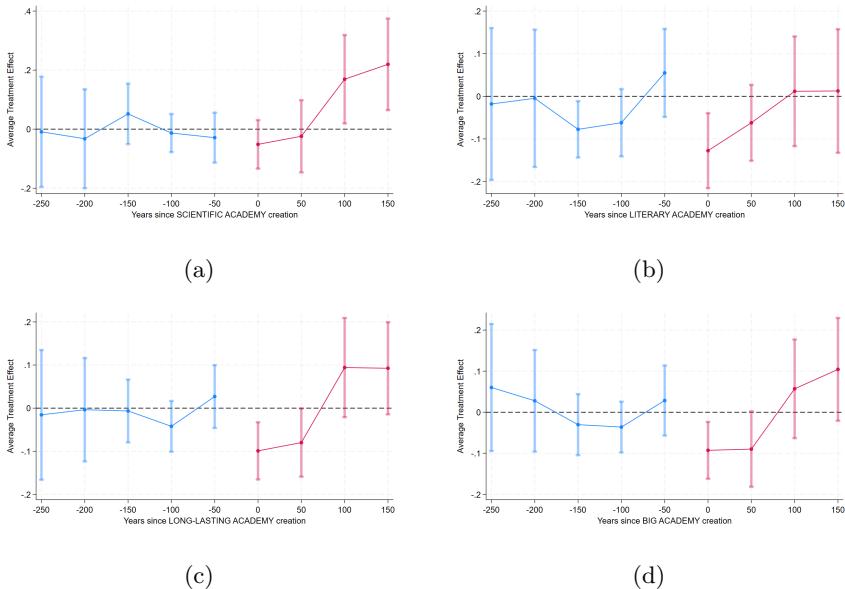
Figure H14 presents the event-study specification for the dynamic effects of creating different types of academies relative to the fields of study, years of activity, and size. As seen in Section 5.3, creating scientific academies increase population growth rate of cities after 100 years by 16.9% (p-value: 0.03) on average with respect to cities without scientific academies. There are no pre-trends ( $-0.6\%$ , p-value: 0.79) and the post-treatment average effect is slightly significant ( $7.8\%$ , p-value: 0.068). In addition, the last two calendar time effects tell that after 1850 the population growth rate is on average 10% (p-value: 0.08) higher in cities with a scientific academy, and after 1900 the growth rate reaches 29% (p-value: 0.00).

On the other hand, creating a literary academy (Figure H14b) would lower the population growth rate on average by 4% with respect to cities without a literary academy, however the p-value indicates no significance. There are no pre-trends ( $-2.1\%$ , p-value: 0.4). In addition, almost all single calendar time effects are statistically significant and negative, the only positive exception is after 1900 when the growth rate increases by 11% on average but not significantly (p-value: 0.13).

Creating an academy that would last more than 30 years or with more than 30 members do not bring much to the hosting cities. Figure H14c shows the results for long-lasting academies and Figure H14d for big academies. There are no pre-trends but not average post-treatment effect either.



**Fig. H13** Dynamic average effects of creating an academy between 1500 and 1900 in cities that hosted a university at least once estimated with Callaway and Sant'Anna (2021). Control group: never-treated. Dependent variable: city population growth rate in logarithm.



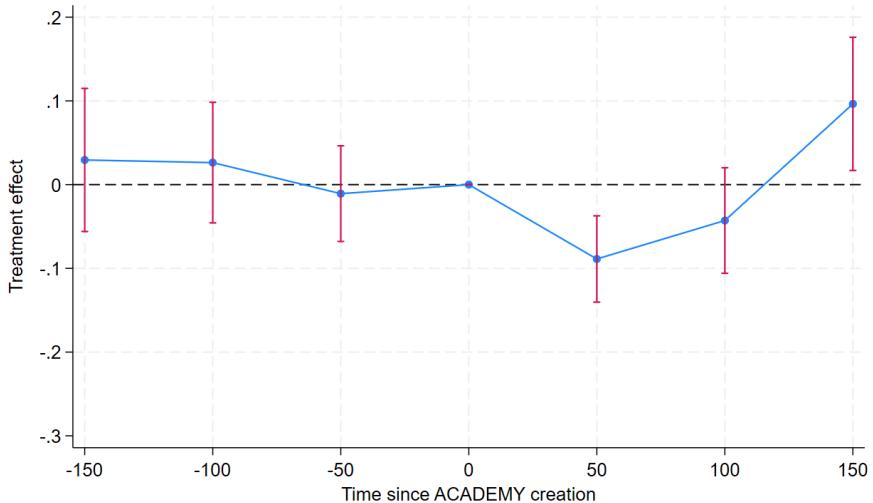
**Fig. H14** Dynamic average effects of creating (a) a scientific academy, (b) a literary academy, (c) a long-lasting academy (with more than 30 years of activity), and (d) a big academy (with more than 30 members) between 1500 and 1900 estimated with Callaway and Sant'Anna (2021). Control group: never-treated. Dependent variable: city population growth rate in logarithm.

## H.2 $DID_l$ results

The De Chaisemartin and d'Haultfoeuille (2024) estimator, referred to as  $DID_l$ , estimates the effect of creating an academy or a university  $l$  periods ago for the first time. It compares cities that are currently experiencing the creation of a higher educational institution for the first time with cities that have not yet experienced the creation of such institutions. This estimator provides insights into the effects of the initial creation of institutions after a specific

$l$  period. It can be used also with continuous treatments, which is the main innovation developed in this last estimator.<sup>49</sup>

In the following sections, I present the results for this estimator  $DID_l$ , which estimates the long-difference placebos and does not allow to include more leads than lags, so I always include three leads and three lags. Nevertheless, this last estimator allows me to obtain a more nuanced understanding of the effects of creating academies in my analysis.



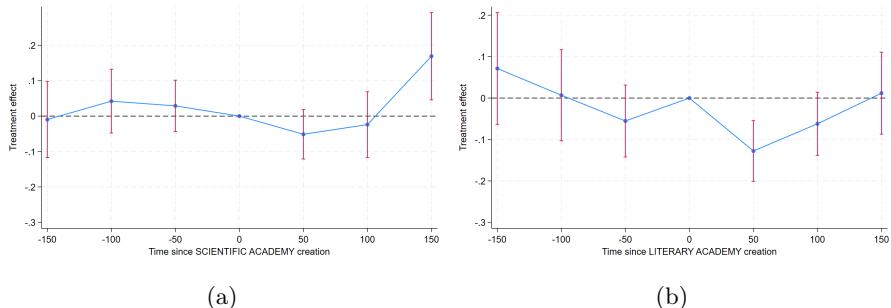
**Fig. H15** Effect of creating an academy estimated with  $DID_l$  – De Chaisemartin and d'Haultfoeuille (2024) – between 1500 and 1900.

Figure H15 presents the treatment effects of creating an academy between 1500 and 1900 using the  $DID_l$  estimator. The dynamic is very similar to the baseline results, with an immediate negative impact followed by a positive effect after 100 years from the creation of the academy. The same is seen when investigating the creation of scientific academies, which bring cities hosting them to grow 16% faster after 100 years - confirming the baseline results. Also the findings about literary academies are confirmed with the first 50 years having a negative impact on the population growth rate. These academies are the only ones to have a (negative) significant average cumulative total effect per treatment city. Figure H16 shows these results.

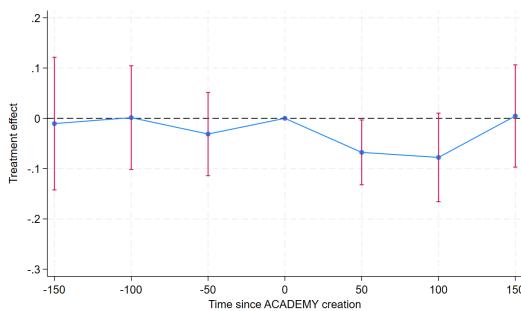
<sup>49</sup> Previous drafts of the current project used the previous estimator developed in De Chaisemartin and d'Haultfoeuille (2022) which produced very similar results to the current ones. I also compared the results with De Chaisemartin and d'Haultfoeuille (2020), which calculates the instantaneous treatment effect by estimating the impact of creating an academy on the population growth rate in cities that are currently experiencing the creation of an academy. This estimator effectively cancels out cities without any institutions and cities that have already had an institution since 1500, focusing solely on cities where the treatment status changes. Again, the results are very similar but - obviously - for the placebo estimates, given that it was the only difference with respect to De Chaisemartin and d'Haultfoeuille (2022).

Figure H17 shows the dynamic of creating an academy in cities that hosted a universities at least once, confirming the same patterns as the baseline findings.

Figure H16 shows the heterogeneity analysis by field of study: scientific academies have a positive effect, while literary academies have a negative effect at least in the short term. These findings align with the main estimates, indicating that the field of study of the academy has a significant impact on the population growth rate.



**Fig. H16** Effect estimated with  $DID_l$  – De Chaisemartin and d'Haultfoeuille (2024) of creating (a) a scientific academy and (b) a literary academy between 1500 and 1900.



**Fig. H17** Effect estimated with  $DID_l$  – De Chaisemartin and d'Haultfoeuille (2024) of creating an academy in cities that hosted a universities at least once between 1500 and 1900.

## Appendix I Sensitivity analyses: leave-one-out

**Table I6** Types of ACAD by country

|             | (1)<br>ACAD | (2)<br>ACAD<br>SCIENCE* | (3)<br>ACAD<br>LIT** | (4)<br>ACAD<br>LONG | (5)<br>ACAD<br>BIG |
|-------------|-------------|-------------------------|----------------------|---------------------|--------------------|
| Europe      | 82          | 43                      | 39                   | 69                  | 62                 |
| France      | 30          | 11                      | 19                   | 24                  | 22                 |
| Italy       | 17          | 8                       | 9                    | 15                  | 12                 |
| Germany     | 10          | 6                       | 4                    | 9                   | 7                  |
| UK          | 6           | 6                       | 0                    | 5                   | 5                  |
| Belgium     | 1           | 1                       | 0                    | 0                   | 1                  |
| Czech Rep.  | 2           | 1                       | 1                    | 1                   | 1                  |
| Denmark     | 1           | 0                       | 1                    | 1                   | 1                  |
| Ireland     | 1           | 0                       | 1                    | 1                   | 1                  |
| Netherlands | 4           | 2                       | 2                    | 4                   | 3                  |
| Norway      | 1           | 0                       | 1                    | 1                   | 1                  |
| Poland      | 1           | 1                       | 0                    | 1                   | 1                  |
| Portugal    | 1           | 0                       | 1                    | 1                   | 1                  |
| Spain       | 1           | 1                       | 0                    | 1                   | 1                  |
| Sweden      | 4           | 4                       | 0                    | 4                   | 3                  |
| Switzerland | 2           | 2                       | 0                    | 1                   | 2                  |

\*An ACAD is considered scientific if at least 50% of the members studies science, applied science, or medicine.

\*\*An ACAD is considered literary if at least 50% of the members theology, law, humanities, or social sciences

Note: Column (2) and (3) sum up to (1).

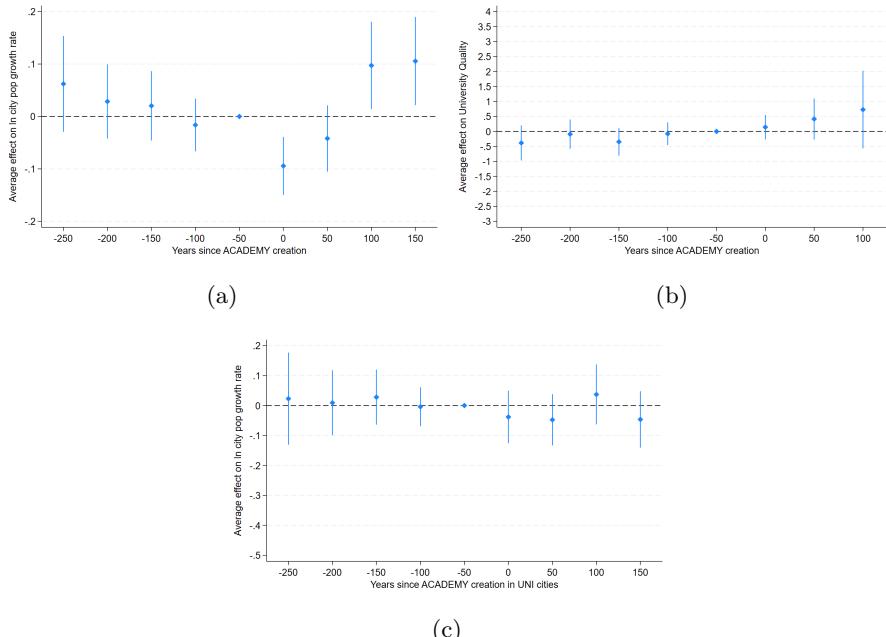
Column (4) and (5) are independent from each other.

**Table I7** Pre-treatment Statistics per *EVENT* by outcome variable

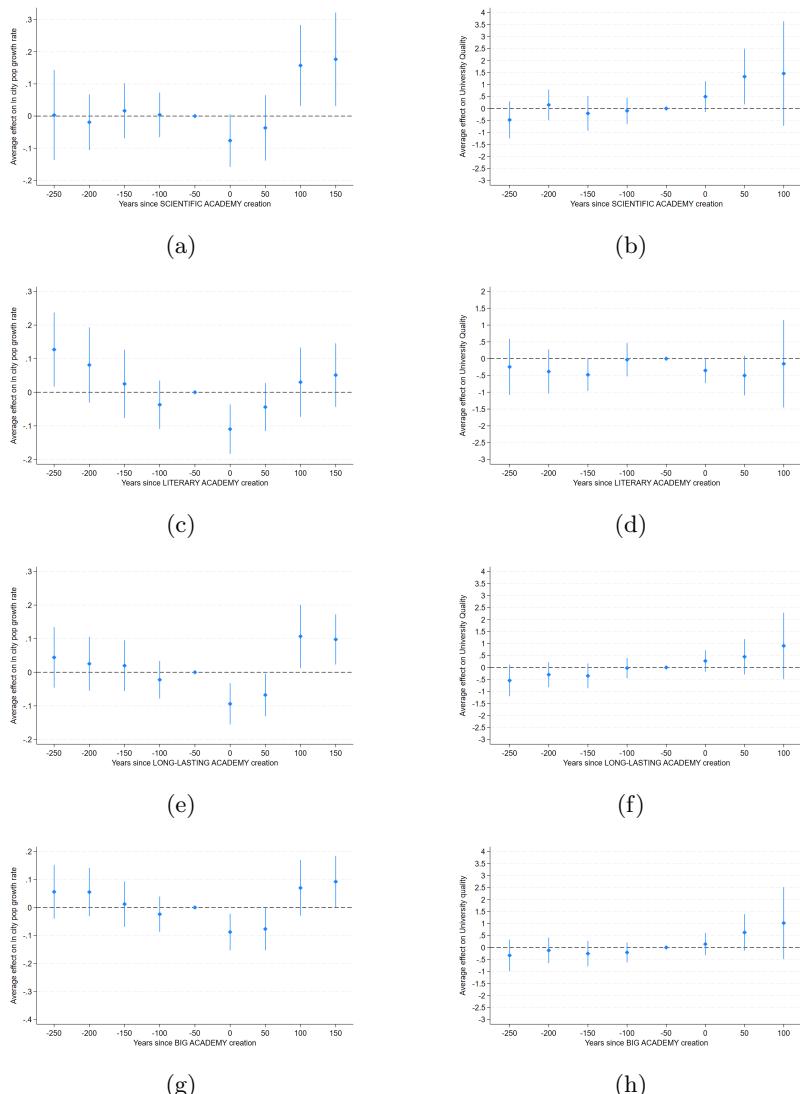
| <i>EVENT</i>  | Obs | Mean  | Std. Dev. | Min    | Max   |
|---|-----|-------|-----------|--------|-------|
| Outcome variable: $\Delta \ln pop$ 1500-1900, 50-years interval |     |       |           |        |       |
| ACAD  | 82  | 0.199 | 0.303     | -0.318 | 1.139 |
| UNI*  | 83  | 0.125 | 0.245     | -0.434 | 1.099 |
| ACAD SCIENCE  | 43  | 0.205 | 0.312     | -0.318 | 1.139 |
| ACAD LIT  | 39  | 0.195 | 0.297     | -0.236 | 1.099 |
| ACAD LONG   | 69  | 0.216 | 0.295     | -0.318 | 1.099 |
| ACAD BIG  | 62  | 0.224 | 0.320     | -0.318 | 1.139 |
| Outcome variable: $AvgQ$ 1500-1900, 50 years interval           |     |       |           |        |       |
| ACAD  | 40  | 2.659 | 2.362     | 0      | 7.060 |
| ACAD SCIENCE  | 21  | 3.270 | 2.345     | 0      | 7.060 |
| ACAD LIT  | 19  | 1.984 | 2.249     | 0      | 6.768 |
| ACAD LONG   | 35  | 2.814 | 2.314     | 0      | 7.060 |
| ACAD BIG  | 32  | 2.549 | 2.271     | 0      | 7.060 |

\*There are 152 universities in total (St. Petersburg is excluded), 69 open before 1500, which is the beginning of my main sample period, so the statistics are computed on only 83 observations.

## I.1 Leaving London out

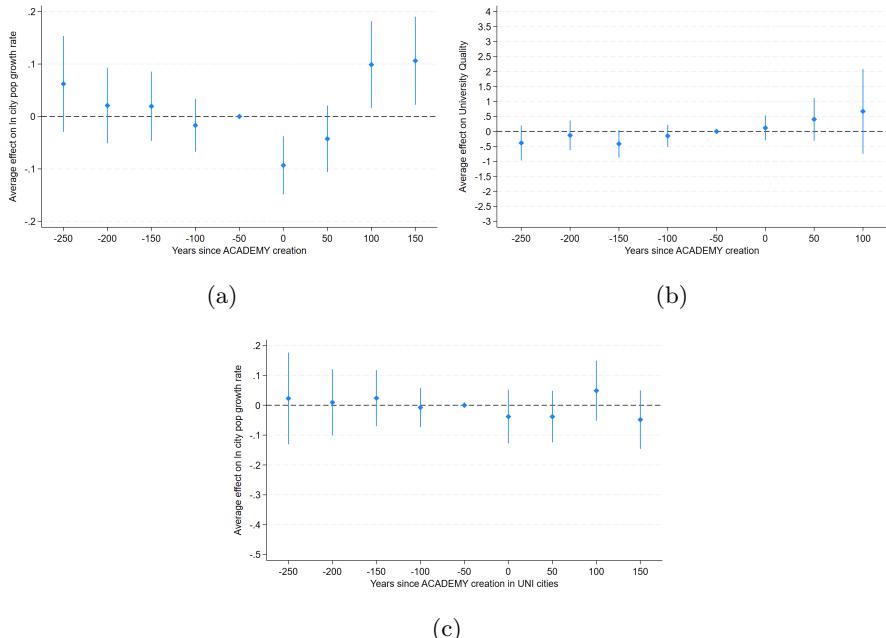


**Fig. I18** Effect of creating (a) an academy on population growth rate, (b) an academy on the quality of universities, and (c) an academy in cities that hosted a university at least once; estimated with Sun and Abraham (2021). Control group: never-treated. Leaving London out from the sample.

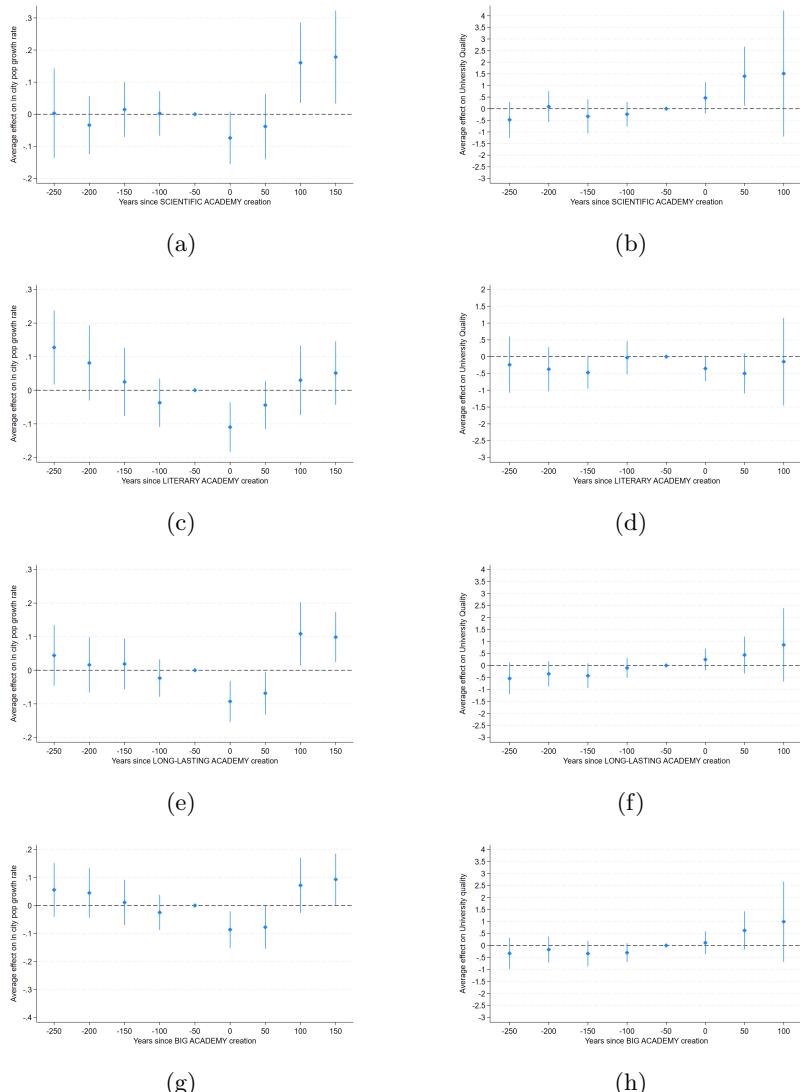


**Fig. I19** Effect of creating (a - b) a scientific academy, (c - d) a literary academy, (e - f) a long-lasting academy, and (g - h) a big academy; estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: population growth rate on the left column, and quality of universities on the right column. Leaving London out from the sample.

## I.2 Leaving Paris out

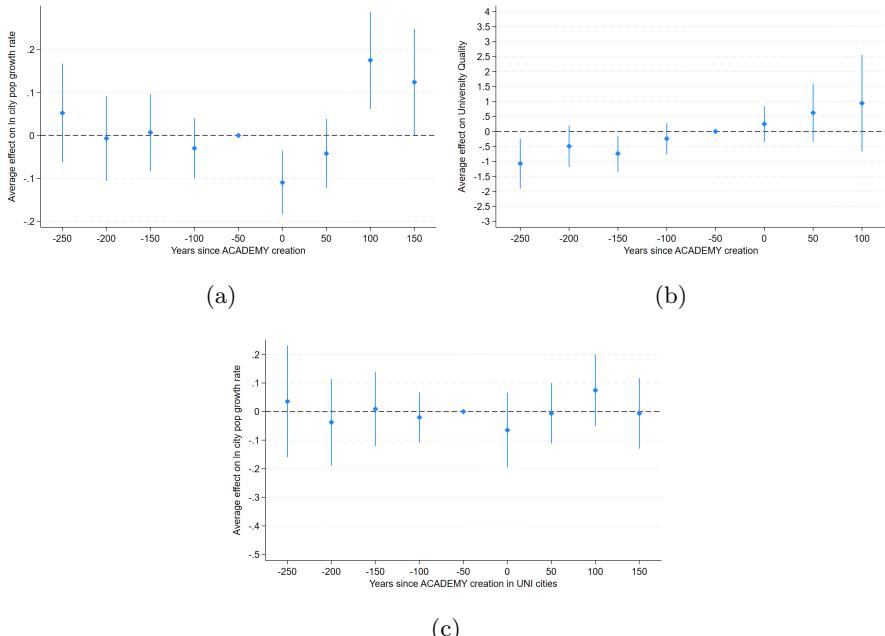


**Fig. I20** Effect of creating (a) an academy on population growth rate, (b) an academy on the quality of universities, and (c) an academy in cities that hosted a university at least once; estimated with Sun and Abraham (2021). Control group: never-treated. Leaving Paris out from the sample.

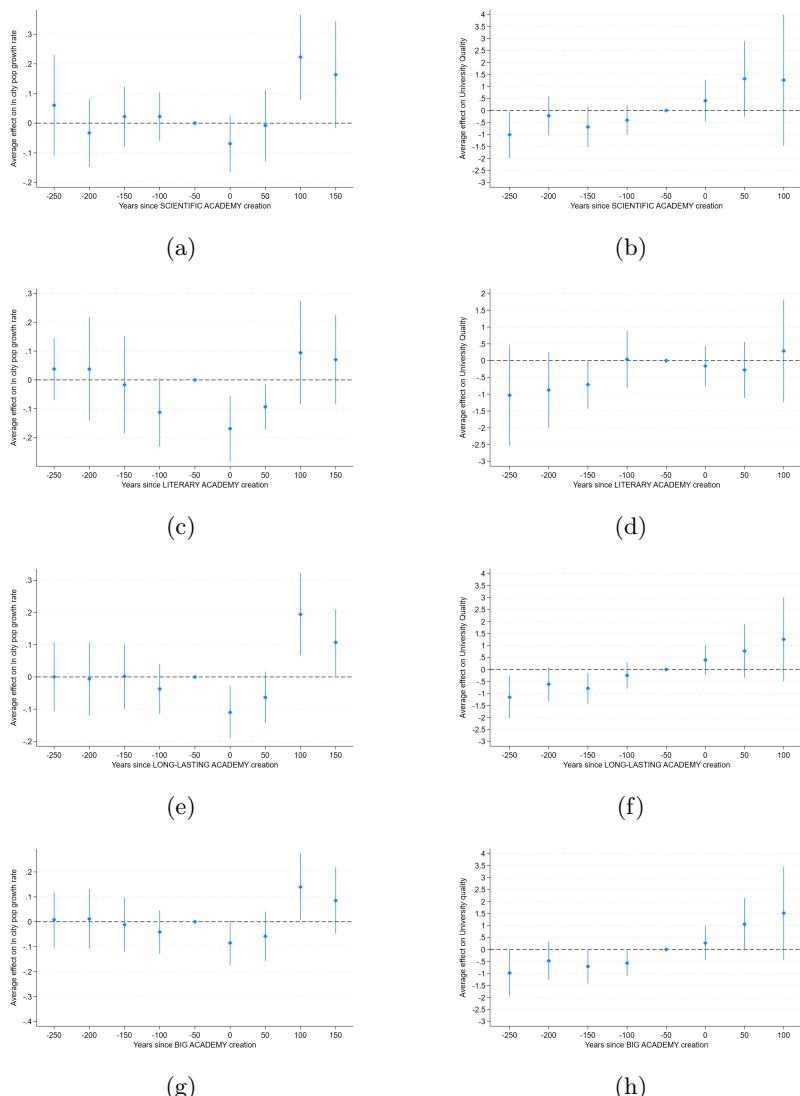


**Fig. I21** Effect of creating (a - b) a scientific academy, (c - d) a literary academy, (e - f) a long-lasting academy, and (g - h) a big academy; estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: population growth rate on the left column, and quality of universities on the right column. Leaving Paris out from the sample.

### I.3 Leaving France out

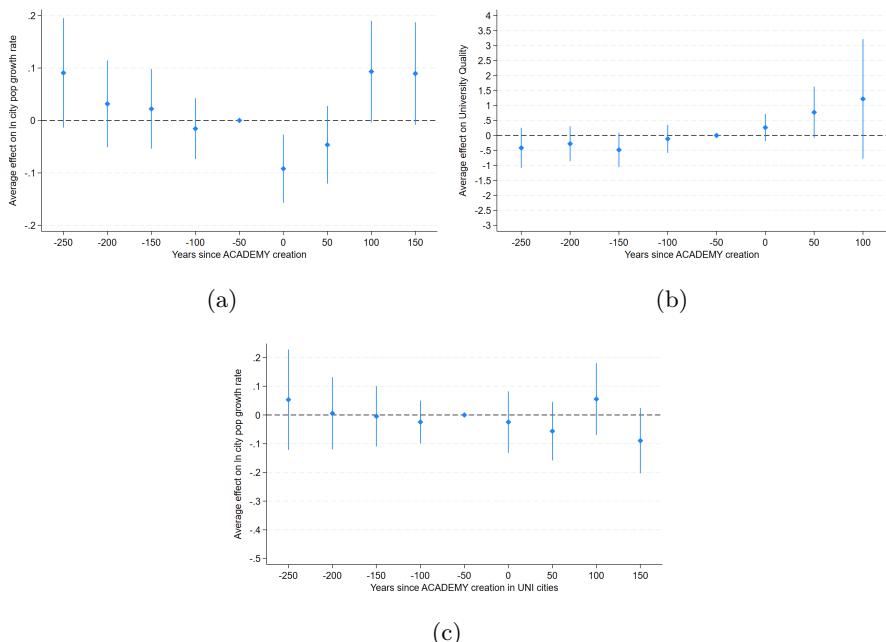


**Fig. I22** Effect of creating (a) an academy on population growth rate, (b) an academy on the quality of universities, and (c) an academy in cities that hosted a university at least once; estimated with Sun and Abraham (2021). Control group: never-treated. Leaving France out from the sample.

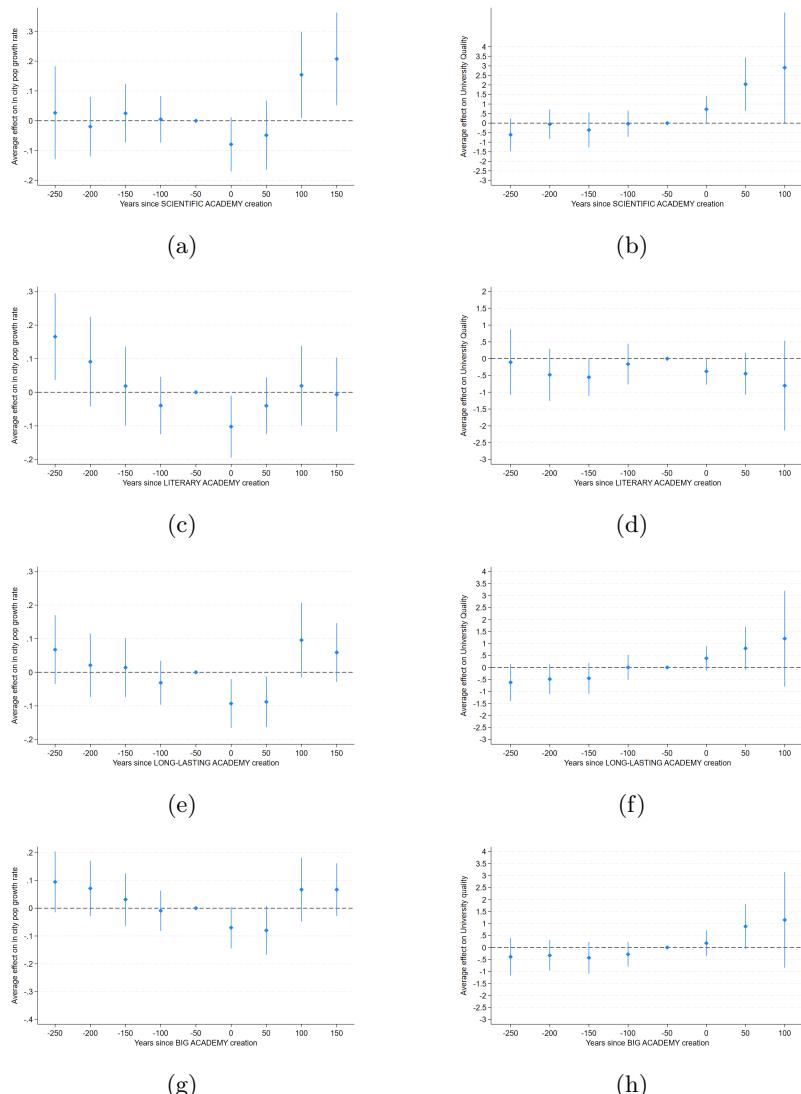


**Fig. I23** Effect of creating (a - b) a scientific academy, (c - d) a literary academy, (e - f) a long-lasting academy, and (g - h) a big academy; estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: population growth rate on the left column, and quality of universities on the right column. Leaving France out from the sample.

## I.4 Leaving Italy out

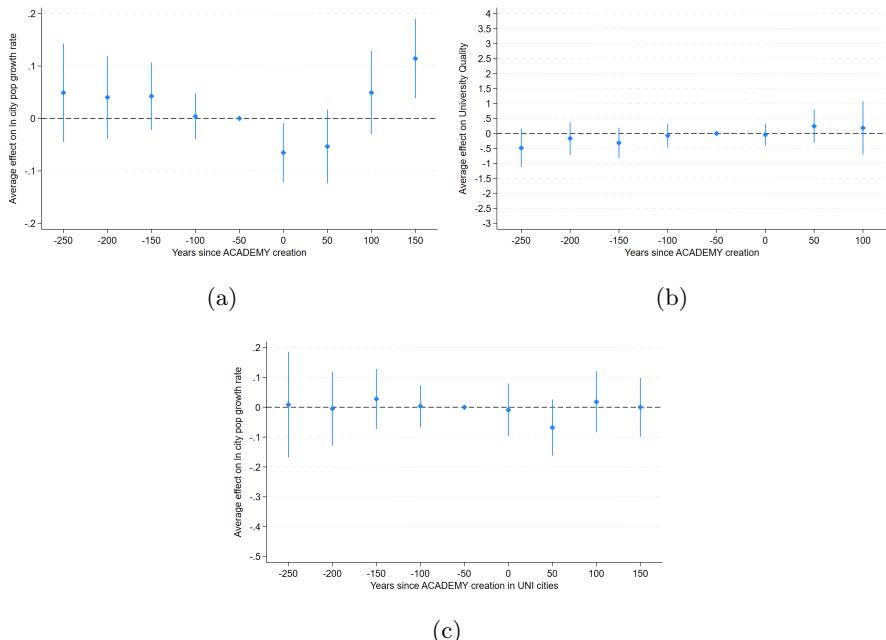


**Fig. I24** Effect of creating (a) an academy on population growth rate, (b) an academy on the quality of universities, and (c) an academy in cities that hosted a university at least once; estimated with Sun and Abraham (2021). Control group: never-treated. Leaving Italy out from the sample.

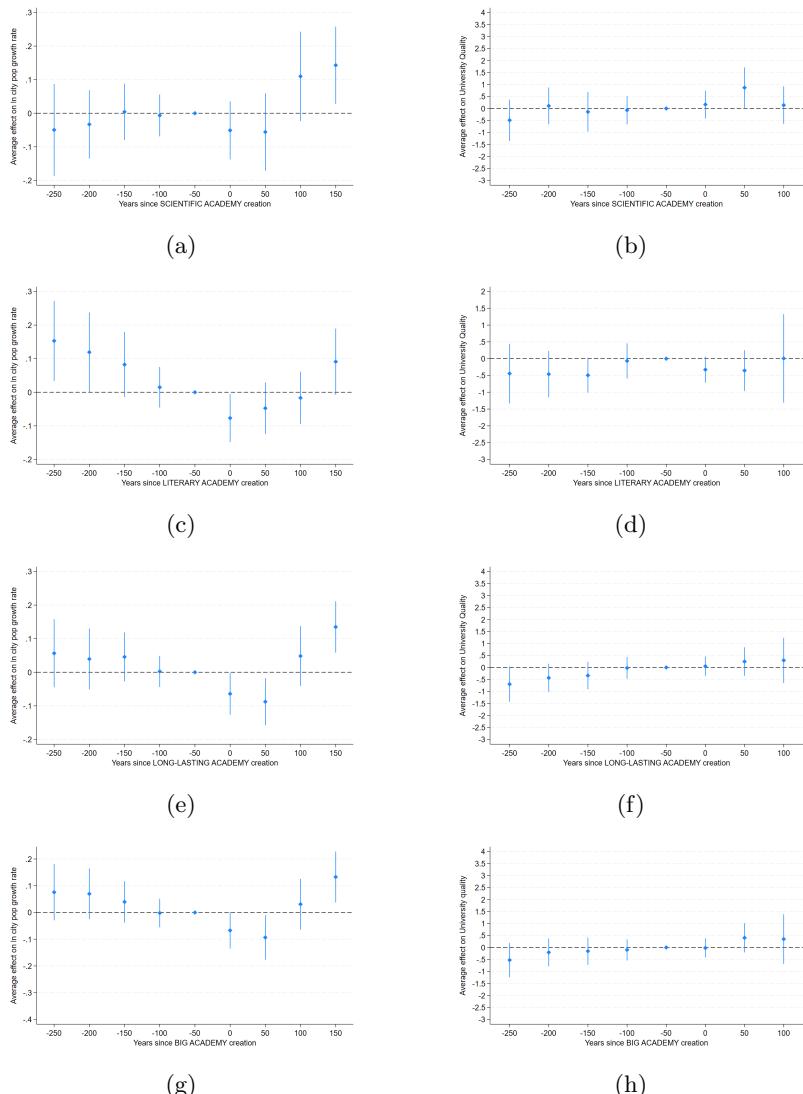


**Fig. I25** Effect of creating (a - b) a scientific academy, (c - d) a literary academy, (e - f) a long-lasting academy, and (g - h) a big academy; estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: population growth rate on the left column, and quality of universities on the right column. Leaving Italy out from the sample.

## I.5 Leaving Germany out

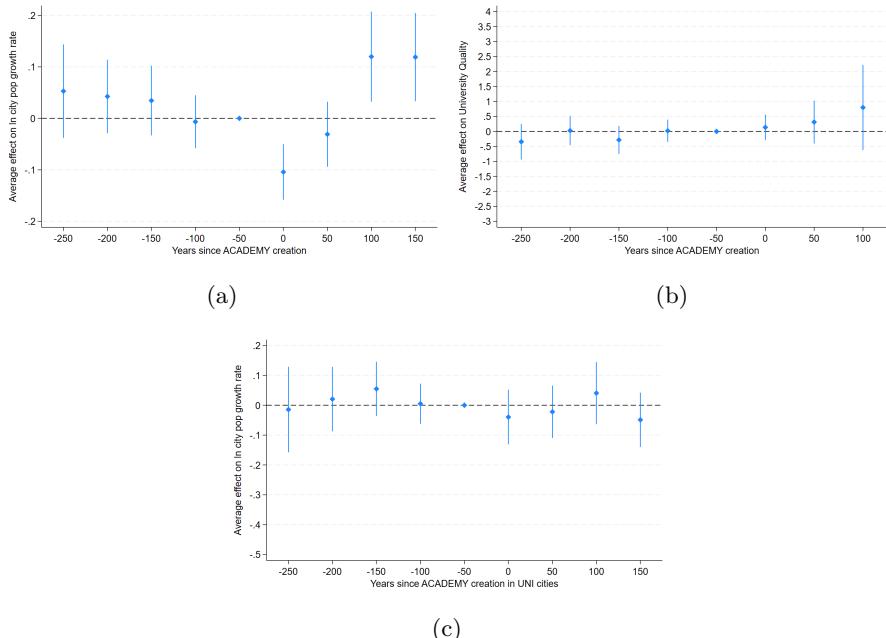


**Fig. I26** Effect of creating (a) an academy on population growth rate, (b) an academy on the quality of universities, and (c) an academy in cities that hosted a university at least once; estimated with Sun and Abraham (2021). Control group: never-treated. Leaving Germany out from the sample.

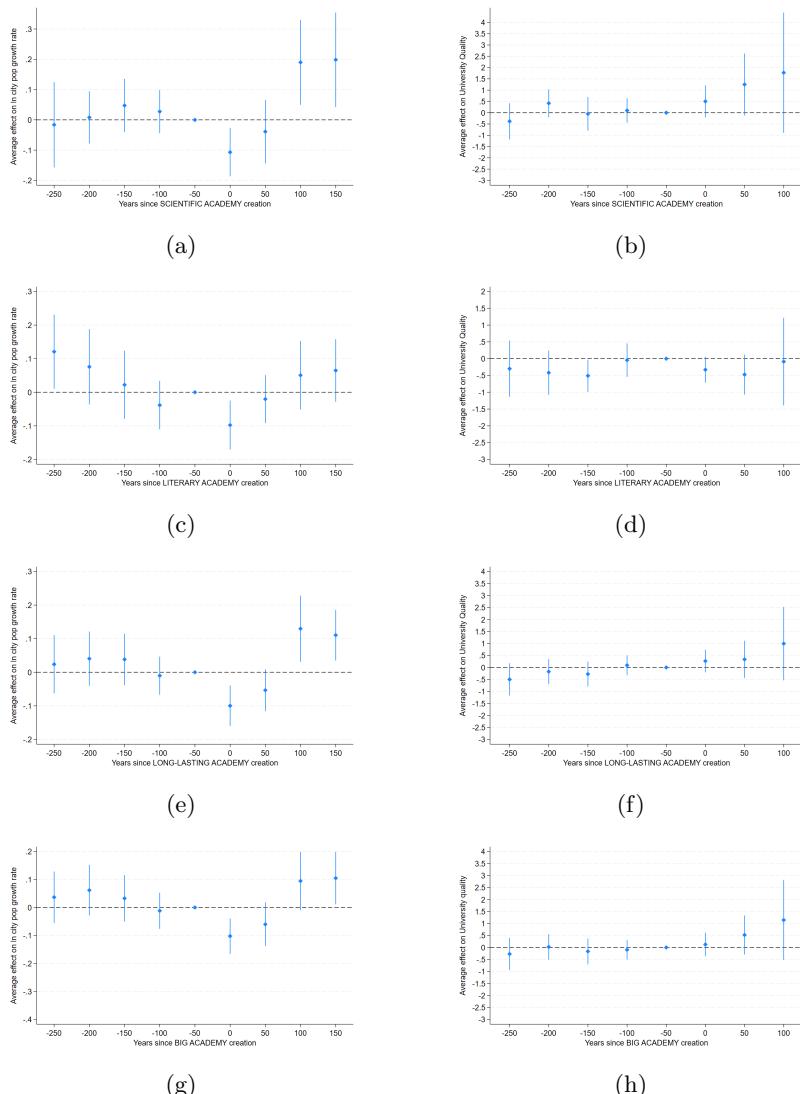


**Fig. 127** Effect of creating (a - b) a scientific academy, (c - d) a literary academy, (e - f) a long-lasting academy, and (g - h) a big academy; estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: population growth rate on the left column, and quality of universities on the right column. Leaving Germany out from the sample.

## I.6 Leaving GB out

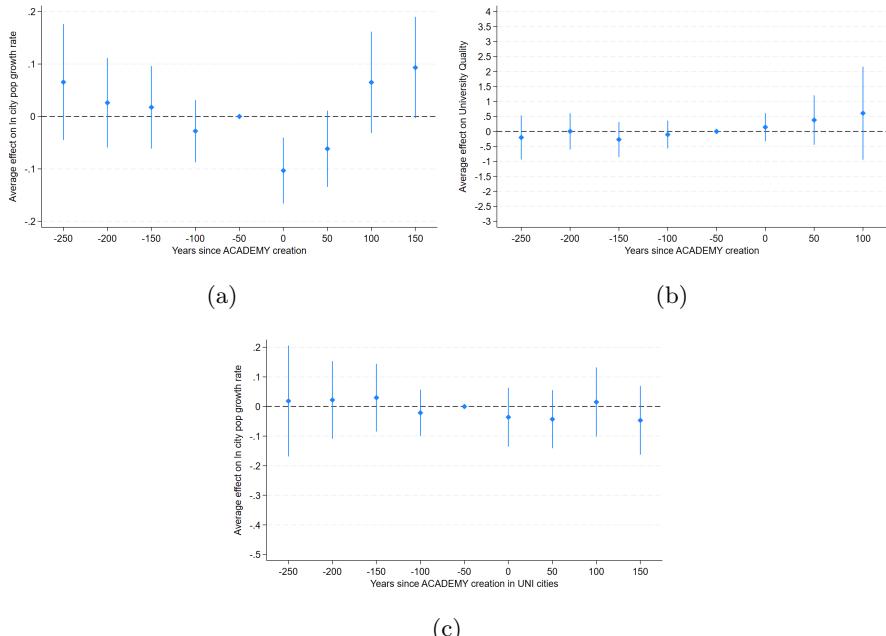


**Fig. I28** Effect of creating (a) an academy on population growth rate, (b) an academy on the quality of universities, and (c) an academy in cities that hosted a university at least once; estimated with Sun and Abraham (2021). Control group: never-treated. Leaving GB out from the sample.

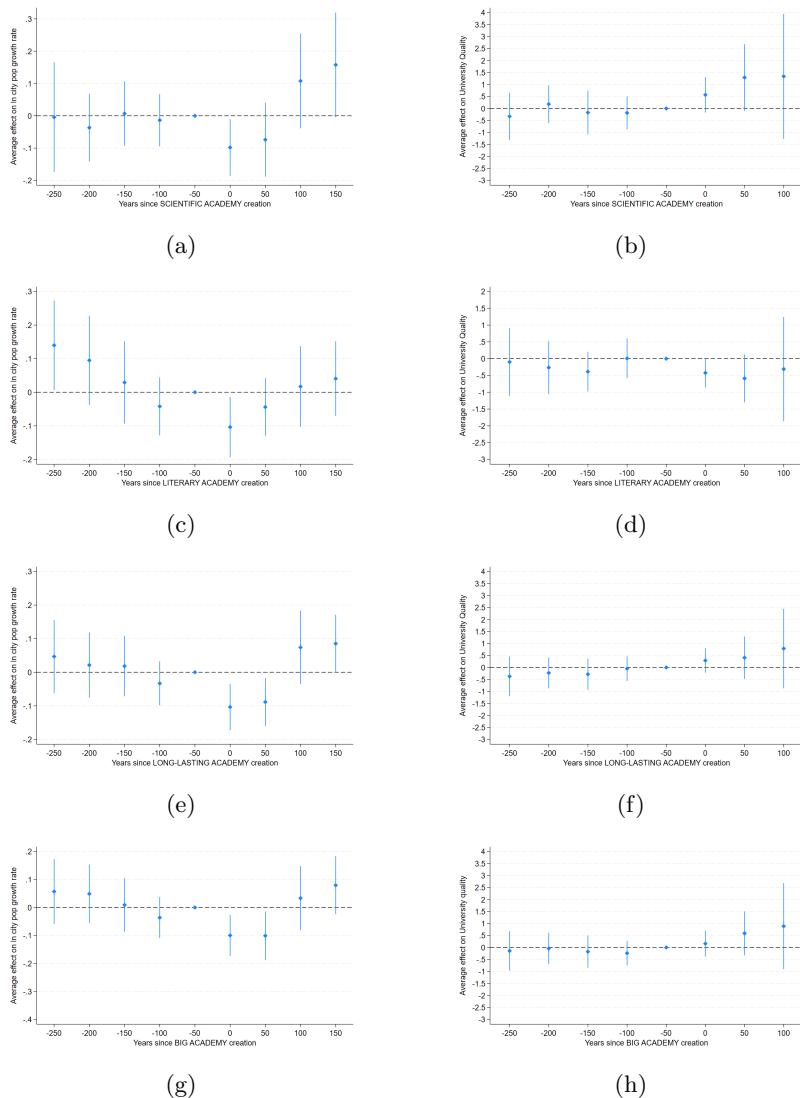


**Fig. I29** Effect of creating (a - b) a scientific academy, (c - d) a literary academy, (e - f) a long-lasting academy, and (g - h) a big academy; estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: population growth rate on the left column, and quality of universities on the right column. Leaving GB out from the sample.

## I.7 Leaving Spain out

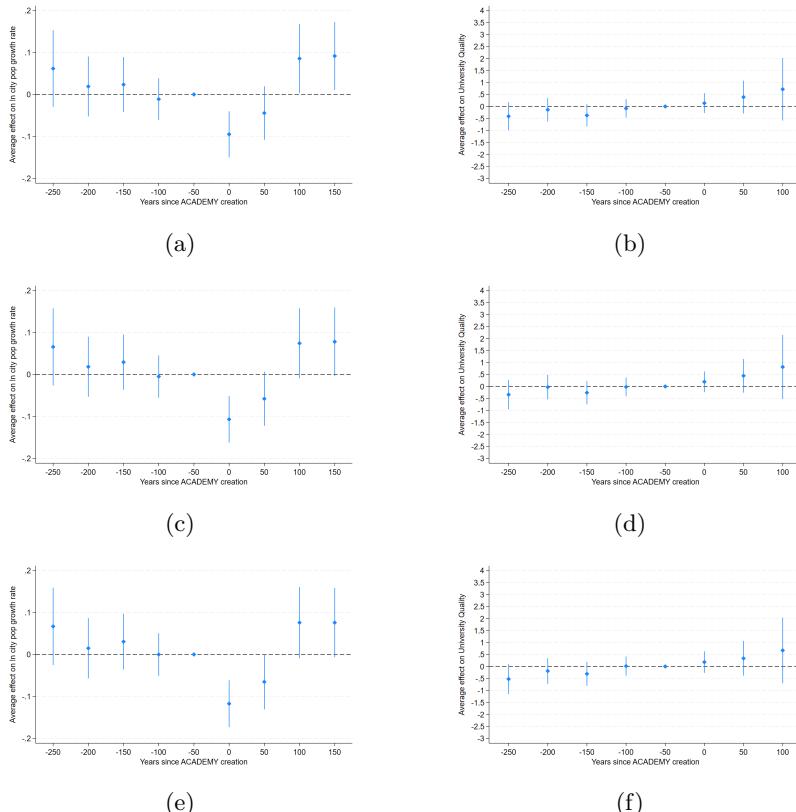


**Fig. I30** Effect of creating (a) an academy on population growth rate, (b) an academy on the quality of universities, and (c) an academy in cities that hosted a university at least once; estimated with Sun and Abraham (2021). Control group: never-treated. Leaving Spain out from the sample.

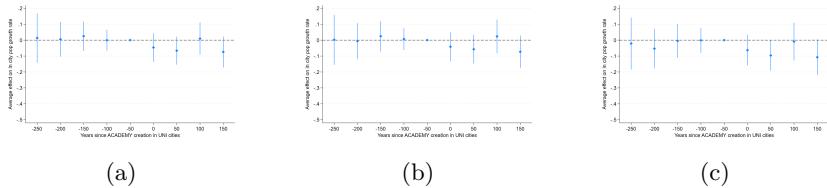


**Fig. I31** Effect of creating (a - b) a scientific academy, (c - d) a literary academy, (e - f) a long-lasting academy, and (g - h) a big academy; estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: population growth rate on the left column, and quality of universities on the right column. Leaving Spain out from the sample.

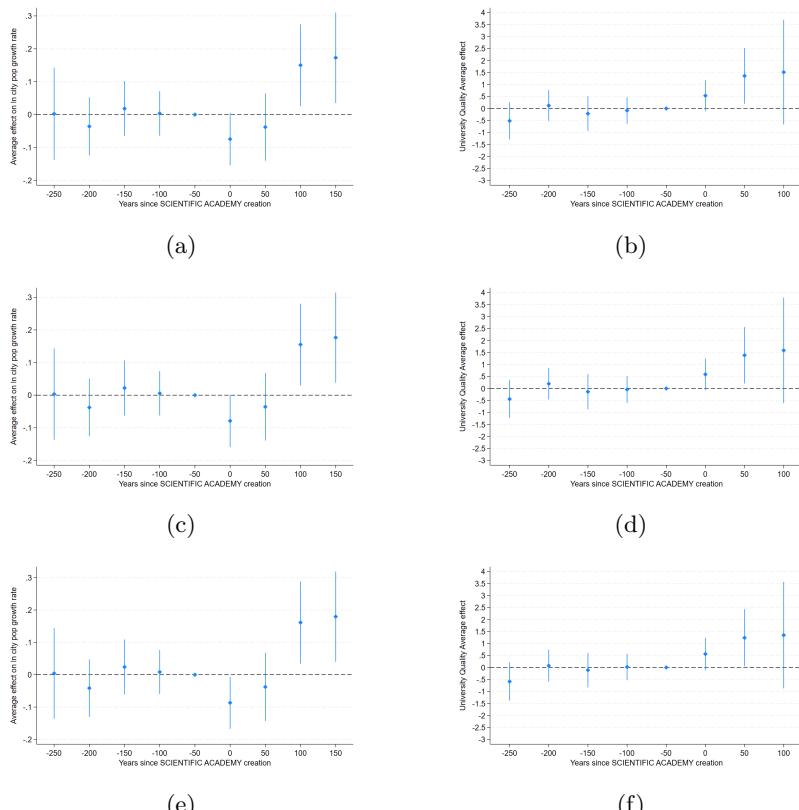
## Appendix J Local effects: dropping cities within 50-100-150 km radius



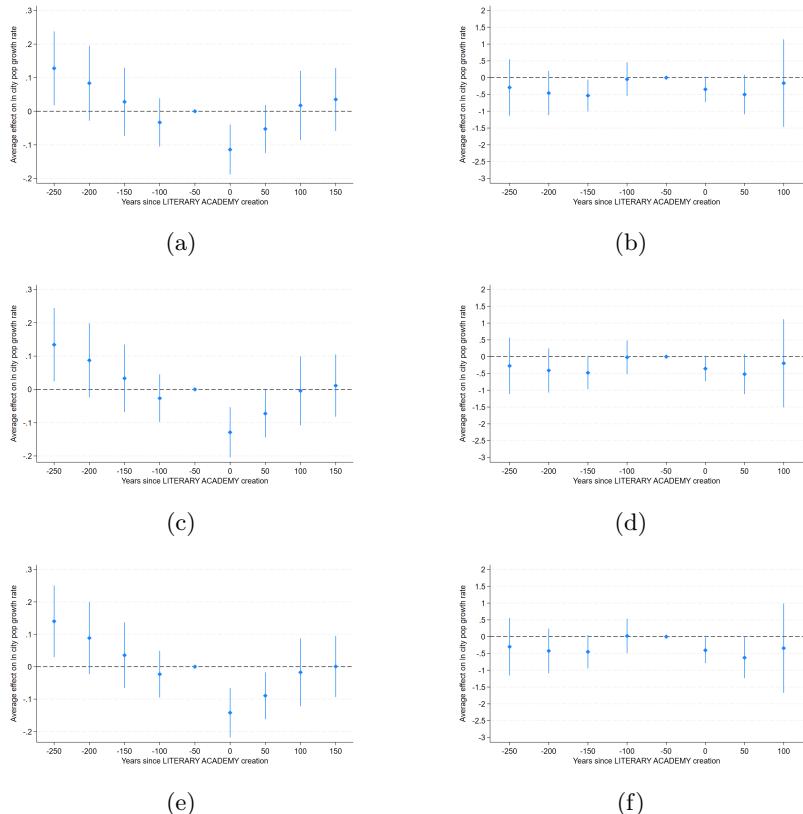
**Fig. J32** Effect of creating an academy excluding cities (a - b) within 50 km, (c - d) within 100, (e - f) within 150km; estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: population growth rate on the left column, and quality of universities on the right column.



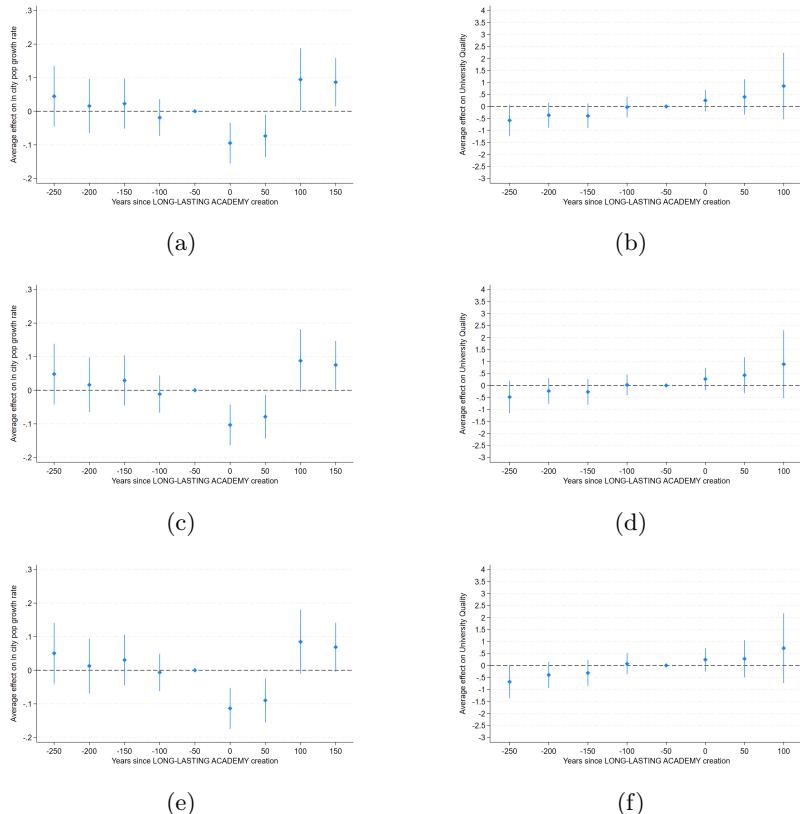
**Fig. J33** Effect of creating an academy in cities that ever had a university, excluding cities (a) within 50 km, (b) within 100, (c) within 150km; estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: population growth rate.



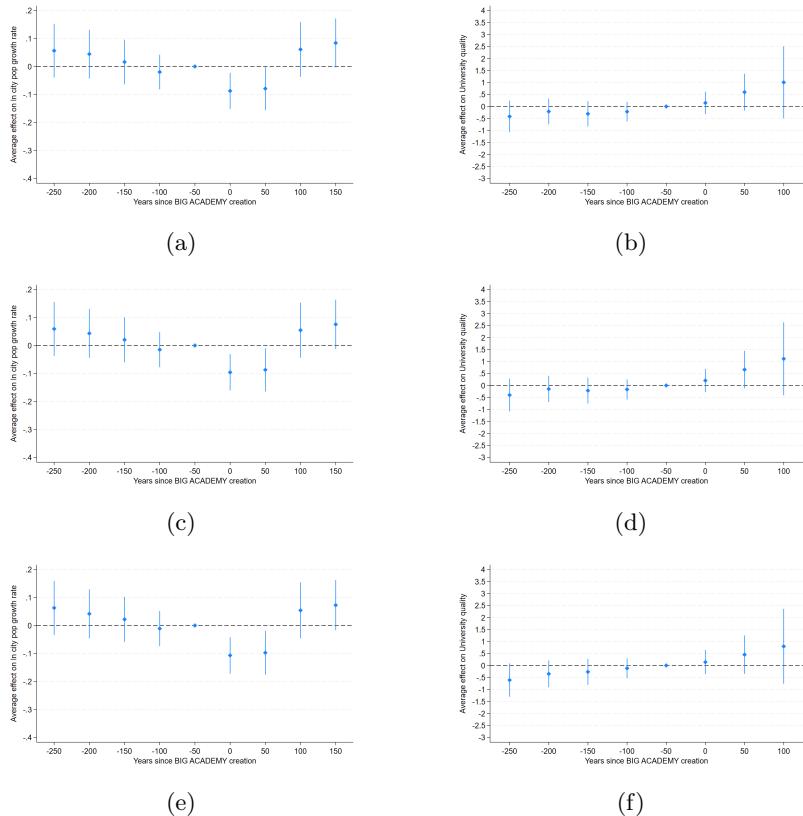
**Fig. J34** Effect of creating a scientific academy excluding cities (a - b) within 50 km, (c - d) within 100, (e - f) within 150km; estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: population growth rate on the left column, and quality of universities on the right column.



**Fig. J35** Effect of creating a literary academy excluding cities (a - b) within 50 km, (c - d) within 100, (e - f) within 150km; estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: population growth rate on the left column, and quality of universities on the right column.

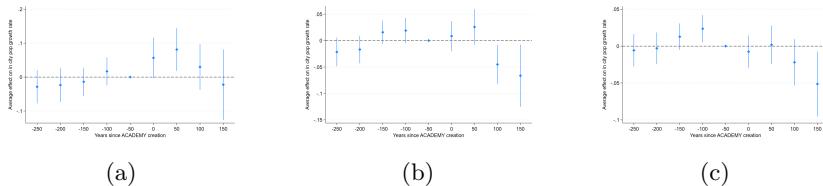


**Fig. J36** Effect of creating a long-lasting academy excluding cities (a - b) within 50 km, (c - d) within 100, (e - f) within 150km; estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: population growth rate on the left column, and quality of universities on the right column.

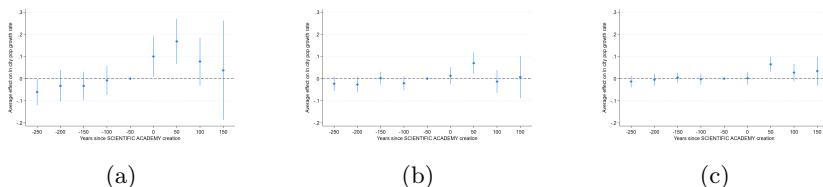


**Fig. J37** Effect of creating a big academy excluding cities (a - b) within 50 km, (c - d) within 100, (e - f) within 150km; estimated with Sun and Abraham (2021). Control group: never-treated. Dependent variable: population growth rate on the left column, and quality of universities on the right column.

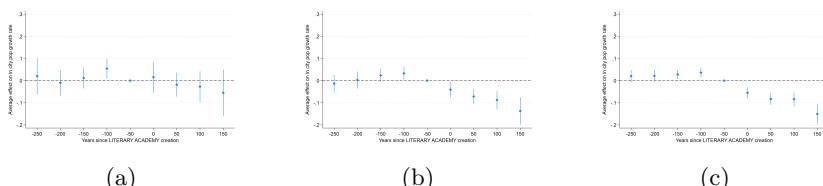
## Appendix K Spillover effects



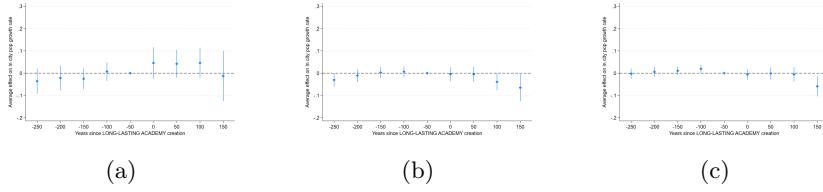
**Fig. K38** Effect of creating an academy in cities (a) within 25km from the hosting cities, excluding the hosting city, (b) between 25km and 50km from the hosting cities, excluding hosting cities and within the 0-25km ‘donut’, (c) between 50km and 75km from the hosting cities, excluding hosting cities and within the 25-50km ‘donut’; estimated with Sun and Abraham (2021). Control group: cities further away than 25km-50km-75km, respectively. Dependent variable: population growth rate.



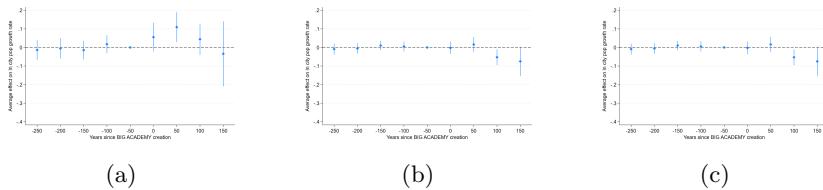
**Fig. K39** Effect of creating a scientific academy in cities (a) within 25km from the hosting cities, excluding the hosting city, (b) between 25km and 50km from the hosting cities, excluding hosting cities and within the 0-25km ‘donut’, (c) between 50km and 75km from the hosting cities, excluding hosting cities and within the 25-50km ‘donut’; estimated with Sun and Abraham (2021). Control group: cities further away than 25km-50km-75km, respectively. Dependent variable: population growth rate.



**Fig. K40** Effect of creating a literary academy in cities (a) within 25km from the hosting cities, excluding the hosting city, (b) between 25km and 50km from the hosting cities, excluding hosting cities and within the 0-25km ‘donut’, (c) between 50km and 75km from the hosting cities, excluding hosting cities and within the 25-50km ‘donut’; estimated with Sun and Abraham (2021). Control group: cities further away than 25km-50km-75km, respectively. Dependent variable: population growth rate.



**Fig. K41** Effect of creating a long-lasting academy in cities (a) within 25km from the hosting cities, excluding the hosting city, (b) between 25km and 50km from the hosting cities, excluding hosting cities and within the 0-25km ‘donut’, (c) between 50km and 75km from the hosting cities, excluding hosting cities and within the 25-50km ‘donut’; estimated with Sun and Abraham (2021). Control group: cities further away than 25km-50km-75km, respectively. Dependent variable: population growth rate.



**Fig. K42** Effect of creating a large academy in cities (a) within 25km from the hosting cities, excluding the hosting city, (b) between 25km and 50km from the hosting cities, excluding hosting cities and within the 0-25km ‘donut’, (c) between 50km and 75km from the hosting cities, excluding hosting cities and within the 25-50km ‘donut’; estimated with Sun and Abraham (2021). Control group: cities further away than 25km-50km-75km, respectively. Dependent variable: population growth rate.