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Lead speed and nepotism in early modern ecclesiastical administration: A new quantitative approach

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ABSTRACT

This article proposes two methods to analyze processual and social dynamics in early modern administration, based on thousands of digitally encoded records from the Vatican Archive concerning 17th-century ecclesiastical office provisions. The Roman Curia as the most wide-reaching center of premodern Church administration was largely bureaucratic and heavily reliant on patronage and nepotism. We introduce two quantitative metrics: 'lead speed,' relating spatial to temporal distances to measure administrative pace; and a 'nepotism probability,' using linguistic comparison of personal names and morphosyntactic markers in the sources within one appointment entry as an indicator of familial provision ties. Aggregating these metrics across thousands of administrative instances reveals evolving patterns of global governance in early modern Catholicism while underscoring the necessity of research into the comparability of locally embedded and possibly varying notions of kinship and distance on a continental or global scale. The article situates the methods historically and explains dataset construction and computational implementation, validates initial results, and shows how the metrics enable systematic analysis of administrative pace understood as efficiency and nepotistic dynamics within established historiographical debates.

KEYWORDS

Catholic church; administration; efficiency; nepotism; 17th century

Introduction

> "The king is said to be in his entire kingdom by his power, although he is not present everywhere" (Thomas Aquinas 1926, 1:1a q. 8 a. 3. co).[1]

Bureaucracy is ubiquitous in modern societies. Historical and sociological research on bureaucracy has pointed out that its establishment at the state level and within administrative systems primarily aimed to streamline processes, enhance efficiency and transparency, and prevent corruption (Cornelißen and Fahrmeir 2021; Diefenbach 2012; Hildreth et al. 2021; Pfister 2019).[2] In our own times, Western societies crave reducing bureaucracy and "cutting red tape" but, ideally, without diminishing efficiency and fostering corrupt structures at the same time. Pre-modern bureaucracies, for the most part so at least, were not yet driven by goals such as transparency and efficiency. Projecting modern compliance schemes, best practices, or process mining back onto past administrative processes misses out on historical ideologies and societal embeddings of bureaucracy. Bureaucracy hence is no ahistorical component of society and governance, but different bureaucracies nonetheless lend to similar historiographical longue-durée perspectives and thus need similar methodological frameworks.

But how can historians investigate regimes of pre-modern bureaucracies without anachronistic import and bias? The large array of existing qualitative historical research is hardly complemented by quantitative studies until now.[3] Extensive quantitative analyses are predominantly available for the modern, post-19th-century era (Gao et al. 2023; Shapiro et al. 1973; Velychenko 1999; Vogler 2019). This lack corresponds to the lack of larger datasets but also to missing unified quantitative methodologies that are applicable to heterogeneous data of different epochs. This paper offers two models for a non-causal but indicative bird's-eye view exploration and analysis of 17th-century Church administration. One model seeks to identify social linkage through kinship in provisions of lower and middle church offices while another model approximates how fast the involved stakeholders operated.

The governance of the Catholic Church in the early modern period is an ideal subject for taking this

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perspective and developing such models: The bureaucratic apparatus of the so-called Roman Court is often considered as a paradigmatic precursor for secular and monastic powers of the era. Bureaucracies in the early modern period had to react and respond to an ever-increasing number of requests and do so within a reasonable time frame (Ludwig and Verreycken 2025, 14). The Roman Church managed to unite striking plurality and localism, polycentricity and loose organization under the umbrella of the appearance of a strongly centralized order, which manifested itself, among other things, in a vast empire of graceful acts that extended across a wide range of political powers and geographical distances.[4]

Furthermore, although the governance of the Church underwent considerable changes in its history, bureaucratic practice created an image of stability at the same time. As a matter of fact, it regulated the distribution of church property and taxes at global scale for eight centuries, from the 11th until the eighteenth century (Ago 1990; Boute 2010, 79–80; Fattori 2004). Last but not least, there is an abundance of relevant archival documents, as the Roman Curia is renowned for its meticulous documentation of numerous bureaucratic processes, which no other early modern court could match (Emich 2015, 325–26). However, collecting and systematically analyzing this abundance of administrative data appeared to be an almost insurmountable task in the past. Today, digital technologies offer significantly enhanced possibilities for managing and utilizing these extensive archival resources (Sander et al. 2025).

Which administrative processes do these sources record? The ways in which offices were granted, and the bureaucratic practices and legal authorities established for this purpose, were diverse and developed within a dynamic interplay between local traditions and the centralizing ambitions of particular actors. In the case at hand, we are facing a "job market" for church positions, to use the metaphor of German medievalists, encompassing all minor and middle clerical roles such as parish priests, canons, but also appointments to read the mass at certain altars and be compensated for it (Meyer 1991; Schwarz 1991, 1993). The appointments *via* so-called apostolic provisions emerged in the context of "ruling by exception" (Ludwig and Verreycken 2025; Smith 2015), i.e., acts of grace were used to fill vacant positions or decide on related matters. Every year, thousands of people from all over Europe wrote supplication letters to Rome to ask for local office appointments, seeing some vantage point in the papal administration handling their applications, bypassing other stakeholders with rights to appoint offices, such as bishops, abbeys, princely courts, and others (Boute 2018, 170). In fact, the very notion of nepotism has even been coined to describe one driving social force within this pre-modern ecclesiastical job market (Reinhard 1994, 1974c).

While the procedures for electing a new pontiff have even been depicted in multiple Hollywood films and television series, the vast majority of minor and middle office appointments outside the Curia remain a subject mainly for specialists (Becker 2016; Boeselager 1999; Boute 2010; D'Amelia 2008; Fattori 2004; Flug 2005; Hesse 1996; Meyer 1986b; Reinhard 1974a; Schwarz 1993; Swanson 1985; G.-R. Tewes 2001; Weiss 1994). In spite—and because—of the abundance of sources, the exact mechanisms and their extent are still understudied in a quantitative framework.[5]

Investigating these apostolic provisions at large scale allows for a high-resolution analysis of the mechanics and functioning of the bureaucratic process of office appointments. As such, they offer valuable insights into best practices and patterns of this system, its social embedding, and its capacity to attract local requests, raising questions about family strategies and nepotism. The centralized organization of the Vatican Archives offers a unique vantage point for examining the effective scope of the Papacy as a form of premodern global governance as it records the multitude of actors of different localities that turned to the Roman bureaucracy for the granting of benefices.[6] By systematically retrieving and structuring archival records and applying statistical methods, researchers can gain profound insights that both complement existing specialized studies and broaden their scope. The Vatican sources offer a much broader social 'range' of actors as recorded, e.g., in archives of the high nobility. Clerics of all social status applied to Rome, opening new perspectives into their strategies to obtain church offices, especially in European comparison. This approach not only tests existing hypotheses with quantitative methods but may also uncover broader relationships between the phenomenon under investigation and contextual factors such as economic trends, demographic patterns, and geographic influences, integrating data from other projects.

This essay presents two methods and instruments needed to arrive at these more complex, quantitative insights in a systematic and reproducible way. The focus lies on how related data can be analyzed in ways that reveal correlations and uncover patterns insightful for historians. More concretely, we propose two approaches to measure and analyze focal aspects of processual and social dynamics of early modern church administration on the basis of thousands of digitally encoded records of provisions of lower and middle ecclesiastical offices in the seventeenth century, held by the Vatican Archive. We argue that the organizational pace of the global provision of offices can be measured by way of a 'lead speed', a metric that relates spatial to temporal distance. Moreover, we propose that the provision of offices within one family can be measured probabilistically by way of linguistic comparison of personal names, including explicit markers of family affiliation, as a 'nepotism indicator'. Both metrics, if aggregated for thousands of provisions to administrative units within the Church, testify to evolving patterns of global governance within early modern Catholicism(s) and open interesting questions for comparison between different regions across Europe (and beyond).

Papal administration and its encoding as data

Before providing a detailed presentation of the two central methods discussed in this paper, it is necessary to outline the historical context of the phenomena testified by the archival resources used and to explain their translation into structured data. This explanation will be kept as concise as possible and will avoid an in-depth discussion of the state of research, as the samples used primarily serve as demonstration objects for the methods. This paper does not aim to produce definitive historical findings.

Papal administration in the seventeenth century

The Roman Curia in the seventeenth century staged itself as an internationally operating, monarchical institution, simultaneously governing the Papal States in Central Italy and claiming primacy over the universal Catholic Church avowedly founded by Christ and inherited from the Apostles (Boeselager 1999, 74; Pattenden 2019; Reinhard 2009, esp. 3–320). The fundamental rules of its organization were defined in Canon Law, although deviations from these rules occurred repeatedly, either implemented ad hoc or established through councils, new decrees or papal bulls (Boeselager 1999, 35, 47, 55; Frenz 2000; Prodi 2010). Requests of an act of grace (including papal provisions of benefices, indulgencies, dispensations, absolutions) could be submitted to the Curia in form of a supplication letter which was accepted or dismissed. The appointment of ecclesiastical offices (benefices) went down the same way.[7] So-called apostolic provisions were, as stated, exceptional (though very frequent) acts of grace used to fill vacant positions or decide on related matters and were granted by an office of the Curia, the Apostolic Datary.[8]

While, *de iure*, the Pope formally grants each grace, this task was, of course, effectively delegated. Requests for an act of grace, such as the provision of a benefice, could be submitted to the Curia in the form of a supplication, a written application letter. Office holders were required to fulfill pastoral or religious duties and were provided income and social capital in return (Boute 2010, 63).[9] Since the eleventh century, the right to grant benefices was subject to centralization as claimed by the Roman Curia, which attempted to submit local channels of recruitment to complex Roman legal regulations. Benefices could therefore now be traded on the Roman benefice market, with rules to prevent secularization or inheritance (R. Becker 2006, 177). Upon death, resignation, or forfeiture of an office holder the vacant benefice theoretically returned to a central pool for reassignment by eligible parties. In the course of the sixteenth century, the Apostolic Datary gained the right to assign these graces in the name of the pope (Celier 1910, 2–3; Fabbricatore 2007, 66–75; Storti 1969, 290). Local actors (individuals or institutions) possessed preserved appointment rights in opposition to the Curia, thereby challenging Roman claims of religious centrality that were institutionalized through the creation of various congregations and offices dealing with global affairs.[10] The conciliarist crisis of the fifteenth century pitted, among others, local recruitment channels and the claims of the papacy against each other. At the end of the 15th and the beginning of the sixteenth century, compromises were negotiated, rules were codified and set down in writing, which could vary territorially (Meyer 1986a).[11] The Datary had therefore only the right to approve requests for papal provisions of local church offices in specific circumstances, not in general, although the claim to appoint every benefice remained. For individual petitioners, this created the opportunity to appeal to different awarding authorities with granting rights: local church magnates such as abbots, bishops, and chapters of canons, but also to use Roman bureaucratic procedures to pursue their own interests.

The Curia as well as the local petitioners had a significant interest in ensuring smooth and swift administration of personnel decisions for various reasons. Firstly, time to appoint a person played a crucial part in the compromises made in the late Middle Ages: the party with the right to appoint had to put a person into office vacant due to the death of the previous holder within three to six months, with additional time, if the candidate was in Rome and had to travel back to the location of his appointment.[12] Once exceeded, the right to appoint a person was transferred to the next party with according rights (either the pope or a local authority).[13] Secondly, it was imperative to avoid scandals and the vulnerability to internal disputes, more likely to occur in lengthy procedures, especially when involved persons (allegedly) breached rules and were contested in court. Additionally, the Curia faced immense financial challenges in the seventeenth century, impacted by various crises (Bauer 1928, 492; Reinhard 1994, 1974c; Schnettger 2024). Filling vacant positions promised revenue through the fees on provisions and taxation of the office holder's income (Reinhard 1974b, 6). Moreover, positions could not remain vacant for long, as this risked disrupting social harmony or neglecting the duty of pastoral care (Herzig 2000, 81).[14] Eventually, the beneficiaries themselves were keen on obtaining their benefices and salaries as soon as possible, for obvious motives. All these reasons created a time pressure by regulations, design, or practice, and hence the need for the parties involved to negotiate bureaucratic decisions within a limited period of time.

Efforts toward a streamlined, and, in one consequence, also quicker, curial administrative organization in the seventeenth century built on the establishment of new administrative corporations since the Council of Trent (1545–1563). The central bureaucracy in Rome developed a bureaucratic language that allowed it to unite heterogeneous local contexts under the umbrella of a universal world Catholicism, placing itself at the center of it (Ditchfield 2018; Emich 2023). Since late antiquity, the Church had been hierarchically and geographically organized into dioceses and ecclesiastical provinces, which in turn encompassed individual parishes and churches. Each diocese was headed by a bishop, while archdioceses were overseen by an archbishop. The administration of these provinces and dioceses was in practice shaped by a complex cooperation of local, regional, and curial influences. While codified written administrative processes provided a formal framework, their implementation often depended on negotiations with secular rulers, episcopal autonomy, and customary practices. The papal granting of benefices shows how Rome successfully asserted its influence and claim to local granting processes, attracting actors to pursue their local interests *via* Roman administrative decisions: the registration of the vast variety of territories and dioceses in the archival records testify to the large number of persons deploying Roman administration.[15]

Nepotism

Rome's apparent attractiveness to local actors from a wide variety of local contexts and geographical distances to get invoked as a decision-making or awarding authority in local processes can be attributed not least to the increasingly differentiated landscape of bureaucracies and the recognition of legality accorded to Roman procedures. Nepotistic networks were central to this process, as the interplay between their interests, ambitions, and strategies and the Roman Curia's ability to absorb them generated mutually stabilizing effects (Boute 2018, 169–70). Power relations in the seventeenth century were fundamentally social networks, which were often strengthened through family connections (Ago 1988; Byatt 2020; Emich et al. 2005; Emich 2001; Engels 2009; Fattori 2004; Haug et al. 2016; Karsten and von Thiessen 2006; Menniti Ippolito 2008; Pattenden 2013; Pellegrini 1989; Reinhard 1975, 1979, 2009; Reinhardt 2000). The Church was no exception to this, even though clerical celibacy limited the formation of patrilinear dynasties within the clergy. Nepotism, in this context, should not be understood as a moral category from a modern perspective or as a failure of compliance but rather as a characteristic and inherent dynamic of the social structures of the time.

The matter is, however, somewhat more complex, as the possible abusive consequences of nepotism were indeed recognized at the time, and especially Protestant critics famously blamed the Roman Church accordingly.[16] The Council of Trent sought to establish regulations to address these issues, based on medieval reform ideas (Wiesner 2022). This was particularly relevant to the appointment of higher offices, which carried significant political weight. Positions were excessively taken by the pope's own family which has often been described as a nepotistic network in the literature.[17] On the level of individual parishes, however, family ties to Roman bureaucracy in connection to obtaining lower or middle church offices have hardly been systematically scrutinized in historical scholarship.[18] This is particularly important because, at least normatively, the frame of reference changed as a result of the Council of Trent (Wassilowsky 2016): Ecclesiastical offices should only be awarded to morally upright and competent individuals after careful examination, based exclusively on merit and virtue. (Wohlmuth 2002, Sessio XXIV, c. 18, 770–72). The thin line between nepotism as an accepted social norm and nepotism discerned as corruption was highly disputed and renegotiated (Menniti Ippolito 2008; Tabacchi 2013).

The increasingly regulated legal framework through Canon Law, Chancery rules, papal bulls and decrees (Boeselager 1999, 35–36) however were only half of the story.[19] In fact, thousands of petitioners triggered bureaucratic responses in the central bureaucracies and thereby demanded state actors to elaborate their ways to respond (Ludwig and Verreycken 2025). This resulted in slightly divergent interpretations of the regulations elaborated in Rome, reflecting the complexities of applying a centralized legal framework for applications from diverse political and cultural contexts across Europe (and beyond). Roman regulations on the granting of benefices and dispensations made it possible for local actors to supply clientelistic networks with Roman provisions.

How then does nepotism typically work in these local contexts? As we show, the transfer of a benefice within a family mostly occurs through resignation rather than upon the death of the current holder. In such cases, the incumbent negotiates with a successor before stepping down or immediately after his resignation (Boeselager 1999, 314).[20] This arrangement allows the previous holder, now without a benefice, to seek a new one, potentially increasing the number of benefices held within the family network. Alternatively, a benefice might be passed on in anticipation of the holder's imminent death to prevent it from reverting to the central Roman pool for reassignment or to other eligible parties.[21]

This context constitutes the enabling conditions of the meaningfulness of our respective method, as it statistically records familial relationships as a prerequisite for nepotistic office appointments. As nepotism unarguably informed the appointments of lower offices, it needs an efficient way to predict potential cases probabilistically—this is the core aim of our nepotism probability method.

Lead speed

The Curia's efforts to process requests for benefices within a limited period of time—for the various reasons mentioned above—faced considerable distances between Rome and the individual dioceses and parishes. We argue that what we measure as a 'lead speed', i.e., overcoming distance in a specific timeframe, can be understood as efficiency, especially when the results are compared on a large scale and relate to each other. Concentrating decision-making processes related to a single office, even though various actors are still involved in that process, can be seen as streamlining resources, which in a way makes efficiency the "ratio of administrative input to administrative output," as famously defined by Gorski (2003, 103) for the *Rise of the State in Early Modern Europe*.[22] Our respective lead speed method approximates a so-conceived efficiency of overcoming distance within a given time frame as a speed. This measurement is historically meaningful and significant as it represents a way to evaluate success in achieving a timely decision of a specific administrative process. A process is conceived as successful and efficient if both parties, Rome and the local petitioner, converged in their aim for a quick decision and contributed their part to make this happen, approximately reflected in a high lead speed.

Spatial distance is taken as a proxy for one crucial effort that determined the time needed to process a centralized bureaucratic decision that importantly relied on information transmission. Before the advent of near-instantaneous communication technology, which only became possible with the electromagnetic telegraph, geographic distance played a crucial role in determining the speed of information transmission. Premodern communication relied on physical and social means to overcome distance by way of messaging networks, postal services, infrastructures such as travel routes and waterways for long-distance travel (Midura 2025; Sander 2022).[23]

How, then, should one imagine the process in a case where, for example, a parish priest in the Rhineland passed away and a new appointment was determined in Rome? First, the petition had to be prepared and formalized locally, i.e., in the parish of the vacant position, and, if necessary, in consultation with the overseeing diocese or other stakeholders.[24] Communication with Rome did not necessarily require personal travel; single petitioners or local authorities could hire a proxy in Rome to present their case to the Apostolic Datary. The petition was then processed according to internal protocols and officially recorded with a timestamp in the register of expeditions.

This entire 'pipeline' represents a segmented and highly complex sequence of processes, for which, in the overwhelming majority of cases, only a relatively vague date of vacancy and a precise date of the decision are known. As we demonstrate statistically below, this time interval indeed correlates in the data with the geographic distance between Rome and the respective diocese. However, it must be emphasized that geographic distance was by no means the sole factor explaining the duration of these processes. Yet, reconstructing the social factors relevant to individual cases would only be possible on a case-by-case basis, which the available sources do not nearly allow. Even if such reconstructions were feasible on a large scale, these factors would likely not lend themselves to adequate quantification for statistical methods.

Decoding papal administration

The temporal, geographic, and social dimensions of appointing vacant positions were subject to bureaucratic documentation within the Apostolic Datary, which is still available in significant quantities in the Vatican Archives (Sander et al. 2025). Different administrative processes within the Apostolic Datary are documented in corresponding series in the archives. Of a total of 7,365 extant volumes, we focus on a series called *Expeditiones*. This series' volumes record the granting of above-mentioned provisions processed by the Datary (Pásztor 1970, 56).[25] Each has a total of five sub-registers, extending to different regions of the world. While a single volume was created for each pontificate year, only eight volumes of the seventeenth century survived, of which two volumes (1622–1623 and 1677–1678) were selected for full transcription.[26] The current sample used for this paper entails ca. 80% of these two volumes, comprising 25,706 entries, testifying to 21,115 apostolic provisions.

Extracting entities

The quantitative methods proposed in this paper necessarily rely on structured data to describe the significantly more complex phenomena captured in the bureaucratic documents, as is described in more detail elsewhere (Sander et al. 2025; Sander 2025). These sources are syntactical Latin sentences or short paragraphs detailing decisions and proposals subjected to supervised machine learning information extraction techniques and resulting in a knowledge graph for subsequent retrieval. In our data model (with some similarity to van Hage et al. 2011), a decision regarding the appointment to a position is represented as an 'event' that relates to the very position or benefice as its 'object'. These events and objects amongst others relate to 'persons', 'dates', 'locations', 'dioceses', and are further described with categorical 'types' as part of taxonomies. A brief explanation of these relevant entities in a typical entry from the source is best illustrated through an example, focusing solely on the relevant entities.

> [Per obitum$_{\text{ADDITIONAL INFORMATION}}$] [Rome apud Smm$_{\text{ADMINISTRATIVE LOCATION}}$] [v kal Octobri a ii$_{\text{PROVISION DATE}}$] [Barchinonen$_{\text{INSITUTION}}$] [Josephus de Farrera$_{\text{PROVIDEE}}$] super [beneficio$_{\text{ADDITIONAL INFORMATION}}$] sub Invocatione Sancti Francisci et Sanctae Clarae in [Ecclesia$_{\text{ADDITIONAL INFORMATION}}$] [Beatae Mariae de Mari$_{\text{REMOTE LOCATION}}$] nuncupat [Barchinonen$_{\text{REMOTE LOCATION}}$] per obitum q [Gabrielis Garau$_{\text{FORMER POSSESSOR}}$] extra [de augusti prox pret$_{\text{VACANCY DATE}}$] defuncti vacan fruct 24 d.[27]

- **Providee**: The name of the individual being appointed, here "Josephus de Farrera" and therefore Joseph de Farrera
- **Former Possessor**: The name of the individual previously holding the office, here "Gabrielis Garau", i.e., some Gabriel Garau.
- **Provision Date**: The date of the decision, here "v kal Octobri", i.e., the 27th of September; "a ii", here the second pontificate year of Gregory XV (crowned in February 1621) and thus the year 1622.
- **Vacancy Date**: The date of the vacancy, "de augusti prox pret", and thus in the past month of August, i.e., here between August 1 and August 31, 1622.
- **Administrative Location**:[28] The administrative location of the decision, typically the place of the Pope's residence in and around Rome, here "Romae apud SMM", i.e., Rome's Cathedral Santa Maria Maggiore.
- **Remote Location and Institution**: The diocese location, as well as precise location of the parish (or other type of church) and the church's name, here "Barchinonen" and thus the diocese of Barcelona; "Barchinonen" (second mention), the city in which the benefice is located, here Barcelona; "Sancta Mariae de Mari", here the name of the church 'Santa Maria del Mar'.
- **Additional Categorical Information**: The classification of the benefice or provision, here "Per obitum", i.e., the subregister of the source, here the subregister reserved for deceased office holders; "Ecclesia", a reference to the ecclesiastical building to which the benefice is affiliated, here an unspecified "church"; "beneficio", the office that the person provided receives, here an unspecified benefice, i.e., office in the named church. Specific technical terms are repeatedly used to describe certain characteristics of a provision or benefice in a consistent manner.

Locations

The identification and encoding of locations is comparatively straightforward. The administrative location is limited to a few places in the vicinity of Rome,[29] and for practical reasons, the distant location proxied by the seat of the diocese.[30] Dioceses were clearly defined entities for both the petitioners and scribes as well as for the Roman administrative system in general, allowing for clear identifications.

Persons

Person names are typically given in Latinized and inflected forms, posing challenges for the automated identification. Additionally, names may have been misspelled by the scribe, particularly in the case of foreign-sounding names. This issue is further compounded by the error-prone nature of transcriptions of proper names. From historical onomastics, however, we learn that relatively stable family names already existed in the seventeenth century.[31] Hereditary surnames and the subsequent separation of first names and surnames emerged as early as the twelfth century (L. Becker 2018, 18). Population's increased growth, density, and mobility as well as the expansion of statal administration and legal systems stabilized surnames until the sixteenth century (Nübling et al. 2015, 146–47). This provides a basis for deducing potential familial relationships based on personal names. Additionally, suffixes such as "Senior" or "Junior" are sometimes appended to names. Moreover, scribes occasionally explicitly note that individuals mentioned within the same or consecutive entries belong to the same family, further facilitating the identification of kinship connections.

Dates

Dates pose a particular challenge. The date of the provision is precisely recorded as an absolute date in the source, but its semantic encoding is not straightforward. It was customary in Roman Catholic administration to calculate dates based on the year of the pope's coronation—for example, 'in the first, second, etc., year of the pontificate'—and to define the month and day using the old Roman calendar, employing concepts such as the Ides. The dating of vacancies is even more challenging. Here, relative or deictic references are often used, such as 'last week', 'last year', or even 'today'. Encoding such expressions depends on complex reasoning systems performing calculations to generate absolute dates. Moreover, these references often pertain to time spans rather than specific points in time. These time spans are frequently intentionally vague and, as a result, must be manually encoded based on informed judgment to approximate the intended periods.

Methods

To analyze large-scale patterns in early modern ecclesiastical administration, we propose two complementary predictive models that approximate geo-temporal ('lead speed') and socio-relational ('nepotism') dimensions of governance. Rather than making causal claims, both models treat these dimensions as latent constructs inferred from observed regularities in the data. Leveraging a scarce but extensive dataset, the models generate graded predictions that allow us to trace structural tendencies in Papal bureaucracy and governance. We present both methods' calculation, premises, and challenges and evaluate results in light of the state of research ('domain expert in the loop'). Although a full-blown application of our models for the dataset is left to future dedicated publications, the discussion will provide some preliminary insights and future research avenues.

Nepotism probability

Nepotism involves granting favors or advantages to relatives. One crucial enabling condition for nepotism thus is the kinship of persons participating in a relevant transaction. We predict the likelihood of this enabling condition of nepotism. We call this target score hence pseudo-probability of nepotism, reflecting its derivative, potentially indicative, but non-causal and non-comprehensive nature. Nepotism does extend beyond family relationships, which is not accounted for here by definition as it would require a per-case investigation that does not scale for quantitative approaches. Moreover, family relations amongst transactional stakeholders themselves do not constitute nepotistic transactions by definition, but this is likewise almost undetectable ex post without investigating single cases. We predict the likeliness of conditions for nepotism only and exclusively to the extent that it can possibly be detected from the data at hand and at scale. While significantly cropping the phenomenon thereby, it is arguably the only option that allows for a computational scaling for the scarce information tangible through historical records.

This pseudo-probability of nepotism potentially influencing any provision is thus determined by kinship between two agents participating in one event in different roles, most importantly the former possessor of a benefice and its new providee or recipient. Provisions are represented as couples of two persons in these roles. Surname sharing is used as a proxy for familial kinship. However, surnames correlate with a range of structural factors (e.g., regional clustering, name frequency, social background) that may independently affect the dynamics of provisions. As a result, estimates based on surname similarity are subject to proxy-induced confounding and should be interpreted as correlational evidence rather than causal identification of nepotism.

The resulting score, expressed as a zero-to-one ratio, measures the degree to which the data supports the hypothesis of enabling nepotism as opposed to a null hypothesis of random association:

- Premise 1: Individuals sharing a family name and participating in the same provision with a limited time range and spatial scope are statistically more likely to be relatives than individuals with different family names 'other circumstances being similar'.[32] Put differently, surname sameness in this context is more likely to indicate kinship than that it is to indicate non-kinship with the same plausibility.
- Premise 2: Nepotism involves granting favors or advantages to relatives.
- Conclusion: Consequently, a provision involving individuals with the same family name is more indicative of nepotism than a provision involving individuals with different family names.

Calculation

$$Confidence \in \{0.5, 0.7, 1.0\}$$

$$Fuzzy\ Ratio(A,B) = \left(1 - \frac{Levenshtein\ Distance(A,B)}{\max(|A|,|B|)}\right)$$

$$Combined\ Score = Confidence \times Fuzzy\ Ratio$$

Event	Person 1 (Former Possessor)[33]	Person 2 (Providee)	Confidence[34]	Fuzzy Ratio[35]	Combined Score
986	Petrus[36] de *Rosis*	Acchilius etiam de *Rosis*	1.0	1.0	1.0
3595	Josephi *Espanol*	Hieronimo etiam *Estanyol*[37]	1.0	0.8	0.8
4186	Gisberti etiam *Perani* Senioris	Gisbertus *Peranus*	1.0	0.77	0.77
3204	Joannis de *Petria*	Joannes Laurentius *Petria*	0.5	1.0	0.5
1192	Salvatoris *Boni*	Antonius *Bonus*	0.5	0.67	0.35
2209	Rumbidi *Cardinali*	Antonius Maldonado de *Barrientos*	0.5	$0.42 < 0.6 \rightarrow 0$	0

The current sample includes 15,649 rows in this query result table of unique pairs of persons per event.

Family names and kinship

Kinship in our method is, in spite of all limitations, only based on persons' shared family name. This approach, however, has been successfully used in historical and sociological studies and results in plausible predictions in our data set, validated by spot test.[38] Computationally, transcribed full names are segmented into given and family name components in an unsupervised algorithm but also allows for the inclusion of supervised data. If segmentation is inferred from morphosyntactic patterns but unvalidated, it is assigned a lower confidence score of 0.5.[39] Family names segmented and validated manually raises the confidence to 0.7, reflecting the improved reliability of this information. These confidence factors do not express confidence about kinship directly as they relate to name segmentation only. However, as this is the method's basis to predict kinship itself if agents in one provision, we take them to indirectly qualify kinship as well, if and only if agents co-participate in the same event. Importantly, there are explicit kinship markers in the data, such as "senior," "junior," or "etiam," which directly indicate family relationships by the author or scribe of the respective record. Those assessments are therefore assigned a confidence of 1.0, as are validated relationships explicitly recorded as such. These markers make explicit that two persons are related by family, or that the scribe put emphasis on the identity of the family of both persons by noting that someone is "also" of the family of the other person.

The similarity of family names within a pair of individuals is calculated using a fuzzy matching algorithm based on the Levenshtein distance (Levenshtein 1966), yielding a ratio between 0.0 and 1.0.[40] Only pairs with a ratio above the threshold of 0.6 are considered indicative of kinship, as this threshold has proven effective in minimizing false positives while avoiding overly permissive interpretations. The multiplication of this thresholded Levenshtein score with the confidence factor leads to a robust combined score for kinship. In fact, a high confidence correlates ($r = 0.50$) with a short Levenshtein distance (i.e., a small ratio, before multiplication with the confidence). This indicates that confidences truly signal something also expressed in the fuzzy score, adding credibility to both factors of the resulting product.

We also see that more frequent surnames do not inflate kinship probabilities, as those do not correlate at all with higher kinship prediction ($r = -0.08$). Persons with frequent family names are thus not more likely to be predicted as family related to another person participating in the same provision. For two persons participating in one provision requires their spatial and temporal proximity and hence does not assume kinships on some generic level but in a case-by-case context.

This probabilistic measure offers as nuanced an approach as possible, by balancing confidence factors and similarity thresholds for analyzing nepotistic patterns in ecclesiastical provisions.

Validation

The plausibility of this method is evaluated by combining historical scholarship and semantic (Pearson) correlations within our data. Invoking additional categorical information on provisions and benefices reveals that resignations significantly correlate with events of a high pseudo-nepotism probability, while postmortem reappointments correlate significantly less with nepotism (Figure 1).

This correlation can be clearly explained through historical context and is directly supported by the research literature. In cases of resignations, that is, the deliberate relinquishment of office, Arturo Iglesias Ortega (2016, 261–66), has produced a confirming result, though based on a significantly smaller sample with more detailed examination of familial relationships: resignations, in particular, were especially prone to nepotistic allocation of offices within a family.[41] A relevant context here is that these resignations formally allowed the possibility of appointing a successor (*in favorem tertii*).[42] The resigning officeholder could therefore act out of a deliberate calculation, which often favored family members. This option was not available in the case of death, which is why the negative correlation with vacancies caused by death provides a strong confirmation of the explanatory power of the previous findings. While this finding does not truly extend our understanding of the historical phenomena by itself, it allows us to use the now credited method to explore previously unexplored territory, even if it may only detect a part of the enabling conditions of Church nepotism. While additional potentially nepotism-related correlations within our data cannot be explored here in greater detail, it is another take on the results that is most promising

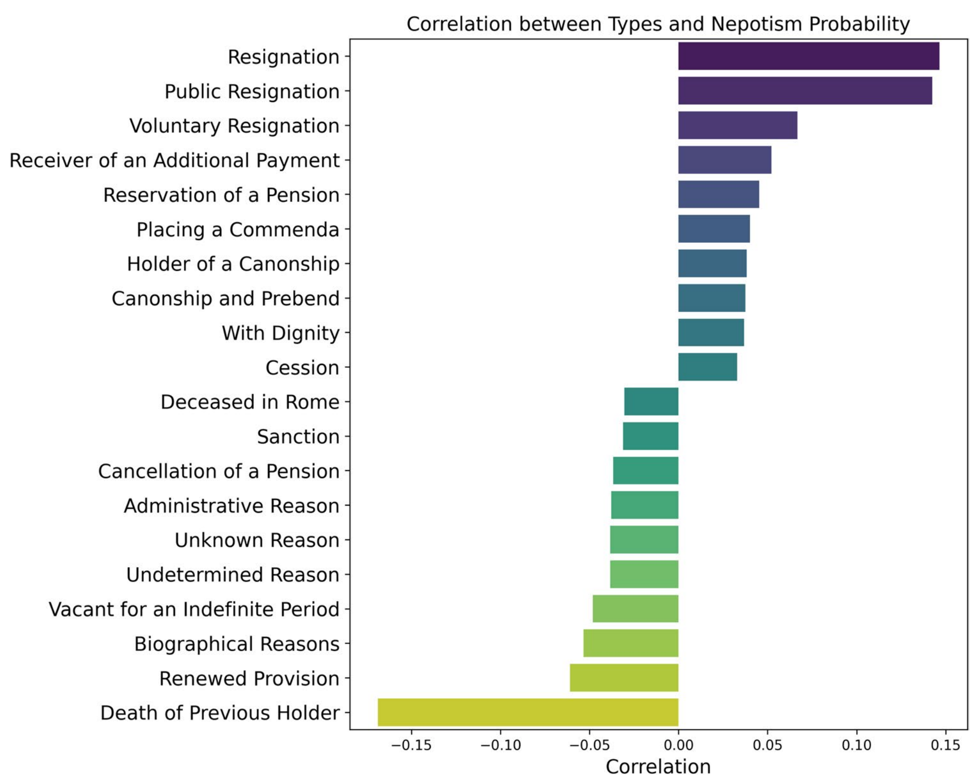

Figure 1. A plot to show r-values of a Pearson correlation between provisions' nepotism probability and relevant categorical information (one-hot encoded) of single provisions and related benefice. Correlations were truncated by top and bottom ten r-values. While much of the categorical information may require further explanation, the crucial categories are the two top and bottom ones, i.e., resignations and events of death as strongest and weakest correlations with nepotism probability. Note that the resignation category is further subdivided into public resignation and voluntary resignation, which are treated as child types of resignation in the analysis. Structuring categories in this parent–child hierarchy allows us to capture both the overall effect of resignations and the nuanced differences between specific types, improving interpretability and comparability across cases (Chart created with seaborn.barplot in Python).

for historians and testify to the presumed local dynamics at play: geographical clusters.

Aggregation

The geographical aggregation of pseudo-probability of nepotism in provisions relates to the individual holders of benefices, e.g., churches. However, these were under the jurisdiction of dioceses, perfectly apt for aggregation: they are ca. 600 known and clearly identified institutions, governing thousands of churches and smaller institutions. More than 400 of these are referenced in at least five provisions bearing a pseudo-nepotism score (including zero-valued ones) calculated with our method. Simply averaging the combined scores for all provisions within one diocese tentatively reflects the aggregated mean nepotism likeliness of any given diocese. Our preliminary data does already yield dioceses of high pseudo-probability of nepotism but dedicated studies need to delve into these findings as comparative case studies.

Lead speed

The lead speed metric measures how quickly administrative acts, such as the provisions of ecclesiastical offices, were completed in a transnational context. As such, the metric estimates ‘best practice’ or even ‘efficiency’ in a very formal way: how quickly leads are completed relative to the effort required to complete them, following Gorski’s seminal definition of the concept for early modern administration and governance (2003, 103). The duration of decision-making is quantified as the time delta between the date of vacancy of a position in the remote location of the office and the date of the provision in Rome. As a proxy for effort, we assume an ‘information distance’ to Rome, as the central node of decision-making for petitions addressing the Roman Datary. The metric is then calculated as effort divided by duration. This could be expressed as distance divided by time—yielding a physical speed or velocity, such as kilometers per day (km/d). As explained below, however, we use logarithmic scaling for distance as a proxy for effort. This more abstract unit for lead speed moderates the fact that geographical distance is only one causal determinant of transmission time in the premodern age, but it is entangled with multiple confounding structures of social, political, infrastructural, or institutional connectedness—which are all impossible to model due to the lack of respective data. Crucially, lead speed is independent of the actual number of provisions granted.

The metric is based on the following argument:

- Premise 1: In premodern administrative processes, ‘other circumstances being similar’, longer geodesic distances required greater effort than shorter distances because of the physical, logistical, social, political challenges involved.
- Premise 2: Administrative processes can be assessed by how quickly tasks are completed relative to the effort required to complete them.[43]
- Conclusion: Therefore, calculating the ratio of geodesic distance to actual duration (distance divided by time) effectively measures administrative practice as a speed.

Calculation

$$\Delta t = t_{vacancy} - t_{provision}$$

$$s = 2r\,arcsin\left(\sqrt{\sin^2\left(\frac{\phi_2-\phi_1}{2}\right)+\cos(\phi_1)\cos(\phi_2)\sin^2\left(\frac{\lambda_2-\lambda_1}{2}\right)}\right)$$

$$Lead\,Speed = v = \frac{ln(s)}{\Delta t}$$

Event	Vacancy date	Provision date	Time delta	Distance[44]	Lead speed
637	1622-08-14	1622-08-25	11 days	739.37 km	67.22 km/d $0.60\,\frac{ln(km)}{d}$
851	1622-02-14	1622-11-19	278 days	1486.33 km	5.35 km/d $0.32\,\frac{ln(km)}{d}$
1364	1622-07-16	1622-12-05	142 days	321.16 km	2.26 km/d $0.04\,\frac{ln(km)}{d}$:

The current sample includes 4,365 rows in this query result table of events with a (encoded) vacancy and provision date.

Duration

Explicit source information allows us to calculate the duration as a time delta t between the date of a cause of vacancy and the date of the issuance of the provision. The provision date is recorded as an absolute date, the vacancy date as relative to the provision date. Midpoint estimates are used for vague vacancy dates that span over a period of time, such as ‘some months ago’ or ‘recently’ etc. Moreover, long durations may sometimes be deliberate, reflecting factors far beyond what our data and sources allow to take into account. The time deltas should be conceived as segmented, where each segment is connected to its own duration, e.g., an interval Δt_1 encompasses the duration for the petition to be received in Rome, determined by postal services, travel circumstances etc. An interval Δt_2 followed within the Datary, making officials aware and prioritizing the petition or supplication. Δt in our data is a total of all Δt_i, in lack of information of each segment. We take this total nonetheless to be expressive as it is correlated with geodesic distance, as outlined in the following. Our results do not indicate a significant seasonality in Δt, i.e., vacancies occurring in winter months, e.g., do not significantly correlate with longer time deltas, and thus seasonal effects can be ignored for normalization.[45]

Distance

In order for relevant apostolic decisions to be made and authorized in Rome as provisions, it required information about an actual and dated vacancy to 'travel' to Rome from the place of the cause of the vacancy, e.g., the place of death of a former possessor in some parish in Spain. Overcoming this distance is seen as a necessary effort for receiving a provision. The exact channels of this information, i.e., the petition or supplication, to arrive in Rome vary and are not recorded in the available sources—they can only be known through case studies, which are out of scope for this large amount of data. While personal or political connections, geographical factors, and seasonal variations may certainly influence real-world information distance and efforts, for analytical purposes, geographical or geodesic distance (s) is used as a proxy—in lack of high-resolution data for all contingencies determining the actual efforts it took to communicate between Rome and remote places. Accordingly locations closer to Rome are assumed to cost less effort to communicate to Rome than more remote locations, 'other circumstances being similar'.[46] We use logarithmic scaling for distances to address extremely small or large distances. Effort did not scale linear with distance, as efforts would entail constants, e.g., a minimum effort even at zero distance or a maximum effort, even if antipodal to Rome.

As clearly seen in our data, geographical distances between Rome and any other place are the strongest predictor for time deltas of respective administrative acts,[47] plausibly hypothesizing that spatial distance mattered and was not fully absorbed by nonphysical factors such as political ties or social networks (which may in turn be correlated with, and partially confound, spatial distance). Taking (logarithmic) s as a proxy for the entire effort related to t makes it a baseline measure of infrastructural friction and logistical constraints. Deviations from this distance-based expectation can then be interpreted as indicators of socio-political proximity, institutional privilege, or network effects, which presumably led to a swifter or better established pipeline in the process within Roman offices, as argued in the literature.[48] In this sense, time is treated as a lower-bound proxy for administrative effort, while reduced time relative to distance suggests the presence of relational shortcuts within Roman bureaucratic structures: a high lead speed.[49]

Validation

Corroborated by linear correlation and non-linear model prediction,[50] a high lead speed is most likely for provisions following the death of a predecessor *apud sedem*, i.e., in spatial proximity to Rome and therefore under the Pope's jurisdiction (Figures 2 and 3).[51] In such cases, the pontiff is entitled to bestow the benefice that has become unoccupied in the diocese of origin of the deceased clergyman who died nearby or in Rome. These cases of *apud sedem* in fact benefit from geographic, maybe also social or institutional, proximity to the Apostolic Datary, potentially reducing efforts of various sorts to a minimum. This correlation is unbiased, as the spatial distance used to calculate the lead speed is not the distance between the actor's death place and the Datary but the distance between the benefice holding diocese and the Datary. Hence, it is the short duration for the provision to be granted that increases the lead speed so drastically to correlate with the *apud sedem* provisions.[52] This strongly underscores the metric's ability to capture variations in administrative streamlining. The lack of strong correlations to other qualities of provisions, in return, suggests that, e.g., the types of offices or other legal circumstances did not impact the lead speed.

Aggregation

Aggregation at the diocesan level for lead speed follows a similar logic to the nepotism metric, grouping all events associated with the same diocese. However, different methods of aggregation seem particularly relevant here: Diocesan lead speed can be computed as total distance divided by total time delta across all events associated with a diocese. Alternatively, the diocesan lead speed can be defined as the median event-level lead speed within a diocese. Depending on the method, diocesean

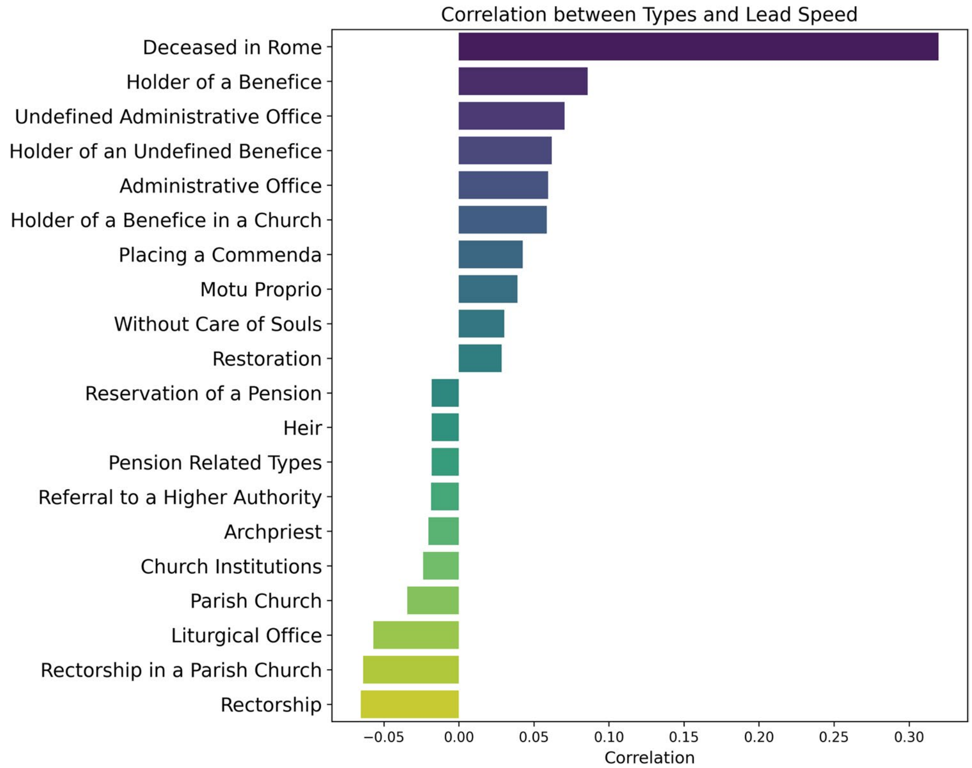

Figure 2. A plot to show r-values of a Pearson correlation between provisions' lead speed and relevant categorical information (one-hot encoded) of single provisions and related benefice. Correlations were truncated by top and bottom ten r-values. While much of the categorical information may require further explanation, the crucial category is the top one, i.e., events of death in Rome. (Chart created with seaborn.barplot in Python).

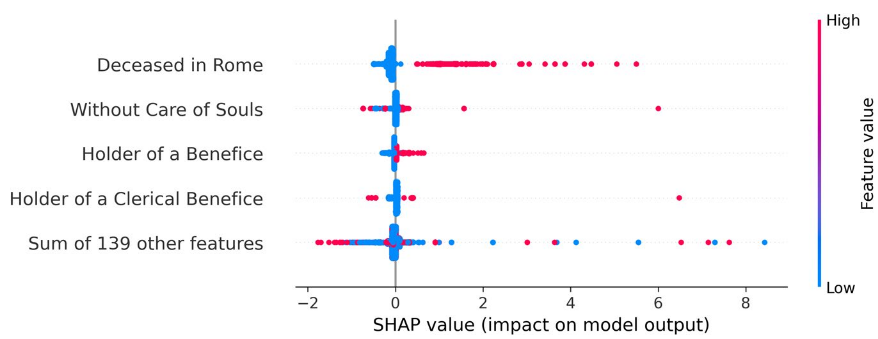

Figure 3. Beeswarm plot for an unsupervised machine learning model (CatBoostRegressor) predicting provisions' lead speed. The figure displays the impact of the most influential features on the model output, measured as SHAP values (Lundberg et al. 2020). Each point represents a single observation; its horizontal position indicates the magnitude and direction of the feature's contribution, while color encodes the feature value (low to high). Positive SHAP values correspond to an increase in predicted lead speed, negative values to a decrease. Features are ordered by overall importance (mean absolute SHAP value). Notably, events of death in Rome exert the strongest positive influence on the predicted lead speed, whereas other categorical and aggregated features show comparatively smaller and more dispersed effects.

aggregations differ, yielding different historical interpretations as will be discussed in the final section below. Importantly, there is no significant correlation between (logarithmic) distance and lead speed, neither on the level of single provisions nor for lead speed per diocese, regardless of the aggregation method. This shows that the dioceses' lead speed does not depend on its distance to Rome, effectively normalizing the rather strong correlation between distance and time deltas.[53] It may also suggest that lead speed, if taken as an indicator of administrative efficiency or linkedness to Rome, is much more complex than geographical distance itself—a finding easily backed by historical literature. Among the more than 200 dioceses with a threshold of at least five recorded provisions allowing to calculate their lead speed, experts may yet find other patterns beyond mere to-Rome distance.

Results and discussion

The proposed methods for the quantitative calculation of a lead speed and a pseudo-nepotism probability in apostolic provisions offer concrete practical benefits for explorative historical research, as well as broader methodological and conceptual insights. Our quantitative approach not only enhances the reproducibility of analytical historiographical results but also enables comparative studies that can be more directly contrasted due to a unified methodology. While the proposed methods require structured data, this data allows for rapid collection—for instance, linguistic interpretation of family names in inflected forms significantly accelerates data acquisition and curation. By calculating continuous variables and probabilities we incorporate data confidence and moderate binary/categorical effects of some (simplistic) digital approaches. Our numerical metrics tentatively capture the data's inherent vagueness and the historians' own epistemic modalities.[54]

The datafication of complex social phenomena is a much contested practice and epistemological challenge that sometimes can be coped by better data modeling or complementary qualitative approaches such as interviews (Fourcade and Healy 2024; Goertz and Mahoney 2012; Healy 2017; Mau 2018; Merry et al. 2015; Merry 2016; Porter 1995). As the latter are impossible for premodern sources, case studies need to validate and contextualize our quantitative indicators. As for the former, 'better data', various contingencies of transmission and availability of sources as well as the immense effort needed to get larger datasets are a bias and a bottle neck for quantitative research in premodern history. It is evident that computational history may not meet all the standards established by historians when studying sources in small numbers. To at least partly remedy this, computational methods should be more complex than mere counts along axes in the data. The combination of condition probabilities (nepotism) and relations (lead speed) with linear correlations and averaged aggregations is merely the beginning. However, it employs linear deterministic models and explainable algorithms, which deep learning and AI all too easily neglect or leave to computer specialists (El-Hajj et al. 2023; Sander 2025).

On a conceptual level, our quantitative approach to historical phenomena applies common physics concepts. Arguably, notions such as 'network', 'centrality', 'homogeneity', 'velocity', or 'density' are often employed metaphorically in predominantly qualitative historical research. In our approach, they remain metaphors on an ontological level, but also gain renewed rigor and relevance in our computational analysis. The use of physical models and concepts to interpret or predict social and semantic dynamics has sparked methodological debates since its early positivist proponents and remains a point of contention in contemporary scholarship—discussions too elusive and complex for the present paper (Arnopoulos 2005; Abbott 2004; Ball 2006; Pentland 2014). To be sure, the physics concepts and proposed calculations in this essay are not intended to express natural laws or to imply ontological equivalence between the physical and societal domains. Instead, they are employed as the metaphors or analogies they are, but straightforwardly translated into mathematical formulas: Our lead speed is, ontologically speaking, not a physical speed, i.e., moving a material object through space and time, but nonetheless is calculated with a physical formula 'as if it was' a physical speed. This approach, both conceptually and methodologically, provides a valuable heuristic for exploring the semantic or pseudo-physical implications of the chosen analogies or metaphors. While the epistemic gains of such metaphorical mappings are often latent, making them explicit in and as quantitative methods allows for a rigorous evaluation of the model's coherence in relation to the historical insights it yields.

From initial data exploration to historical research questions

A comprehensive application of our two methods to any larger dataset will provide crucial insights into the functioning of (early modern papal) administration. In particular, the aggregation of relevant metrics for individual bodies, such as dioceses, enable a bird's-eye view on the structure and mechanisms governing administrative processes.

An interactive web-based map tool (Figure 4) for visualizing the topology of lead speed can already provide some of these insights.[55] The map displays all dioceses with a calculated lead speed as circles on a world map, with the circle radius proportional to the number of provisions considered for each diocese.[56] The color of each circle indicates the unsupervised, mathematical assignment of dioceses' lead speed to so-called Natural Breaks clusters for quick and visually less complex comparison: Green circle dioceses exhibit faster lead speeds, red circles slower lead speeds. The simple GIS tool offers to explore and interpret the otherwise merely numerical tabular data.

What insights might such an interactive map provide? A preliminary analysis of the expedition

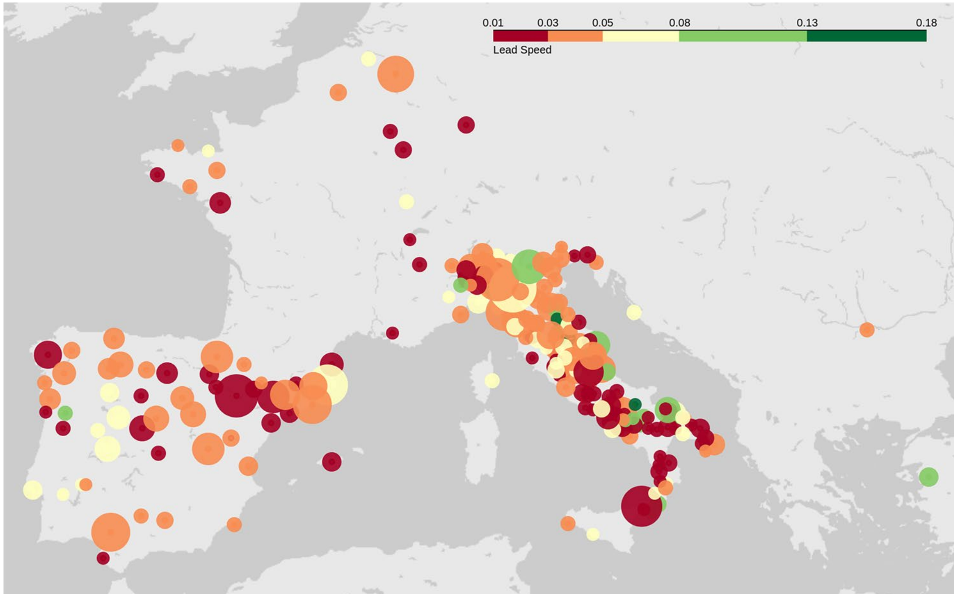

Figure 4. A screenshot of an interactive map to explore dioceses' mean lead speed. Each diocese's mean lead speed is based on the median time delta of all its related events and its logarithmic distance to Rome. Dioceses are clustered into five groups (NaturalBreaks) given their mean lead speed aggregate, represented as color coded dots, using a color map (RdYlGn) from red (slow) to green (fast). The size of the dots represents the total number of events accounted for. We easily see that clusters do not form based on the dioceses' distances to Rome. Investigations into single dioceses or clusters call for individual explorations and case studies. (Map created with folium.Map and geoPandas.explore in Python).

registers with its more than 4,000 provisions shows Italian ecclesiastical provinces of the Papal States dominating median lead speed, including Fermo, Urbino, and Ravenna. This supports Prodi's (1982) thesis of Roman centralism and administrative integration, while also revealing stratification within the Papal States. These provinces' high petition numbers combined with their high median lead speed suggest political proximity to Rome, strong curial networks, and efficient infrastructure.

This admittedly fairly simplified birds-eye view then can lead to more concrete research questions concerning regional integration and proximity to Roman bureaucracy, illustrated by the following example. From a geographic perspective, the two cities of Bologna and Ferrara lie in close proximity and were both incorporated into the Papal States during its intensified expansionist policies in the sixteenth century. Despite notable differences in their political relationship with Rome, their lead-speed values are remarkably similar. This finding is somewhat unexpected in light of the existing historiography. Studies by Reinhardt (2000) and DeSilva et al. (2013) have emphasized Bologna's comparatively reluctant acceptance of papal rule and the persistence of a strong regional identity (De Benedictis 1995). Moreover, papal clients often struggled to secure influence within the city's senatorial politics (Reinhardt 2000, 362–63). Ferrara, by contrast, is generally portrayed as more accommodating toward papal authority after its incorporation into the Papal States. Administrative reforms facilitated the integration of its urban elite, while the maintenance of a resident ambassador of the Curia granted Ferrara a privileged constitutional position comparable to that of Bologna (Emich 2005, 162–63). The similarity in lead speed therefore suggests that differing levels of political accommodation to papal rule did not necessarily translate into different patterns of ecclesiastical career advancement. Instead, shared access to Roman institutions and patronage networks may in some cases have outweighed local political differences, pointing to the importance of investigating more direct mechanisms linking diocesan elites to the Roman Curia.

For algorithmic criticism, a comparison between the dioceses of Bologna and Ferrara serves as a good example to illustrate the extent to which interpretations of aggregated lead speed depend on the chosen method. When calculated on the basis of median lead speed values of all respective events per diocese, Bologna appears substantially faster than Ferrara, suggesting marked differences in the typical pace at which provisions were processed and granted. Such a result would seem to support interpretations that emphasize the distinct political and institutional development of the two cities within the Papal States (De Benedictis 1995; Emich 2005, 162–63; Reinhardt 2000, 362–63). The median is particularly useful for remaining relatively robust against outliers, i.e., exceptionally fast or slow single provisions, making the aggregation well suited for reconstructing the ordinary experience of ecclesiastical administration.

A different picture emerges, however, when lead speed is aggregated as the ratio of total effort (i.e., distance) to total processing time of all respective provisions per diocese. In this case, Bologna and Ferrara appear considerably more similar. This convergence would suggest that, despite differences in the speed of a typical provision, both dioceses may have possessed communication and patronage networks that were comparably effective in maintaining access to Roman decision-making structures. This aggregation captures the overall performance of the system and incorporates the full distribution of observations. As a result, exceptionally efficient connections to Rome contribute directly to the final value and may compensate for a larger number of slower transactions.

The divergence between both methods highlights an important methodological point. Neither metric is inherently superior, rather they capture different dimensions of administrative performance. Median lead speed privileges regularity and predictability. It is therefore particularly sensitive to the question of how rapidly an average petitioner could expect a vacancy to be resolved. Aggregate lead speed, by contrast, places greater emphasis on the overall capacity of a diocesan network to process information, mobilize intermediaries, and secure provisions from the Curia. In this sense, it measures the overall performance rather than the 'typical' case.

Against this backdrop, and regardless of the aggregation method used, the lead speed generates a series of questions that prompt us to reflect about the role that granting of benefices played between local and curial politics: How was the granting of benefices regulated at the local level? How extensive was Roman influence, and how was it legally defined? Who—particularly within the urban nobility—held patronage rights, and of what kind? Did certain families use papal provisions to gain an advantage over their competitors, or, in other words, how were the groups of petitioners supplicating to Rome composed?[57] To integrate lead speed meaningfully into historical research, the metric must be embedded within broader historiographical frameworks. It draws attention to patterns and anomalies that then require closer examination through both Roman and local source material. As additional data from Roman and local archives are incorporated, the dataset becomes increasingly robust. In this way, the lead speed can develop into a methodological tool that does not replace historical interpretation but helps to substantiate or revise it.

Perspectives

Taking a conceptual perspective, our metrics invite us to engage with established historiographical notions and narratives. For nepotism, the probability associated with single provision events can aptly be interpreted in network-theoretical terms as the edge weight of the actors involved in the events.[58] Applying a genuinely network-theoretical, actor-centered analysis of nepotism using our method would yield particularly valuable insights over an extended diachronic timespan (cf. Gramsch-Stehfest 2020; Gubler 2024). This approach not only facilitates the calculation of metrics for individual events or aggregated averages but also enables the evaluation of the influence of specific families within the network, inferred from the family names of the actors involved. Over time, shifts in the weights of particular ties could reveal local policymaking strategies, power dynamics, or the influence of key players—such as the rise or decline of local dynasties and their interactions with Roman administration.

The socio-political concept of *Herrschaftsverdichtung* (intensification of governance), which has been used almost exclusively for monarchical territories to date (Ludwig and Verreycken 2025), invites a technical and physical interpretation building on our lead speed metric.[59] Despite notable initial quantification efforts, this notion has little mathematical rigor to it in the literature: If *Herrschaftsdichte* can be tentatively understood as a ruler's presence, influence, jurisdiction, or activity in the governed domain, *Herrschaftsverdichtung* refers to the process of intensifying this presence (Friedrich 2011, 97).

By accounting for the absolute number of apostolic provisions in a territory over a specific period and applying our lead speed metric consistently, we can effectively quantify the papacy's *Herrschaftsverdichtung* as an intensification of its influence in interest spheres, testified by the interplay of the willingness of local actors to address Rome in huge numbers as a center of decision-making and vice versa Rome's eagerness to play a central role in local contexts (esp. relevant for dioceses outside the Papal States).[60]

Although the number of provisions depends on local dynamics, a higher lead speed implies the potential for a greater number of provisions within a given timeframe. This may indicate an intensification of communication, which in turn suggests the emergence of mutually defined spheres of interest. The average lead speed of a diocese thus indirectly reflects, particularly in comparison with other dioceses, how closely it was connected to Roman bureaucratic processes. Combining the number of provisions and the lead speed indicate the degree of attractiveness mutually attributed to one another by the petitioners and by Rome. Crucially, lead speed is independent of the actual number of provisions granted; rather, it measures the potential frequency of provisions within a given period.

Notes

1. "Rex enim dicitur esse in toto regno suo per suam potentiam, licet non sit ubique praesens".
2. The Middle Ages and the early modern period already encompassed vast bureaucratic systems (Raadschelders 2017). For the pre-modern era, comprehensive qualitative studies exist on the bureaucracy of past and still existing empires and its institutions (Brakensiek et al. 2014; Blockmans 1995; Emich 2001, 2010; Hochedlinger and Winkelbauer 2010; Haug et al. 2016; Hochedlinger 2019; Reinhard 2009; Stollberg-Rilinger 2013; Thiessen 2010; Weber 2023; Zwierlein 2020).
3. Impulses for quantitative historical research on governance emerged in the mid-1990s at the Max Planck Institute for Legal History with the project Repertorium der Policeyordnungen (1995). For the late Middle Ages, Tewes (2001), who uses his data only for a numeric comparison. Boute (2010) tried to bring the local and Roman point of view together by counting and comparing types of benefices and frequencies of local and papal provisions. Quantitative studies of nepotism in the 16th century are provided by Iglesias Ortega (2016, 2014). Eisenhauer (2015) describes the advantage of using quantitative methods to calculate the wealth of monasteries on the basis of certificates. Reinhard (1974b) takes an equally quantitative approach with regard to the listing of costs, revenues and invoices at the time of Paul V. (1605-1621). Hersche (1984) classified with computational methods appointments to German cathedral churches in the 17th and 18th century. Frenz (1986) found that 69% of supplications were completed within three months.
4. With the Council of Trent (1545-1563) we see an intensified Roman attempt of centralization, which is reflected in the establishment of many so-called congregations in Rome soon after the Council. The cardinals present in Rome were appointed to such a congregation, which was entrusted with different tasks in the administrative apparatus (Emich 2001, 20–23; Fosi 2020; Pizzorusso 2020). One of these administrative offices was the Apostolic Datary. As Emich (2023) has highlighted, in order to remain attractive as a centre, the interests of those who address a centre as such must be taken into account by the centre. This opens up an unprecedented field of opportunities for historical actors to exert influence, synchronising their own local interests with those of Rome and thus helping to shape the Roman centre through their requests.
5. It should be noted once again that Rome was only one of several possible ecclesiastical administrations that could grant benefices. Thus, the Roman registers show only a portion of the total benefices granted, and it remains essential for future individual studies to consult local registers, which recorded other benefices in varying degrees of completeness.
6. The global scope of the Papacy is not to be mistaken with the much more limited extent of Papal States (broadly middle Italy and parts of the Adriatic coast) where the Pope was also the political sovereign. Beyond these borders, the Pope could exert only limited influence, most importantly in ecclesiastical matters such as provisions. Emich (2005) examined the connection of the Papal States to neighbouring territories and, in the case of Ferrara, integration into it.
7. Benefices include both the office (*officium*) and thus the right to carry out an office in church institutions and to receive the salary (*beneficium*) (Boeselager 1999, 31–32; R. Becker 2006, 177; Wiesner 2022, 65). Church institutions can take many forms: Parish churches, collegiate churches, cathedral churches, etc.
8. The concept of grace is theologically theorized through the *thesaurus ecclesiae* (treasury of the Church), an infinite resource generated by the sacrifice of Jesus Christ on the cross. Papal acts of grace include provisions of benefices, dispensations, legal absolutions, indulgences, indults, licenses for transactions involving church property, provisions, and faculties. Besides Storti (1969) and Fabbricatore (2006), work about the organization of the Datary is almost lacking. Although there is ample literature on the other major institution of grace, the Apostolic Penitentiary, e.g. Salonen (2001), there is still no work that examines the relationship between the Penitentiary and the Datary.
9. This goes back to 1 Corinthians 9:13 "qui altari deserviunt, cum altari participantur?".
10. For the role of the congregations see footnote #4.
11. Roman centrality was not the result of a teleological evolvement towards global Roman power. The Pope faced competition against his claims of global centrality by various actors, e.g. other patriarchs, bishops, kings or lay princes. At the end of the Middle Ages so called national concordats (e.g. Concordat of Vienna in 1448; Concordat of Bologna in 1516) tried to find balance between the Roman and the monarchic interests, regulating local clerical recruitment dominated by abbots, bishops, and chapters.
12. If the bishop or another local ecclesiastical patron had the right to fill the vacant benefice, he had six months to do so, otherwise he lost the right to the Pope. In the case of secular patrons, a four-month rule applied. If a benefice became vacant during a papal month, the petitioner had to assert his right locally within three months of the vacancy with the papal provision, otherwise the Curia lost the right to grant the benefice to a local collator. See a guideline for these rules from the hand of an unknown employee of the Datary in the Vatican Library

(Anonymus 17. century, fol. 22v). See for the three months rule the Vienna Concordat of 1448: "However, whenever a benefice becomes vacant in the months of January, March, May, July, September, and November—months that are specially reserved to the disposition of the Apostolic See—and it does not become apparent within three months from the day the vacancy is made known at the place of the benefice that someone has been provided to it by apostolic authority, then and not before, the ordinary or another person to whom the disposition of that benefice pertains may freely dispose of it." (Weinrich 1983, 505).

13. The following passage shows that "taking action in a certain timeframe" was an important factor in the granting of benefices in the minds of contemporaries: Here, the rector of the *Collegium Germanicum et Hungaricum* in Rome, Bernardino Castorio, writes to the newly elected Paul V in 1605 that it is important for the Pope to give preference to the alumni of the college in the Datary when granting vacant benefices in the papal months, in order to avoid the time allotted to the Pope passing and thus giving local actors with granting rights the opportunity to appoint heretics (i.e., Protestants) (Castorio 1605, fol. 5v): "But because notices of vacancies arrive very late, and sometimes the first letters are lost, and because, moreover, the ordinary examination very often causes such delays in the expeditions that the grace of the benefices obtained is lost for not being notified in time; and it often happens as a result that some heretic is introduced.".
14. For example, consider the criticism of Rome that was prevalent in Germany around 1500, which Protestants later endorsed: that papal candidates, i.e. persons with papal provisions, were bleeding local churches dry through their greed (G. R. Tewes 2005, 232–33).
15. E.g. the so-called *Expeditiones* volumes, that form the basis of this paper's sample, are structured in multiple sub-registers: *Per obitum*, *Extraordinarius Sanctissime* as well as *Ordinarius* are dedicated to the European dioceses in Italy, the Iberian Peninsula, the Holy Roman Empire, isolated dioceses in Eastern Europe, Ireland and on the Balkan Peninsula. The French entries can be found in the separate sub-registers *Extraordinarius Galliarum* and *Ordinarius Galliarum*. A brief summary of these archival documents is given by Pásztor (1970, 56). In the current data sample we use for our two proposed methods, these French sub-registers are less represented. With regard to the nepotism indicator, they are underrepresented because not all French provisions have been transcribed yet—this is currently in progress and can soon be included. With regard to lead speed, they are underrepresented despite the thousands of provisions that went to French clerics because they lack the vacancy dates required to calculate the time delta. The missing vacancy dates in Roman registers can therefore only be supplemented by local sources and requires further research.
16. Martin Luther (1983, 92) harshly criticized the conditions regarding nepotism and (in his view) simony of the Roman Curia, especially of the Apostolic Datary, in his famous essay of 1520 *To the Christian Nobility of the German Nation*: "Finally, the Pope has established a kind of marketplace of his own for all these dealings. This is the house of the Datary in Rome. All those who wish to engage in such transactions concerning fiefs and benefices must go there. From the Datary one must purchase these declarations and transactions and obtain the authority to carry out these principal knaveries." Reinhard (1975, 177) also points out that Luther depicted the Cardinal Nephews as "Bastards of the respective popes".
17. The pre-modern term *familia* does not mean exclusively blood-related family but also includes social family. This is the foundation of patronage as the fundamental social structure. Emich (2001, 2020) shows that the system of the Cardinal Nephew was introduced in the late 16th century to separate at least symbolically the newly elected pope from his previous clientele. The pope would appoint a close relative, usually a nephew, as cardinal and transfer key political responsibilities and clients to him. Reinhard's works since the 1970s (1974a, 1975, 1979) are considered foundational for research on papal nepotism.
18. While important research (Aschoff 1992; DeSilva 2013; Iglesias Ortega 2014, 2016) has been produced on individual chapters or parishes, it has largely focused on local source material. It should not be overlooked that there is repeated evidence of how Roman provisions could support local interests, as DeSilva (2013, 178) shows for Bologna: "The concentration of men from these families in the four chief cathedral offices through the fifteenth and sixteenth centuries shows that both the pope and the Bolognese patriciate used these dignities as a way to raise social status, build support for papal governance, and establish bridges with local secular institutions like the Senate and the university." However, these cases were not systematically investigated further using Roman source material elaborating family ties to Roman bureaucracy and institutions with rights to grant benefices.
19. Especially the *Liber Sextus* and *Liber Extra* contain clear instructions on the awarding of benefices, such as the order of precedence of the candidature and the determination of the papal provision as the highest-ranking provision.
20. The direct link between the local actor, the act of resignation and the pope (or in his name, the Datary), is found in the supplication itself: often the *resignatio ad favorem tertii* (resignation in favor of a third party) was *in manibus Sanctitati Vestre resignet* (resigned in the hands of your Holiness).
21. Also Boeselager (1999, 314) sees a correlation between nepotism and the act of resignation, but did not elaborate further on this argument. How so-called *Patronatsbistümer* (patron diocese) and other benefices under lay patronage were used to keep a benefice in the family and the family in the benefices is described by Boute (2010, 71).
22. Gorski's full definition is: "[L]et us define [efficiency] as the ratio of administrative input to administrative

output, and let us further define input in terms of material and/or human resources and output in terms of coercion, extraction, and/or regulation." A quantitative ratio, however, is mostly lacking in the analysis.

23. As Friedrich (2011, 83) highlighted, postal services developed from the late Middle Ages onwards, which became established in the 16th century. The Christian periphery and thus the dioceses were now systematically and regularly connected with their centre, Rome. As regular courier services emerged, main transport routes developed at the same time, connecting the most important centres and covering almost the entire continent. According to Poncet (2011, 298) and Camprubí Pla (2014, 866) the duration of the journey had to take into account the time of year and therefore the climate, as well as wars and diseases.
24. As Emich (2015, 328) showed, new professions and manuals emerged to streamline and professionalize the preparation of supplications.
25. The Latin verb *expedire* means 'to expedite' or 'to issue', i.e. the formal act of granting. As Emich (2015, 326) showed, there are different ways to expedite. Whether records were written during the awarding of the office or at a later stage has yet to be understood.
26. At least 48 expedition registers were lost when the Vatican Archives were transported to Paris by Napoleon's troops in 1810, as Pásztor (1970, 56, note 1).
27. Archivio Apostolico Vaticano, Dataria Ap. Expedit. 2. (1622, fol. without).
28. The curia's changing location—likely due to papal travel, diseases, or unrest—explains why the place of issuance could vary.
29. The Datary used the location of the Pope when processing (and dating) the supplication e.g. Saint Peter's or Saint Mary Major. When the Pope was outside Rome, it was often used just the name of the locality such as Tusculum, according to Boeselager (1999, 153, fn 735).
30. We use the seat's location only, since determining the specific location of a church or parish would be an excessively labor-intensive task.
31. Nübling, Fahlbusch, and Heuser (2015, 146) focus on German-speaking territories but suggest a wider extent as well. For names and name development on the Iberian Peninsula, see L. Becker (2018, 18–22). A general overview of surnames is provided by Kohlheim (1996).
32. The phrase 'other circumstances being similar' introduces the requirement of a sufficient homogeneity of the phenomenon in question. We take this condition to be met for the premise in question, at least for the statistically relevant majority.
33. Pairs of different persons per same event, events with more than two persons will be separate data rows. Persons must act in different roles per event. In our dataset these two persons mostly relate to the roles of the former possessor and the future possessor or providee of the office The token(s) in italics are the automatically extracted family names.
34. A value of either 1.0, 0.7, or 0.5, as outlined below.
35. Fuzzy Ratio is calculated as fuzzywuzzy.fuzz.ratio/100. It is thresholded at 0.6.
36. From the 11th century onwards, a decline in the variety of first names can be observed. The reasons for this were the emergence of 'fashionable names' and the increase in Christian names. As L. Becker (2018, 18) highlighted, naming was further restricted after the Council of Trent (1545-1563): from this point onwards, names were primarily taken from the calendar of saints. However, other names did not disappear entirely .
37. What might appear as a typo (Espanol/Estanyol) could also/in addition relate to different spellings in Catalan and Castilian. The former tends to replace a "y" by a "ñ" and the "t" by a "p".
38. Iglesias Ortega (2016) used the same methodological approach—surnames as a proxy for kinship—to examine nepotism and patronage in the 16th-century Cathedral chapter of Santiago de Compostela. Renata Ago (1990, 32) has used the comparison of family names to detect kinship of candidates for the curial *referendariato* around 1700. There are two contemporary studies (Allesina 2011; Grilli and Allesina 2017) that use family names as a marker for nepotism. As middle names are often omitted as part of the surname in official documents, we have decided not to include them.
39. We neglect certain stop words, such as particles, titles, suffixes.
40. The Levenshtein distance is applied because kinship relations are, with very few exceptions, not explicitly documented as validated facts in the current dataset.
41. Iglesias Ortega (2016, 261–66) examines 492 capitulars between 1508 and 1582, focusing on family ties based on names and genealogies. He finds that 88.72% of those who passed on offices within their family did so through papal provisions, mostly between brothers, uncles and nephews, sometimes from father to son or grandfather to grandson. Such transfers often occurred via resignations, coadjutories, or office exchanges.
42. In the words of Boeselager (1999, 314): "Resignation at the Curia was almost always chosen when the subsequent owner had already been determined and wanted to secure succession. Thus, in most cases, this involved the controversial *resignatio in favorem tertii*.".
43. See also note #22.
44. Our data encodes coordinates of the two relevant places. Distances in kilometers are calculated via geopy.distance.geodesic.kilometers.
45. Such expectations could be based on the assumption of difficult travel conditions in the winter months, leading to longer time deltas due to longer travel times or postponement of travel in the spring. We see a slight correlation between the May to November vacancy date months with shorter time deltas, but the r-values are between -0.010 and -0.090, providing little evidence of actual causality. When the time deltas are normalized against seasonal effects, our

analysis yields virtually identical results for lead speed. Hirschmann (2001) examined the seasonality of the dispatch of chancery documents and found no strict pattern. He notes that most petitioners traveled in fall and winter to avoid Rome's summer heat and disease, with good roads and passes allowing winter access. Summer relocations of the Curia outside Rome may also have caused delays.

46. Locations related to the vacancy are recorded by the sources but not easy to identify, as those often were little villages, singles churches, that even ceased to exist nowadays, and therefore require too much effort on identification. Instead, distances are calculated between Rome and the primary place of the diocese that governed the individual institution related to the vacancy.
47. *s* shows a linear correlation with t up to $r = 0.34$, depending on the threshold of *s*. If exceedingly large time deltas are removed, correlations are much stronger, expectedly.
48. The efficiency of processing supplications depended on both the petitioners and the Roman administration. Von Boeselager (1999, 95) notes that internal interventions in the supplication registry office, were used to speed up procedures. Petitioners often hired procurators familiar with chancery rules, while scribes took these rules back to local dioceses to avoid early rejection and spread knowledge to ensure smoother processing (Boeselager 1999, 52, 94, 102, 130, 131). Reinhard (2009, 37) emphasizes that the Pope and the Datar discussed appointments in weekly meetings and could set priorities for granting benefices. Petitioners, if their networks allowed, could also enlist other high-ranking clerics, such as Cardinals, to put in a favorable word with the bureaucrats.
49. Also historical actors thought accounted for geographic distance in relation to frequency or effort, Friedrich (2011, 95–96) confirms: "The rhythms of writing [in Jesuit correspondence] were defined in accordance with postal transit times and geographical distance. A pragmatic assessment of infrastructural conditions led to a stratification of the sphere of rule into zones of varying degrees of connectedness to Rome.".
50. In contrast to the Pearson correlation (Figure 2), which captures only linear bivariate associations between individual categories and lead speed, the SHAP analysis reflects the full multivariate, non-linear model structure learned by CatBoost. Thus, a feature may exert a strong local impact on predictions even if its global linear correlation with lead speed is weak.
51. As Denzel (2018, 139) showed, with the constitution *Praesenti* from early 1298, Boniface VIII. expanded the Pope's provision rights through a new definition of the term *vacans per obitum apud sedem apostolicam* to include locations within two statutory days' travel (*dieta legalis*) from the Curia, roughly corresponding to the extent of the Diocese of Rome.
52. At this point, however, it must be added that this only applies if the petitioner for the office is already in Rome. Otherwise, this discovery would rather suggest rapid communication to the periphery, since the news of the death first had to reach the local diocese, where the supplication was written and sent back to Rome.
53. This correlation changes if distances were not scaled logarithmically. On the other hand, diocesean lead speed has a slight negative correlation with logarithmic distance which may indicate that logarithmic scaling does indeed make remote dioceses appear a bit slower. This effect only shows in the aggregation and not for single provisions.
54. E.g., the encoding of calendar dates in lead speed analysis allows for uncertainty by using time ranges, the nepotism probability uses fuzzy character distance and a confidence variable. Both metrics are rational numbers.
55. The code to create the map is part of the enclosed Jupyter Notebook. For a demo, see for now at https://raw.githack.com/ch-sander/g17-article1/main/renders/lead_speed.html [accessed 05.03.2025]. Insights delivered below are backed up by both this map and its underlying data table in the respective repository.
56. On why France is highly underrepresented, see footnote 15.
57. As e.g. DeSilva (2013, 177) has shown for the archdeacons in Bologna in the 15th and 16th centuries, papal appointments reveal not only the pope's attitude toward certain Bolognese families, but also the clientage ties to promote the goals of individual families. Bologna, after all, produced a notably high number of cardinal families, and Pope Gregory XV (1621–1623) originated from the old Bolognese noble family of the Ludovisi. We are therefore dealing with social groups that were closely connected to Roman administration or, at the very least, highly familiar with its practices.
58. Reinhard (1979) already conceived of these social relations (*Verflechtung*) in terms of mathematical network analysis but had not yet employed this method himself.
59. The term "Herrschaftsverdichtung" attempts to synthesize various theories on early modern state building. It brings together constitutional, administrative, and institutional historical approaches, addressing questions of state centralization through taxation policies, bureaucracy, and the military, as well as issues of deviance and resistance among the population. Additionally, it explores how governmental structures were utilized by the population and, in doing so, were also shaped by them. Hochedlinger (2010) and Ludwig and Verreycken (2025) give a concise summary of the research landscape, the latter emphasizing the role of acts of grace in consolidating monarchical power.
60. See Tewes (2001, 355–60) conclusion on the Pope's administrative interest spheres in the late Middle Ages: they match largely the territories, from where the most supplications came from.

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Data availability statement

The data that support the findings of this study are openly available in a Zenodo repository at http://doi.org/10.5281/zenodo.15111775. The analytical code is available https://doi.org/10.5281/zenodo.15267530.

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