Early Modern Academies, Universities and Growth*

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Abstract

Knowledge production is central to modern economic growth, but what role did it play in the past? Despite growing interest in the history of human capital, we still know little about how knowledge shaped long-term development in pre-industrial societies. This paper explores the contribution of academies—dynamic, scientifically oriented institutions that emerged across Europe between 1650 and 1800. Drawing on newly assembled data and employing advanced difference-in-differences methods, I show that academies contributed to sustained urban growth. Using individual-level data on scholars, I further demonstrate that while literary academies had limited long-term effects, scientific academies led to persistent gains. I also document positive spillovers: cities near academies experienced faster growth, and the presence of academies improved the quality of existing universities. These findings provide the first empirical evidence of the pivotal role scientific academies played in shaping Europe's long-run economic development.

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

JEL Classification: N13 , N23 , N33 , I23 , O31 , O47

*You can find the most recent version of the paper here: https://chiarazanardello.github.io/files/zanardello_jmp.pdf.

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1 Introduction

Today, we widely recognize the value of knowledge: human capital and innovation drive economic growth and societal progress (Nelson & Phelps, 1966). Skills in science and technology are especially important in modern economies.[1] Yet we still know relatively little about how knowledge and human capital contributed to major technological advances in the past—largely due to limited historical data.[2] While we now have high-quality data to assess the short-term impact of contemporary universities and research institutions (Bianchi & Giorcelli, 2020), the long-term effects of today's investments in human capital remain difficult to measure. One way forward is to look backward. Historical evidence can help us project how current investments may unfold in the future, by learning from patterns observed in the past. In particular, Early Modern Europe saw the creation of new educational institutions—academies and universities—that brought together talented individuals with the aim of producing knowledge that could benefit society. Over the following centuries, Europe emerged as a global scientific leader. In this paper, I introduce new micro-level data and use cutting-edge empirical methods to investigate how academies contributed to this transformation.

I revisit the idea that a relatively small group of highly skilled individuals played a key role in Europe's development before the Industrial Revolution (Mokyr, 2005a; Mokyr & Voth, 2009). Specifically, this paper studies the impact of experimental academies—new types of institutions dedicated to scientific inquiry—and their interaction with more traditional universities. I ask two questions. First, did these academies contribute to the economic development of European cities? Second, how did their presence affect universities? I examine whether universities responded to the presence of academies by modernizing their teaching and organization. I answer these questions by expanding a unique database that tracks scholars active in European educational institutions from 1000 to 1800 (de la Croix, 2021).

Between the 16^{th} and 18^{th} centuries, European intellectual life underwent major change. New scientific ideas and methods emerged. Instead of relying on traditional authorities such as Aristotle or Ptolemy, scholars began to base claims on observation, experimentation, and evidence (Mokyr, 2016). A new kind of institution developed to support this effort: the academy. These academies—distinct from universities founded from the 12^{th} and 13^{th} centuries—provided a more flexible space for experimentation and problem-solving (Applebaum, 2000; McClellan, 1985). They prioritized practical knowledge and the improvement of everyday life, often focusing on local needs. This "useful knowledge," as Mokyr describes it, was a key ingredient in Europe's long-run development (Mokyr, 2005a, p.287). I also explore whether

[1] C.f. Barro (1991, 2001); D. Cohen and Soto (2007); Hanushek and Woessmann (2008)
[2] See Cantoni and Yuchtman (2014); de la Croix, Docquier, Fabre, and Stelter (2023); Dittmar and Meisenzahl (2022); Squicciarini and Voigtländer (2015) for recent empirical studies on this topic.

the influence of these academies extended beyond their host cities—consistent with the idea that knowledge is a non-rival good that can spread across space (Romer, 1990). By 1800, nearly every major urban center in Europe either hosted an academy or felt the influence of the academy movement (McClellan, 1985). As a robustness check, I present detailed sensitivity analyses to assess whether my results are driven by a few cities or countries which were highly involved with the academy movement.

To study the role of academies across time and space, I use a new and comprehensive dataset on scholars affiliated with both academies and universities, based on the database developed in de la Croix (2021). This dataset includes micro-level information on nearly 80,000 individuals from over 370 institutions across Europe. For each scholar, we document their institutional affiliations, places of birth and death, and field of study. I also enhance the original dataset by improving coverage of academies with a scientific orientation, based on institutions listed in McClellan (1985).[3]

My main outcome variable is population growth at the city level, a standard proxy for historical economic development in a Malthusian context (Ashraf & Galor, 2011; Buringh, 2021). I use difference-in-differences (DID) methods to compare cities that established academies to those that did not. Since academy creation occurred at different times across cities–*staggered* treatment–I rely on recent DID estimators designed to address bias in such designs (Callaway & Sant'Anna, 2021; De Chaisemartin & d'Haultfoeuille, 2024; Sun & Abraham, 2021).

The key identifying assumption is that, in the absence of an academy, cities would have followed similar growth trends. I find that the parallel trends assumption holds during the 1500–1900 period, reducing concerns about reverse causality—that is, that fast-growing cities were more likely to attract academies. However, questions remain about the exogeneity of academy timing. Specifically, unobserved factors might have simultaneously influenced both the decision to create an academy and urban development.

To address this concern, I conducted a detailed historical investigation into the founding of these institutions. I collected extensive qualitative evidence on their origins, including their organizational structures, sources of funding, and the biographies of their founders. This historical record consistently shows that most academies were initiated by groups of scholars motivated by the desire to revitalize scientific inquiry, rather than by rulers or economic elites seeking direct development gains. Political authorities—such as local lords, bishops, or monarchs—often supported these initiatives, but typically at a later stage, once the academic community had already laid the groundwork. This timing reduces the likelihood that academies were strategically created in response to economic conditions.

While I cannot claim full exogeneity, I adopt an empirical strategy that progressively addresses endogeneity concerns. I include city fixed effects to

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[3]Access the database at the following link: https://shiny-lidam.sipr.ucl.ac.be/scholars/

control for time-invariant differences across cities, and country-by-time fixed effects to absorb broader national trends. These controls, together with the staggered treatment structure and historical evidence, mitigate—at least partially—concerns about omitted variable bias and reverse causality.

I find that, on average, cities that created an academy experienced 9–15% higher population growth over the next 100 years compared to those that did not. These estimates are based on the period 1500–1900 and are robust across a wide range of specifications.

The type of academy plays a key role in explaining this effect. Leveraging the scholar-level information in the database, I classify academies based on the fields of study of their members. Scientific academies—those where over 50% of members were active in natural sciences or empirical disciplines—had the strongest and most persistent effects, with growth rates 12–15% higher than those of the control group. In contrast, literary academies had weaker and more delayed effects, and their impact was less stable across models.

Academies not only contributed to growth directly—they also appear to have influenced the institutions around them. In cities that already had universities, the arrival of a scientific academy often led to reform. Historical accounts suggest that universities modernized their curricula and teaching methods under the influence of academies (Applebaum, 2000; McClellan, 1985). Using a quality index of universities from de la Croix et al. (2023), I show that university quality increased by 44% on average within 50 years of the creation of a scientific academy. Literary academies did not have the same effect. To my knowledge, this is the first empirical study to measure the influence of academies on universities and their complementarities.

This paper contributes to three literatures. First, in economic history, it improves our understanding of the upper tail of the human capital distribution in Europe before the Industrial Revolution (Mokyr, 2005b, 2016; Mokyr & Voth, 2009; Ó Gráda, 2016). I provide new micro-level data on scholars and institutions, including detailed biographies and institutional histories. I also build on existing work on the long-run effects of educational institutions (Becker & Woessmann, 2009; Cantoni & Yuchtman, 2014; Cinnirella & Streb, 2017; Dittmar & Meisenzahl, 2022; Squicciarini & Voigtländer, 2015). Universities have long been the focus of this literature: from Cantoni and Yuchtman (2014) we know that universities played an important role in mediating uncertainty during Middle Ages, educating judges and public administrators, and 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. This paper highlights the complementary role of academies in producing useful, applied knowledge (Gage, 1938; Mokyr, 2003). As far as I am aware, the sole study exploring the newly emerging societies at the end of the 18^{th} century is that of Cinnirella, Hornung, and Koschnick (2024), which centers on German economic societies exclusively. I show that academies more broadly—not just economic ones—played a major role in Europe's intellectual and economic transformation. Additionally, while much of the literature focuses on single-country case studies, my research adopts a pan-European perspective– like Benos, Conti, Papazoglou, and Tsoumaris (2024); Bosker, Buringh, and Van Zanden (2013); de la Croix et al. (2023) do– 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, in the economics of innovation, this paper highlights how scientific knowledge mattered even before 1800 (Dittmar, 2019; Koschnick, 2025; Mokyr, 2003, 2005a). Specifically, Hanlon (2022) provides quantitative evidence that the rise of the engineering profession during the first technological breakthrough fundamentally transformed both the process and direction of innovation. My findings also align with Dittmar and Meisenzahl (2022), who shows that German universities contributed to scientific innovation only after implementing more research activities. Similarly, I find that academies, as research-driven institutions, fostered innovation by applying empirical methods and focusing on local problems.

Third, this paper contributes to the economics of education. It is, to my knowledge, the first to study the interaction between different types of higher education institutions with a historical perspective. I show that academies encouraged universities to reform and improve, thereby contributing to city progress through channels beyond direct economic growth.

The rest of this paper is structured as follows. Section 2 provides historical context on academies and their relationship with universities. Section 3 describes the data. Section 4 outlines the empirical methods. Section 5 presents the main findings. Section 6 examines the effects on university quality. Section 7 discusses sensitivity analyses and potential spillover effects. Section 8 concludes.

2 Historical and institutional context

2.1 Universities and academies

Universities were the first wave of higher educational institutions in Medieval and Early Modern Europe.[4] A second major development occurred in the 1650s with the rise of academies and learned societies. These institutions marked a significant shift in the European educational system, serving as a bridge between two traditions: the classical university model and a more modern, practice-oriented approach to scientific learning and dissemination that would gain prominence in the 19th century (McClellan, 1985). Academies represent

[4]Universities are among the earliest institutions of higher learning to employ multiple masters. Prior to their emergence, cathedral and monastic schools dominated the landscape. These typically had only one master and focused on a narrow curriculum, often limited to a single subject (Pixton, 1998). However, some schools—such as the School of Laon—gained significant popularity and attracted students even from abroad, thanks to the depth and reputation of their teaching (Luscombe, 1969).

the roots of what has been described as an *"extraordinary educational breakthrough"* (Schütte, 2007, p.545), a transformation that would continue and evolve throughout the 19th century.[5]

Europe stands out historically for its bottom-up development of higher educational institutions. These institutions, largely absent elsewhere, were predominantly founded on the European continent. In contrast, other regions followed different models. In China, for example, kinship-based institutions such as clans prioritized social stability and security over economic advancement or educational innovation (Chen & Ma, 2022). In the Middle East and North Africa, the madrasa was the dominant form of higher education (Bosker et al., 2013); however, it functioned more like a specialized high school than a university in the European sense.

It is important to acknowledge that the scientific method and major innovations were not exclusive to Europe. Significant discoveries originated in other parts of the world, often preceding those made in Europe (Bala, 2006; Needham, 1964). However, this project focuses on Europe as the first region to industrialize and to develop a system of bottom-up higher educational institutions. Figure 1 shows the cumulative number of institutions included in the analysis between 1500 and 1800.

The emergence of academies exposed key shortcomings in the institutional structure of universities. In particular, universities were slow to embrace new ideas, especially in the natural sciences. They remained anchored to traditional curricula, prioritized ancient authorities, and maintained Latin as the primary language of instruction well into the 18th century—traits that signaled cultural conservatism and resistance to innovation.[6]

Academies, by contrast, created dedicated spaces for empirical inquiry and scientific experimentation. Initially, their relationship with universities was tense. For instance, the Society of Haarlem, founded in 1752, only received official recognition in 1761—after the nearby University of Leiden accepted that the Society would not deliver lectures or publish in Latin (Bierens de Haan, 1952). Over time, however, a clearer division emerged: universities remained teaching institutions focused on formal instruction and degree granting, while academies evolved into research institutions where knowledge was actively produced and exchanged (Applebaum, 2000; McClellan, 1985; Pepe, 2008).

The academies' mission centered on the generation and dissemination of "useful knowledge"—science that could improve local living conditions and address practical challenges (Mokyr, 2005a, 2016). Their experimental approach and open engagement with applied problems eventually helped pressure universities into updating their curricula and organizational structures by the end of the Scientific Revolution (Applebaum, 2000).

[5] Although the academies considered in this paper did not serve students directly, their focus on practical research laid the groundwork for technical colleges and universities of applied sciences in various European countries—such as German *Fachschulen* (Pahl & Ranke, 2019) and Danish *tekniske skolers* (Rasmussen, 1969).

[6] Universities did teach some scientific subjects, notably within the *Quadrivium*—arithmetic, geometry, astronomy, and music—but often in a qualitative rather than empirical or applied form (Applebaum, 2000).

The case of Turin illustrates these dynamics. While the university of the city, founded in 1404 and later supported by Enlightenment-era rulers, benefitted from several waves of reform, it remained largely focused on classical education with limited engagement in the sciences (Vallauri, 1875; Zanardello, 2022). In 1757, three students of Professor Giovanni Battista Beccaria's—Giuseppe Lagrange, Giuseppe Cigna, and Giuseppe Saluzzo—founded the Scientific Academy of Turin. Their goal was to create a platform for empirical research and applied science, independent from the university and free from its constraints.

The academy, formally recognized in 1783 by King Vittorio Amedeo III, adopted the motto *veritas et utilitas* ("truth and usefulness") and initiated public competitions to solve real-world problems. Its early challenges addressed issues like employment in the silk-textile sector, urban lighting, and agricultural modernization (Accademia delle Scienze di Torino; de la Croix and Zanardello (2021)). These efforts filled a gap left by the university and exemplify how academies carved out a new institutional space for science that emphasized experimentation, application, and local relevance.

Figure B1 reflects the lasting impact of this shift, showing a marked increase in university quality in the late 18th century, as measured by scholarly output and the arrival of notable faculty.[7]

Table 1 Main differences between universities and academies.

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

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

2.2 Academies' characteristics

Having outlined the differences between higher educational institutions, this section describes the main features of academies across European countries.

Academies were closely linked to the intellectual currents of the Scientific Revolution and the rise of "New Science," with a strong emphasis on experimental methods and empirical data. A key institutional turning point was the founding of the Accademia del Cimento in Florence in 1657—one of the

[7] For details on how scholarly output and institutional quality are measured, see Section 3.

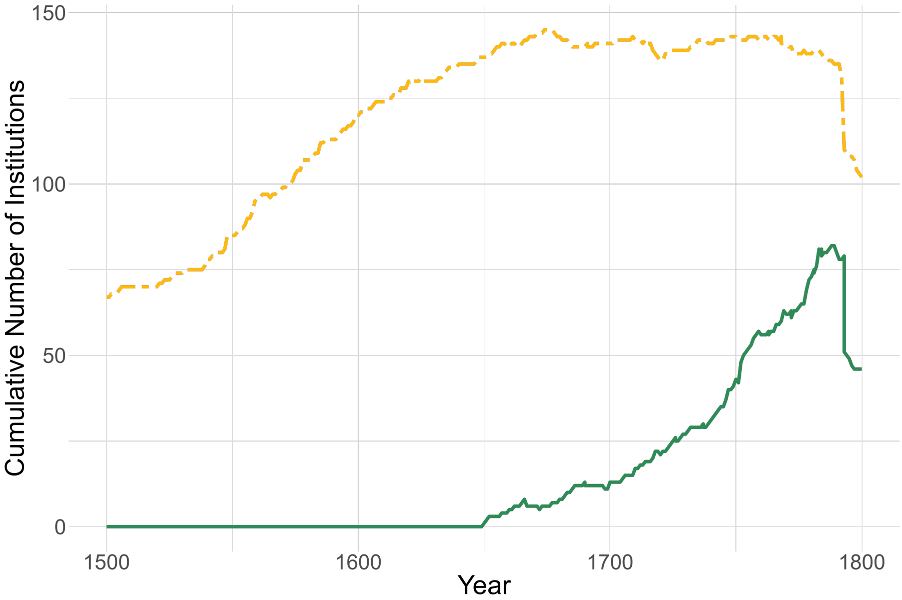

Fig. 1 Cumulative number of institutions over time.

This figure shows the number of universities and academies opened (or closed) over time. The dashed yellow line indicates universities; the solid green line indicates academies. Both openings and closures are included.

first academies explicitly dedicated to scientific experimentation (McClellan, 1985). Its creation was made possible by local interest and strong patronage: Grand Duke Ferdinand II and his brother Leopold, both disciples of Galileo, sought to promote and apply Galileo's methods in a free and open intellectual environment (Maylender, 1930; Middleton, 1971).

Inspired by this model, many later academies turned their attention to practical applications of science—in agriculture, industry, commerce, and the betterment of society. Often, these institutions began informally in the private homes of enlightened individuals who hosted small circles of intellectuals. Over time, these gatherings became more formalized, and official recognition (especially through royal patronage) was key to their development, particularly in France, Italy, Germany, and Sweden.

Academies also formed transnational networks through correspondence and the exchange of publications. Scientific journals played a central role in this diffusion of knowledge, offering a more accessible and dynamic alternative to books (McClellan, 1985). Major examples include the *Philosophical Transactions* of the Royal Society in London and the *Journal des Savants* which was closely associated with the Académie des Sciences in Paris (henceforth, "Paris Academy"). Other academies published their own periodicals, such as the *Giornale di Letteratura, scienza ed arti* in Messina (now in Italy), the *Monatliche Auszüge* in Olmouc (now in the Czech Republic), and bulletins from academies in Stockholm, Uppsala, and Verona. These publications likely generated spillover effects that extended beyond the immediate location of the academies—analyzed in Section 7.3.

Appendix A.1 summarizes key institutional characteristics by modern country, including patterns of official recognition, topics of study, membership, governance, and funding. In France, a highly centralized system ensured that most academies received prompt royal recognition and followed the hierarchical model of the Paris Academy. Italy and Germany showed greater diversity: Italian academies were often influenced by papal support, while German ones leaned more heavily on local patronage. In Great Britain, academies tended to be informal, focused on experimental science, and received limited government funding.

To deepen this institutional overview, I also collected micro-level data on academy founders, who are individuals involved in the initial establishment of the institution. Comparing founders with later affiliates offers insight into the origins of these institutions. Data were compiled for 90 of the 101 academies in my sample. Four of the eleven excluded cases were created directly by monarchs—such as the Academy of Göttingen (King George II of Great Britain) and the Academy of Naples (King Ferdinand IV of Bourbon)—and thus have no individual founder recorded.

Removing those and other cases lacking sufficient data, I identified 413 founders across the sample (as academies often had multiple founders). Table B1 compares these individuals with their non-founder peers. Founders appear to have slightly higher individual quality, though this difference is not statistically significant once year fixed effects are included.[8] The two groups do not differ significantly in age at appointment or death, but founders tend to remain active in the academy for longer.

The most striking difference is geographic: founders are more likely to be local. They were born closer to the academy's location and also died closer to their birthplace, indicating lower geographic mobility. This pattern supports the qualitative view that academies were often founded by local scholars motivated to promote science in their own communities. While this paper does not claim full exogeneity in the spatial distribution of academies, these founder characteristics provide suggestive descriptive evidence.

Appendix A.2 lists each academy with a brief account of its founding.

3 Data

To assess whether the presence of an academy influenced economic growth in cities, I use data on population, academic institutions, scholars, university quality, and fields of study. This section describes the data sources and construction.

Population data. Population size is a widely used proxy for economic development in pre-industrial societies, based on the assumption that such

[8] Individual quality is measured as a composite indicators of citation outputs. See Section 3 for more detailed quality measures.

economies operated under a Malthusian regime; meaning that the higher the technological progress, the larger the population (Ashraf & Galor, 2011). The primary source for population data is Buringh (2021), an updated and extended version of Bairoch, Batou, and Pierre (1988), a widely used historical population dataset. It covers 2,262 cities that reached at least 5,000 inhabitants at some point between 700 and 2000–while Bairoch et al. (1988) span from 800 to 1850. It also improves on previous efforts by systematically imputing missing values based on city- and time-specific characteristics and correcting earlier miscalculations through new data collection and a refined imputation algorithm. However, some uncertainty remains—particularly in earlier centuries (see Buringh (2021) for details).

Because academies emerged primarily after 1650, I restrict the main analysis to the period after 1500 to minimize potential measurement error in the population data.

The geographical focus is limited to Europe, where the development of educational institutions followed a distinct trajectory. I exclude cities in countries that were part of the Ottoman Empire, removing 161 cities across 11 countries.[9] [10] To avoid inconsistencies and missing values, I aggregate populations of historically separate settlements that later merged into single urban units.[11] The resulting dataset includes population figures for 2,096 cities across 19 time points: every century from 700 to 1400, and every 50 years from 1500 to 2000.

Academies and Universities. While population size is the main dependent variable, my primary independent variables capture the presence of higher education institutions—specifically, academies and universities—reflecting the role of advanced knowledge in a city's development. I rely on a new and unique database on scholars described in de la Croix (2021), which I have expanded to better account for scientific academies. It includes over 79,000 individual scholars active in European universities and academies between 1000 and 1800. For each scholar, the dataset records key information: place and year of birth and death, mobility, affiliations, and a measure of individual quality or "human capital." The database also lists affiliation data: scholars may be affiliated with a university, an academy, or both. For the main analysis, I aggregate these data into binary indicators. The key variable is a dummy for the presence of an academy (ACAD) in city c at time t. Similarly, I define a dummy for the presence of a university (UNI). To capture the effect of institutional overlap, I define a third variable (ACADxUNI), which equals 1 if both an academy and a university are active in the same city and time period, and 0 otherwise. This variable reflects the potential interaction or complementarity between the two

[9] See Section 2.1 for a discussion of the project's regional focus, which acknowledges important scientific developments outside Europe (Bala, 2006; Needham, 1964).

[10] Excluded countries are listed here: https://en.wikipedia.org/wiki/Outline_of_the_Ottoman_Empire (accessed June 2023). Hungary and Slovakia are retained, as they were only partially under Ottoman rule. These exclusions reflect the argument that Ottoman political and strategic priorities may have shaped educational institutions in ways less influenced by the cultural and intellectual currents driving academy formation in Western Europe.

[11] I combine Barmen and Elberfeld into Wuppertal (Germany); Rheydt into Mönchengladbach; Depford into London (Buringh, 2021); and Pest with Buda, which became Budapest in 1873.

types of institutions. The database used in this project covers 79,554 scholars and 375 institutions.[12]

For universities, I consider those listed in *A History of the University in Europe* by Frijhoff (1996). I include only institutions identified as "typical" universities, excluding convent-universities, seminaries, collegia, and any that were never operational.[13] This yields data on 171 universities, with location and operating dates based primarily on Frijhoff (1996), supplemented by more precise sources where necessary.[14]

The original database already covers university professors well, so I focus my additions on scholars active in academies.[15] I identify academies based on McClellan (1985), which includes only those with an experimental approach. Renaissance academies are excluded because they followed traditional intellectual models and are not suitable for comparison.[16] I include both official and private academies from McClellan's list, excluding those without corroborating sources.[17] Dates of creation and closure are taken directly from McClellan (1985), unless more accurate sources suggest otherwise. In official cases, I use the date of formal recognition. However, with reliable evidence of activity before that date, I use the foundation year of the society, even if it remained only a private entity for a while.

When a city hosted more than one university or academy, I generally include the oldest institution. This occurs with universities in four cities—Aberdeen, Aix-en-Provence, Nîmes, and Rome. The situation is more complex for academies: several cities had multiple academies (e.g., Bologna, Naples, Florence, and London had three or more). In these cases, I choose the oldest unless another lasted significantly longer, as in Bologna, Caen, and Florence.

Figure 2 maps the geographical distribution of educational institutions from 1000 to 1800 CE. Yellow circles represent universities (from Frijhoff (1996)), and green triangles mark academies (from McClellan (1985)). Cities with both institutions—i.e., overlapping markers—represent instances of the ACADxUNI interaction. By 1800, almost every major European city had either an academy or was influenced by the academy movement and its experimental approach

[12]The version used in this paper is dated January 31, 2025. Institutions with over 100 scholars are documented in the Repertorium Eruditorum Totius Europae: https://ojs.uclouvain.be/index.php/RETE/index.

[13]For example, I exclude the Angelicum in Rome and the University of Camerino (both founded in 1727), which are considered minor or insufficiently documented (Brizzi, 2001).

[14]For the University of Modena, I use information from its official website: https://www.unimore.it/ateneo/cennistorici.html.

[15]This includes both secondary sources and primary material—e.g., handwritten registers from the Academy of Nîmes.

[16]We track only 57 Renaissance academies: 40 in Italy, 12 in France, and one each in Germany, Croatia, the UK, Spain, and Poland. Most (42) were founded before 1650 and few lasted more than a decade—only 25 survived 50 years—making them unsuitable for comparison.

[17]This is the case only in the list of private academies of McClellan (1985, p. 281). 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 Society in Mainz (Germany), the Academy *Clelia de' Vigilanti* in Milan (Italy), the Society in Newcastle-Upon-Tyne (UK), and the *Temple Coffee House Botany Club* of London (UK). I also merged the two academies in Mannheim (Germany): the *Societas Meteorologicae Palatinae* created in 1780 with the *Academia Electoralis Scientiarum et Elegantiorum Literarum Theodoro-Palatina* created in 1763 (Cassidy, 1985).

(McClellan, 1985).[18] The figure shows only where institutions were founded, not whether they remained open until 1800. Appendix Figure B2 illustrates the distribution of founding dates, highlighting the temporal heterogeneity between universities and academies—an important feature for identification. Appendix Figure B4 displays the establishment of institutions every 50 years between 1500 and 1800. Finally, I note that measurement error remains a concern: the dataset includes only institutions with sufficient historical visibility, either due to survival or record-keeping.

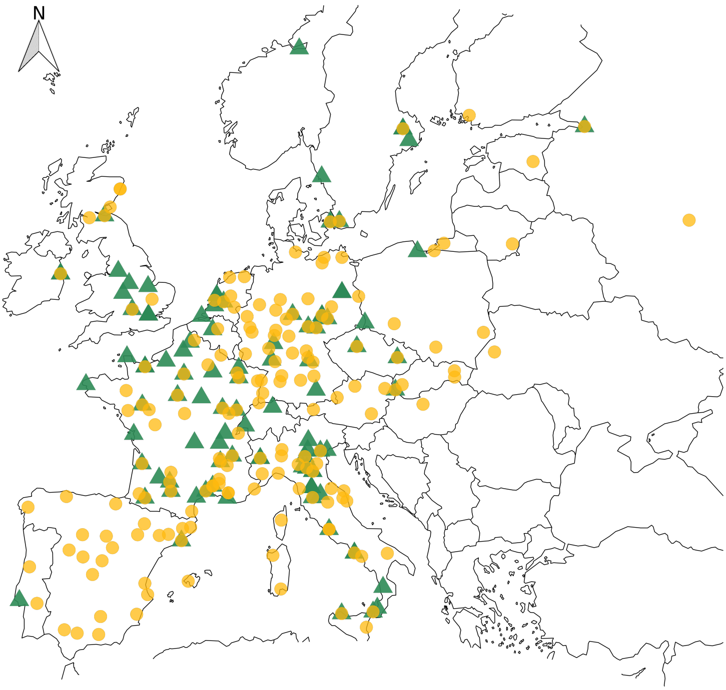

Fig. 2 Locations of higher educational institutions (1000 - 1800 CE).

Yellow circles represent universities, and green triangles represent academies. When both institutions are present in the same city, the overlap of the two shapes indicates an interaction. Country borders reflect those in the year 2000. Only locations of creation are shown; the figure does not reflect whether institutions were still active in 1800.

Scholars. The dataset also includes detailed information on individual scholars, including their VIAF (Virtual International Authority File) identifiers—an online catalogue that tracks name variations, nationalities, publishers, and published works. Additionally, the dataset integrates information

[18] Spain has only one academy, in Barcelona; I investigate this further in Section 7.1.

from each scholar's Wikipedia page, such as the number of characters (a proxy for entry length) and the number of languages in which the entry is available.

These data are used by de la Croix et al. (2023) to construct a composite measure of scholar quality, referred to as "human capital." This index is derived using principal component analysis (PCA), combining various indicators into a single metric (see Curtis and de la Croix (2023a) for details on the weighting scheme). However, this measure is subject to presentist bias: both VIAF and Wikipedia reflect the current visibility and recognition of historical scholars, rather than their contemporary impact. The metric therefore captures the prominence of those whose work has survived, not necessarily those most influential in their own time.

Language and national biases are also a concern, particularly if relying solely on the English-language Wikipedia, which systematically underrepresents non-Anglophone scholars (Laouenan et al., 2022). To mitigate this, I use Wikipedia entries in all available languages, which significantly reduces this issue. Nonetheless, I acknowledge a broader Western bias, as noted by Laouenan et al. (2022), given the exclusive focus on European institutions. This necessarily excludes significant scholarly contributions from other regions of the world (Bala, 2006; Needham, 1964).

The database further contains individual-level data on scholars' age at death, age at appointment, period of activity in any institution, and geographic mobility—measured by the distance between their birthplace, institutions of activity, and place of death. Table 2 reports descriptive statistics for these variables.

Column 1 presents data for scholars affiliated with academies, and Column 2 for university professors. To ensure comparability, I restrict the university professor sample to those active from 1600 onwards, excluding earlier medieval scholars. These two groups are distinct, with statistically significant differences across all characteristics (p-values < 0.001).[19] For instance, consistent with findings from Stelter, de la Croix, and Myrskylä (2021), scholars in academies appear to live longer than their university counterparts. Specifically, Stelter et al. (2021) document life expectancy trends among members of academies and university professors over time, showing that academicians were the first to experience increased longevity—from the 1750s to the 1850s. They attribute this advantage to social status, arguing that academicians represented an elite subset of scholars with superior academic output and greater access to international networks. This pattern is also reflected in Table 2, where academicians display higher individual quality and longer travel distances.

Column 3 shows statistics for individuals affiliated with both a university and an academy at some point in their careers (the "interaction" group). Columns 4 and 5 show the differences between this group and scholars affiliated exclusively with an academy or university, respectively. The interaction group is distinct from both, though it resembles university professors in two aspects: average distance from their institution to their place of death, and

[19] I do not report standard errors or coefficients, as all differences are strongly significant.

from birthplace to place of death. All regressions include year fixed effects to account for secular trends. When scholars are active in multiple institutions simultaneously, I compute the mean value of their individual statistics and count them only once in the sample.

Table 2 Summary statistics at individual level.

	(1) **ACAD**	(2) **UNI**	(3) **ACADxUNI**	(4) **ACADxUNI** vs ACAD	(5) vs UNI
Number of scholars	16002	32112°	1166		
	μ	μ	μ	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
Distance Birthplace-Institution	338	186	257	0.000	0.000
Distance Institution-Death place	428	188	196	0.000	0.504
Distance Birthplace-Death place	380	269	247	0.000	0.770
Year FE⋆				YES	YES

Note: Summary statistics are reported for scholars affiliated only with Academies (1), only with Universities (2), and with both Academies and Universities simultaneously at least once in their lifetime (3). Columns (4) and (5) report the statistical significance of the differences between group (3) and groups (1) and (2), respectively. All comparisons control for year fixed effects.
°) University professors are included only if active after 1600.
◇) For activity year statistics, note that when no precise time frame is available in the database: academicians are assumed to be active at their academy for their entire lifetime, while university professors are assumed to be active for 8 years (or until death, if earlier).[20]
⋆) Year fixed effects are based on the scholar's initial year of activity.

University quality. Using the individual-level quality data, I compute an aggregate measure of university quality. Following de la Croix et al. (2023), I adopt their index, which is based on the top five professors who were active at each institution during the 25 years preceding the year for which the quality index is calculated (see de la Croix et al. (2023) for further details). In Section 6, I use the 50-year average of this index as the dependent variable.

Fields of study. Universities and academies also differed significantly in their disciplinary focus, as classified in our database (de la Croix & Zanardello, 2022). Figure B5 shows the distribution of institutions by main field of study—that is, the discipline with the highest number of affiliated members. Universities primarily concentrated on the humanities, including history, literature, philosophy, ethics, rhetoric, Greek, poetry, theology, and law. Medicine also played a significant role in university curricula. In contrast, academies were predominantly oriented toward the sciences, though 30 academies also had members working in the humanities.

Figure B6 displays the distribution of fields by country, separately for academies and universities. Tables B2 and B3 provide descriptive statistics on size, years of activity, and primary field of study for academies and universities, respectively.

4 Empirical strategy

This paper investigates the effects of the creation of early modern academies on urban population growth. The treatment of interest—the founding of an academy—occurred in different cities between 1500 and 1900. To capture its effects, I use a panel dataset with 50-year intervals, focusing on nine such periods that include approximately five intervals before and three after the treatment. Including post-1800 periods is essential to observe long-term effects beyond the initial establishment of academies.

The empirical analysis proceeds in stages, beginning with simpler approaches and progressing toward more robust causal identification strategies. I first employ Ordinary Least Squares (OLS) regressions (Section C.1). While OLS estimates cannot be interpreted causally, they provide preliminary correlational evidence and help assess whether the creation of an academy is systematically associated with changes in population growth. These exploratory results motivate the use of more rigorous methods.

To address endogeneity concerns and uncover dynamic treatment effects, I then use a difference-in-differences (DID) design with a dynamic two-way fixed effects (TWFE) specification (Section C.3). This event-study framework treats academy creation as the focal event and allows for the estimation of both pre- and post-treatment effects. By visualizing treatment effects over time, this method helps identify potential pre-trends and anticipation effects.

For the event-study and subsequent DID estimators to be valid, three key assumptions must hold. First, the *parallel trends assumption* requires that, in the absence of treatment, cities that created an academy would have followed similar growth trajectories to those that did not. Second, the *no anticipation assumption* requires that cities did not change their growth patterns before the academy was officially established. Third, the *Stable Unit Treatment Value Assumption* (SUTVA) implies that the treatment effect in one city is independent of treatment status in neighboring cities. I test the plausibility of these assumptions throughout the analysis. The main results confirm the first two assumptions, and the third is explored further in the robustness checks using spatial analysis and sensitivity exercises (Berkes & Nencka, 2021; Butts, 2021).

Since academies were established at different times across cities, the staggered treatment setting introduces the possibility of treatment effect heterogeneity. Standard TWFE estimators are known to produce biased estimates in such contexts due to inappropriate weighting and implicit assumptions of homogeneity across cohorts (Goodman-Bacon, 2021; Roth, Sant'Anna, Bilinski, & Poe, 2023). To address this issue, I employ three recent advanced DID estimators that correct for these biases and better account for heterogeneity: the method by Sun and Abraham (2021) (Section 5.1), and those developed by De Chaisemartin and d'Haultfoeuille (2024) and Callaway and Sant'Anna

(2021) (Appendix D). These estimators construct more appropriate counterfactuals and improve the precision of treatment effect estimation in staggered settings. I also compare and discuss their methodological differences.

The use of multiple methodologies reflects both practical and theoretical motivations. OLS offers initial correlational evidence and justifies deeper analysis. TWFE helps illustrate dynamics and potential anticipation effects but assumes homogeneous treatment impacts. The advanced DID estimators are better suited for identification in staggered treatment settings and thus form my main empirical results.

In a separate analysis, I examine the potential effect of academy creation on the quality of universities. This is motivated by historical claims that early academies played a role in raising standards in higher education. Section 6 analyzes university quality as a distinct outcome, shedding light on possible institutional complementarities and broader educational dynamics.

Finally, in Section 7, I conduct a set of additional analyses. These include explicit tests of the SUTVA assumption using spatially defined neighborhood treatment variables, sensitivity checks that exclude individual sample units, and an examination of possible spillover effects to assess whether the observed impacts extend beyond the treated cities themselves.

Taken together, this multi-method empirical approach—ranging from exploratory OLS to dynamic and advanced DID frameworks—aims to provide a robust and comprehensive understanding of the relationship between academy creation and long-run urban development in early modern Europe.

5 Results

Appendix Table C6 reports panel fixed effects regressions using Ordinary Least Squares (OLS) estimator. The dependent variable is the natural logarithm of city population, and the main independent variable is the presence of an academy. The regressions also control for the presence of a university, allowing for a comparison between different types of higher education institutions across European cities from 1500 to 1900. My preferred specification includes city fixed effects and country-by-period fixed effects, which together account for time-invariant city characteristics and broader national trends over time.[21] I do not include additional time-varying controls because there are no such data for my sample of cities. As discussed in Appendix C.2, I show that the inclusion of city and country-by-period fixed effects already captures the most relevant sources of variation, mitigating omitted variable bias. This is further supported by analyses using a subset of larger cities for which more detailed time-varying data are available, following Bosker et al. (2013). The results in Appendix Table C6 show that the coefficient on the presence of an academy is positive and statistically significant across all specifications. Moreover, its

[21] Country borders are defined as of the year 2000.

magnitude is consistently larger than the corresponding coefficient for universities, suggesting that academies may have played an especially important role in driving urban growth. Appendix Table C7 explores heterogeneity by field of study, based on the categorization introduced in Section 3. This analysis provides initial evidence—later confirmed in the main results—that the positive effects are primarily driven by scientific academies.

To reduce concerns about endogeneity, I estimate a dynamic two-way fixed effects (TWFE) model and present the results using a panel event-study framework (Bhalotra, Clarke, Gomes, & Venkataramani, 2023; Clarke & Tapia-Schythe, 2021; Jacobson, LaLonde, & Sullivan, 1993).[22] [23] This strategy exploits variation in the timing of academy creation across cities, allowing me to estimate the dynamic effects of treatment over time. I classify cities into two groups: the treated group consists of those that experienced the creation of at least one academy, while the control group includes cities without any academy throughout the sample period. The outcome variable is the growth rate of the natural logarithm of population, denoted as $\Delta \ln POP_{ct}$, where c indexes cities and t time periods. The event-study specification is given by:

$$\begin{aligned} \Delta lnPOP_{ct} = \beta_0 + & \sum_{l=2}^{5} {\beta_l}^{lead} EVENT_c \times \mathbb{1}\{lead_t = l\} + \\ & \sum_{k=0}^{3} {\beta_k}^{lag} EVENT_c \times \mathbb{1}\{lag_t = k\} + \\ & \mu_c + \psi_s \lambda_t + \epsilon_{ct} \end{aligned} \tag{1}$$

In Equation 1, μ_c denotes city fixed effects, and $\psi_s \lambda_t$ represents country-by-period fixed effects to account for broader national shocks and trends. The terms ${\beta_l}^{lead}$ and ${\beta_k}^{lag}$ capture, respectively, the effects in the periods leading up to and following the creation of an academy. The first lead is omitted and serves as the reference category. No additional time-varying controls are included, consistent with the fixed effects strategy discussed in Appendix C.2.

By construction, this specification assumes absorbing treatment states: once a city creates an academy, the institution is assumed to remain open throughout the remainder of the sample period. As a result, the analysis estimates the intention-to-treat (ITT) effect of academy creation on urban growth between 1500 and 1900 in cities where an academy was created before 1800. This assumption of absorbing states is consistently applied across all empirical specifications, including those presented in Sections 5.1 and Appendix D.[24]

[22] As discussed in the introduction, this approach only partially addresses issues of reverse causality. While the DID framework helps mitigate endogeneity arising from the non-random location of educational institutions, it cannot fully rule out the influence of unobserved factors that may affect both the establishment of academies and urban growth. Based on the historical context, however, I assume that most academies were founded and managed by enlightened scholars, whose decisions were largely independent from the local economic or demographic conditions.

[23] Appendix C.4 reports the static TWFE estimates.

[24] This assumption is necessary due to data limitations. While many academies in my sample were founded in the 18th century, I do not observe precise closure dates after 1800. Collecting

5.1 Main findings on city population

Recent advances in the difference-in-differences (DID) literature have shown that classical dynamic two-way fixed effects (TWFE) estimators can be biased when treatment occurs at different times across units, especially in the presence of heterogeneous effects (Goodman-Bacon, 2021; Roth et al., 2023). In my context, it is reasonable to expect that the effect of founding an academy in Oxford in 1651 differs from founding one in Turin in 1757. As the dynamic TWFE estimates in Appendix C.3 suggest, heterogeneity exists not only across cities but also across time.

In simple settings—such as a 2x2 DID framework with only one treatment period and no staggered adoption—heterogeneity over time is not a concern, and negative weighting does not arise. I present these simple event studies in Appendix C.5, where I estimate dynamic TWFE regressions using only one cohort of treated units at a time. The results confirm that post-treatment effects vary by cohort, supporting the presence of treatment effect heterogeneity.

In more complex staggered adoption settings, dynamic TWFE estimates aggregate 2x2 DID comparisons across all groups and time periods using implicit weights. These weights can be negative, particularly when comparing earlier- and later-treated units, leading to potentially misleading estimates (Goodman-Bacon, 2021; Jakiela, 2021). To assess this in my case, I compute the weight decomposition for the $ACADEMY$ treatment and find that the proportion of negative weights is negligible. Nonetheless, given the evidence of heterogeneity, using estimators robust to staggered treatment timing remains crucial to ensure valid inference.

To address this issue, I adopt three heterogeneity-robust estimators: those proposed by Sun and Abraham (2021), De Chaisemartin and d'Haultfoeuille (2024), and Callaway and Sant'Anna (2021). These estimators improve upon TWFE by constructing counterfactuals more carefully and avoiding inappropriate weighting, thus producing more reliable average treatment effect estimates when treatment timing and effects vary across units and periods (De Chaisemartin & D'haultfœuille, 2023).

My primary interest lies in estimating the dynamic effects of academy creation—specifically, the average impact on city population in each period following the treatment. I define cohorts as groups of cities that established an academy in the same period and aim to estimate a separate treatment effect for each cohort-period pair.

My main results rely on the interaction-weighted (IW) estimator proposed by Sun and Abraham (2021). This regression-based approach estimates a weighted average of cohort-specific average treatment effects on the treated

such data would require accounting for the disruptions caused by major historical events, such as the Napoleonic Wars, which led to temporary closures and later reopenings. In most cases, these interruptions lasted less than 50 years, making them difficult to track accurately in the panel structure of the analysis.

(CATT) for each relative time period. The method interacts indicators for relative period l with indicators for cohort e, yielding interpretable $\text{CATT}_{e,l}$ coefficients. The IW estimator then averages these using non-negative, data-driven weights—computed as the proportion of treated units in each cohort-period combination—to produce consistent estimates of the overall dynamic effects.

In the event-study implementation, cities that never hosted an academy serve as the control group. As said earlier, I include outcomes through 1900 to ensure sufficient post-treatment periods, relying on the assumption of absorbing treatment states (i.e., once treated, always treated). This allows for an intention-to-treat (ITT) interpretation of the effects. However, including the nineteenth century introduces a small number of outlier observations—cities with population growth rates exceeding 200% or dropping below −100%. To obtain more conservative estimates, I exclude these outliers from the event-study analysis.[25] After this exclusion, the final sample used for the main event-study analysis includes 2,023 observations, covering 149 universities and 81 academies. Cities such as Saint Petersburg and Arras, which hosted both universities and academies and fall within the outlier range, are excluded from this part of the analysis.

Figure 3 presents the average treatment effect of academy creation between 1500 and 1800, estimated using the interaction-weighted estimator by Sun and Abraham (2021). The pre-trends assumption is jointly satisfied, supporting the validity of the identification strategy. Post-treatment estimates reveal that, beginning around 100 years after the creation of an academy, treated cities experience population growth approximately 9–15% higher than untreated cities (pre-treatment stats: $\mu = 0.2$, $sd = 0.3$).

To explore the interaction between universities and academies, I restrict the sample to cities that hosted a university at least once. I then apply the same estimator to assess whether the creation of an academy in these cities produced additional effects. This reduces the sample to 149 cities. As shown in Figure 4, I find no significant impact of academy creation in cities that already had a university. The estimated coefficients are initially negative and very close to zero, suggesting a potentially negative or null marginal effect of adding an academy in a city with a traditional university. After 100 years, some coefficients become slightly positive, but none are statistically different from zero.

I further disaggregate the *ACADEMY* event by examining academy characteristics: field of study, longevity, and size. Figure 5 shows results for scientific, literary, long-lasting, and large academies.[26] Long-lasting academies display a pattern similar to the general case, while large academies show weaker and less consistent effects.

[25] Out of 73 outliers, only a few occurred before 1800. Examples include: Cacares (ESP), Chaves (PRT), Kronslot (RUS), Rochefort (FRA), Saint Petersburg (RUS), Valletta (MLT), and Versailles (FRA) which grew by more than 200%; and Arras (FRA) Bagnères-de-Bigorre (FRA), Bolgary (RUS), Burgos (ESP), Cartagena (ESP), Lucera (ITA), Salerno (ITA), Wolin (POL), Worms (DEU) and others, which experienced population declines exceeding 100%.

[26] Long-lasting academies are those that operated for more than 30 years; large academies are those with more than 30 members.

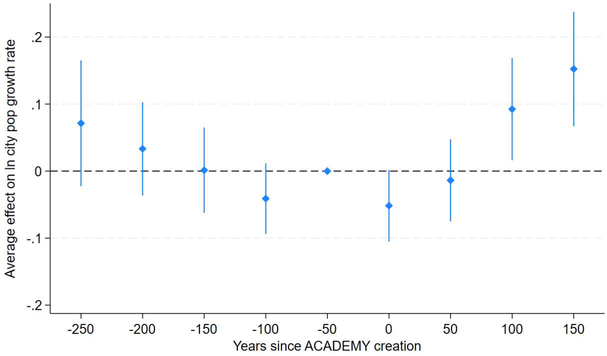

Fig. 3 Academy event.

Effect of academy establishment between 1500 and 1900 on population growth estimated using the method of Sun and Abraham (2021). The control group includes cities that never established an academy.
Note: The dependent variable is the logarithmic city population growth rate. The sample includes 2020 clusters. The adjusted R^2 of the model is 0.299.

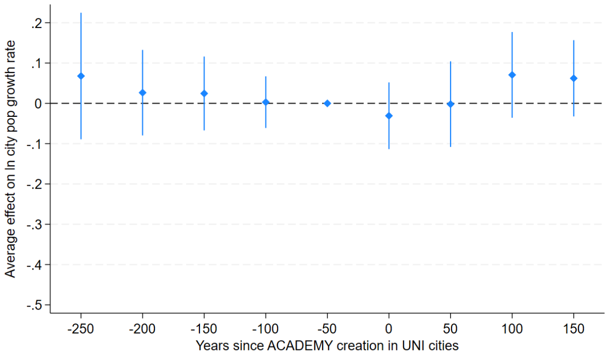

Fig. 4 Academy event in university cities.

Effect of academy establishment between 1500 and 1900 on population growth in cities that hosted a university at least once, estimated using the method of Sun and Abraham (2021). The control group includes cities that never established an academy.
Note: The dependent variable is the logarithmic city population growth rate. The sample includes 142 clusters. The adjusted R^2 of the model is 0.397.

Field of study appears to be the most important factor. Figure 5b shows estimates for literary academies. While a slight downward pre-trend is visible, it is not statistically significant when considered jointly (see Appendix D.1). The first post-treatment coefficient is negative but quickly turns slightly positive—though statistically insignificant—up to 100 years after academy creation. Interestingly, after 150 years, literary academies appear to be associated with a 14% increase in city population growth relative to cities without literary

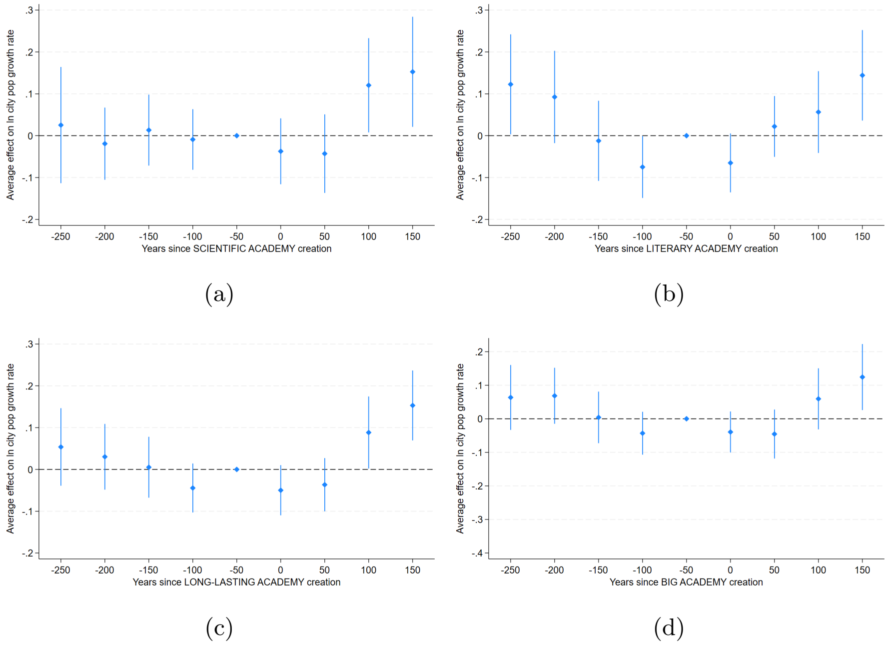

Fig. 5 Academy event by field, size, length.

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 using the method of Sun and Abraham (2021). The control group includes cities that never established an academy.

Note: The dependent variable is the logarithmic city population growth rate. The sample includes 2020 clusters. The adjusted R^2 of the model is (a) 0.298, (b) 0.298, (c) 0.299, (d) 0.299.

academies. However, these results are not confirmed by the alternative estimator from De Chaisemartin and d'Haultfoeuille (2024) (see Appendix D.2), suggesting they should be interpreted with caution.

In contrast, scientific academies consistently show strong and statistically meaningful effects. As shown in Figure 5a, cities in which more than 50% of academy members were involved in science, applied science, or medicine experienced significantly higher population growth. These cities grew 12% faster 100 years after academy creation (p-value: 0.079), with the effect persisting over time and reaching 15.3% after 150 years (pre-treatment stats: $\mu = 0.20$, $sd = 0.31$).

These findings align with the OLS and dynamic TWFE estimates, the observed positive effects of academies on urban growth are primarily driven by scientific institutions. Literary academies do not appear to produce robust effects on population growth. These results highlight the importance of tracking micro-level variation in institutional characteristics—particularly the fields of study emphasized—to evaluate the role of human capital formation prior to the Industrial Revolution. This conclusion is further supported by the findings in Section 6, where I explore the link between academy creation and university quality.

Finally, as robustness checks, I replicate the analysis using the DID estimators developed by Callaway and Sant'Anna (2021) and De Chaisemartin and d'Haultfoeuille (2024). The results are consistent with those obtained using the interaction-weighted estimator. Full details are provided in Appendix D.

6 Quality of Universities

In this section, I examine whether the establishment of academies influenced the quality of universities over time. Using the same period analyzed in Section 5.1, I apply an identical DID identification strategy to estimate the effect of academies on this alternative outcome.

While this analysis does not fully eliminate concerns of endogeneity, it offers important insights into the potential link between the rise of academies and the modernization of universities. In particular, it sheds light on the mechanisms by which academies may have contributed to the emergence of professionally oriented, innovation-driven universities in Europe by the 19th century.

University quality is measured using the approach in de la Croix et al. (2023), based on the aggregated quality of the top five professors who taught at a university in the preceding 25 years. I calculate the average university quality for each 50-year interval up to 1800. This allows me to replicate the DID design used in the population growth analysis, applying my preferred estimator from Sun and Abraham (2021). Two lags are included in the event structure to maintain balance timing across cohorts, as quality data is unavailable after 1800. Including more lags would introduce estimation noise, particularly since the first academy—Accademia degli Investiganti—was founded in 1650 and would be the only one considered for the estimation of the third (and last) lag.

Figure 6 presents the baseline results. Pre-treatment trends are flat, indicating no anticipation effects. However, I find no statistically significant change in university quality following the creation of an academy. That is, establishing an academy in a city with an existing university does not lead to improvements in university quality compared to similar cities without academies.

This changes when I focus on scientific academies. As shown in Figure 7a, the creation of a scientific academy significantly improves university quality after 50 years. The estimated effect is 1.45 (p-value: 0.06), which corresponds to an average increase of over 44% relative to pre-treatment levels ($\mu = 3.27$, $sd = 2.35$). This suggests that scientific academies played a meaningful role in fostering higher academic standards within universities.

By contrast, literary academies show no such effect. As shown in Figure 7b, while the pre-trend is stable, the post-treatment coefficients are negative and statistically insignificant. This aligns with findings in the main analysis: literary academies do not appear to enhance either urban growth or university quality.

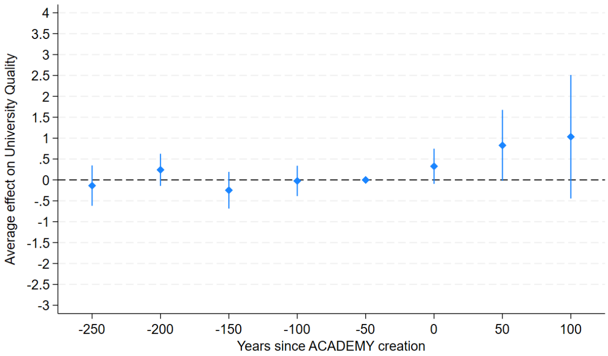

Fig. 6 Academy event on university quality.

Effect of academy establishment between 1500 and 1900 on university quality in cities that hosted a university at least once, estimated using the method of Sun and Abraham (2021). The control group includes cities that never established an academy.

Note: The dependent variable is the 50-year average of university quality. The sample includes 142 clusters. The adjusted R^2 is 0.744.

Finally, I examine whether academy size or longevity makes a difference. Figures 7c and 7d show that neither long-lasting nor large academies have a meaningful impact on university quality. These characteristics, while potentially reflective of institutional strength, do not translate into measurable improvements in academic standards.

Taken together, these results suggest that scientific orientation, rather than institutional scale or survival, is the key channel through which academies influenced universities. The presence of a scientific academy appears to contribute directly to the development of higher-quality institutions of learning—highlighting the importance of intellectual specialization and research orientation in shaping the evolution of European universities.

7 Additional analyses

This section provides additional analyses to assess the robustness and specificity of the main findings. In Section 7.1, I conduct leave-one-out tests by excluding key cities—such as London and Paris—and major countries that host a large number of innovative academies, including France, Italy, Germany, and Great Britain. I also test the effect of excluding Spain, a country with only one academy, to address concerns that its limited variation may disproportionately affect the construction of counterfactuals.

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.

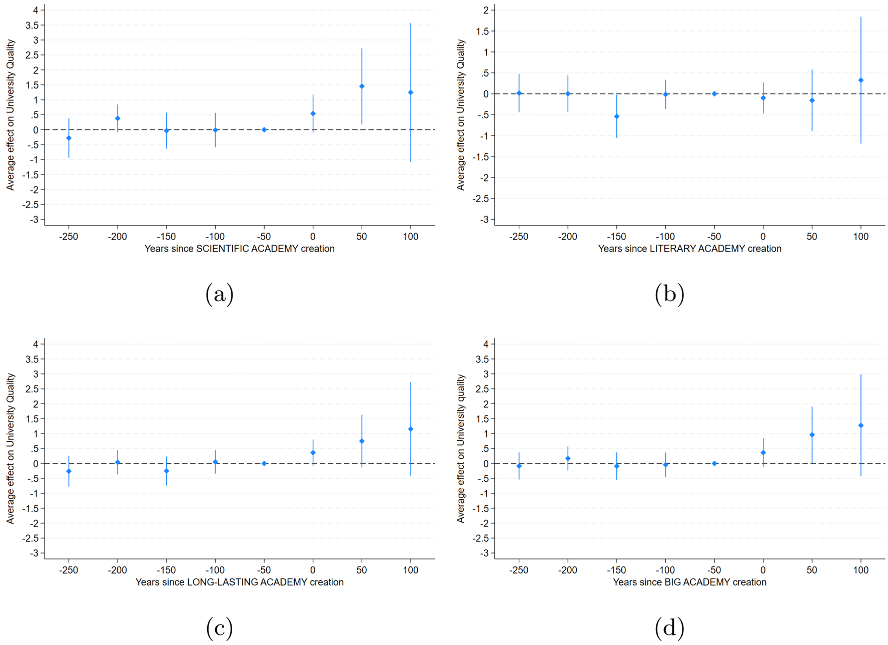

Fig. 7 Academy event by field, size, and length on university quality.

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 on university quality estimated using the method of Sun and Abraham (2021). The control group includes cities that never established an academy.
Note: The dependent variable is the 50-year average of university quality. The sample includes 142 clusters. The adjusted R^2 is (a) 0.742, (b) 0.736, (c) 0.744, (d) 0.744.

Finally, Section 7.3 presents spillover results from "donut" regressions, which explicitly test for effects extending beyond the treated city itself.

7.1 Sensitivity analyses: leave-one-out

Maintaining a European perspective provides a broad and generalizable framework, but it also raises the possibility that individual units—especially prominent cities or countries—might disproportionately influence the results. To address this concern, I conduct a series of leave-one-out sensitivity tests. These exclude major cities such as London and Paris, as well as countries with a high concentration of academies: France, Italy, Germany, and Great Britain. I also test the effect of excluding Spain, which contributes only one academy but many untreated observations.

London and Paris. Excluding London or Paris has no meaningful effect on the results. The estimated coefficients from the event studies—across all types of academies—remain virtually unchanged. In fact, their magnitudes slightly increase, without affecting significance. These findings indicate that the main effects are not driven solely by the most prominent scientific centers and help alleviate concerns about endogeneity.

The broader European dataset allows for the exclusion of entire countries without compromising statistical power. I begin with France, which hosts the largest share of academies (29 of 81) and universities (33 of 149).

France. Excluding France alters some dynamics. In the main specification, the parallel trends appear stronger, but there is a small, negative, and marginally significant effect immediately after academy creation. However, this is offset within the following century, where cities grow 13% faster than those without academies. The positive effect at 100 years is larger than in the baseline but does not persist.[27] This pattern may reflect France's unique revolutionary history. In 1793, the National Convention abolished all academies linked to the *Ancien Régime*, confiscating their assets and disbanding their networks (Taillefer, 1984, p.241).[28] Removing France therefore eliminates these late-period shocks, which could bias long-run estimates downward.

For other events—such as academy effects in cities that ever hosted a university, or impacts on university quality—excluding France yields results consistent with the benchmark.[29]

However, results by academy type are more sensitive. Excluding France increases the estimated long-run effect on population growth of scientific academies (16% after 100 years), though the effect again fades over time. University quality estimates remain similar in magnitude and sign, but drop in significance—likely due to reduced statistical power.[30]

For literary academies, excluding France weakens the pre-trends and reveals a small, temporary negative effect immediately after academy creation, followed by coefficients close to zero. These results, though not robust, echo theories of rent-seeking behavior (Murphy, Shleifer, & Vishny, 1991) and recent literature linking slower growth to religious-legal scholarship and traditional education systems (Curtis & de la Croix, 2023b; Squicciarini, 2020).[31]

Excluding France also anticipates the positive effect of long-lasting academies on population growth (though not on university quality), while results for large academies lose significance.[32]

Italy. Italy's exclusion does not alter the baseline event on population growth and actually strengthens the estimated effects on university quality. The statistical significance of scientific academies weakens slightly at 100 years but becomes stronger at 150 years. Literary academies remain insignificant, and pre-trends are slightly worse.[33]

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[27] See Appendix Figure E22.

[28] The second article of the Decree on August 8, 1793 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, p.241).

[29] Appendix Figures E22c and E22b.

[30] France includes 11 of 43 scientific academies. See Figures E23a and E23b.

[31] Figures E23c and E23d.

[32] Figures E23e, E23f, E23g, and E23h.

[33] Appendix Figures E24a to E25c.

Germany. Removing Germany delays the observed positive impact of academies by 50 years—likely because German academies were, on average, established later (around 1755, compared to 1741 in the full sample).[34] The most notable change is a drop in the significance of the scientific academy effect, despite Germany hosting only six such academies. This suggests those few institutions play an outsized role.[35]

Great Britain. Excluding Great Britain does not substantially affect the main results. The academy event shows a small, short-term negative effect, which is reversed after 100 years. Subgroup analyses by field, size, or duration remain consistent. However, scientific academies fall just outside standard significance thresholds in the university quality regressions, again suggesting a loss of power.[36]

Spain. Spain hosts only one academy (Barcelona, 1764) and 20 universities. While the treatment group is largely unaffected by Spain's exclusion, the untreated pool changes meaningfully. Despite this, the main results remain robust. The only difference is a delay in the positive effects of scientific academies to 150 years after creation. Literary academies show slightly better pre-trends and continue to exhibit a long-run positive effect.[37] Estimates on university quality are also unchanged. This suggests that even in the absence of Spain, the analysis retains sufficient variation and the core findings remain valid.

7.2 Local effects

So far, the event studies in this paper have assumed that the effects of academy creation are purely local. However, hosting cities may themselves be influenced by nearby cities through various channels—such as shared labor markets, intellectual exchange, or regional development patterns. In such cases, the Stable Unit Treatment Value Assumption (SUTVA) may be violated. SUTVA requires that treatment effects depend only on whether a city is treated, not on the treatment status of its neighbors. To address this, a common strategy is to exclude nearby cities to account for potential "inbound" spatial spillovers—i.e., cases where neighboring cities affect the treated unit itself (Butts, 2021). This exclusion refines the construction of the counterfactual, ensuring that nearby cities which could bias the estimate of the treated city's outcome are removed. If all such potentially influential cities are excluded, the resulting estimates can be interpreted as unbiased local effects of academy creation.

Following the methodology of Johnson, Thomas, and Taylor (2023), who explore spatial spillovers in a historical context similar to this study, I exclude cities located within 50, 100, and 150 km of an academy, while keeping the

[34] Although the difference is only 15 years, it aligns with the cut-off point for sample periods, shifting the results by 50 years.
[35] Figures E27a and E27b.
[36] Figure E29b.
[37] Figures E31a and E31c.

hosting city in the sample.[38] If the results remain robust under these exclusions, the estimated effects can be interpreted as unbiased local impacts of academy creation.

When cities within 50 km of any academy are excluded, the main findings on population growth remain largely intact. While significance declines—expected due to the smaller sample (1,614 cities, down from 2,023)—the core pattern persists.

Excluding cities within 100 and 150 km slightly reduces the magnitude of the positive effects observed 100 years after academy creation. At this horizon, the estimates are no longer statistically relevant. However, the long-run effects (after 150 years) remain positive and highly significant. For university quality, the results also persist.[39]

I repeat the analysis for scientific, literary, long-lasting, and large academies, too, excluding cities near each respective type. For scientific academies, the results are particularly robust. Excluding nearby cities within 50, 100, or 150 km does not materially alter the findings. The event study reveals a 16.9% increase in population growth rate 150 years after creation, alongside a substantial 86% average improvement in university quality within the first 50 years (relative to a pre-treatment mean of 1.70 and standard deviation of 2.18).[40] Literary academies also show consistent trends when excluding cities within the first 50km. However, when excluding cities within 100 km or more, the positive long-run effect disappears, and a slightly significant short-term negative impact emerges, suggesting again that the results for literary academies should be interpreted with caution.[41] For long-lasting and large academies, the spillover adjustments do not change the main patterns. The estimates remain positive but become slightly less statistically significant as the exclusion radius increases to 150 km.[42]

7.3 Spillover effects

In this section, I investigate "outbound" spatial spillover effects from academy creation, complementing the previous analysis of unbiased local effects. While the earlier analysis focused on whether nearby cities influence the treated city, I now assess whether the creation of an academy affects neighboring cities themselves. This follows standard spatial analysis techniques (Butts, 2021; Keller & Shiue, 2021). Specifically, I implement a "donut regression" approach: I construct concentric zones—donuts—around academy-hosting cities, using cities within these rings as the treated group, and those further away as controls.

[38] I do not extend the exclusion radius beyond 150 km to preserve statistical power.
[39] See Figure E32.
[40] Figure E34.
[41] Figure E35.
[42] Figures E36 and E37.

The hosting city is excluded to isolate spillovers. Due to constraints on statistical power, I limit the analysis to cities within 75 km, split into three bands: 0–25 km, 25–50 km, and 50–75 km.[43]

The results show a short-term positive spillover within the 0–25 km band: nearby cities experience a temporary increase in population growth for about 50 years following academy creation. However, this effect fades over time. In contrast, the hosting cities maintain long-run benefits. This may suggest that nearby cities benefit from initial knowledge diffusion or reputational spillovers without incurring the institutional costs, while only the hosting city captures persistent gains. Similar patterns appear—though with weaker significance—in the 25–50 km band and disappear entirely beyond 50 km. When disaggregating by academy type, scientific academies exhibit a positive but only slightly statistically significant short-run spillover in the 0–25 km ring, which does not extend beyond. This result is somewhat surprising, as one might expect scientific institutions to exert broader regional influence. By contrast, literary, long-lasting, and large academies do not exhibit measurable outbound spillovers at any distance, with coefficients close to zero throughout.[44]

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 is a unique dataset of academicians active between 1500 and 1800, combined with a robust DID design to analyze the establishment and evolution of these educational institutions. Evaluating economic growth through population growth rates, I find that academies had a positive effect—particularly science-focused academies, which exhibited a stronger and more persistent impact.

When examining their impact on local university quality, I observe a strong positive effect from the establishment of purely scientific academies. Similarly, only scientific academies produced short-term positive spillover effects beyond the local area. Finally, the analysis of historical interactions between academies and universities opens the door to further research on the origins of the modern, professionally oriented educational system.

These results contribute to our understanding of the complex relationship between human capital, science, and economic dynamics in historical contexts. I emphasize the importance of experimental approaches and practical research in driving economic growth—even in pre-industrial times—in line with the literature on "useful knowledge" (Mokyr, 2005b). At the same time, I acknowledge the Eurocentric focus of this history of science: my analysis centers on European scientific institutions, methods, and scholars, as the West was the first to experience the Industrial Revolution. Nevertheless, future

[43] I explored spillovers up to 150 km, but results beyond 100 km were not statistically significant due to sample limitations.

[44] See Appendix E.3 for full results.

research could extend this analysis to include contributions from other civilizations—particularly Arabic and Chinese traditions—and their connections to the development of the modern scientific method (Bala, 2006; H.F. Cohen, 1994; Needham, 1964).

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Appendix A Additional details on historical context

A.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.[45]

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).[46] 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) (Maylender, 1930; Middleton, 1971) 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).

[45] Sometimes honorary members were also limited to a specific number, but for this category, exceptions were applied more regularly than the rule itself.

[46] 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.

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.

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,[47] 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-Kaßler, 2005). The latter aimed to supplement university lessons with more empirical applications through their collection of instruments and their own laboratory (Böhme-Kaßler, 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.

[47] The *Academia Electoralis Scientiarum et Elegantiorum Literarum Theodoro-Palatina* created in 1763 and the *Societas Meteorologicae Palatinae* founded in 1780.

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 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.[48]

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)[49] (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.

[48] 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.

[49] Francis Ysidro is considered the pioneer of utility theory with his development of indifference curves and the Edgeworth box.

- 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 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.**[50] 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,[51] 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.

A.2 Academies' establishments

- **Acad Agen.** The *"Société des Sciences, arts et belles lettres"* was created in Agen (FRA) on January 1, 1776 and officially recogniez 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).

[50] 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.

[51] 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.

- **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 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 Arrezo.** 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-Kaßler, 2005).

- **Acad Besançon.** The *"Académie des Sciences, belles lettres et arts"* was founded in Besancon (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 Inqueti 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 Bratislava.** The *Pressburgischen Gesellschaft der Freunde der Wissenschaften* was the first Hungarian society. It was created in 1752 by a group of protestant scholars, guided by Karl Gottlieb Windisch, and it was active only until 1763 (Réka & Tüskés, 2017).
- **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 (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 Vidensakkernes 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 founded in 1683, which is from when I consider it active. However, it 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. This earlier society was founded in 1731, which will be the date from when I consider the academy active. 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-Kaßler, 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-Kaßler, 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 Sallskapet"* 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) between October 15–20, 1763. The academy was established by Karl Theodor, the Elector Palatine of Bavaria, and effectively organized by the French historiographer Johann Daniel Schöpflin and Leopold Maximilian, Baron of Hohenhausen, the Prince's chamberlain. The academy aimed to promote both science and the humanities. It had a structured governance system with a president and a secretary appointed for life (Academiae Electoralis Scientiarum et Elegantiorum Literarum Theodoro-Palatina, 1766; Cassidy, 1985). Another relevant institution, the *"Societas Meteorologica Palatina"*, was also founded in Mannheim (DEU), on September 5, 1780. It was likewise initiated and supported by Elector Palatine Karl Theodor and strongly advocated by scholars Father Hemmer and Stefan von Stengel. This academy focused on meteorology, aiming to connect international meteorological stations equipped with similar instruments to allow for comparative measurements. It, too, had a structured governance system and received financial support from Karl Theodor (Cassidy, 1985). I consider these two academies as a unique one, especially given the presence of intermediary societies and institutions that bridged the two, paving the way for the latter meteorological society.
- **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 Petrash, 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 Reinassance 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 Boreliana"* 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 (Gosseaume, 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 Spalding.** The *Philosophical Society* was founded informally by Maurice Johnson in 1710 to foster the study of archaeology and antiquarianism. Two years later the organization of the society became more formal with structured meetings and transcription of the minutes (Spalding Gentlemen's Society , 2025).
- **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 & Doraghi, 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 Schoning, 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 Akerman 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 Johanes 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 B Descriptive Statistics

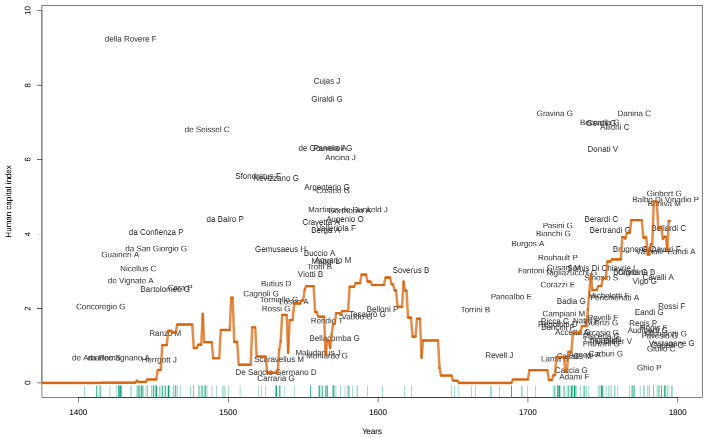


Fig. B1 Notable scholars at the University of Turin.

The figure displays ordinary members of the University of Turin with a non-negative individual quality index. Vertical green lines represent the distribution of scholars over time, including those with a quality index of zero. The orange line shows the evolution of the university's aggregate quality. Source: Zanardello (2022).

Table B1 Summary Statistics: Founders vs. Non-Founders of Academies.

	(1) **Founders**	(2) **Not Founders**	(3) **t-test**
Obs.	413	16860	
	μ	μ	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
Years Active	19.5	16	0.338
Distance Birthplace-Academy	220	344	0.003
Distance Academy-Death place	317	421	0.260
Distance Birthplace-Death place	248	368	0.074
Year FE⋆			YES

Note: Column (1) reports summary statistics for scholars who founded an academy; Column (2) shows statistics for those who did not. Column (3) reports p-values from t-tests comparing the means between the two groups, controlling for year fixed effects.
⋆Year fixed effects refer to the scholar's initial year of activity.

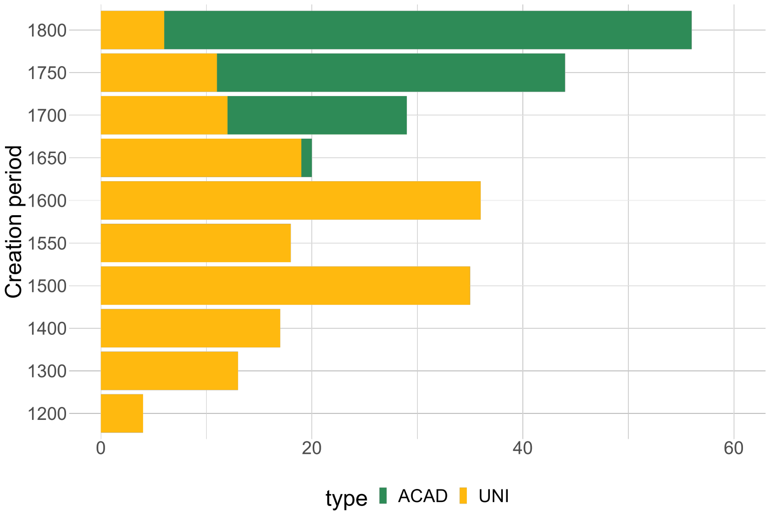


Fig. B2 Creation Timeline of Academies and Universities.

Note: The figure shows the cumulative number of institutions established up to the year indicated on the y-axis. Universities (yellow) exhibit a more heterogeneous timeline, with establishments beginning in the 11th century. In contrast, academies (green) began to proliferate in the second half of the 17th century.

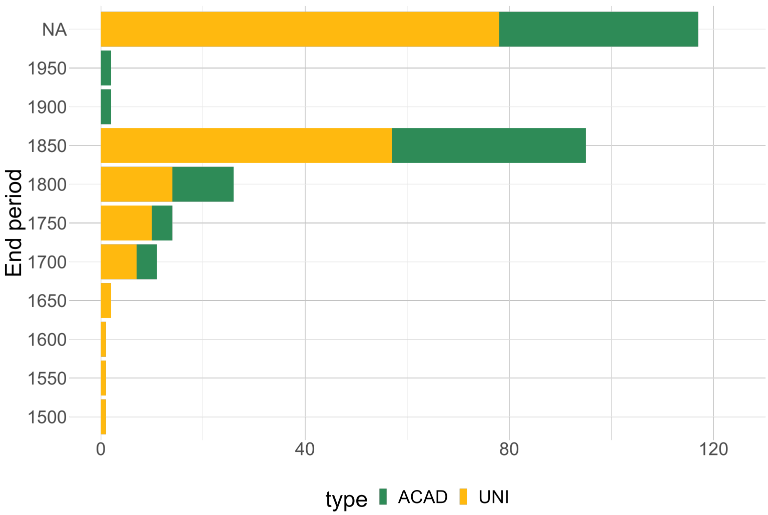


Fig. B3 Closure Timeline of Universities and Academies.

Note: The figure shows the number of institutions that closed in the 50 years preceding the year indicated on the y-axis. Universities are shown in yellow; academies in green. *NA* refers to institutions that never closed. Most institutions remained open before 1800; a wave of closures occurred between 1800 and 1850, although the majority are still active today.

Table B2 Summary Statistics for Academies.

	Mean	**Med**	**Min**	**Max**	**Obs**
Total activity years	137	81	2*	372**	101
Creation Date	1740	1750	1650	1793	101
End Date	1877	1794	1667	2024	101
Total size	137	57	1†	1622‡	101
% SCIENCE	53.2%	53.0%	0.0%	100.0%	101
% LITERARY	43.1%	43.1%	0.0%	100.0%	101
% UNKNOWN	2.4%	0.0%	0.0%	28.7%	101
Size in 1650–1700	238	49	2	1622‡	16
% SCIENCE	58%	56.4%	19.6%	100.0%	16
% LITERARY	39.3%	41.8%	0.0%	73.9%	16
% UNKNOWN	2.6%	0.0%	0.0%	14.0%	16
Size in 1700–1750	142	70	4	873⊕	33
% SCIENCE	49.1%	47.4%	0.0%	100.0%	33
% LITERARY	49.5%	51.7%	0.0%	100.0%	33
% UNKNOWN	1.4%	0.0%	0.0%	12.9%	33
Size in 1750–1800	103	52	1†	480•	52
% SCIENCE	54.4%	54.3%	0.0%	100.0%	52
% LITERARY	42.6%	42.1%	0.0%	100.0%	52
% UNKNOWN	3%	0.0%	0.0%	28.7%	52

Note: This table presents summary statistics for the academies in my sample. ‘Med’ indicated the median, ‘Min’ the minimum, ‘Max’ the maximum, and ’Obs’ the number of observations considered. * Refer to *Accademia della Traccia* in Bologna (ITA, 1665).

** Refer to *Leopoldina Academy* in Halle (DEU, 1652).

† Refer to *Naturforschende Gesellschaft* in Jena (DEU, 1793).

‡ Refer to the *Royal Society* in London (UK, 1660).

⊕ Refer to the *Prussian Academy* in Berlin (DEU, 1700).

• Refer to the *Erfurt Academy* in Germany (DEU, 1754).

Table B3 Summary Statistics for Universities.

	Mean	**Med**	**Min**	**Max**	**Obs**
Total activity years	366	356	3*	936**	171
Creation Date	1517	1548	1088	1781	171
End Date	1883	1811	1460	2024	171
Total size	155	70	0†	1958‡	171
% SCIENCE	20.7%	19.1%	0.0%	100.0%	171
% LITERARY	74.7%	76.9%	0.0%	100.0%	171
% UNKNOWN	2.8%	0.0%	0.0%	31.3%	171
Size in 1650–1700	91	50	12	246°	12
% SCIENCE	20.8%	19.2%	0.0%	40.0%	12
% LITERARY	74.3%	75.5%	60.0%	84.4%	12
% UNKNOWN	4.9%	1.7%	0.0%	16.7%	12
Size in 1700–1750	65	26	1	354⊕	11
% SCIENCE	28.8%	19.1%	0.0%	67.8%	11
% LITERARY	69.6%	81.0%	19.4%	100.0%	11
% UNKNOWN	1.6%	0.0%	0.0%	12.9%	11
Size in 1750–1800	27	20	1	71•	6
% SCIENCE	34.2%	33.6%	0.0%	80.0%	6
% LITERARY	65.5%	65.7%	20.0%	100.0%	6
% UNKNOWN	0.2%	0.0%	0.0%	1.4%	6

Note: This table presents summary statistics for the universities in my sample. 'Med' indicated the median, 'Min' the minimum, 'Max' the maximum, and 'Obs' the number of observations considered. * Refer to *Corte University* in France (1765). ** Refer to the *University of Bologna* in Italy (1088).

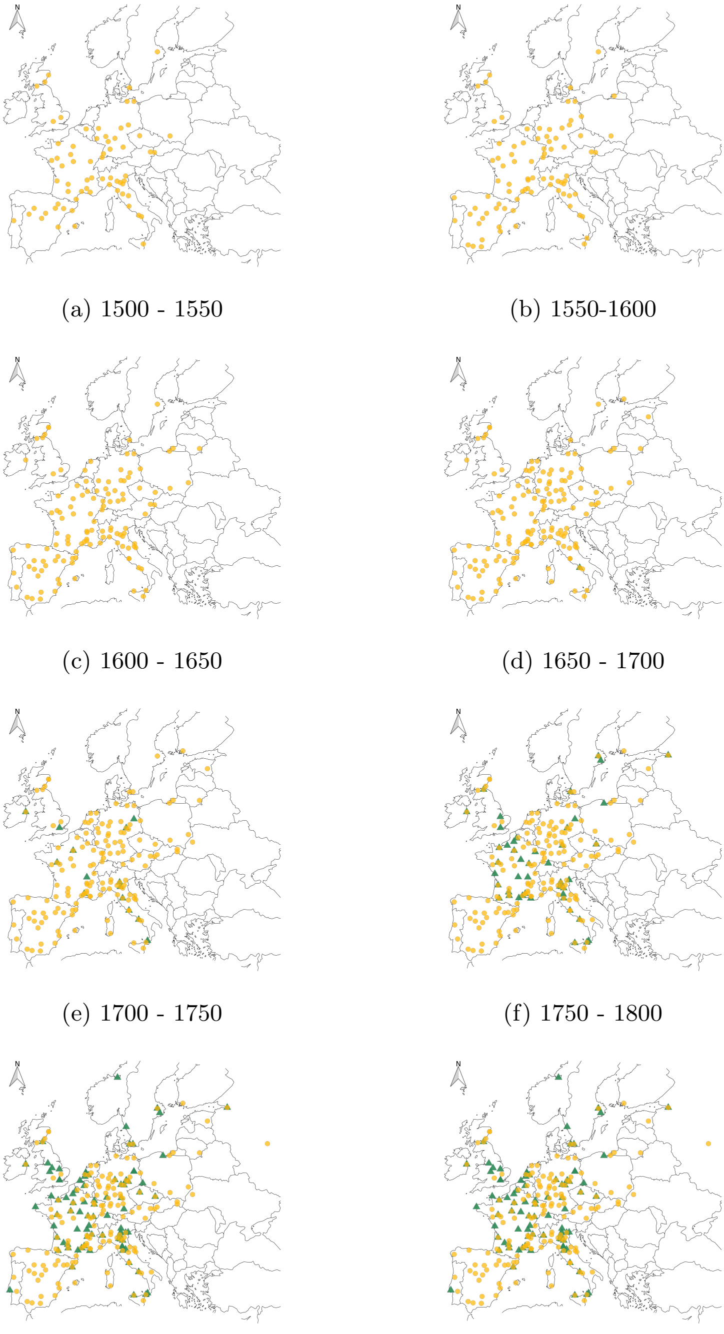
† Refer to the universities for which we did not find any member yet in Burgo-de-Osma (ESP, 1555), Genova (ITA, 1471), and Palma (ESP, 1483).

‡ Refer to the *University of Cambridge* in UK (1209).

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

⊕ Refer to the *University of Göttingen* in Germany (1734).

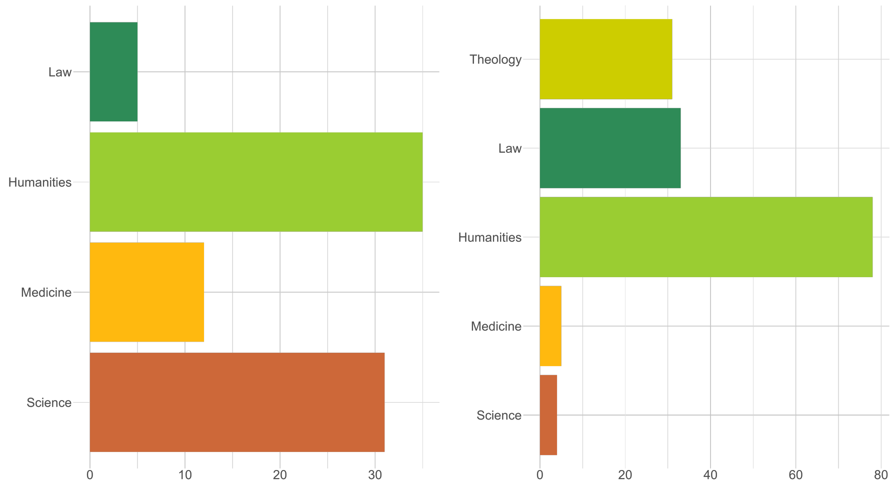
• Refer to the *University of Moscow* in Russia (1755).



(a) 1500 - 1550
(b) 1550-1600
(c) 1600 - 1650
(d) 1650 - 1700
(e) 1700 - 1750
(f) 1750 - 1800
(g) 1800 - 1850
(h) 1850 - 1900

Fig. B4 Locations of Academies and Universities (1500 - 1900 CE).

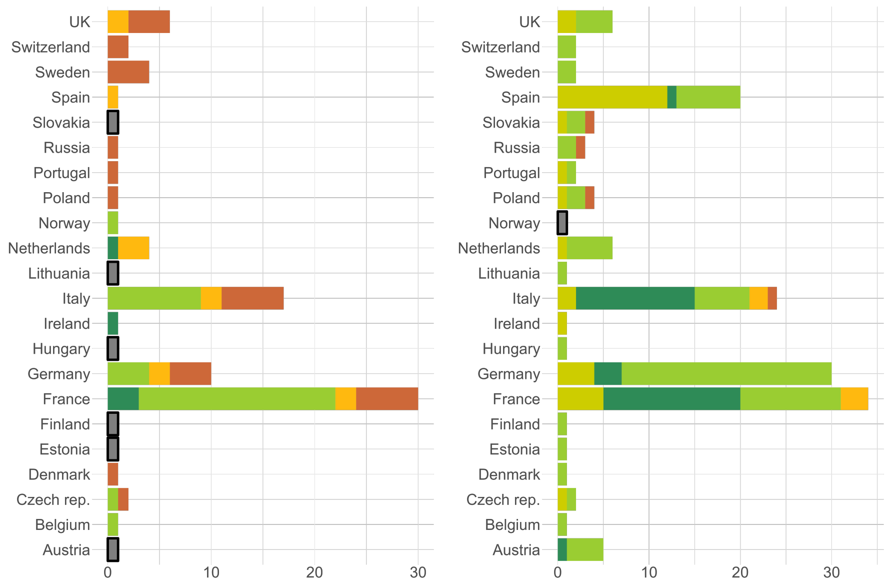
Note: Yellow circles represent universities, while green triangles represent academies. In cities where both institutions were established, the shapes overlap to indicate interaction. Country borders reflect those in the year 2000.



(a) Academies (b) Universities

Fig. B5 Institutions by Main Field of Study.

Note: Number of institutions by their main field of study, defined as the field in which the majority of the institution's members were active.



(a) Academies (b) Universities

Fig. B6 Institutions by Major Field of Study per Country.

Note: Number of institutions by major field of study, shown by country. The major field of study refers to the most commonly studied field within each institution, without applying a minimum threshold. Science is shown in red, Medicine in gold, Humanities in light green, Law in dark green, and Theology in lime. Countries without any identified institutions are shown in grey and outlined with a solid black border.

Table B4 Types of Academies by Country.

	(1) **ACAD**	(2) **Scientific ACAD***	(3) **Literary ACAD****	(4) **Long-lasting ACAD**	(5) **Big ACAD**
Europe	81	43	38	68	62
France	29	11	18	23	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 Republic	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

Note: This table shows the number of the academies in my sample by type and by country. Columns (2) and (3) add up to Column (1). Columns (4) and (5) are independent of each other.
* An academy (ACAD) is classified as scientific if at least 50% of its members study science, applied science, or medicine.
** An academy is classified as literary if at least 50% of its members study theology, law, humanities, or social sciences.

Table B5 Pre-treatment Summary Statistics.

EVENT	Observations	Mean	Standard Deviation	Minimum	Maximum
Outcome variable: $\Delta lnpop$ 1500-1900, 50-years interval					
Academy	81	0.204	0.302	−0.318	1.139
University*	83	0.125	0.242	−0.434	1.099
Scientific Academy	43	0.205	0.312	−0.318	1.139
Literary Academy	38	0.203	0.297	−0.236	1.099
Long-lasting Academy	68	0.220	0.294	−0.318	1.099
Big Academy	62	0.224	0.320	−0.318	1.139
Outcome variable: $AvgQ$ 1500-1900, 50 years interval					
Academy	40	2.659	2.362	0	7.060
Scientific Academy	21	3.270	2.345	0	7.060
Literary Academy	19	1.984	2.249	0	6.768
Long-lasting Academy	35	2.814	2.314	0	7.060
Big Academy	32	2.549	2.271	0	7.060

Note: There are 149 universities in total, of which 66 opened before 1500 — the start of the sample period. Therefore, the statistics are computed using only 83 observations.

Appendix C Additional results

C.1 OLS results

In this section, I present results from OLS regressions examining the relationship 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 C6 reports estimates for the full sample of 2,096 cities, following Buringh (2021), while Table C8 focuses on a subset of 633 large cities as defined by Bosker et al. (2013).[52] In my preferred specification (Column 4), I include both city fixed effects and country-by-time fixed effects. This helps account for unobserved, time-invariant city characteristics and broader national trends. While no time-varying controls are available for the full sample, I argue that the combination of city and country-by-time fixed effects mitigates omitted variable bias. In Appendix C.2, I support this claim using the smaller sample of large cities for which time-varying controls are available, showing that the results are similar with and without these controls (see Table C8).

Table C6 shows that the presence of an academy is positively and significantly associated with higher population growth. The magnitude of the academy coefficient (ACAD) is consistently larger than that of universities, suggesting a strong correlation between academies and urban growth. However, the interaction between academies and universities (ACAD $\times$ UNI) is not statistically significant in Columns 2 and 4. Interestingly, this coefficient is negative, suggesting that establishing an academy in a city that already has a university may not further enhance local economic conditions—and might even have a slight crowding-out effect. Nevertheless, the total correlation of having both institutions remains positive and significant. Results for the large-city sample in Table C8 mirror these patterns. Specifications that omit city fixed effects but include country and time fixed effects separately (e.g., Column 3 in Table C6 and Column 2 in Table C8) produce stronger coefficients, but they fail to account for city-specific factors, as reflected in lower R-squared values.

Table C7 presents a first heterogeneity analysis by field of study, as introduced in Section 3. The results suggest that the positive effects identified in Table C6 are primarily driven by scientific academies. Only the coefficients for academies focused on science, applied science, and medicine (Columns 1 and 3) are positive and highly significant. In contrast, literary academies—those emphasizing humanities, theology, law, and the social sciences (Columns 2 and 4)—do not yield significant results.

The interaction terms between the presence of a university and either type of academy mirror those in Table C6: negative in sign and statistically insignificant, suggesting that the combination of both institutions does not reinforce the positive association with population growth.

[52] Bosker et al. (2013) define large cities as those exceeding 10,000 inhabitants at least once between 800 and 1800. My full sample includes cities exceeding 5,000 inhabitants at least once between 700 and 2000.

Table C6 OLS Estimates: Effect of Academies and Universities on City Population.

	Dependent Variable: ln pop in 1500-1900			
	Obs.: **ALL cities** as in Buringh (2021)			
	(1)	(2)	(3)	(4)
ACAD	0.308**	0.316**	1.757***	0.271**
	(0.118)	(0.130)	(0.226)	(0.113)
UNI		0.142**	1.089***	0.082
		(0.056)	(0.077)	(0.056)
ACADxUNI		−0.055	−1.005***	−0.008
		(0.225)	(0.323)	0.205
Cities	2096	2096	2096	2096
R^2	0.806	0.806	0.442	0.845
city FE	YES	YES	NO	YES
time FE	YES	YES	YES	NO
country FE	NO	NO	YES	NO
countryXtime FE	NO	NO	NO	YES

Note: *p<0.1; **p<0.05; ***p<0.01.
Standard errors are clustered at the city level (in parentheses).
ACAD indicates the presence of only an academy in a given city and time period; **UNI** indicates the presence of only a university; **ACAD**×**UNI** denotes the presence of both an academy and a university in the same city and time period.
The dependent variable is the natural logarithm of city population, measured every 50 years from 1500 to 1900, following the dataset in Buringh (2021).
Each column reports estimates from a different specification. The models include the indicated combinations of fixed effects (city, time, country, or country-by-time).

C.2 Additional OLS results: time-varying controls

In Section C.1, I use the full city sample from Buringh (2021), for which time-varying controls are not available. This raises concerns about omitted variable bias. To address this, I demonstrate here that including city and country-by-time fixed effects already captures the most important sources of variation, as results remain stable when time-varying controls are added.

This check is possible only for the subset of large cities from Bosker et al. (2013), for which time-varying characteristics are available until 1800. I first identify relevant variables by examining their temporal variation. Several factors clearly change over time: for example, cities were plundered with differing frequency across years; Bruges and Seville lost direct access to the sea; some cities gained or lost status as a bishopric, archbishopric, or capital. The religious landscape also shifted, as seen in cities like Granada, which ceased to host a madrasa between 1500 and 1600, and in changing exposure to Muslim influence. Measures such as Muslim and Christian urban potential—defined by (Bosker et al., 2013, p.1423) as the distance-weighted population of nearby cities—also evolve over time.

In contrast, many controls remain stable: distances to Rome, Mecca, or Byzantium; soil quality (based on Ramankutty, Foley, Norman, and McSweeney (2002)); elevation and terrain variation; and proximity to rivers or Roman roads. These are effectively accounted for by city fixed effects.

Table C7 OLS Estimates: Effect of Scientific and Literary Academies on City Population.

	Dependent Variable: ln pop in 1500-1900			
	Obs.: **ALL cities** as in Buringh (2021)			
	(1)	(2)	(3)	(4)
$\mathbf{ACAD}_{Science}$	0.365**		0.443***	
	(0.178)		(0.319)	
$\mathbf{ACAD}_{Literary}$		0.172		0.089
		(0.122)		(0.157)
UNI			0.098*	0.090
			(0.056)	(0.071)
$\mathbf{ACAD}_{Science}\mathbf{xUNI}$			−0.184	
			(0.319)	
$\mathbf{ACAD}_{Literary}\mathbf{xUNI}$				−0.167
				(0.235)
Cities	2096	2096	2096	2096
R^2	0.845	0. 845	0.845	0.845
city FE	YES	YES	YES	YES
countryXtime FE	YES	YES	YES	YES

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.
Standard errors clustered at the city level are reported in parentheses.
$\mathbf{ACAD_{Science}}$ indicates the presence of a scientific academy in a given city and time period; $\mathbf{ACAD_{Literary}}$ indicates the presence of a literary academy.
$\mathbf{ACAD_{Science}} \times$ **UNI** and $\mathbf{ACAD_{Literary}} \times$ **UNI** represent interaction terms capturing the joint presence of a university and a scientific or literary academy in the same city and period.
The dependent variable is the natural logarithm of city population, measured at 50-year intervals from 1500 to 1900, based on the dataset in Buringh (2021).
All regressions include city fixed effects and country-by-time fixed effects. Each column represents a separate specification.

While city FE controls for all time-invariant characteristics, it does not capture time-varying dynamics. However, Table C8 shows that adding time-varying controls has little effect: none of the coefficients in Columns 2 and 3 becomes significant or changes sign. Column 1 complements Table C6 in the main text and confirms similar trends, supporting the robustness of the baseline specifications.

C.3 Dynamic TWFE results

This section presents the main results from the dynamic TWFE estimations, addressing two key identifying assumptions: parallel trends and no anticipation effects. Section 7.2 further considers the SUTVA assumption and investigates possible inbound spatial spillovers (Berkes & Nencka, 2021; Butts, 2021).

Figure C7 displays the main event study, analyzing the effects of academy creation between 1500 and 1900 in 50-year intervals. The assumptions of no pre-trends and no anticipation are met.[53] Results show a significant positive effect emerging 100 years after the academy's founding, persisting throughout the last century of the period studied. This implies that, in the long run, cities

[53] Testing for pre-trends offers only a partial check of the parallel trends assumption.

Table C8 OLS Estimates for Large Cities (as in Bosker et al. (2013)).

	ln pop in 1500-1900	ln pop in 1500-1800	
	(1)	(2)	(3)
ACAD	0.248*	0.166	0.173
	(0.133)	(0.129)	(0.136)
UNI	0.033	−0.021	−0.062
	(0.068)	(0.068)	(0.068)
ACADxUNI	−0.128	−0.038	−0.086
	(0.169)	(0.163)	(0.169)
Cities	633	633	633
Adj. R^2	0.823	0.810	0.800
$\Delta time$ controls	NO	YES	NO
city FE	YES	YES	YES
countryXtime FE	YES	YES	YES

Note: *p<0.1; **p<0.05; ***p<0.01.
Standard errors are clustered at the city level and reported in parentheses.
The dependent variable is the natural logarithm of population in large cities over three periods: 1500–1900 (Column 1), and 1500–1800 (Columns 2 and 3).
ACAD indicates the presence of an academy; **UNI** indicates the presence of a university; **ACAD** × **UNI** captures cities hosting both types of institutions in the same period.
City and country-by-time fixed effects are included in all specifications. Column (2) additionally controls for time-varying characteristics, including: direct sea access, presence of a bishop or archbishop, capital city status, presence of a madrasa, number of times plundered, Muslim or Christian urban potential, and whether the city was predominantly Muslim.

with academies experience faster population growth than comparable cities without them.

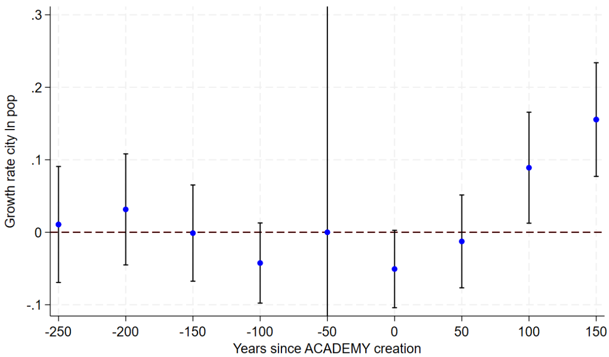


Fig. C7 Event Study: Academy Creation.

This figure shows the estimated effects of academy creation on city population from 1500 to 1900, based on an event-study specification.
Note: The control group is cities that never established an academy. The dependent variable is the logarithmic city population growth rate. The sample includes 2,023 city-level clusters. The within R^2 is 0.315.

To examine the interaction between universities and academies, I restrict the sample to cities that hosted a university at any point. Since universities were typically established before academies, this subset offers a more comparable group of cities and allows for a cleaner investigation of the interaction term.[54] However, this reduced sample has lower statistical power. Figure C8 shows that while parallel trends hold, no significant effect follows academy creation in university cities.

Next, I explore heterogeneity by field of study, longevity, and size of the academies.

I first distinguish between scientific and literary academies based on member composition. An academy is classified as scientific if over 50% of its members focus on science, applied science, or medicine (43 academies); literary academies include those where over 50% of members engage in literature, history, theology, law, or social sciences (38 academies).

Figure C9, Panel (a), shows a strong and lasting positive effect from scientific academies, with population growth increasing by 23% ($p = 0.000$) 150 years after establishment. In contrast, Panel (b) shows no significant effect from literary academies. A mild pre-trend is present but in the opposite direction of the post-treatment effect, suggesting any bias would attenuate the observed results.

I also analyze large academies (more than 30 members; 62 cases) and long-lasting academies (active over 30 years; 68 cases). Both groups show similar patterns: a significant positive effect appears only after 150 years.[55]

These findings emphasize the importance of scholarly focus: it is not size or longevity that drives outcomes, but the scientific orientation of the academy. Institutions centered on experimental and applied inquiry—rather than literary or humanistic pursuits—have the strongest and most persistent impact on long-run urban growth.

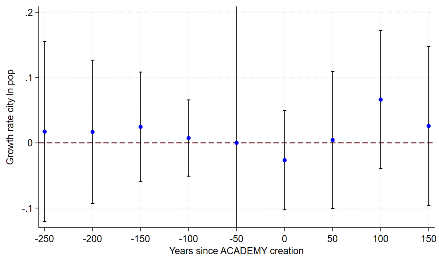
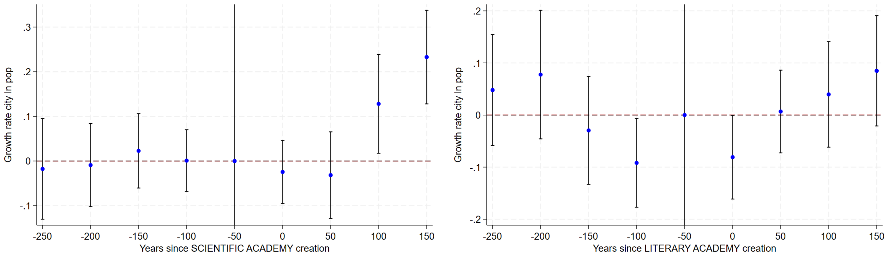


Fig. C8 Event Study: Academy Creation in University cities.

This figure shows the estimated effects of academy creation on city population from 1500 to 1900 in cities that hosted a university at least once, based on an event-study specification.
Note: The control group is university cities that never established an academy. The dependent variable is the logarithmic city population growth rate. The sample includes 149 city-level clusters. The within R^2 is 0.528.

[54] Only in Nancy (France) was the academy created clearly before the university. In two other cases—Halle (Germany) and Pau (France)—the academy slightly precedes the university but within the same 50-year period.

[55] See Figures C10a and C10b.

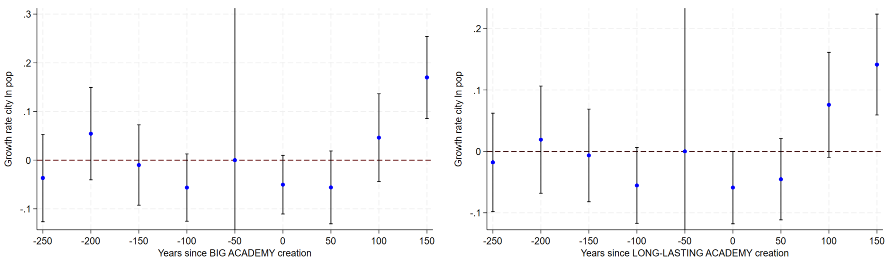


(a) (b)

Fig. C9 Event Study: Academy Creation by Field.

This figure shows the estimated effects of academy creation on city population from 1500 to 1900, based on an event-study specification. Panel (a) refers to scientific academies; panel (b) to literary academies.

Note: The control group is never-treated cities. The dependent variable is the logarithmic city population growth rate. The sample includes 2,023 city-level clusters. The within R^2 is 0.315 for both panels.



(a) (b)

Fig. C10 Event Study: Academy Creation by Size and Duration.

This figure shows the estimated effects of academy creation on city population from 1500 to 1900, based on an event-study specification. Panel (a) refers to large academies; panel (b) to long-lasting academies.

Note: The control group is never-treated cities. The dependent variable is the logarithmic city population growth rate. The sample includes 2,023 city-level clusters. The within R^2 is 0.315 for both panels.

C.4 Static TWFE

In this section, I estimate a traditional static Two-Way Fixed Effects (TWFE) specification as follows:

$$lnPOP_{ct} = \beta_0 + \beta_1 EVENT_c \text{x} Post_{ct} + \mu_c + \psi_s \lambda_t + \epsilon_{ct} \tag{C1}$$

Here, $lnPOP_{ct}$ denotes the logarithm of the population of city c at time t, which is the outcome variable. $Post_{ct}$ is an indicator equal to 1 in all periods following the creation of an academy in city c, while $EVENT_c$ identifies whether the event occurred in the city. The interaction term $EVENT_c \text{x} Post_{ct}$ captures the treatment effect. The coefficient of interest, β_1, measures the average change in population size after the establishment of an academy, relative to cities without academies.

The model includes city fixed effects μ_c and country-by-time fixed effects $\psi_s \lambda_t$ to control for unobserved heterogeneity across cities and over time.

While the static TWFE model provides a straightforward interpretation, it tends to deliver conservative estimates, as it downweights long-term effects in favor of short-term ones. Moreover, the assumption of homogeneous treatment effects across time and space is unlikely to hold in this setting, limiting the credibility of causal identification through this approach.

I report these static estimates for completeness. However, the main analysis relies on more robust dynamic TWFE models and advanced difference-in-differences estimators, which are discussed in the main text.

Table C9 Static Two-Way Fixed Effects: Academy Creation.

	ln pop in 1500-1900		
	(1)	(2)	(3)
ACAD x Post	0.255***		
	(0.072)		
ACAD$_{science}$ **x Post**		0.277***	
		(0.096)	
ACAD$_{literary}$ **x Post**			0.217**
			(0.106)
Constant	2.969***	2.9731***	2.975***
	(0.013)	(0.013)	(0.013)
Obs.	18207	18207	18207
within R^2	0.725	0.724	0.724
city FE	YES	YES	YES
countryXtime FE	YES	YES	YES

Note: *p<0.1; **p<0.05; ***p<0.01
Standard errors are clustered at the city level in parenthesis. The dependent variable is the logarithm of city population. All regressions include city and country-by-time fixed effects.
This table reports estimates from static two-way fixed effects regressions, examining the association between academy creation and city population from 1500 to 1900. Column (1) shows the effect of any academy; column (2) restricts to scientific academies; column (3) to literary ones.

C.5 2x2 Event Studies

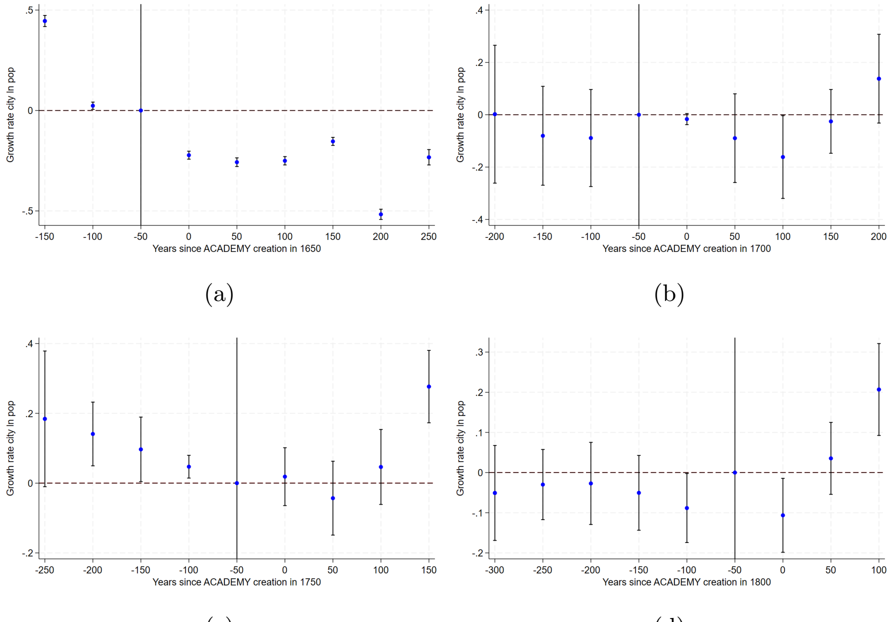


Fig. C11 Event Study: Academy Creation by Period.

This figure shows the estimated effects of academy creation on city population using a 2x2 event-study design for four selected periods: (a) 1650 — only the Investiganti Academy in Naples was founded; (b) 1700 — 14 academies were established; (c) 1750 — 26 academies were created; (d) 1800 — 40 academies were opened.
Note: The control group is never-treated and cities treated in a different period of time.The dependent variable is the logarithmic city population growth rate. The sample includes 2,023 city-level clusters. The within R^2 is (a) 0.314, (b) 0.314, (c) 0.315, (d) 0.316.

Appendix D Alternative DID estimators

D.1 *CSDID* results

As in Sun and Abraham (2021), Callaway and Sant'Anna (2021) focuses on estimating average treatment effects by cohort—groups of cities g that experience the creation of an academy for the first time at time t. The $CSDID$ estimator developed by Callaway and Sant'Anna (2021) is methodologically close to the IW estimator from Sun and Abraham (2021), which I use for the main results in Section 5.1.

Compared to Sun and Abraham (2021), Callaway and Sant'Anna (2021) offers greater flexibility, allowing for various aggregation methods. However, these features are less relevant in my setting. Instead, I rely on the event-study structure from Sun and Abraham (2021) to ensure balanced timing across cohorts. Still, due to the methodological similarities, I report results using the $CSDID$ estimator as a robustness check.

Figure D12 presents the dynamic treatment effects from creating an academy, estimated using a balanced panel with five pre-treatment and three post-treatment periods. The results mirror those in the main analysis: effects become statistically significant at the 90% level in later periods, consistent with the long-run impact detected by Sun and Abraham (2021). The pre-treatment coefficient is small and not statistically significant (−0.7%, p-value: 0.69), providing reassurance against differential pre-trends. However, the average treatment effect on the treated (ATT) is only marginally insignificant (4.5%, p-value: 0.11), suggesting that the overall effects may be modest when using this estimator.

An additional feature of $CSDID$ is that it allows for interpretation of effects by calendar time. For example, in Naples—the only city to receive an academy in 1650—the estimated population growth rate is 22% lower (p-value: 0.000) between 1650 and 1700 compared to a counterfactual without an academy. A significant positive effect (21%, p-value: 0.000) is only observed after 1900.

Figure D13 shows the dynamic effects of academy creation in cities that hosted a university at least once. As in Figure 4, there are no significant pre-trends (0.35%, p-value: 0.91) or post-treatment effects (−2.4%, p-value: 0.51), confirming the absence of interaction effects on population growth.

Figure D14 displays the dynamics by type of academy. Scientific academies are associated with a delayed but positive effect on city population growth: after 100 years, growth is 12.5% higher on average (p-value: 0.059), with no pre-trends (−0.2%, p-value: 0.93). The ATT is slightly insignificant (6.6%, p-value: 0.12), but the final calendar year (1900) shows a significant 29% increase (p-value: 0.00).

Conversely, literary academies (Figure D14b) are associated with short-term slow down in growth: an 8% decrease immediately after the creation of the academy. There are no significant pre-trends (−1.2%, p-value: 0.60)

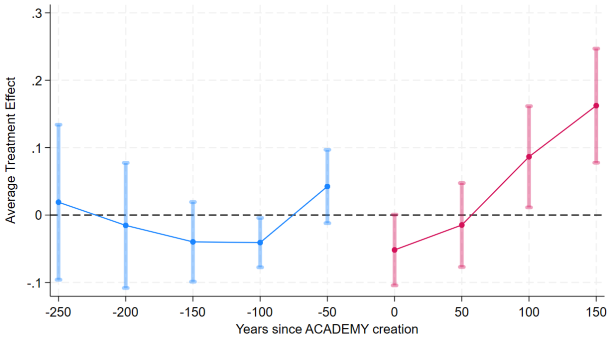


Fig. D12 Academy event using Callaway and Sant'Anna (2021).

This figure shows the dynamic average effects of creating an academy on city population growth between 1500 and 1900, estimated using the method of Callaway and Sant'Anna (2021).
Note: The control group is cities that never established an academy. The dependent variable is the logarithmic city population growth rate.

which is reassuring also no joint post-treatment effect. In addition, three post-treatment calendar periods show statistically significant negative effects, only after 1900 does the effect turn positive (17%, p-value: 0.005).

Finally, Figures D14c and D14d examine long-lasting academies (over 30 years) and large academies (over 30 members). Their dynamic patterns are similar to the overall case. While no significant pre-trends are detected, there is also no statistically significant average post-treatment effect.

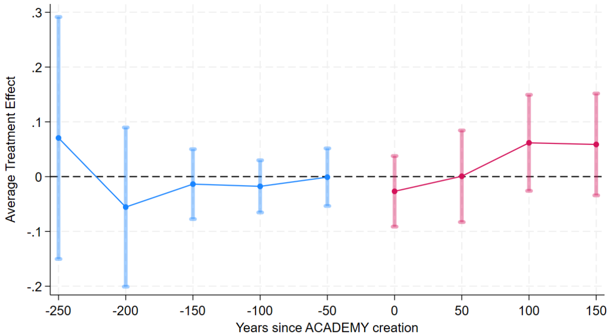
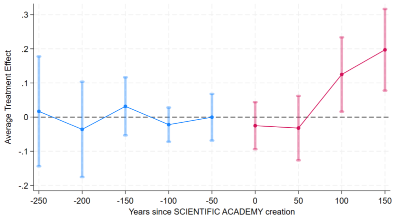
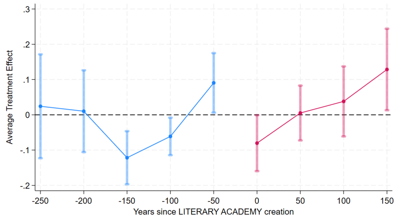


Fig. D13 Academy event in university cities using Callaway and Sant'Anna (2021).

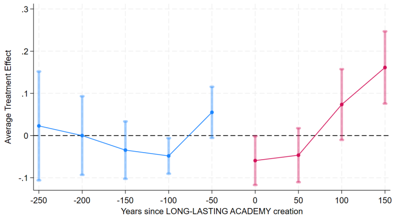
This figure shows the dynamic average effects of creating an academy between 1500 and 1900 in cities that hosted a university at least once, estimated using Callaway and Sant'Anna (2021).
Note: The control group is university cities that never established an academy. The dependent variable is the logarithmic city population growth rate.



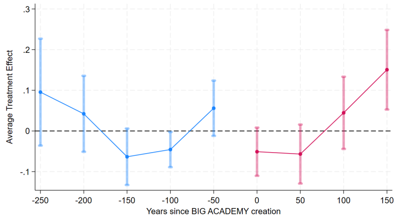
(a)



(b)



(c)



(d)

Fig. D14 Academy event by field, size, and length using Callaway and Sant'Anna (2021).

This figure shows the dynamic average effects of creating (a) a scientific academy, (b) a literary academy, (c) a long-lasting academy (active more than 30 years), and (d) a big academy (with more than 30 members) between 1500 and 1900, estimated using Callaway and Sant'Anna (2021). *Note:* The control group is never-treated cities. The dependent variable is the logarithmic city population growth rate.

D.2 DID_l results

The estimator proposed by De Chaisemartin and d'Haultfoeuille (2024), denoted as DID_l, measures the effect of creating an academy or university exactly l periods ago for the first time. It compares cities undergoing the initial creation of a higher education institution at time t with those that have not yet received such a treatment. This method captures the delayed effects of institutional creation and is particularly suited for assessing long-difference dynamics. A key innovation of DID_l is its ability to handle continuous treatments.[56]

In what follows, I present results from the DID_l estimator. Since it does not allow for more leads than lags, I include a balanced specification with three leads and three lags. This setup provides a more nuanced perspective on the timing and persistence of treatment effects.

Figure D15 reports the estimated impact of academy creation between 1500 and 1900. The dynamic closely mirrors the baseline: a significant positive effect emerges roughly 100 years after the academy's establishment. The same

[56] Earlier drafts of this project relied on the estimator from De Chaisemartin and d'Haultfoeuille (2022), which yielded nearly identical results. I also compared findings with De Chaisemartin and d'Haultfoeuille (2020), which estimates the instantaneous treatment effect by focusing solely on cities whose treatment status changes in the current period. That approach excludes cities that have always or never been treated since 1500. While results were again broadly consistent, placebo estimates varied slightly due to differences in treatment status definitions.

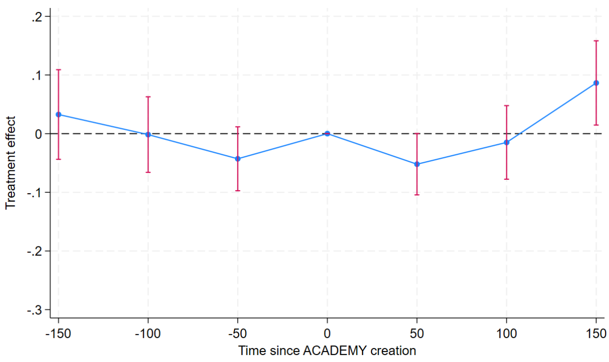
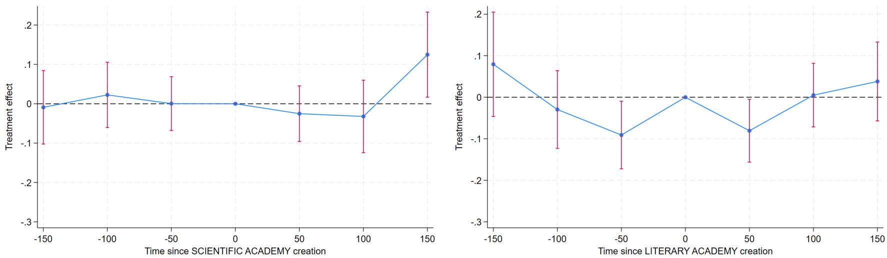


Fig. D15 Academy event using De Chaisemartin and d'Haultfoeuille (2024).

This figure shows the effect of creating an academy estimated using DID_l (De Chaisemartin & d'Haultfoeuille, 2024) between 1500 and 1900.
Note: The control group is cities that never established an academy. The dependent variable is the logarithmic city population growth rate.

pattern holds for scientific academies, which increase city population growth by 12.5% after a century, as shown in Figure D16. In contrast, literary academies show no statistically significant effect on population growth.

Finally, Figure D17 illustrates the dynamics for cities that had at least one university. These results reinforce previous findings—there is no significant interaction effect between universities and academies on city growth.



(a) (b)

Fig. D16 Academy event by field, size, and length using De Chaisemartin and d'Haultfoeuille (2024).

This figure shows the effect estimated using DID_l (De Chaisemartin & d'Haultfoeuille, 2024) of creating (a) a scientific academy and (b) a literary academy between 1500 and 1900.
Note: The control group is never-treated cities. The dependent variable is the logarithmic city population growth rate.

Appendix E Robustness checks

E.1 Sensitivity analyses: leave-one-out

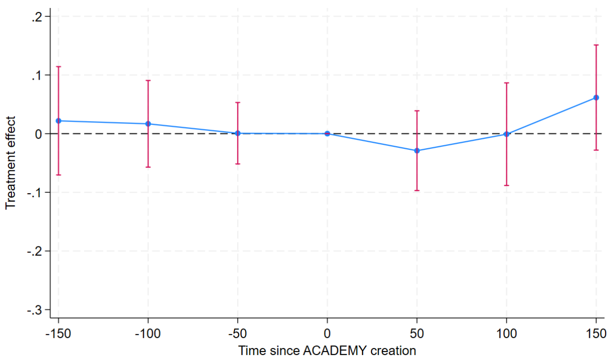


Fig. D17 Academy event in university cities using De Chaisemartin and d'Haultfoeuille (2024).

This figure shows the effect estimated using DID_l (De Chaisemartin & d'Haultfoeuille, 2024) of creating an academy between 1500 and 1900, in cities that hosted a university at least once. *Note:* The control group is university cities that never established an academy. The dependent variable is the logarithmic city population growth rate.

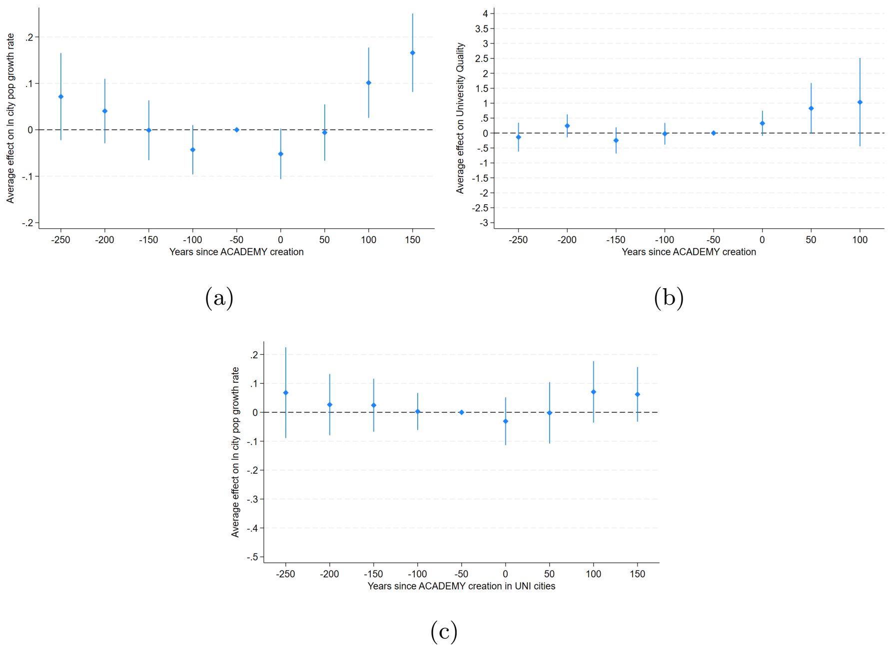


Fig. E18 Academy events leaving London out.

This figure shows the effect of creating (a) an academy on logarithmic city population growth rate, (b) an academy on university quality, and (c) an academy in cities that hosted a university at least once on logarithmic city population growth rate; estimated using Sun and Abraham (2021). *Note:* The control group is cities that never established an academy. London is excluded from the sample.

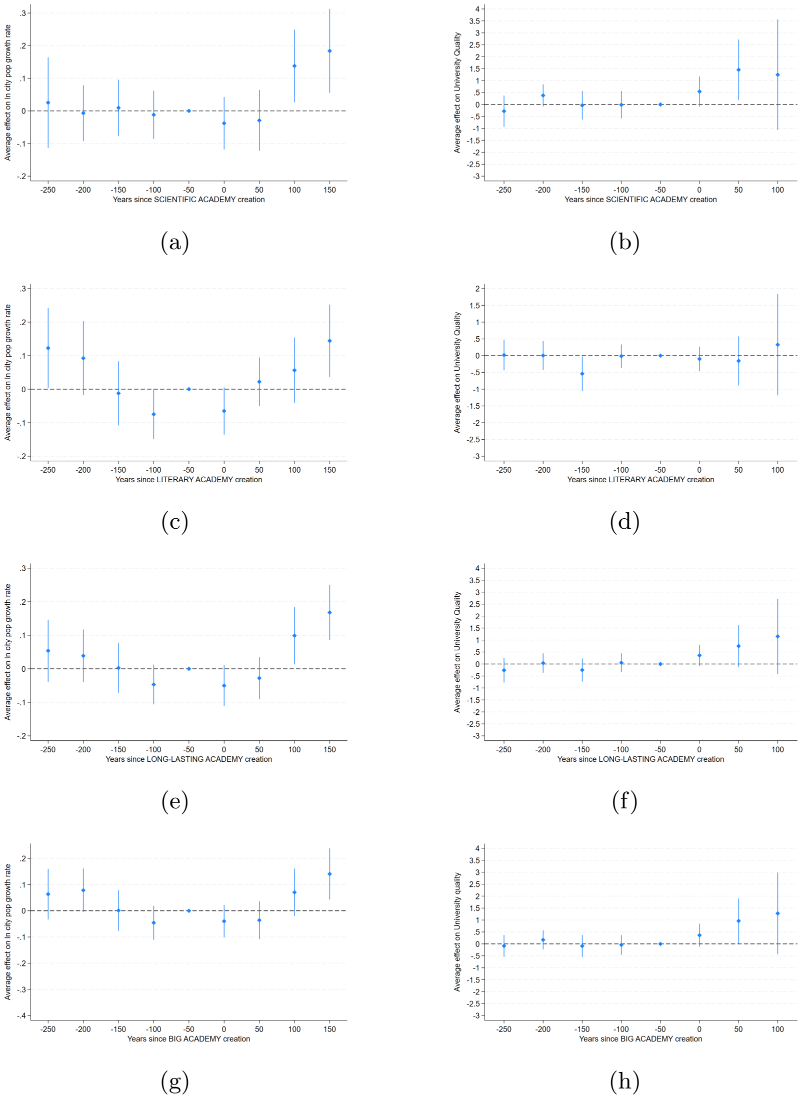
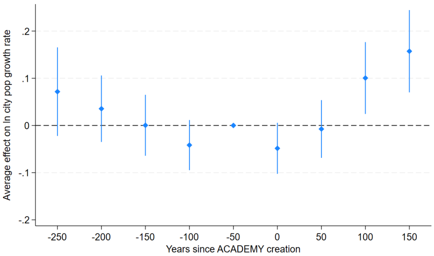
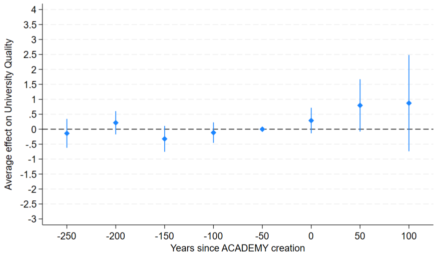


Fig. E19 Academy events by field, size, and length leaving London out.

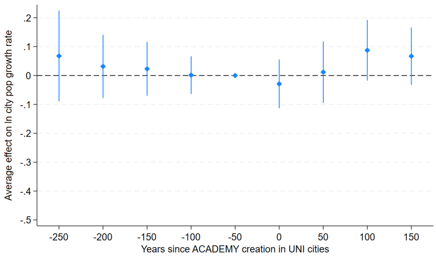
Effect of creating (a - b) a scientific academy, (c - d) a literary academy, (e - f) a long-lasting academy, and (g - h) a big academy; estimated using Sun and Abraham (2021).
Note: The control group is never-treated cities. The dependent variable is logarithmic city population growth rate in the left column, and university quality in the right column. London is excluded from the sample.



(a)



(b)



(c)

Fig. E20 Academy events leaving Paris out.

This figure shows the effect of creating (a) an academy on logarithmic city population growth rate, (b) an academy on university quality, and (c) an academy in cities that hosted a university at least once on logarithmic city population growth rate; estimated using Sun and Abraham (2021). *Note:* The control group is cities that never established an academy. Paris is excluded from the sample.

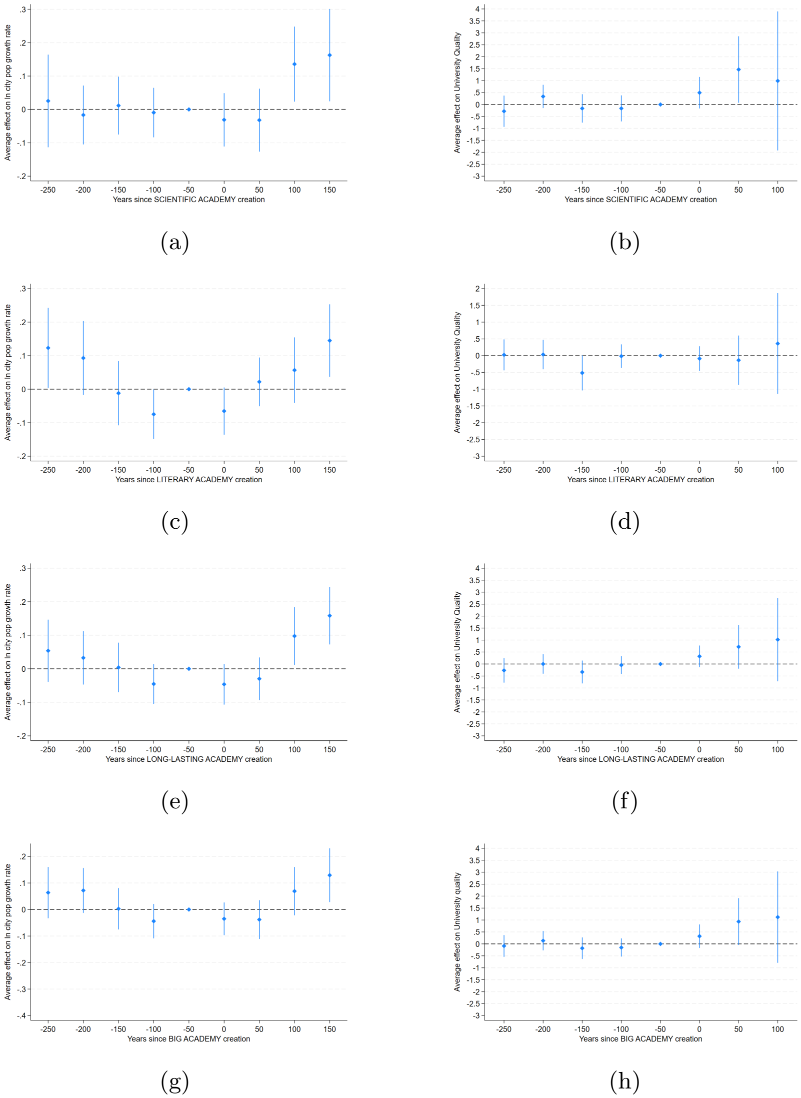
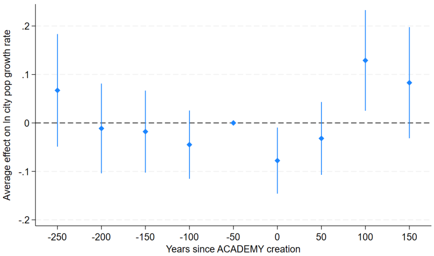
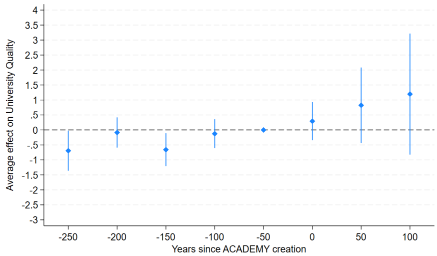


Fig. E21 Academy events by field, size, length leaving Paris out.

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 using Sun and Abraham (2021).
Note: The control group is never-treated cities. The dependent variable is logarithmic city population growth rate in the left column, and university quality in the right column. Paris is excluded from the sample.



(a)



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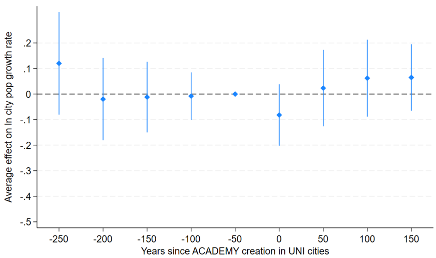
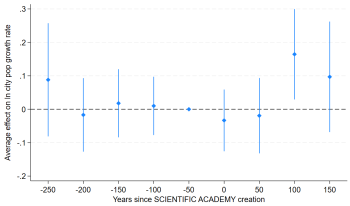


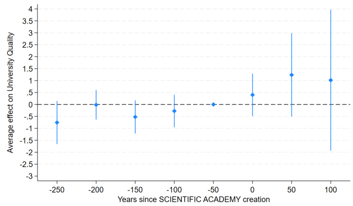
(c)

Fig. E22 Academy events leaving France out.

This figure shows the effect of creating (a) an academy on logarithmic city population growth rate, (b) an academy on university quality, and (c) an academy in cities that hosted a university at least once on logarithmic city population growth rate; estimated using Sun and Abraham (2021). *Note:* The control group is cities that never established an academy. France is excluded from the sample.



(a)



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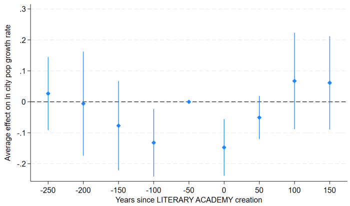
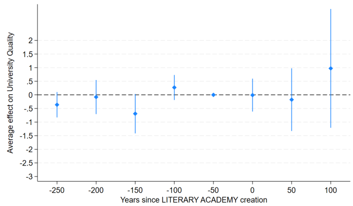
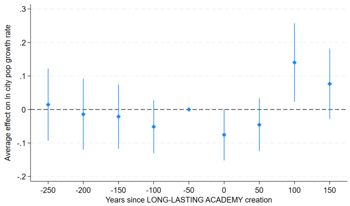


(c)



(d)



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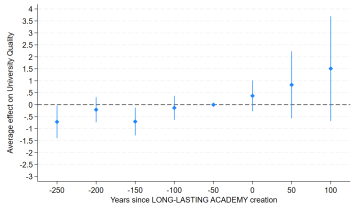

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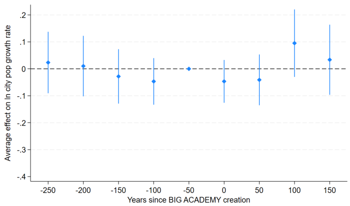
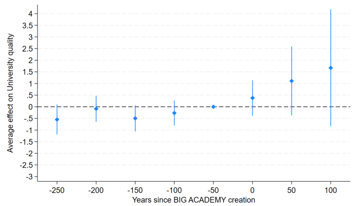


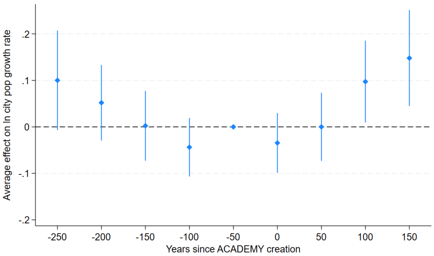
(g)



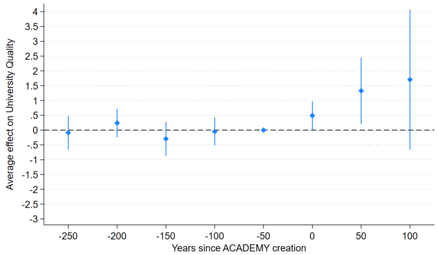
(h)

Fig. E23 Academy events by field, size, length leaving France out.

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 using Sun and Abraham (2021).
Note: The control group is never-treated cities. The dependent variable is logarithmic city population growth rate in the left column, and university quality in the right column. France is excluded from the sample.



(a)



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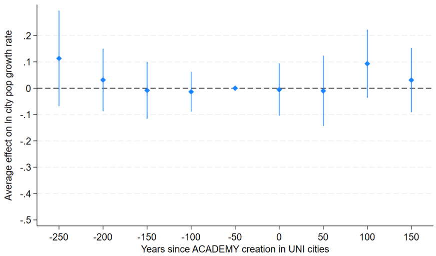


(c)

Fig. E24 Academy events leaving Italy out.

This figure shows the effect of creating (a) an academy on logarithmic city population growth rate, (b) an academy on university quality, and (c) an academy in cities that hosted a university at least once on logarithmic city population growth rate; estimated using Sun and Abraham (2021). *Note:* The control group is cities that never established an academy. Italy is excluded from the sample.

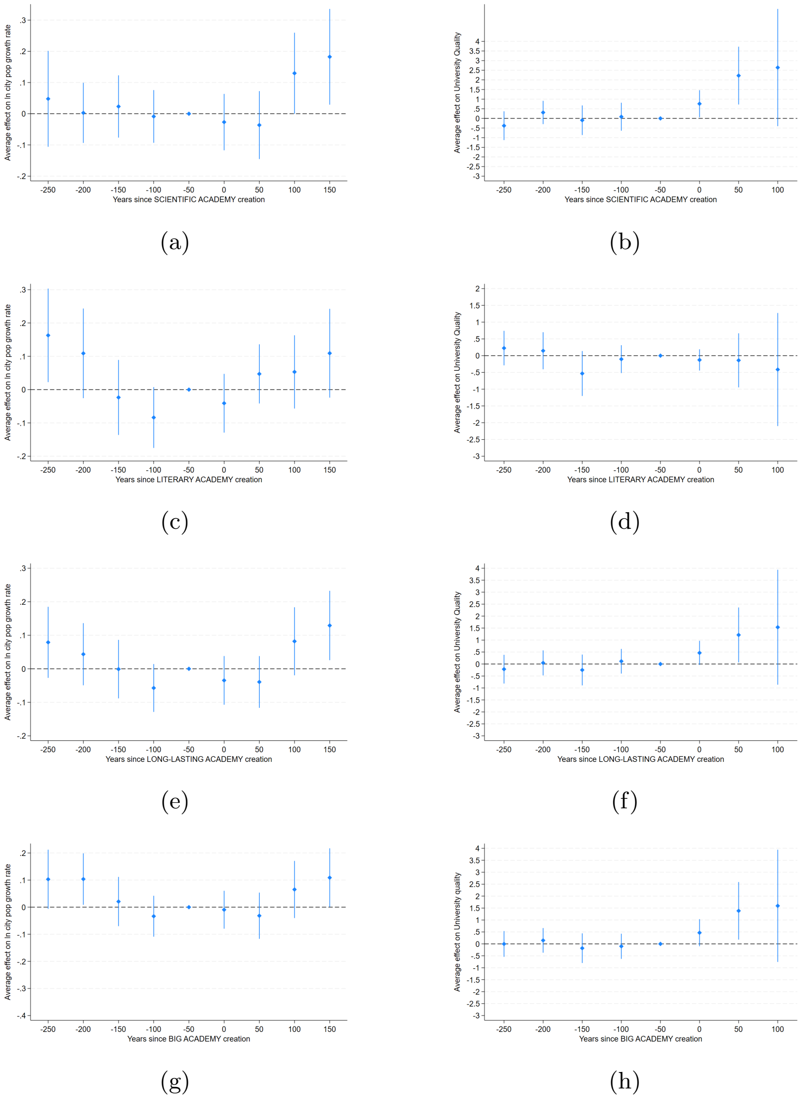
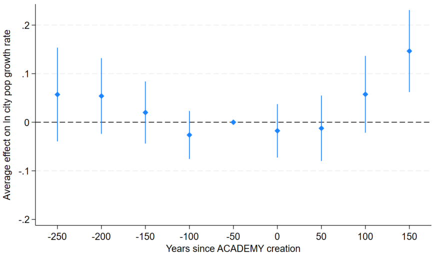


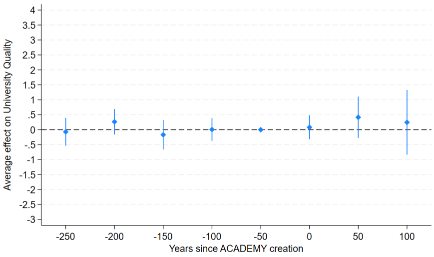
Fig. E25 Academy events by field, size, length leaving Italy out.

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 using Sun and Abraham (2021).

Note: The control group is never-treated cities. The dependent variable is logarithmic city population growth rate in the left column, and university quality in the right column. Italy is excluded from the sample.



(a)



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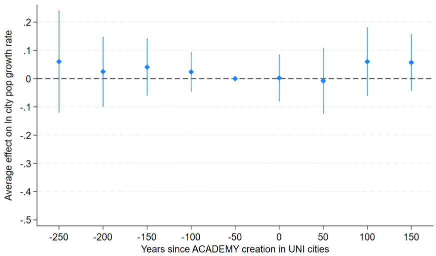


(c)

Fig. E26 Academy events leaving Germany out.

This figure shows the effect of creating (a) an academy on logarithmic city population growth rate, (b) an academy on university quality, and (c) an academy in cities that hosted a university at least once on logarithmic city population growth rate; estimated using Sun and Abraham (2021). *Note:* The control group is cities that never established an academy. Germany is excluded from the sample.

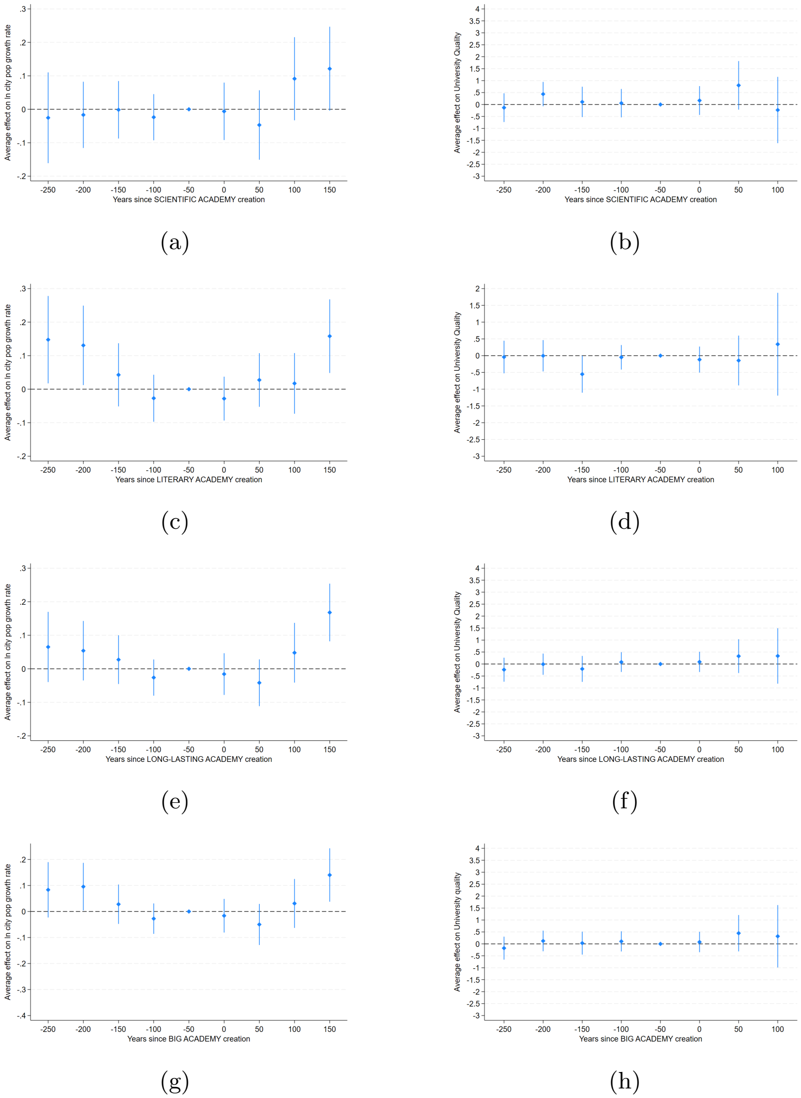
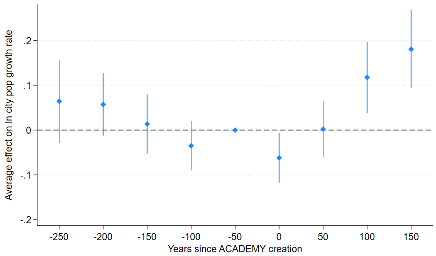


Fig. E27 Academy events by field, size, length leaving Germany out.

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 using Sun and Abraham (2021).
Note: The control group is never-treated cities. The dependent variable is logarithmic city population growth rate in the left column, and university quality in the right column. Germany is excluded from the sample.



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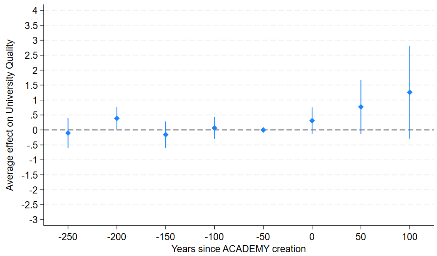

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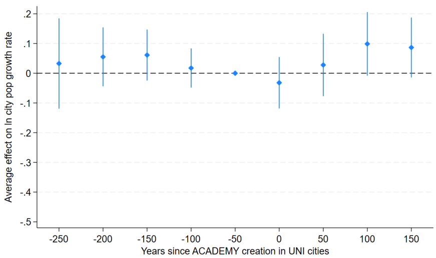
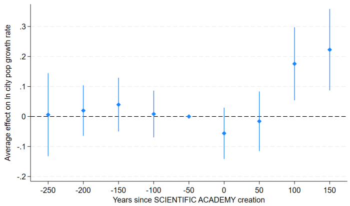


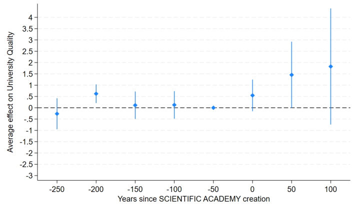
(c)

Fig. E28 Academy events leaving Great Britain out.

This figure shows the effect of creating (a) an academy on logarithmic city population growth rate, (b) an academy on university quality, and (c) an academy in cities that hosted a university at least once on logarithmic city population growth rate; estimated using Sun and Abraham (2021). *Note:* The control group is cities that never established an academy. Great Britain is excluded from the sample.



(a)



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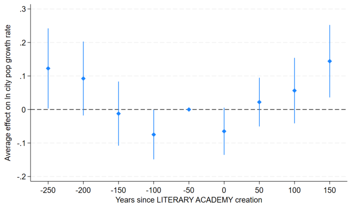

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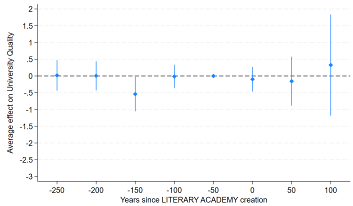

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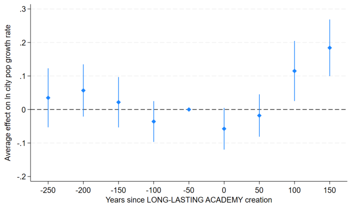

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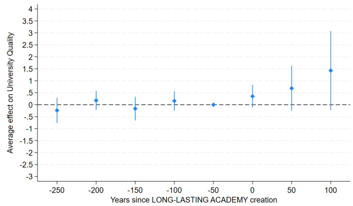

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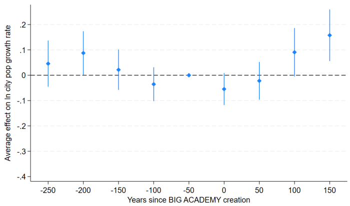

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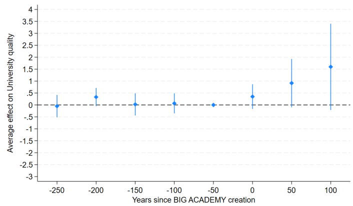
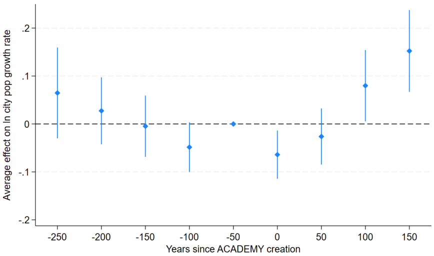


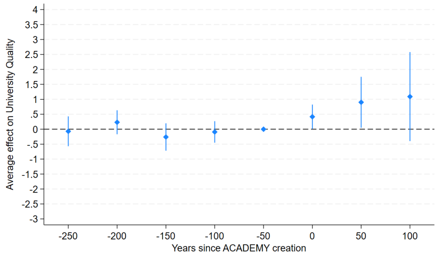
(h)

Fig. E29 Academy events by filed, size, length leaving Great Britain out.

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 using Sun and Abraham (2021).
Note: The control group is never-treated cities. The dependent variable is logarithmic city population growth rate in the left column, and university quality in the right column. Great Britain is excluded from the sample.



(a)



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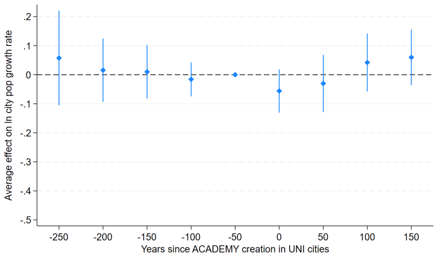
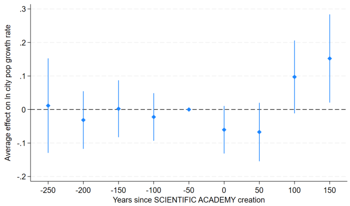


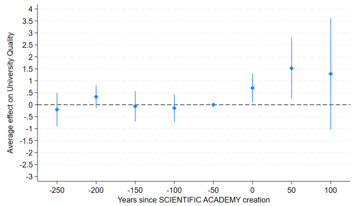
(c)

Fig. E30 Academy events leaving Spain out.

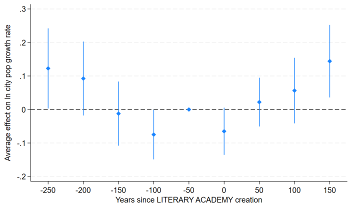
This figure shows the effect of creating (a) an academy on logarithmic city population growth rate, (b) an academy on university quality, and (c) an academy in cities that hosted a university at least once on logarithmic city population growth rate; estimated using Sun and Abraham (2021). *Note:* The control group is cities that never established an academy. Spain is excluded from the sample.



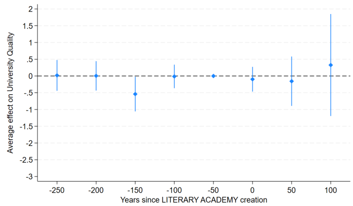
(a)



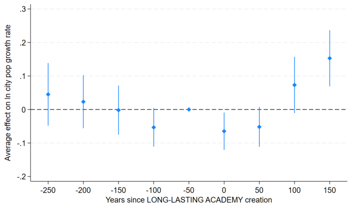
(b)



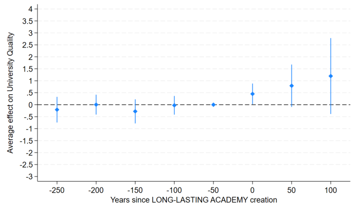
(c)



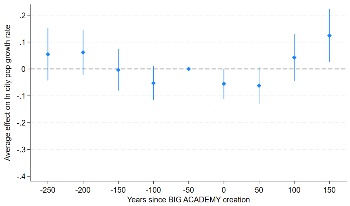
(d)



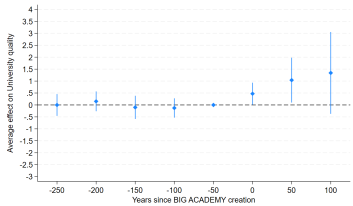
(e)



(f)



(g)

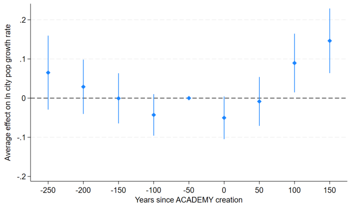


(h)

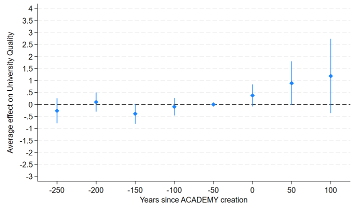
Fig. E31 Academy events by field, size, length leaving Spain out.

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 using Sun and Abraham (2021).
Note: The control group is never-treated cities. The dependent variable is logarithmic city population growth rate in the left column, and university quality in the right column. Spain is excluded from the sample.

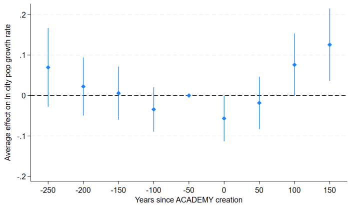
E.2 Local effects



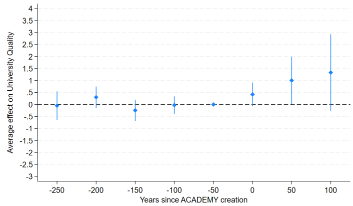
(a)



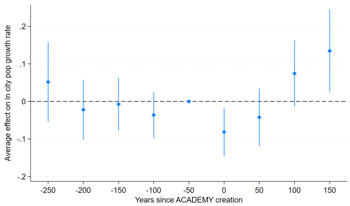
(b)



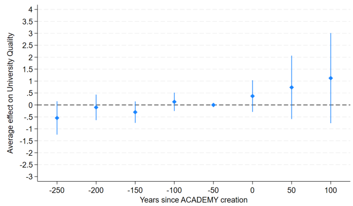
(c)



(d)



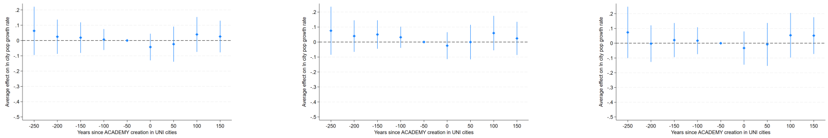
(e)



(f)

Fig. E32 Test for local effects of academy events.

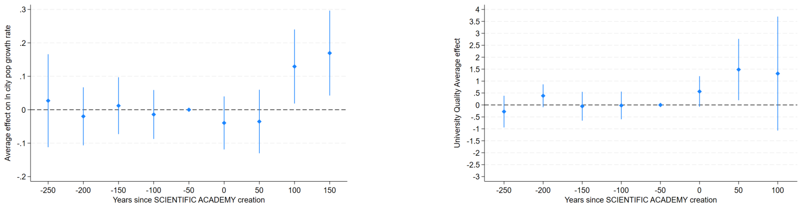
Effect of creating an academy excluding cities (a - b) within 50 km, (c - d) within 100 km, and (e - f) within 150 km from the seat of the academy; estimated with Sun and Abraham (2021). *Note:* The control group is cities that never established an academy. The dependent variable is logarithmic city population growth rate in the left column, and university quality in the right column.



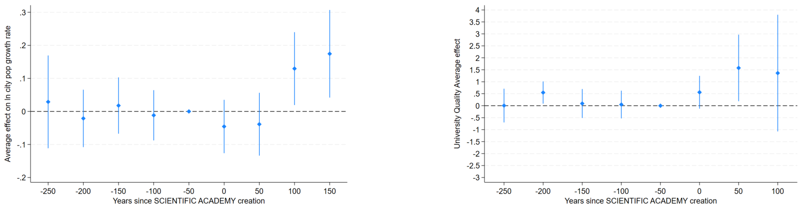
(a) (b) (c)

Fig. E33 Test for local effects of academy events in university cities.

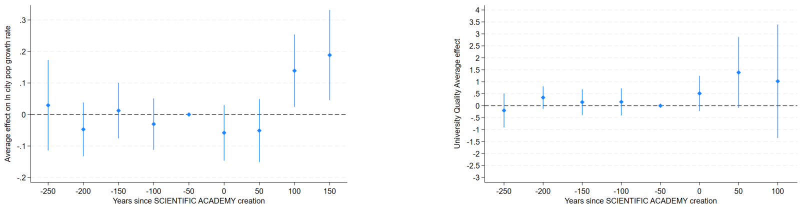
Effect of creating an academy in cities that ever had a university, excluding cities (a) within 50 km, (b) within 100 km, and (c) within 150 km from the seat of the academy; estimated with Sun and Abraham (2021).
Note: The control group is university cities that never established an academy. The dependent variable is the logarithmic city population growth rate.



(a) (b)



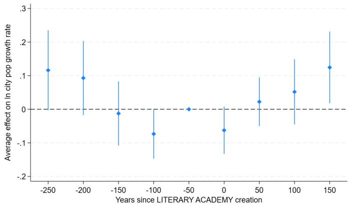
(c) (d)



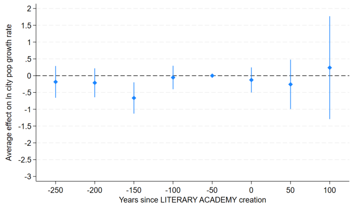
(e) (f)

Fig. E34 Test for local effects of scientific academy events.

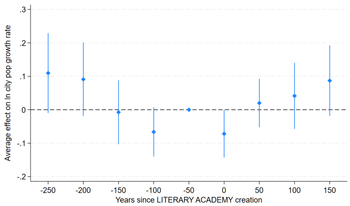
Effect of creating a scientific academy excluding cities (a - b) within 50 km, (c - d) within 100, (e - f) within 150km from the seat of the academy; estimated with Sun and Abraham (2021).
Note: The control group is cities that never established a scientific academy. The dependent variable is the logarithmic city population growth rate on the left column, and quality of universities on the right column.



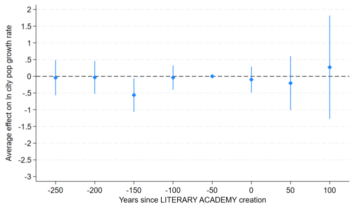
(a)



(b)



(c)



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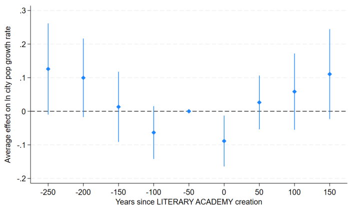
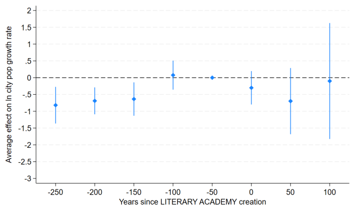


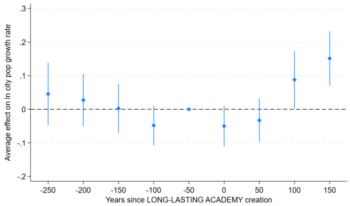
(e)



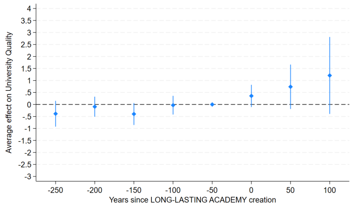
(f)

Fig. E35 Test for local effects of literary academy events.

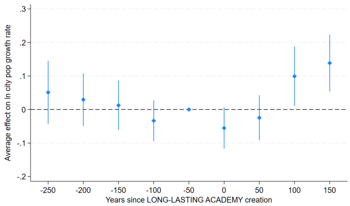
Effect of creating a literary academy excluding cities (a - b) within 50 km, (c - d) within 100, (e - f) within 150km from the seat of the academy; estimated with Sun and Abraham (2021).
Note: The control group is cities that never established a literary academy. The dependent variable is the logarithmic city population growth rate on the left column, and quality of universities on the right column.



(a)



(b)



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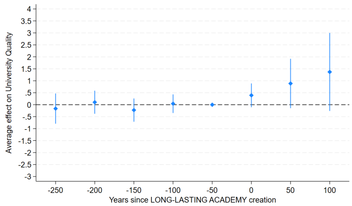

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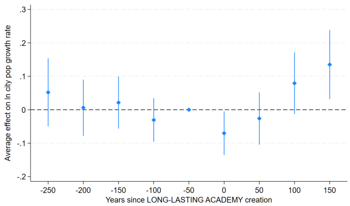

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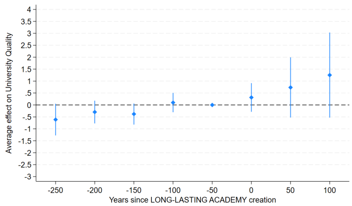
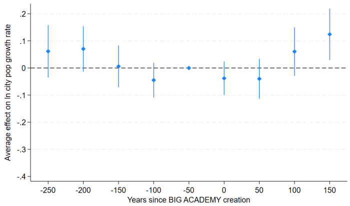


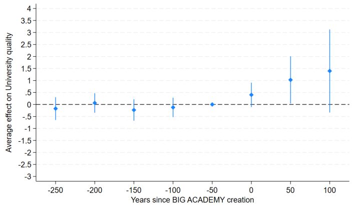
(f)

Fig. E36 Test for local effect of long-lasting academy events.

Effect of creating a long-lasting academy excluding cities (a - b) within 50 km, (c - d) within 100, (e - f) within 150km from the seat of the academy; estimated with Sun and Abraham (2021). *Note:* The control group is cities that never established a long-lasting academy. The dependent variable is the logarithmic city population growth rate on the left column, and quality of universities on the right column.



(a)



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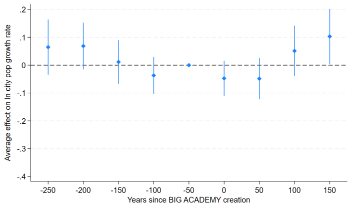
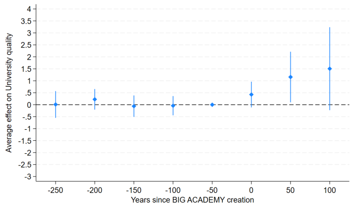
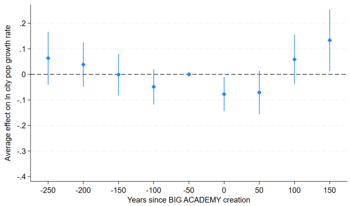


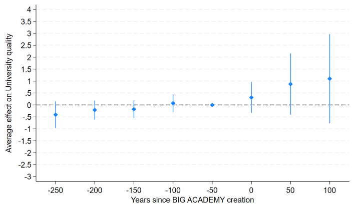
(c)



(d)



(e)

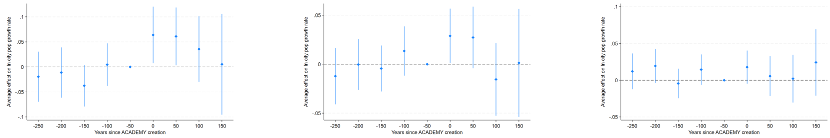


(f)

Fig. E37 Test for local effects of big academy events.

Effect of creating a big academy excluding cities (a - b) within 50 km, (c - d) within 100, (e - f) within 150km from the seat of the academy; estimated with Sun and Abraham (2021).
Note: The control group is cities that never established a big academy. The dependent variable is the logarithmic city population growth rate on the left column, and quality of universities on the right column.

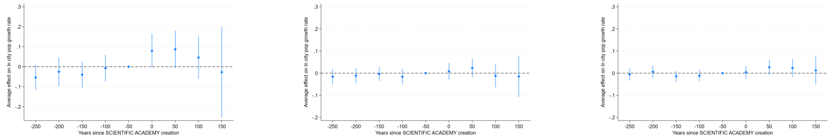
E.3 Spillover effects



(a) (b) (c)

Fig. E38 Test for spillover effects of academy events.

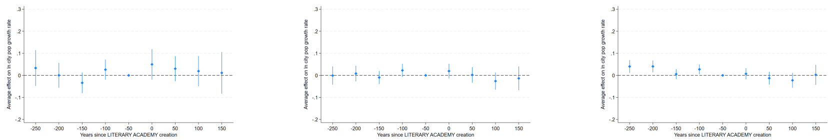
Effect of creating an academy in cities (a) within 25 km from the hosting cities, excluding the hosting city, (b) between 25 km and 50 km from the hosting cities, excluding hosting cities and within the 0–25 km "donut," (c) between 50 km and 75 km from the hosting cities, excluding hosting cities and within the 25–50 km "donut"; estimated with Sun and Abraham (2021).
Note: Control group includes cities that never established an academy and further away than 25 km, 50 km, and 75 km, respectively. Dependent variable is the logarithmic city population growth rate.



(a) (b) (c)

Fig. E39 Test for spillover effects of scientific academy events.

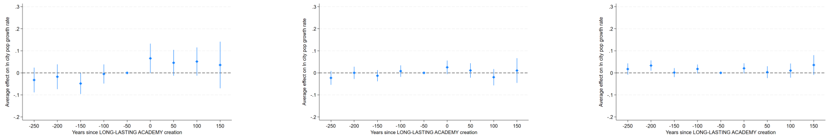
Effect of creating a scientific academy in cities (a) within 25 km from the hosting cities, excluding the hosting city, (b) between 25 km and 50 km from the hosting cities, excluding hosting cities and within the 0–25 km "donut," (c) between 50 km and 75 km from the hosting cities, excluding hosting cities and within the 25–50 km "donut"; estimated with Sun and Abraham (2021).
Note: Control group includes cities that never established a scientific academy and further away than 25 km, 50 km, and 75 km, respectively. Dependent variable is the logarithmic city population growth rate.



(a) (b) (c)

Fig. E40 Test for spillover effects of literary academy events.

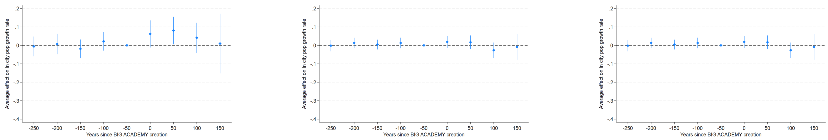
Effect of creating a literary academy in cities (a) within 25 km from the hosting cities, excluding the hosting city, (b) between 25 km and 50 km from the hosting cities, excluding hosting cities and within the 0–25 km "donut," (c) between 50 km and 75 km from the hosting cities, excluding hosting cities and within the 25–50 km "donut"; estimated with Sun and Abraham (2021).
Note: Control group includes cities that never established a literary academy and further away than 25 km, 50 km, and 75 km, respectively. Dependent variable is the logarithmic city population growth rate.



(a) (b) (c)

Fig. E41 Test for spillover effects of long-lasting academy events.

Effect of creating a long-lasting academy in cities (a) within 25 km from the hosting cities, excluding the hosting city, (b) between 25 km and 50 km from the hosting cities, excluding hosting cities and within the 0–25 km "donut," (c) between 50 km and 75 km from the hosting cities, excluding hosting cities and within the 25–50 km "donut"; estimated with Sun and Abraham (2021).
Note: Control group includes cities that never established a long-lasting academy and further away than 25 km, 50 km, and 75 km, respectively. Dependent variable is the logarithmic city population growth rate.



(a) (b) (c)

Fig. E42 Test for spillover effects of big academy events.

Effect of creating a big academy in cities (a) within 25 km from the hosting cities, excluding the hosting city, (b) between 25 km and 50 km from the hosting cities, excluding hosting cities and within the 0–25 km "donut," (c) between 50 km and 75 km from the hosting cities, excluding hosting cities and within the 25–50 km "donut"; estimated with Sun and Abraham (2021).
Note: Control group includes cities that never established a big academy and further away than 25 km, 50 km, and 75 km, respectively. Dependent variable is the logarithmic city population growth rate.