

Tracing the Confucian Legacy: Mechanisms Shaping the Geographical Educational Achievement Gap in Vietnam

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Abstract

This study examines how historical state formation influences contemporary educational inequality in Vietnam. Using time since annexation as a continuous treatment variable, I decompose effects on provincial achievement (measured by the density of students scoring at or above the national 90th percentile in Mathematics, Literature, and Foreign Language) into two pathways: Confucian elite density and Confucian institutional infrastructure from feudal eras. Provinces incorporated earlier into the state exhibit higher present day achievement on national high school examinations. The institutional infrastructure pathway captures formal Confucian educational institutions established during the Nguyen dynasty, Vietnam’s last feudal dynasty, including provincial examination halls, Confucian temples, and district schools that administered the imperial civil service examination system. Mediation analysis reveals that the institutional infrastructure pathway is the dominant and most robust mechanism, accounting for most or all of the total effect for mathematics and literature, whereas the elite density pathway is substantially weaker and less consistent across subjects. These findings demonstrate how historical institutional exposure persists primarily through tangible, geographically fixed educational infrastructure rather than through elite networks alone, perpetuating regional disparities in educational attainment.¹

1 Introduction

In 2012, Vietnam, then still a lower income country, surprised international observers by ranking 8th in science, 17th in mathematics, and 19th in reading among 63 PISA participants ([BBC News, 2015](#)). Although a growing body of research examines Vietnamese schools, household resources, and classroom practices, conventional structural factors explain only approximately 30% of this exceptional performance, leaving roughly 70% unaccounted for ([Dang et al., 2023a](#)). This gap motivates our investigation: do modern indicators overemphasize

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Western centric frameworks for explaining academic success? Can factors predating Western involvement in Vietnam (prior to French colonization) explain Vietnamese educational outcomes today? The Vietnamese case therefore merits closer examination to illuminate this phenomenon.

This paper focuses particularly on Vietnam’s 4000 years under a feudal system, with special attention to the imperial examination tradition. When studying Vietnamese educational outcomes, we contribute to broader debates on how historical institutions, cultural legacies, and contemporary development jointly shape outcomes (Acemoglu and Robinson, 2025). More specifically, the paper adds to evidence on the persistent legacy of the imperial examination (keju) in China (Chen et al., 2020; Bai and Jia, 2016; Bai, 2019a) and in Vietnam (Vu and Pham, 2023; Vu and Yamada, 2024a; Hoang and Nguyen, 2025), offering a more complete framework for interpreting Vietnam’s modern educational performance. Crucially, the paper asks not only whether these legacies matter, but through which pathways they operate, specifically examining whether effects work primarily through the density of Confucian elite or through Confucian institutional infrastructure.

Vietnam provides an ideal setting for this inquiry. The country operates a highly standardized school system with a unified national curriculum, a common language of instruction, and a national university entrance examination, while also exhibiting long documented North–South cultural variation. Building on Ho et al. (2022), we use the Time of Annexation as our treatment, capturing when Confucian ideas emphasizing education were introduced to each region. We then examine two mediators through which this ideology may have traveled: first, through the construction of Confucian institutions such as exam halls, schools teaching Confucian texts, and Confucian temples; second, through networks of Confucian elite within each province who generated social capital. We operationalize these mechanisms by creating original data from historical texts and records documented by Ngô Đức Thọ (2006). Our primary outcome is the provincial density of students scoring in the top decile of the Vietnam National High School Examination across Mathematics, Vietnamese Literature, and Foreign Language, measured using novel data we collected through web scraping of Vietnam high school examination results from 2017 to 2024. We find a robust positive association: provinces with longer exposure to Sinic Confucian institutions perform better, with the density of Confucian elite and Confucian Infrastructure pathway showing particular robustness across different subjects.

We investigate the mechanisms through which Sino-Confucian institutions were transmitted and continue to impact education in Vietnam today. In particular, we explore how this ideology transfers across generations through two hypothesized pathways: (1) the accumulated density of Confucian elites over time until the end of imperial examinations in 1919, or (2) the physical institutions they created as recorded in the last dynasty of Vietnam, which may enable students to achieve higher exam scores more readily. Given the reciprocal relationship between these mediators—each can causally influence the other—we treat them as parallel mediators and allow for correlation in our causal mediation analysis. Together, these pathways provide a testable account of how Confucian legacies persist in Vietnamese education.

We organize the paper to connect historical transmission to contemporary outcomes. Section 2 situates our argument in the literature on cultural persistence, institutions, and educational stratification. Section 3 reconstructs the Vietnamese historical context in which

Confucian elites and their institutions took shape and potentially diffused across space and generations. Section 4 describes the data and presents a causal mediation framework that allows the two pathways to operate in parallel while remaining interdependent. Section 5 reports the empirical results and sensitivity analyses. Section 6 concludes by summarizing contributions and discussing implications for understanding how historical ideologies shape present-day educational opportunity.

2 Literature Review

2.1 Institutionalizing Confucianism and Configuring Culture

The relationship between policy and culture is fundamentally reciprocal: institutional frameworks both embody and reshape societal norms (Bau, 2021; Acemoglu and Robinson, 2025). Building on Acemoglu and Robinson (2025), this study emphasizes that contemporary cultural configurations are highly fluid. Multiple configurations can emerge from the same underlying cultural repertoire, each capable of sustaining different institutional arrangements. Political forces operating through institutions can transform culture from the top down, through state-imposed systems like imperial examinations, or from the bottom up, via village-level learning institutions, altering cultural practices. In contrast, when policy regimes consistently reinforce particular norms and behaviors within a given institutional structure, such as selecting officials based on merit, existing cultural configurations can persist and accumulate over time.

Confucian philosophy as developed in China regarded education as inseparable from the cultivation of moral character and the realization of ren (仁)—the ideal of becoming fully human. In this view, learning was not simply about acquiring knowledge but about internalizing ethical principles and embodying virtuous conduct. The Vietnamese Confucian tradition adopted and reinterpreted this moral pedagogy, institutionalizing it through both statecraft and village life (Tai, 1992). Rather than relying on coercive law, the Sino-Confucian state sustained political stability through a moral regime anchored in education (Steinberg et al., 1971). The moral regime was further institutionalized through the system of recruiting government officials via standardized examinations. Far from serving solely as a bureaucratic recruitment mechanism, the examination system functioned as a principal vehicle for instilling moral discipline, cultivating cultural conformity, and fostering political loyalty. Its core objectives were twofold: to disseminate Sino-Confucian ideology on a mass scale and to identify and recruit individuals best equipped to implement this ideology within the state apparatus (Elman, 2000a; Feng, 1995, 1999). To achieve these goals, the curriculum was standardized nationwide, centering on canonical Confucian texts such as the Four Books and Five Classics, thereby enforcing ideological unity across regions (Feng, 1999; Elman, 2000b). Through this mechanism, Confucianism was institutionalized via the imperial examination system to secure loyalty and unity in service of the feudal order.

The institutional pattern was not unique to China but was mirrored and adopted across the broader Sinosphere, such as Korea’s Gwageo (958–1894), Japan’s Kakyo system during the Heian period (8th–10th centuries), and Vietnam’s civil examination (Khoa cử) system (1075–1919). Their modern equivalents are China’s National College Entrance Examination

(Gaokao), Korea’s College Scholastic Ability Test (CSAT), and Vietnam’s National High School Examination (Feng, 1999). The imperial examination system left a durable imprint across multiple levels of the shared Sinosphere. At the individual level, students internalized rigorous norms of self-cultivation and discipline, with a strong orientation toward examination outcomes (Elman, 2000b). At the household level, families prioritized educational success and devoted substantial resources to it. Within schools, it cultivated meticulous memorization, disciplined study routines, hierarchical teacher–student relations, and deference to authoritative readings of canonical texts.

This configuration operated through both declarative and nondeclarative forms of cultural transmission (Lizardo, 2017). Declarative culture encompasses collective memories transmitted through semantic knowledge in texts and literary genres, as well as rituals shaped by law and institutional arrangements from prior regimes or by explicit references to individual and communal experience. These collective memories are widely shared across large segments of the population. As a clan-based culture, people from the same clan or hometown share collective memories embedded in province-specific semantic knowledge. Actively produced and reproduced within particular provinces, these memories and rituals generate a distinctive sense of place-based cultural heritage.

By contrast, nondeclarative cultural acquisition unfolds through implicit, enduring cognitive-emotional associations, embodied dispositions, and perceptual or motor skills formed via repeated exposure to stable experiential patterns (Lizardo, 2017; Bourdieu, 2006). This mode of learning internalizes the structural regularities of experience while retaining little detail from any single episode. Declarative and nondeclarative pathways are mutually reinforcing and function as dual processes in the formation and transmission of culture, making attention to both essential for understanding cultural persistence and change. The interaction between culture and institutions generated the prominent features shared across Sinosphere education systems: text-centricity, hierarchical relationships between students and teachers, examination-oriented pedagogy, and emphasis on disciplined study practices.

In Vietnam’s case, Confucian ideology—institutionalized through the civil service examination system—embedded a culture of learning via both declarative and nondeclarative pathways. Subsequent institutional forms, whether socialist or republican, perpetuated this culture by demanding skilled human capital. Far from weakening over time, this test-oriented learning culture has intensified through the accumulating weight of centuries-long institutional reinforcement. Understanding Vietnamese students’ learning practices today therefore requires examining the historical depth of their educational heritage. Contemporary socioeconomic factors offer only a partial explanation; we must also account for cultural patterns shaped and sustained by both historical and present-day institutions.

2.2 Historical legacy of Confucianism ideology and Imperial exam system

The enduring influence of the civil service examination system on modern education in China and Vietnam has been well documented (Kung and Ma, 2014; Chen et al., 2020; Chen and Ma, 2022; Ho et al., 2022; Vu and Pham, 2023; Hoang and Nguyen, 2025). By replacing aristocratic privilege with merit-based advancement, this system fundamentally reshaped social structures

during the feudal era. It created pathways for individuals from non-elite backgrounds to attain official positions through demonstrated competence rather than inherited status. From the Tang dynasty onward, examination performance increasingly supplanted family lineage as the determinant of elite standing, significantly expanding social mobility [Wen et al. \(2024\)](#).

This meritocratic ethos continues to shape contemporary institutions. The principles of fair competition and achievement-based advancement remain central to China’s civil service and educational systems. Moreover, the examination system’s structural innovations—standardized testing procedures, confidential content protocols, and quota-based selection—have left lasting imprints on modern assessment and recruitment practices. Perhaps most significantly, the "official standard ideology" persists, positioning academic and bureaucratic success as paramount measures of social worth [He \(2023\)](#).

To study the impact of the imperial exam system, scholars have used a range of proxies to operationalize imperial exam system—from the presence of Confucian temples ([Kung and Ma, 2014](#)), to the density of imperial degree-holders ([Chen et al., 2020](#)), to the legacy of clan-based hierarchies as documented in tomb epitaphs ([Wen et al., 2024](#)), and the geographical distribution of classical sage temples ([Ma, 2024](#)). Others highlight the bureaucratic mechanisms of the keju system itself, such as quota restrictions on entry-level civil service exam candidates by region and status ([Bai and Jia, 2016](#); [Bai, 2019b](#)). While these approaches provide historical context, they suffer from fundamental empirical limitations that undermine causal inference about contemporary outcomes. Studies by [Vu and Yamada \(2023a, 2024b\)](#) and [Hoang and Nguyen \(2025\)](#) operationalize the imperial examination’s legacy through the spatial density of historical degree-holders, treating this measure as an exogenous treatment variable to explain modern educational disparities in China and Vietnam. This strategy encounters at least three critical methodological problems.

First, measurement validity presents some challenges. Archival records of imperial degrees show incompleteness and spatial variation, with preservation rates differing across regions and time periods. This issue is more pronounced at the provincial examination level (thi Hương), where documentation is most complete for the Nguyễn dynasty but less systematic for earlier periods. Treating missing records from prior dynasties as equivalent to the absence of degree-holders introduces potential measurement error that may not be random. This missingness could correlate with institutional capacity—regions with stronger administrative infrastructure likely preserved records more consistently—potentially leading to attenuated estimates or inflated correlations that reflect archival survival rather than historical reality. However, these concerns are less severe for national examinations (thi Hội and thi Đình), where multiple contemporaneous sources enable cross-validation and provide more reliable historical coverage.

Second, the identification assumption of exogeneity is empirically untenable. As [Chen et al. \(2020\)](#) acknowledges, the relationship between examination systems and educational achievement is inherently endogenous and historically bidirectional. Regions with higher examination success likely had pre-existing advantages—greater wealth, stronger local governance, or deeper scholarly traditions—that both facilitated imperial achievement and independently influenced subsequent development trajectories. Controlling for distance to the capital and basic geographic covariates does not adequately address this confounding.

Third, the binary treatment logic presents empirical challenges. Classifying provinces without imperial elites as "control" units assumes minimal or no cultural or institutional

spillover—an assumption that may be difficult to sustain given evidence of elite mobility, knowledge diffusion, and administrative integration across regions. The absence of degree-holders does not necessarily indicate the absence of influence from examination culture.

In light of these complexities, this study does not treat the density of Confucian elite as a causal proxy, nor does it assume that proximity to examination sites is an exogenous factor. The foundational conditions required for credible causal identification cannot be firmly supported by the available evidence. Instead, the analysis employs temporally sensitive historical indicators—such as duration of exposure to Sino-Confucian institutions—to trace the enduring influence of the examination system, following approaches similar to [Ho et al. \(2022\)](#); [Ho \(2025\)](#). It further highlights a non-declarative or “slow learning” pathway, arising from prolonged and repeated exposure to stable patterns of experience. The knowledge formed through this gradual enculturation is not organized by explicit semantic or logical structures such as formal instruction or examination content. Rather, it emerges through recurrent associations grounded in perceptual, spatial, and temporal similarities, as discussed by [Lizardo \(2017\)](#).

We then examine how Sino-Confucian institutions continue to shape contemporary education through two channels: a slow, experiential pathway operating via long-run exposure to Confucian practices, and a more explicitly institutionalized, declarative pathway operating through the imperial examination system. The study focuses on spatial inequality in education by comparing these pathways and assessing which mediating mechanisms matter more: the embodied institutions of Confucian temples, schools, and examination halls that historically fostered learning, or the local density of imperial examination activity, transmitted both through formal curricular content and vernacular sayings embedded in provincial cultures. In doing so, the analysis helps to open the black box of “Confucian influence” and clarify the mechanisms through which cultural configurations exert causal effects.

3 Historical background

3.1 Southward Expansion and Variation in Sinic Institutional Influence

The historical development of Vietnam have many layers. Vietnamese identity is often traced back to the Lạc Việt, a confederation of tribal groups who established agrarian societies in the Red River Delta during the Bronze Age. This proto-state was colonized by imperial China for over a millennium (111 BCE–938 CE). During this period, Sino-Confucian ethical and political doctrines were introduced and gradually embedded into the upper class of Vietnamese scholar-officials. Vietnamese students were sent to represent the *Annam Protectorate*—known as the “Pacified South”—in Confucian academies in the Chinese capital ([Steinberg et al. \(1971\)](#)). As [Woodside \(1971\)](#) famously argued, Vietnam’s eventual independence from China resembled “a fruit ripening and falling from its parent tree”—a moment of political separation that retained deep cultural continuities. As in Korea and Japan, Vietnam gained independence while retaining the institutional structure of Chinese imperial governance, particularly the Civil service examination system (or imperial examination system).

After independence, the northern Vietnamese court adopted and localized the Chinese-

style bureaucracy. The Imperial civil examination system, known in Vietnam as Khoa bảng (or in Chinese Keju - 科举), was formally established under the Lý Dynasty in 1075 and remained in place until 1919, when it was abolished under French colonial rule. This system offered a structured, meritocratic path to social mobility. Poor but talented individuals could rise through the ranks of society based on scholarly achievement. Candidates were assessed on their knowledge of the Confucian classics, literary composition, and political philosophy (Nguyen (2005)). The highest achievers—trạng nguyên—were revered not only by the court but also by their communities, where villages took great pride in producing successful scholars (National Archives Center IV (2011)). As London (2011) notes, education in Vietnam became a principal route to power, status, and wealth—anchoring a deeply rooted meritocratic culture that continues to shape contemporary aspirations.

In contrast, the southern regions of Vietnam—historically part of the Champa and Khmer civilizations—did not share the deep-rooted Sinic institutional heritage of the North. Education in these societies was oriented mainly toward religious and royal rituals rather than the cultivation of bureaucratic governance. Following the Trinh–Nguyen division during the Le dynasty, the Nguyen lords expanded southward, establishing control over these territories. Southern society developed with a different orientation, where Sino-Confucian ideals were applied more flexibly. The imperial examination system was introduced to the South much later, and its influence remained limited, soon diluted by the spread of Catholic missions, French colonial rule, and the subsequent disruptions of the Vietnam War (Giang, 2022; Nhean, 2017; Trân, 1988). During the early Nguyễn period, following the collapse of the Ming Dynasty in China, a wave of Han Chinese migrants fled southward into Vietnam. Many settled in the Mekong Delta and brought with them Confucian texts and practices, contributing—alongside Vietnamese feudal elites—to the partial transplantation of Confucianism in the South. Nevertheless, Confucianism in Cochinchina remained relatively relaxed and less institutionalized (Nguyen and Nguyen, 2020). As Tai (1992) notes, Sino-Confucian ideals were far more deeply embedded in Tonkin (northern Vietnam), where education served as a central mechanism for both state-building and moral reproduction.

Notably, war and political fragmentation did not erase the cultural foundation of educational aspiration. Even during colonial occupation, revolution, and postwar reconstruction, the symbolic power of scholarly achievement endured. At the same time, the introduction of Western learning—particularly in the South—added new layers of complexity to Vietnam’s educational landscape. Under French colonial rule, Cochinchina (Southern Vietnam) became the first and most thoroughly colonized region. Here, French missionaries and colonial administrators established Western-style schools and promoted Catholic education, introducing secular curricula and French-language instruction that diverged sharply from Confucian pedagogy. This Western influence persisted into the era of the Republic of Vietnam (RVN, 1955–1975), when the southern regime, aligned with American Cold War interests, expanded liberal and vocational education under a more individualist and modernist ideology (Tai (1992); London (2011)).

The South’s receptiveness to Western ideas was shaped not only by colonial and geopolitical influences but also by its distinct precolonial cultural foundations. Unlike the North, which had long been integrated into a hierarchical Confucian bureaucracy, the South had been shaped by the Champa and Khmer civilizations—societies characterized by less centralized feudal systems and divergent religious traditions. Following the Fall of Saigon, the end of

the Vietnam War, and the historical southward expansion of Vietnamese territory, northern households migrated to the South, bringing with them varying degrees of Sino-Confucian meritocratic values. While these northern migrants introduced elements of Sino-Confucian ideologies into the South, those who remained in the North retained more deeply embedded traditions. According to the selective migration hypothesis ([Bazzi et al., 2020](#)), collectivism and associated group-oriented norms may be comparatively weaker in the South, though they persist to some extent—shaped by historical exposure and institutional continuity.

3.2 The Imperial Examination System in Vietnam, 1075-1919

The *Forty-Seven Rules for Teaching and Changing the People*, promulgated by the Lê Code in 1663 and 1760, exemplified the state’s commitment to moral education as the foundation of social order. These rules directed village officials and family heads to inculcate Confucian virtues—filial piety, hierarchical respect, and gendered propriety—through continuous instruction and personal example. Along side with coercive law, the Vietnamese state sustained political stability through a moral regime anchored in education ([Steinberg et al. \(1971\)](#)). At the core of this system stood the civil service examination, modeled on the Chinese imperial tradition. In Vietnam, exams were administered at multiple tiers—local, regional, and national—and assessed candidates’ mastery of classical Chinese texts, poetry, historical analysis, and moral-political reasoning. Preparation often spanned many years, and the exams themselves were multi-day ordeals, both intellectually and physically demanding. Success at the highest levels conferred elite degrees and access to official posts within the imperial bureaucracy.

Over nearly a millennium, the imperial examination system produced tens of thousands of scholars who served as civil functionaries and moral exemplars. In total, Vietnam held 184 imperial examinations—6 under the Lý, 14 during the Trần, 2 under the Hồ, 28 during the Lê, 73 under the Revival Lê (Lê-Trịnh), 22 under the Mạc, and 39 under the Nguyễn. The hierarchy comprised three main tiers: the prefectural/provincial exam (*thi Hương*), the metropolitan/capital exam (*thi Hội*), and the palace exam (*thi Đình*). Prefectural exams were typically organized regionally rather than in every province, depending on available administrative infrastructure ([National Archives Center IV \(2011\)](#)).

The social value of examination success extended well beyond the court. In villages, successful candidates were celebrated as embodiments of communal virtue and collective achievement. Degree-holders were exempt from labor obligations, granted social privileges, and often invited to teach or arbitrate local disputes. Villagers sometimes established informal learning spaces, often using local pagodas, and formed associations that built shrines to honor scholars and managed communal fields whose revenues supported Confucian education for the poor ([London \(2011\)](#); [Vu and Yamada \(2023a\)](#)). Examination success elevated not only individuals but also conferred lasting prestige upon their families and communities.

In Vietnam, education was never simply a means to an end; it formed part of a broader moral and political order in which governance and self-cultivation were mutually reinforcing. Modeled after the Confucian sage rather than the divine sovereign, the Vietnamese emperor was expected to rule through moral example. Even amidst political upheavals, the civil service examination system persisted as a stabilizing institution and a critical mechanism for upward mobility. Confucianism in Vietnam thus localized the Chinese ideal of education

as a path to ren—becoming fully human—while nurturing a durable culture of scholarship, hierarchy, and ethical formation. This culture of learning, deeply embedded in village life and familial structures, was transmitted across generations, reinforcing long-standing aspirations for academic success. At its best, the exam-centered model functioned not only to legitimize authority but also to equalize opportunity, making education both a moral imperative and a vehicle for social advancement for the Vietnamese.

3.3 Confucian Legacy and Institutional Continuity in Vietnam’s Modern Examination System

As the Vietnamese scholar Ngô Tất Tố once observed, Confucianism historically elevated Vietnam to the ranks of “civilized nations,” yet, in his view, it also brought the country to the brink of stagnation (Tai, 1992). During the French colonial period, Confucianism underwent a process of institutional ossification. Reduced to rigid ritualism and symbolic authority, it came to be derided as Hủ Nho (“decayed Confucianism”). In southern Vietnam, the emergence of the so-called “southern wind”—a metaphor for the influx of liberal, republican, and modernist ideas—posed further challenges to the Confucian order (Tai, 1992).

Despite these transformations, Confucian values persisted. The cultural valorization of education, patriarchal family structures, and moral rectitude remained resilient, even as institutions changed. During the Vietnam War, Confucianism in the South was often associated with traditional conservatism and nation-building efforts (Nễn, 2015; Time, 1957). In contrast, in the North, Confucian ethics were selectively rehabilitated under communist rule as a moral resource compatible with socialist ideals. Hồ Chí Minh—the revolutionary leader and founding president of the Democratic Republic of Vietnam— was at times portrayed as a Confucian-style sage or advisor, blending Marxist-Leninist ideology with Confucian moral symbolism (Ali, 2020). After reunification in 1975, the Socialist Republic selectively integrated Confucian values—particularly those emphasizing discipline, hierarchy, and filial duty—into the moral education curriculum, reinforcing a state-driven model of social harmony and collective responsibility.

This enduring influence remains visible in contemporary schooling. English-language textbooks in Vietnam continue to reflect Confucian gender hierarchies: men are depicted as ambitious, authoritative figures, while women are often portrayed through domestic roles and stereotypical traits (Vu and Pham, 2023; Doan, 2005). These legacies also shape pedagogical and familial dynamics. The teacher-centered model—rooted in Confucian reverence for hierarchy—remains dominant, discouraging student inquiry and privileging deference to authority. In the family sphere, parenting practices emphasize academic achievement, obedience, and emotional discipline, reinforcing Confucian ideals of moral cultivation and hierarchical order (Nguyen et al., 2020).

Linguistic conventions offer subtle but powerful evidence of the persistence of Confucian educational hierarchies in contemporary Vietnam. Academic degrees still bear imperial-era titles—cử nhân (bachelor) and tiến sĩ (doctor)—underscoring the symbolic continuity between past and present. This thread is especially visible in the National High School Examination (NHSE), which mirrors the meritocratic logic of the imperial system. Top scorers are awarded the honorary title of thủ khoa, a direct linguistic and cultural echo of the scholar-officials of

earlier eras. Today, thủ khoa are not only high achievers but also public figures: provincial governments and institutions routinely celebrate them through ceremonies, awards, and extensive media coverage ([VietNamNet, 2024](#); [Dân trí, 2024](#); [Báo Bắc Ninh, 2024](#)). These rituals of recognition revive the symbolic prestige once associated with imperial examinations, reaffirming the moral and social value placed on academic excellence and reinforcing stratified perceptions of merit.

At the institutional level, the legacy of the imperial examination system finds a clear parallel in Vietnam’s centralized National High School Examination (NHSE), which functions as both a graduation requirement and a gateway to higher education. In 2015, Vietnam introduced a nationwide standardized university entrance exam—the most significant revival of the imperial model since its abolition. Administered by the Ministry of Education and Training (MOET), this exam serves three purposes: it qualifies students for high school graduation, determines university admission, and acts as a national benchmark for educational performance ([Dân Trí, 2015](#)). The NHSE is a high-stakes, standardized assessment that evaluates students’ academic progress after 12 years of formal schooling. The exam includes two compulsory subjects: Mathematics and Literature. In addition, candidates select two subjects from the national curriculum, which may include: Chemistry, Physics, Biology, Literature, Geography, History, Economic and Legal Education, Information Technology, Technology, and Foreign Languages (English, German, Russian, Japanese, French, Chinese, Korean) ([VnExpress, 2024](#)).

In this way, the NHSE operates not merely as a standardized assessment, but as a contemporary articulation of the imperial civil examination ethos and a vehicle for the continued centralization of educational governance in Vietnam—functionally analogous to China’s National College Entrance Examination (NCEE) ([Feng, 1999](#)). It institutionalizes long-standing associations between education, moral worth, and social mobility, thereby reproducing a historically embedded logic of meritocratic legitimacy. This study examines the continuation from the imperial examination system in the feudal era to today’s NHSE, investigating whether any legacy persists and, if so, through which mechanisms it operates.

4 Data and Methodology

4.1 Data

4.1.1 Education performance

To examine provincial educational outcomes in Vietnam, I assemble a province–year panel of Vietnamese National High School Examination (NHSE) scores for 2017–2024. The dataset is compiled from publicly available online sources and systematic web scraping of official results of almost million exam candidates and is harmonized to the 63 provincial administrative units in place during the study period. Subject-specific coverage is complete from 2017 onward, yielding 504 observations for Mathematics, Literature, and Foreign Language at provincial level.

In 2015 the Ministry of Education and Training (MoET) consolidated the separate high-school graduation and university entrance exams into a single nationwide assessment ([Vietnam News Agency, 2016](#)). During 2017–2024, candidates sat five centrally regulated tests

(Literature, Mathematics, Foreign Language, and one of two composite exams in Natural Sciences or Social Sciences) on a common national schedule, with test development and administration specified by MoET regulation. These features provide a uniform, standardized testing framework suitable for interprovincial comparisons. Further details on construction, coverage, and variable definitions appear in Table 2 and the Data Appendix.

The data score shows that Mathematics consistently attracts the largest number of candidates, followed closely by Literature and Foreign Language. These patterns cannot be separated from the “tổ hợp khối” (exam group combinations) that structure university admission. Group A combinations (e.g., A00: Math–Physics–Chemistry; A01: Math–Physics–English; A02: Math–Physics–Biology) and Group D combinations (e.g., D01: Literature–Math–English; D07: Math–Chemistry–English) dominate application pathways, ensuring strong demand for Mathematics and Literature, which serve as anchors in nearly all clusters ([Thư Viện Pháp Luật, 2024](#)).

This study focuses on three core subjects—Mathematics, Literature, and Foreign Language. Mathematics and Literature are compulsory components of the National High School Examination, ensuring full population coverage. Foreign Language, while optional, is the most commonly chosen subject, thereby providing the broadest comparability among elective examinations. Restricting the analysis to these subjects reduces potential selection bias.

4.1.2 Regional dataset

Geography boundary

I use the Viet Nam Administrative Boundaries dataset to define provincial, district, and commune-level spatial units. This dataset, sourced from the Government of Viet Nam and accessed via the Humanitarian Data Exchange, provides official boundaries for administrative Levels 0–2: national (Level 0), provinces (Level 1, 63 features), and districts (Level 2, 708 features). The dataset was vetted and configured by Information Technology Outreach Services (ITOS) with support from USAID and is compatible with other COD datasets ([Government of Viet Nam, 2023](#)).

Sinic Institutional Features by Province

The annexation years are drawn from two official historical chronicles—*Đại Việt Sử Ký Toàn Thư* (The Complete Annals of Đại Việt) and *Đại Nam Thực Lục* (The Veritable Records of Đại Nam)—as compiled by [Ho et al. \(2022\)](#). The annexation variable is calculated as the difference between the year of analysis (2025) and the earliest recorded year of annexation within each province. This approach is necessary because annexation often occurred incrementally at the commune level, leading to intra-provincial variation in dates. By selecting the earliest annexation date for each province, we impose a consistent and conservative measure of historical incorporation, allowing us to analyze spatial and temporal patterns of state expansion at the provincial level.

To measure Confucian institutional features that embodied Confucian ideology, we compile data on schools and examination venues under the Nguyễn dynasty from *Đại Việt Sử Ký Toàn Thư* (The Complete Annals of Đại Việt). We supplement these with information on 441 Confucian temples from the national to communal levels collected by [Mạnh and Hoàn \(2021\)](#).

The number of imperial laureates recorded after passing the national examinations is taken from Ngô Đức Thọ (2006), the same source used in Vu and Yamada (2023b).

Household dataset

To study additional mechanisms operating at the personal and household level, I draw on micro-data from the Vietnam Household Living Standards Survey (VHLSS). This dataset provides individual- and household-level information on educational attainment, occupation, income, and other socioeconomic characteristics across Vietnamese provinces. By linking households to their provincial historical exposure to Confucian institutions, I can examine how historical treatment effects persist through intergenerational transmission of educational values, occupational choices, and investment in children’s education.

4.2 Variable Settings

Dependent Variable We construct a province-year measure of student performance based on the number of 90th-percentile students per km^2 , i.e., the spatial density of top performers. This metric enables consistent comparisons across provinces and over time while directly matching the spatial density of imperial Confucian elite.

Independent variables For each province (p), I measure *Time since annexation* as the number of years between its incorporation into Đại Việt and the year 2025. Concretely, this is obtained by subtracting the province’s annexation year, documented in Ho et al. (2022), from 2025, so that higher values indicate longer historical exposure to Sino-Confucian institutions.

Mediators We focus on two mediators of interest: (i) provincial Confucian elite density and (ii) a Confucian infrastructure index measuring the density of institutional infrastructure in each province.

Confucian elite density. For each province (p), we measure Confucian elite density as the cumulative number of national-level imperial examination laureates originating from that province between 1075 and 1919 (Ngô Đức Thọ, 2006), scaled by land area. The original dataset records 2,890 laureates from 184 exams, but 17 candidates cannot be reliably matched to a home province, leaving 2,873 laureates for constructing the provincial measure. Concretely, we take the total laureate count for province (p), multiply it by 1,000, and divide by the province’s land area in km^2 , so that the resulting measure represents the number of laureates per $1,000\text{km}^2$ and is directly comparable across provinces of different sizes.

Confucian infrastructure index. To capture cross-provincial variation in Confucian educational and ritual infrastructure, we construct a composite index using principal components analysis (PCA). For each province, we first standardize institutional measures by land area, converting raw counts into densities per $1,000 \text{ km}^2$: (i) Confucian schools at provincial, prefectural, and district levels; (ii) Confucian temples at national, provincial,

¹The analysis acknowledges the full territorial boundary of Vietnam, including the Trường Sa (Spratly) and Hoàng Sa (Paracel) archipelagos. These areas are not depicted because outcome data (e.g., test scores) are unavailable for the empirical analysis.

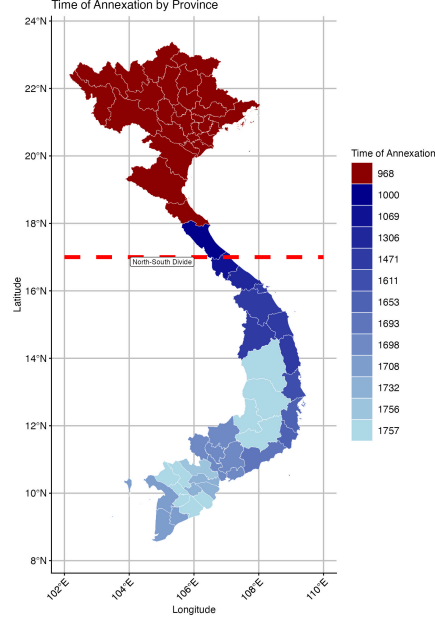


Figure 1: Time of Annexation (Ho et al., 2022)².

and district levels; and (iii) examination-site importance (a province’s share of successful candidates). Because higher-level institutions are historically rarer and plausibly more consequential, we create two rarity-weighted density indices—one for temples and one for schools—by weighting each administrative tier inversely to its aggregate prevalence and then summing across tiers. We log-transform these indices (and the examination-site measure) using $\log(1 + x)$ to reduce skewness and attenuate the influence of extreme values. Finally, we apply PCA to the logged school index, logged temple index, and logged examination-site importance; we retain the first principal component as the Confucian infrastructure index and orient it so that higher values correspond to greater school density.

Control variables

Our analysis incorporates several sets of control variables to account for potential confounders. *Geographic controls* include rice suitability, distance to coast, distance to river, mean elevation, mean slope, mean ruggedness, and mean temperature, capturing spatial variation in agricultural potential, market access, and environmental conditions. *Historical controls* include bombing intensity (bombs per km²), which reflects wartime disruption during the Vietnam War. *Contemporary socioeconomic and demographic controls* include log area, population (in thousands), ethnic minority density, and log GRDP per capita, accounting for province size, demographic composition, and economic development. *Educational infrastructure controls* include a school input index constructed via principal components analysis, capturing the quality and availability of educational resources. *Administrative capacity controls* include a public administration index (also via PCA), measuring provincial governance quality and state capacity. All continuous variables are standardized to mean zero and unit variance to facilitate comparison of effect magnitudes. Additionally, we include year fixed effects to account for time-varying national trends in educational performance and policy changes.

4.3 Methodology and empirical strategy

This study extends [Ho et al. \(2022\)](#) and [Ho \(2025\)](#), which attribute Vietnam’s contemporary North–South divergence to regional differences in historical exposure to Sino-Confucian state institutions. While these studies establish that early state penetration produced lasting regional disparities, the mechanisms through which historical institutions translate into contemporary educational inequality remain underspecified. We address this gap by focusing on the imperial examination system and employing causal mediation analysis to identify the specific pathways linking historical Confucian state presence to contemporary educational outcomes.

A key methodological challenge arises because time since annexation shaped not only contemporary outcomes but also the intervening development of Confucian elite and infrastructure. These mediators are post-treatment variables that lie on the causal pathway from annexation to educational achievement. Treating them as ordinary control variables would condition away precisely the historical transmission channels we seek to understand, a textbook case of post-treatment bias. We therefore adopt a formal causal mediation framework to decompose the total effect of annexation timing into components operating through distinct pathways: (i) Confucian elite density (the ‘sage’ pathway), (ii) Confucian infrastructure (the ‘institutional’ pathway), and (iii) all other mechanisms not captured by these measured mediators (the direct effect or non-declarative pathway).

Our empirical strategy proceeds in two steps. First, we estimate the total causal effect of annexation timing on contemporary educational outcomes without conditioning on mediating pathways. Second, we implement parallel mediation analysis to quantify the proportion of the total effect transmitted through two distinct channels: Confucian elite density versus institutional infrastructure. While these mediators are conceptually related and empirically correlated—provinces with higher examination graduate concentrations also developed denser networks of schools and temples—we analyze them as parallel rather than sequential mediators to distinguish between human capital transmission (through elite families and lineage networks) and institutional persistence (through physical infrastructure and organizational capacity). This specification tests whether cultural or institutional mechanisms dominate the intergenerational transmission process, or whether both contribute substantially. This two-step approach moves us beyond documenting that “history matters” to specifying how it matters.

Baseline estimates First, I estimate the total effect of historical state penetration on contemporary educational outcomes without conditioning on mediators. I pool the three subject specific outcomes into a multivariate linear regression, where the dependent variables are the log densities of high achievers in mathematics, Vietnamese literature, and foreign language at the province year level. The key regressor is time since annexation, and I include the full set of geographic and contemporary controls together with year fixed effects, so that the total effect is identified from variation in annexation timing across provinces with similar observable characteristics.

Formally, for subject $s \in \{\text{math, literature, language}\}$, province p , and year t , I estimate

$$Y_{spt} = \alpha_s + \beta_s T_p + X'_{pt} \gamma_s + \lambda_t + \varepsilon_{spt},$$

where Y_{spt} is the log density of high achieving students in subject s , T_p is time since annexation, X_{pt} is the vector of geographic and contemporary controls, λ_t are year fixed effects, and ε_{spt} is an error term. I estimate this system jointly, allowing the covariance structure of the residuals across subjects to inform the precision of the estimates and to support multivariate tests of the null that annexation timing has no effect on any outcome.

I then assess the robustness of this total effect to alternative specifications of the historical treatment and the error structure. First, I replace the linear term in time since annexation with a flexible spline specification, which allows the marginal effect of annexation timing to vary nonlinearly across the historical range instead of imposing a constant effect of one additional year. Second, I estimate a linear mixed model that augments the specification with province specific random intercepts, which absorb unobserved time invariant province characteristics that may be correlated with both annexation timing and contemporary educational performance. Third, I estimate subject specific quantile regressions at the 25th, 50th, and 75th percentiles of the outcome distributions, which allows the effect of annexation timing to differ between provinces at the lower and upper tails of the excellence distribution. Across these robustness checks I treat the mediators as post treatment variables and exclude them from the right hand side, so that all estimates in this step are interpretable as total effects of historical state penetration rather than as conditional or path specific effects.

Causal Mediation pathways In Step 2, we analyze how *Time since annexation* T_p affects contemporary educational performance through two parallel mediators: (i) provincial *Confucian elite density* and (ii) a *Confucian infrastructure index*. Let Y_{spt} denote the log density of high-performing students (share at or above the national 90th percentile) in subject s , province p , and year t . Within the potential-outcomes framework for causal mediation with parallel mediators (Imai et al., 2010), we decompose the total effect of T_p on Y_{spt} into (i) average causal mediation effects (ACMEs) operating through each mediator and (ii) an average direct effect (ADE) capturing all remaining pathways not accounted for by the specified mediators.

Since the two mediators may be statistically dependent, we specify a joint mediator model that allows their province-level random effects and idiosyncratic residuals to be correlated. Substantively, Confucian elite density and Confucian infrastructure are treated as parallel mechanisms through which time since annexation affects contemporary outcomes. We capture their statistical dependence through correlated error terms rather than modeling direct causal pathways between mediators. Following Hu (2024), we estimate average causal mediation effects (ACMEs) for each mediator conditional on the other, along with the average direct effect (ADE), and interpret these quantities under the assumed joint mediator model. Figure 2 illustrates these causal relationships.

We estimate the mediator models as:

$$M_{pt}^{(1)} = \alpha^{(1)} + \delta_t + \phi_1 T_p + \mathbf{X}_{pt}'\boldsymbol{\beta}^{(1)} + \mathbf{Z}_p'\boldsymbol{\gamma}^{(1)} + u_p^{(1)} + \varepsilon_{pt}^{(1)}, \quad (1)$$

$$M_{pt}^{(2)} = \alpha^{(2)} + \delta_t + \phi_2 T_p + \mathbf{X}_{pt}'\boldsymbol{\beta}^{(2)} + \mathbf{Z}_p'\boldsymbol{\gamma}^{(2)} + u_p^{(2)} + \varepsilon_{pt}^{(2)}, \quad (2)$$

where $M^{(1)}$ is Confucian elite density and $M^{(2)}$ is the Confucian infrastructure index; δ_t are year fixed effects; $u_p^{(j)}$ are province random intercepts; $\mathbf{X}_{pt}$ (time-varying) and $\mathbf{Z}_p$ (time-

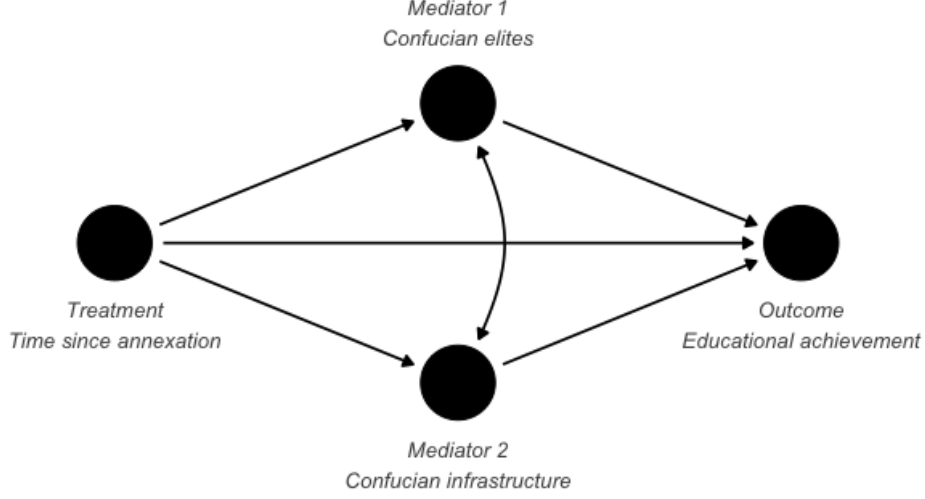


Figure 2: Causal diagram showing parallel mediation pathways through elite density and institutional infrastructure.

invariant) are controls. The outcome equation includes treatment–mediator interactions to allow for heterogeneous mediation effects across levels of historical exposure:

$$\begin{aligned}
Y_{spt} = & \alpha_s + \delta_t + \theta_s T_p + \eta_s^{(1)} M_{pt}^{(1)} + \eta_s^{(2)} M_{pt}^{(2)} \\
& + \kappa_s^{(1)}(T_p \times M_{pt}^{(1)}) + \kappa_s^{(2)}(T_p \times M_{pt}^{(2)}) \\
& + \mathbf{X}_{pt}' \boldsymbol{\beta}_s + \mathbf{Z}_p' \boldsymbol{\gamma}_s + u_{sp} + \varepsilon_{spt},
\end{aligned} \tag{3}$$

with subject intercepts α_s , year fixed effects δ_t , and province-by-subject random intercepts u_{sp} . Following the potential outcomes framework for causal mediation with parallel mediators, we decompose the total effect of time since annexation, T_p , on educational outcomes into direct and mediated components. Because T_p is continuous, we define effects as contrasts between two treatment values: t_0 (the 25th percentile of T_p in the sample) and t_1 (the 75th percentile).

The total effect of changing T_p from t_0 to t_1 captures the overall impact of annexation timing on educational achievement, combining all direct and mediated pathways:

$$\text{TE}(t_1, t_0) = \mathbb{E}[Y_{spt}(t_1, M^{(1)}(t_1), M^{(2)}(t_1)) - Y_{spt}(t_0, M^{(1)}(t_0), M^{(2)}(t_0))], \tag{4}$$

where $Y_{spt}(t, M^{(1)}(t), M^{(2)}(t))$ denotes the potential outcome under treatment level t and the mediator values induced by t .

For mediator $j \in \{1, 2\}$, the average causal mediation effect isolates the portion of the treatment effect that operates through that specific mediator, holding the other mediator

fixed at its value under a baseline treatment level t :

$$\text{ACME}^{(j)}(t_1, t_0 | t) = \mathbb{E}[Y_{spt}(t, M^{(j)}(t_1), M^{(-j)}(t)) - Y_{spt}(t, M^{(j)}(t_0), M^{(-j)}(t))], \quad (5)$$

where $M^{(-j)}(t)$ is the value of the *other* mediator evaluated at treatment level t . For our two mediators:

- $\text{ACME}^{(1)}$: effect mediated through Confucian elite density, with infrastructure held fixed;
- $\text{ACME}^{(2)}$: effect mediated through the Confucian infrastructure index, with elite density held fixed.

Because the outcome model includes treatment–mediator interactions, these mediation effects depend on the chosen baseline t . In the empirical analysis, we report $\text{ACME}^{(j)}(t_1, t_0 | t_0)$ and $\text{ACME}^{(j)}(t_1, t_0 | t_1)$ to assess whether mediation mechanisms vary across levels of historical exposure (lower versus upper quartile).

The average direct effect captures the component of the treatment effect that operates through mechanisms other than the two measured mediators:

$$\text{ADE}(t_1, t_0 | t) = \mathbb{E}[Y_{spt}(t_1, M^{(1)}(t), M^{(2)}(t)) - Y_{spt}(t_0, M^{(1)}(t), M^{(2)}(t))], \quad (6)$$

holding both mediators fixed at their values under the baseline treatment level t . This term captures all residual pathways linking T_p to Y_{spt} that are not mediated by elite density or infrastructure.

Under the standard identification assumptions for causal mediation analysis (sequential ignorability and correct model specification), the total effect at a given baseline t decomposes as:

$$\text{TE}(t_1, t_0) = \text{ACME}^{(1)}(t_1, t_0 | t) + \text{ACME}^{(2)}(t_1, t_0 | t) + \text{ADE}(t_1, t_0 | t), \quad (7)$$

allowing us to attribute the historical effect of Sino-Confucian state presence to the elite-density channel, the infrastructure channel, and all remaining (direct) pathways.

5 Results

5.1 Sample characteristics

Educational outcomes. Educational performance shows marked spatial concentration in the production of academic excellence. The density of top performers—students scoring in the 90th percentile or above on national high school exams, measured per square kilometer of provincial area—averages below one per km² across all three subjects (0.55 for foreign language, 0.73 for literature, 0.68 for mathematics) but exhibits high dispersion, with standard deviations of 1.24, 1.20, and 1.10 respectively that exceed the means. Maximum values reach 9.21, 8.23, and 7.06 per km², indicating that educational excellence clusters in a few high-performing provinces rather than being evenly distributed across Vietnam’s geography. The fact that many provinces record zero top performers in certain subjects while others achieve densities nearly an order of magnitude above the median underscores the extreme spatial inequality in educational outcomes (See Table 3 and Figure 3).

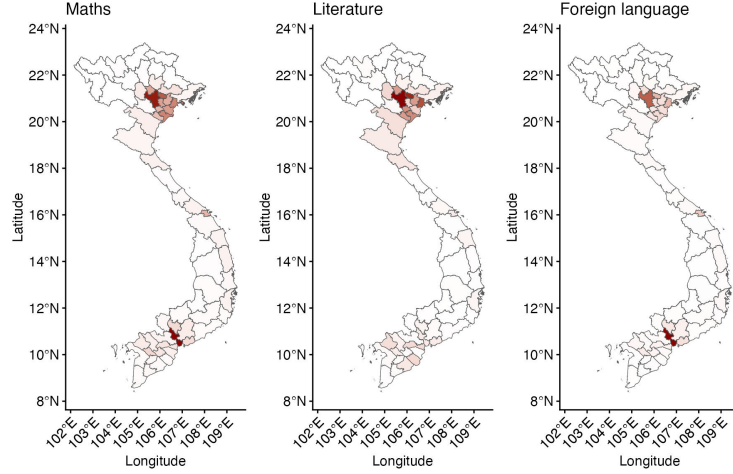


Figure 3: Density of students scoring in the top 10% in mathematics, literature, and foreign language, by province in 2024

Historical, cultural, and ethnic context. The historical and cultural variables capture the depth and persistence of Confucian influence across Vietnamese provinces. Historical Confucian elite density, measuring the number of examination degree holders per square kilometer, averages 0.025 per 1000 km² but exhibits extreme spatial concentration, with a standard deviation of 0.076 and a maximum of 0.469 per 1000 km²—indicating that most provinces had little or no recorded Confucian elite presence while a few possessed dense concentrations of Confucian scholars.

The Confucian infrastructure index was standardized to have mean zero and has a standard deviation of 1.151. Across 504 provinces, the index ranges from -0.883 to 4.140 , indicating substantial spatial heterogeneity in historical investment in Confucian institutions. Years since annexation into the Vietnamese state range from 268 to 1,057 years (mean 686.5 years, SD 357.4 years), reflecting the centuries-long southward expansion of Vietnamese territory and state authority, with newer southern provinces incorporated less than three centuries ago while northern provinces have been under Vietnamese rule for over a millennium. The composite Confucian influence index, which aggregates these historical measures through PCA, is standardized to mean zero with a standard deviation of 1.20 but displays a long positive tail with a maximum of 4.97, confirming that a small subset of provinces possess distinctively strong and enduring Confucian legacies while the majority cluster near or below zero (See Figure 4).

Ethnic composition adds another dimension of heterogeneity. Ethnic minority populations from the 2019 Population and Housing Census range from 110 to nearly 120,000 persons (mean 26,135, SD 30,715), and minority shares span from 0.03 to 16.95 percent (mean 4.17%, SD 4.05%), indicating that most provinces are ethnically homogeneous while a few are characterized by substantial minority presence. This pattern suggests systematic ethno-regional segmentation that likely correlates with geography, historical state presence, and contemporary development outcomes.

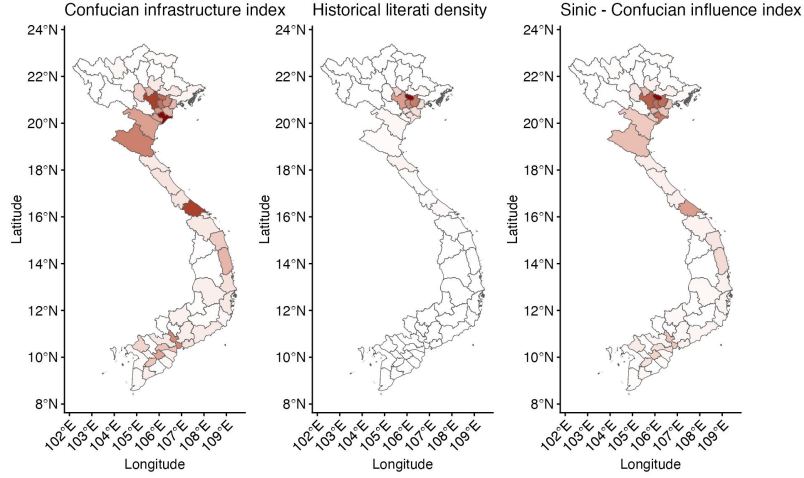


Figure 4: Spatial distribution of Confucian influence, historical Confucian elite density, and Confucian infrastructure, by province

Socioeconomic and institutional context. The socioeconomic variables reveal fundamental disparities in economic performance and state capacity across Vietnam’s provinces. GRDP per capita exhibits a strong right-skewed distribution with a mean of 74.0 million VND, standard deviation of 45.6 million VND, and a maximum of 357.2 million VND—roughly six times the median of 61.1 million VND—signaling a core-periphery economic structure in which a small set of provinces far outperform the rest. Provincial populations range from 310,000 to 9.5 million persons (mean 1.55 million, SD 1.45 million), with the largest provinces containing nearly eight times the population of the median province, reflecting Vietnam’s uneven demographic distribution.

Institutional capacity varies just as dramatically. School inputs, captured through the first principal component of teacher quality, pupil-teacher ratios, and infrastructure measures, show substantial cross-provincial variation with a standard deviation of 4.11 and a range from -13.3 to 25.6 , reflecting highly uneven investment in educational resources and capacity across the provincial landscape. Public administration capacity, measured through the first principal component of governance and fiscal indicators, shows a standard deviation of 1.72 despite being standardized to mean zero, with a range from -4.8 to 5.4 , indicating substantial variation in state capacity across provinces.

The persistence and divergence of these inequalities over time are illustrated in Table 4, which summarises how often each province appears in the national top decile between 2017 and 2024. The rankings count the number of years in which a province lies among the ten provinces with the highest density of 90th-percentile students in each subject or the highest GRDP per capita. A small set of elite provinces—notably Hà Nội, Hồ Chí Minh City, Bắc Ninh, and Hải Phòng—repeatedly enter the top decile across both academic and economic dimensions, indicating a highly persistent concentration of advantage.

However, the table also reveals a sharp disconnect between educational excellence and economic prosperity, pointing to two distinct pathways to elite status. Several northern provinces, especially Hải Dương, Hưng Yên, Thái Bình, and Nam Định, feature in the academic top decile for 7–8 years in mathematics and foreign language but never reach

the top decile of GRDP per capita, suggesting that high educational performance does not automatically translate into regional income gains. By contrast, a group of industrial provinces—such as Bà Rịa–Vũng Tàu, Bình Dương, and Đồng Nai—remain in the economic top decile for most of the period while contributing almost no years in the academic top decile, implying that export-oriented manufacturing and foreign investment can sustain high incomes without a locally produced academic elite. The pattern is geographically skewed: northern provinces dominate the academic rankings, whereas southern provinces (apart from Hồ Chí Minh City) populate the “economy-only” elite. This geographic divergence reflects Vietnam’s dual development model—one pathway based on human capital accumulation concentrated in historically Confucian northern provinces, and another based on industrial agglomeration in southern growth poles—with only the two major metropolitan areas successfully combining both dimensions of excellence.

Geographic context. Geographic fundamentals establish distinct natural endowments and constraints across Vietnam’s provincial landscape. Province area varies more than twentyfold, from 821 to 16,475 km² (mean 5,227 km², SD 3,660 km²), creating differences in both administrative scale and population density. Topographic features show considerable heterogeneity: mean elevation ranges from near sea level (1.6 m) to nearly 1,000 m (mean 250.1 m, SD 282.8 m), mean slope from essentially flat (0.03°) to steep mountainous terrain (9.75°; mean 2.70°, SD 2.65°), and terrain ruggedness from 1.9 to 476 (mean 134.6, SD 129.5), distinguishing lowland delta provinces from upland peripheral regions. Distance to the coast ranges from 1.5 to 404 km (mean 84.5 km, SD 91.5 km), while distance to major rivers varies from 0.05 to 11.2 km (mean 2.94 km, SD 2.92 km), reflecting Vietnam’s elongated coastal geography and the centrality of riverine systems to settlement and agriculture. Rice suitability, a key determinant of agricultural productivity and historical population density, ranges from 0.25 to 0.52 on a 0–1 scale (mean 0.42, SD 0.07), with higher values concentrated in the Red River and Mekong deltas. Annual mean temperature spans from 19.6°C in northern highlands to 27.7°C in southern lowlands (mean 24.2°C, SD 2.39°C), capturing Vietnam’s climatic gradient from subtropical north to tropical south.

War exposure. War exposure during the Vietnam War varied dramatically across provinces, creating differential legacies of destruction and reconstruction. Bombing missions per province ranged from 46 to 265,283 missions (mean 35,970 missions, SD 52,661 missions), while bombing intensity, measured in pounds of ordnance per square kilometer, varied from 8.7 to over 1.5 million lbs/km² (mean 80,729 lbs/km², SD 202,973 lbs/km²). Total ordnance dropped spanned six orders of magnitude, from 68,476 to nearly 7 billion pounds, with this extreme variation reflecting both the geographic concentration of military operations and differences in strategic importance across provinces. These patterns of war damage persist in contemporary development outcomes, as heavily bombed provinces face ongoing challenges from unexploded ordnance, infrastructure destruction, and population displacement.

Together, these variables establish that contemporary spatial inequality in Vietnam emerges atop pronounced differences in “first nature” geography—topography, climate, and location—as well as “second nature” factors including historical state presence, war damage, institutional capacity, and economic development.

5.2 Baseline result

The regression results summarize how historical, geographic, institutional, and contemporary factors jointly structure the spatial distribution of top-performer density across Vietnam’s provinces (Table 5). The models have substantial explanatory power for mathematics and foreign language ($R^2 = 0.723$ and 0.768 , respectively) and more moderate fit for literature ($R^2 = 0.571$). Because all variables are standardized (z-scored), coefficients can be interpreted as the standard-deviation change in top-performer density associated with a one-standard-deviation change in a predictor, enabling direct comparison of effect magnitudes across covariates and subjects. In the multivariate framework, the MANOVA indicates that most predictors have statistically detectable joint associations with performance across the three subjects, though the strength of these associations varies considerably by covariate.

Historical legacies. Time since annexation is the most consistent historical correlate of contemporary achievement, exhibiting positive and statistically significant associations in all three subject models ($\beta = 0.485$, $p < 0.001$ for mathematics; $\beta = 0.605$, $p < 0.001$ for literature; $\beta = 0.257$, $p = 0.0019$ for foreign language). Substantively, a one-standard-deviation increase in state antiquity corresponds to approximately 0.26–0.61 standard deviations higher density of top scorers, conditional on the full set of controls. The implied magnitude is largest for literature, followed by mathematics, and smallest for foreign language. The MANOVA Pillai statistic (0.286 ; $F = 64.26$, $p < 2 \times 10^{-16}$) confirms that this association is a robust cross-subject pattern rather than being driven by a single outcome.

Geographic fundamentals and agricultural potential. Geographic correlates are strong but heterogeneous across outcomes. Provinces closer to the coast perform better in mathematics and foreign language (distance-to-coast coefficients $\beta = -0.149$, $p < 0.001$ and $\beta = -0.190$, $p < 0.001$, respectively), while coastal proximity is not predictive of literature ($\beta = 0.033$, $p = 0.499$). Terrain ruggedness is a consistently negative correlate across subjects ($\beta = -0.517$ for mathematics; $\beta = -0.696$ for literature; $\beta = -0.127$ for foreign language; all $p < 0.05$), and its multivariate association is large (Pillai = 0.282 , $F = 63.07$, $p < 2 \times 10^{-16}$). Elevation shows positive associations that are marginal in mathematics and literature ($p \approx 0.05$ – 0.09) and statistically significant in foreign language ($\beta = 0.245$, $p = 0.016$), and it is jointly significant in MANOVA (Pillai = 0.219 , $F = 44.88$, $p < 2 \times 10^{-16}$).

Distance to major rivers is not predictive in mathematics or literature but is marginally positive for foreign language ($\beta = 0.053$, $p = 0.069$). Nonetheless, the joint multivariate test is significant (Pillai = 0.057 , $F = 9.74$, $p = 2.99 \times 10^{-6}$), suggesting weaker but systematic cross-subject patterning once outcomes are considered together. Rice suitability is negatively associated with literature ($\beta = -0.182$, $p < 0.001$) and marginally so for mathematics ($\beta = -0.072$, $p = 0.055$), with no detectable association for foreign language; the multivariate test is significant (Pillai = 0.034 , $F = 5.60$, $p = 0.00088$), consistent with an overall (but uneven) relationship between agrarian potential and elite exam performance.

Contemporary socioeconomic factors. Population size is the dominant contemporary predictor in all three models ($\beta = 0.552$ mathematics; $\beta = 0.232$ literature; $\beta = 0.793$

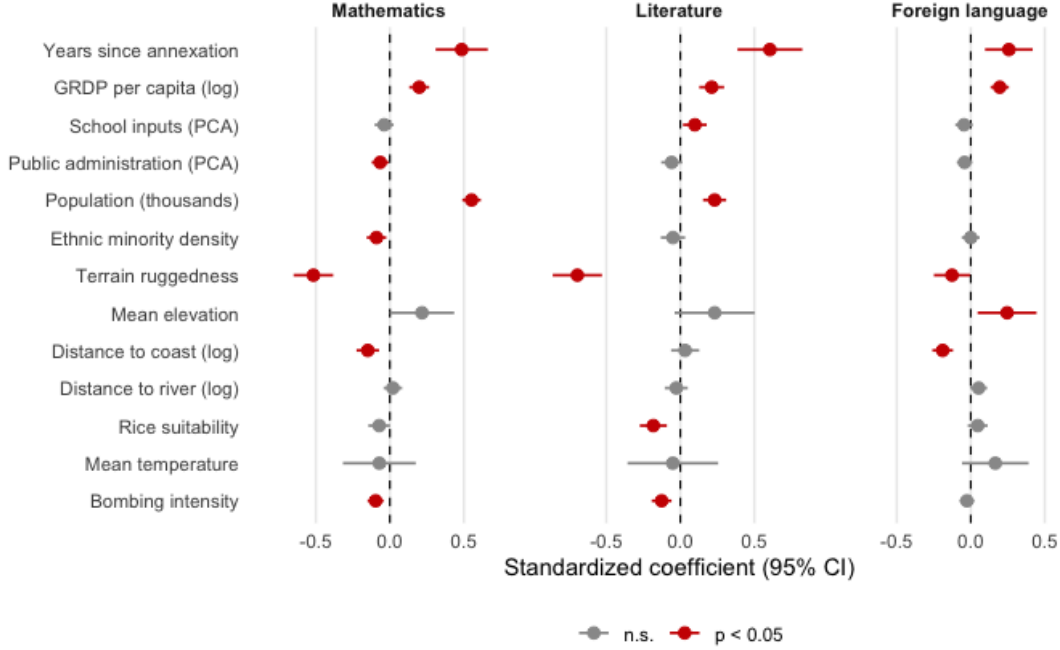


Figure 5: Baseline correlates of elite educational density across subjects

foreign language; all $p < 0.001$), and it has by far the largest multivariate association (Pillai = 0.741, $F = 459.01$, $p < 2 \times 10^{-16}$). This pattern is consistent with strong agglomeration and scale effects in the production of top exam performance, particularly pronounced for foreign language. Economic prosperity (log GRDP per capita) is also positively and consistently associated with outcomes ($\beta \approx 0.196$ – 0.212 ; all $p < 0.001$), though the magnitudes are notably smaller than those for population, implying that economic development is beneficial but does not substitute for the advantages associated with demographic scale.

Institutional capacity, demography, and war legacies. The institutional and conflict variables exhibit more differentiated patterns. The school input index is statistically significant only for literature ($\beta = 0.098$, $p = 0.0166$) and is not predictive of mathematics or foreign language, suggesting that conventional school resources are more closely aligned with performance in vernacular literary domains than with mathematics or foreign language in this specification. Public administration capacity is negatively associated with mathematics ($\beta = -0.065$, $p = 0.024$) but is not statistically distinguishable from zero in the other subject models; correspondingly, it is not jointly significant in MANOVA (Pillai = 0.009, $p = 0.228$).

War exposure (bombing intensity) has significant negative associations for mathematics and literature ($\beta = -0.096$, $p < 0.001$; $\beta = -0.126$, $p < 0.001$), but it is not predictive of foreign language ($p = 0.302$); the MANOVA nonetheless indicates a joint adverse association across outcomes (Pillai = 0.058, $F = 9.88$, $p = 2.47 \times 10^{-6}$). Finally, ethnic density is negatively associated with mathematics ($\beta = -0.090$, $p = 0.0076$) and not significant in the other two univariate models, yet it is jointly significant in MANOVA (Pillai = 0.048, $p = 3.0 \times 10^{-5}$), implying that its relationship to performance may be diffuse across subjects

even when not precisely estimated in each separate regression (see Figure 5).

5.3 Alternative specifications and additional insights.

To assess robustness and to surface nonlinearities and heterogeneity that may be obscured by the baseline linear model, we estimate three complementary specifications: (i) natural splines for years since annexation to allow flexible historical effects, (ii) province random-intercept mixed-effects models to separate persistent cross-province differences from within-province year-to-year variation, and (iii) quantile regressions to probe distributional heterogeneity.

Nonlinear historical trajectories. Allowing annexation history to enter nonlinearly using natural splines ($df = 3$) reveals pronounced curvature in the historical gradient. The multivariate test indicates that the spline term is jointly significant across outcomes (Pillai = 0.413, $F = 25.57$, $p < 2 \times 10^{-16}$). In mathematics, all three basis functions are statistically significant ($\beta_1 = 1.207$, $p = 0.0066$; $\beta_2 = 2.195$, $p < 0.001$; $\beta_3 = 0.425$, $p = 0.044$), with the second basis loading most strongly. Substantively, this pattern is compatible with the idea that provinces incorporated during periods of rapid consolidation of the feudal bureaucracy and expansion of the imperial examination system accrued disproportionate long-run advantages, relative to provinces incorporated either much earlier or much later. Literature exhibits a similarly robust nonlinear pattern, with all three basis terms significant ($\beta_1 = 1.345$, $p = 0.017$; $\beta_2 = 1.832$, $p < 0.001$; $\beta_3 = 0.972$, $p < 0.001$), suggesting a broadly strengthening historical gradient across segments of the annexation distribution. For foreign language, the first two spline components are significant ($\beta_1 = 1.006$, $p = 0.015$; $\beta_2 = 1.070$, $p < 0.001$) while the third is not ($\beta_3 = 0.297$, $p = 0.128$), indicating weaker curvature and possible diminishing marginal gains from additional centuries of incorporation for foreign-language excellence.

Structural versus time-varying inequality. Random-intercept mixed-effects models indicate that a substantial share of residual variation is persistent across provinces. In mathematics, the estimated random-intercept variance is $\sigma^2_{\text{province}} = 0.374$ versus $\sigma^2_{\text{residual}} = 0.049$, implying that approximately 88.5% of the remaining variance lies between provinces. Foreign language is even more structurally concentrated ($\sigma^2_{\text{province}} = 0.284$; $\sigma^2_{\text{residual}} = 0.023$; $\approx 92.4\%$ between), whereas literature is closer to parity ($\sigma^2_{\text{province}} = 0.245$; $\sigma^2_{\text{residual}} = 0.248$; $\approx 49.6\%$ between). Overall, spatial inequality appears predominantly structural for mathematics and foreign language, but comparatively more time-varying for literature.

Consistent with this decomposition, once province intercepts are introduced, several time-invariant predictors (including years since annexation) attenuate in statistical significance because their explanatory power is largely absorbed by stable province-level differences. Notably, the mixed-effects estimates for annexation history remain positive in literature ($\beta = 0.491$, $p = 0.049$) but are small and statistically indistinguishable from zero in mathematics ($\beta = 0.199$, $p = 0.475$) and foreign language ($\beta = 0.075$, $p = 0.754$), reinforcing the interpretation that annexation history primarily organizes cross-province level differences rather than within-province changes over time. Year effects in the mathematics mixed model are positive and increasingly large toward the end of the panel (e.g., 2024: $\beta = 0.357$, $p < 0.001$), while year effects are comparatively muted in literature and foreign language,

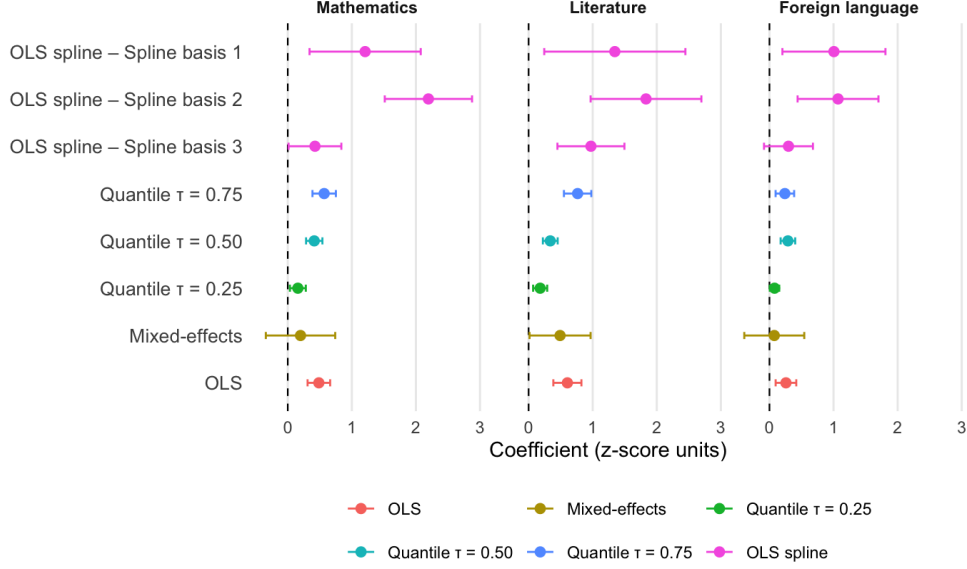


Figure 6: Effect of state antiquity (years since annexation) on top-performer density: OLS, splines, mixed-effects, and quantile regressions

suggesting recent period-specific dynamics that matter most for mathematics.

Heterogeneous effects across the performance distribution. Quantile regressions indicate that the correlates of elite educational density vary systematically across the conditional outcome distribution. Annexation history displays a clear upward gradient for mathematics: $\beta = 0.158$ at $\tau = 0.25$ ($p = 0.013$), $\beta = 0.413$ at $\tau = 0.50$ ($p < 0.001$), and $\beta = 0.568$ at $\tau = 0.75$ ($p < 0.001$). The gradient is even steeper for literature: $\beta = 0.180$ at $\tau = 0.25$ ($p = 0.0014$), $\beta = 0.338$ at $\tau = 0.50$ ($p < 0.001$), and $\beta = 0.765$ at $\tau = 0.75$ ($p < 0.001$). For foreign language, the association is statistically detectable but less monotone: $\beta = 0.079$ at $\tau = 0.25$ ($p = 0.035$), $\beta = 0.288$ at $\tau = 0.50$ ($p < 0.001$), and $\beta = 0.240$ at $\tau = 0.75$ ($p = 0.0012$). Overall, time of annexation is relevant throughout the distribution, but its association is substantially larger in higher-achieving provinces, especially for literature. Conversely, in lower-achieving provinces, the comparatively small coefficients are consistent with the interpretation that contemporary constraints (e.g., GRDP of the province) play a larger role in limiting elite production than differences in deep historical exposure alone (see Table 6).

The alternative models add three substantive refinements: (1) the annexation gradient is nonlinear and strongest over the middle part of the historical period (especially for mathematics and literature), (2) inequality in mathematics and foreign language is overwhelmingly structural across provinces rather than time-varying within provinces, and (3) the correlates of educational performance are highly heterogeneous across the distribution, especially for the upper tail. Provinces with the lowest performance may be influenced by different factors beyond historical legacy (see Figure 6).

5.4 Testing the potential pathways

To explore whether the effects of years since annexation operate through which specific historical-cultural channels, we conduct causal mediation analysis using quasi-Bayesian approximation with 1,000 simulations. We test two potential mediators: (1) the Confucian infrastructure index, capturing the density of Confucian temples, exam halls, and schooling systems; and (2) historical Confucian elite density, measuring the concentration of examination degree holders per square kilometer in the feudal period. The analysis decomposes the total effect of state antiquity into an average causal mediation effect (ACME), representing the indirect pathway through the mediator, and an average direct effect (ADE), capturing all other mechanisms (see Table 1).

	Mathematics		Literature		Foreign language	
	Imperial elites	Confucian infrastructure	Imperial elites	Confucian infrastructure	Imperial elites	Confucian infrastructure
ACME	0.121 [†] [-0.006, 0.248]	0.652*** [0.415, 0.911]	0.118* [0.004, 0.255]	0.412*** [0.248, 0.594]	0.038 [-0.011, 0.113]	0.689*** [0.438, 0.970]
ADE	-0.172 [-0.568, 0.201]	-0.173 [-0.550, 0.209]	0.124 [-0.266, 0.521]	0.119 [-0.301, 0.535]	-0.435 [†] [-0.918, 0.036]	-0.428 [†] [-0.957, 0.098]
Total effect	-0.051 [-0.449, 0.358]	0.479* [0.056, 0.903]	0.242 [-0.164, 0.656]	0.531* [0.094, 0.952]	-0.396 [†] [-0.879, 0.087]	0.261 [-0.305, 0.805]
Prop. mediated	-0.202 [-9.565, 9.390]	1.342* [0.669, 6.228]	0.369 [-4.205, 3.862]	0.772* [0.381, 3.642]	-0.073 [-0.887, 0.583]	1.814 [-23.546, 22.379]

Notes: Entries are point estimates with 95% quasi-Bayesian confidence intervals in brackets. All models use $N = 504$ observations and 1,000 simulations. [†] $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 1: Causal mediation analysis by subject and mediator

Confucian infrastructure as mediator. Confucian infrastructure emerges as a central pathway linking state antiquity to contemporary exam performance, with large and precisely estimated indirect effects for mathematics and literature. For mathematics, the mediated effect is strong (ACME = 0.6519, 95% CI [0.4155, 0.9113], $p < 2 \times 10^{-16}$), while the direct effect is negative but statistically indistinguishable from zero (ADE = -0.1726, 95% CI [-0.5496, 0.2091], $p = 0.408$). The total effect remains positive and statistically significant (Total = 0.4793, 95% CI [0.0564, 0.9026], $p = 0.028$), and the proportion mediated exceeds one (Prop. mediated = 1.3418, 95% CI [0.6689, 6.2276], $p = 0.028$), indicating a suppression pattern in which a positive indirect pathway coexists with an offsetting (negative) direct component.

Results are similar for literature. The infrastructure-mediated effect is again large and highly significant (ACME = 0.4117, 95% CI [0.2477, 0.5943], $p < 2 \times 10^{-16}$), whereas the direct effect is imprecise and not statistically significant (ADE = 0.1194, 95% CI [-0.3009, 0.5347], $p = 0.590$). The total effect is positive and significant (Total = 0.5311, 95% CI [0.0938, 0.9516], $p = 0.014$), with a sizable mediated share (Prop. mediated = 0.7717, 95% CI [0.3814, 3.6425], $p = 0.014$). Together, these patterns suggest that provinces incorporated earlier into the Vietnamese state translate historical advantages into mathematics and literature excellence primarily through durable investments in Confucian educational institutions.

For foreign language, the pattern differs: although the indirect effect via infrastructure is large and precisely estimated (ACME = 0.6892, 95% CI [0.4377, 0.9701], $p < 2 \times 10^{-16}$), the total effect is small and not statistically significant (Total = 0.2613, 95% CI [-0.3047, 0.8051],

$p = 0.364$) because the direct component is negative and only marginal (ADE = -0.4279 , 95% CI $[-0.9574, 0.0985]$, $p = 0.094$). The implied proportion mediated is therefore unstable and very imprecisely estimated (Prop. mediated = 1.8138 , 95% CI $[-23.5461, 22.3791]$, $p = 0.364$). Substantively, this configuration is consistent with foreign-language excellence being shaped by additional, more recent forces that can counteract (or obscure) the historical infrastructure channel, such as contemporary urban exposure, labor-market demand, and international integration.

Historical Confucian elite density as mediator. Mediation through historical Confucian elite density is weaker and less uniform than the infrastructure channel, with limited evidence of a robust pathway once sampling uncertainty is taken seriously. For mathematics, the indirect effect is positive but only marginally significant (ACME = 0.1211 , 95% CI $[-0.0062, 0.2483]$, $p = 0.058$), while both the direct effect (ADE = -0.1720 , 95% CI $[-0.5675, 0.2008]$, $p = 0.390$) and the total effect (Total = -0.0509 , 95% CI $[-0.4489, 0.3577]$, $p = 0.818$) are statistically indistinguishable from zero. Given a near-zero total effect, the implied proportion mediated is unstable and substantively uninformative (Prop. mediated = -0.2017 , 95% CI $[-9.5649, 9.3902]$, $p = 0.860$).

For literature, the elite-density pathway is statistically significant but modest in magnitude (ACME = 0.1179 , 95% CI $[0.0043, 0.2550]$, $p = 0.042$). However, neither the direct component (ADE = 0.1237 , 95% CI $[-0.2662, 0.5208]$, $p = 0.524$) nor the total effect (Total = 0.2417 , 95% CI $[-0.1644, 0.6557]$, $p = 0.256$) is precisely estimated, so the evidence supports (at most) a small mediated association rather than a dominant pathway; correspondingly, the proportion mediated is imprecise (Prop. mediated = 0.3694 , 95% CI $[-4.2050, 3.8619]$, $p = 0.274$).

For foreign language, there is no evidence of mediation through elite density (ACME = 0.0381 , 95% CI $[-0.0110, 0.1130]$, $p = 0.152$), while the direct effect is negative and only marginal (ADE = -0.4346 , 95% CI $[-0.9175, 0.0361]$, $p = 0.074$) and the total effect remains negative but imprecise (Total = -0.3965 , 95% CI $[-0.8788, 0.0868]$, $p = 0.114$). Overall, historical examination-elite concentration does not appear to provide a consistently detectable channel in these specifications, especially relative to the much stronger and more stable mediation results for Confucian infrastructure.

Sensitivity to unobserved confounding. The mediation estimates rely on sequential ignorability of the treatment–mediator relationship. We therefore conduct the sensitivity analysis of Imai et al. (2010), which parameterizes violations of ignorability via the correlation ρ between the mediator- and outcome-model error terms and reports the value of ρ (and associated partial- R^2 measures) at which the ACME would be driven to zero. Overall, the inferred robustness varies by mediator and subject.

For *Confucian infrastructure*, the inferred robustness of the ACME is strongest for mathematics and more moderate for the other subjects. In mathematics, the indirect effect is eliminated only when the residual correlation reaches $\rho = 0.50$ (equivalently, $R_M^2 \times R_Y^2 = 0.25$ and $R_{M \sim Y}^2 = 0.058$), implying that an unobserved confounder would need to explain roughly one quarter of the remaining variance in *both* the mediator and outcome equations to drive the mediation effect to zero. In literature, the ACME crosses zero at $\rho = 0.30$ ($R_M^2 \times R_Y^2 = 0.09$; $R_{M \sim Y}^2 = 0.024$), indicating moderate sensitivity. In foreign language, the corresponding

threshold is $\rho = 0.40$ ($R_M^2 \times R_Y^2 = 0.16$; $R_{M \sim Y}^2 = 0.063$), suggesting greater robustness than the elite-density channel but weaker robustness than the mathematics–infrastructure case.

For *Confucian elite density*, the ACME is driven to zero at $\rho = 0.30$ for mathematics ($R_M^2 \times R_Y^2 = 0.09$; $R_{M \sim Y}^2 = 0.023$) and at the same threshold for literature ($\rho = 0.30$; $R_M^2 \times R_Y^2 = 0.09$; $R_{M \sim Y}^2 = 0.026$), indicating *moderate* sensitivity: eliminating the estimated mediation effect would require an unobserved factor that jointly explains roughly 9% of the residual variation in both the mediator and outcome models. By contrast, the foreign-language ACME through elite density is substantially more fragile: it crosses zero already at $\rho = 0.10$ ($R_M^2 \times R_Y^2 = 0.01$; $R_{M \sim Y}^2 = 0.0043$), implying that a relatively weak unobserved confounder could overturn the sign of the indirect effect.

Taken together, the sensitivity analysis supports three conclusions. First, the infrastructure pathway for mathematics is the most robust to plausible levels of unobserved confounding (largest ρ and $R_M^2 \times R_Y^2$ thresholds). Second, mediation through elite density is at best moderately robust for mathematics and literature and is fragile for foreign language. Third, where the estimated total effects are weak or imprecise (especially in foreign language), interpretation of mediated shares should remain cautious even when point estimates of ACME are positive, because relatively modest violations of ignorability can attenuate or reverse the inferred indirect effect.

6 Conclusion

This study provides evidence that historical state integration and Sino Confucian institutional penetration continue to shape educational outcomes in contemporary Vietnam. Drawing on provincial analysis of annexation timing and causal mediation decomposition, I document multiple channels through which historical institutions persist across centuries. Earlier annexation into the Vietnamese state predicts higher contemporary educational achievement. Each additional century of state integration is associated with a higher density of high performing students in the national high school exam, even after conditioning on contemporary economic development, geographic characteristics, and war exposure. This total effect likely reflects longer exposure to Confucian examination institutions, deeper development of educational infrastructure, denser scholarly elite networks, and the intergenerational transmission of educational values. The subject specific pattern is revealing: strong effects on mathematics but weaker or null effects on literature and foreign language. This suggests that Confucian legacies are especially salient for quantitative reasoning and meritocratic competition rather than vernacular literacy or international integration.

These effects are particularly pronounced in the upper tail of the achievement distribution, which helps explain Vietnam’s strong performance in international assessments. This pattern suggests that a century of imperial examination culture and beliefs about the importance of testing and education primarily benefit high achieving students. In the lower quantiles, other barriers to educational achievement may be more determinative, indicating that historical legacy alone cannot overcome contemporary structural constraints. The picture of educational achievement is thus multifaceted. While geographical conditions set prior constraints, institutions evolving across different generations and eras create a more complex layering that generates contemporary outcomes.

Causal mediation analysis clarifies how these legacies operate and reveals striking asymmetries across pathways and subjects. Decomposing the total effect of state antiquity into pathways through Confucian elite density, measured by historical examination graduates and their descendants, versus institutional infrastructure, measured by temples, academies, and examination halls, shows that these channels contribute unequally and their relative importance varies substantially across contexts and subjects. The infrastructure pathway emerges as the dominant mechanism. For mathematics and literature, the mediated effect through Confucian infrastructure is large and precisely estimated, accounting for most or all of the total positive effect. This suggests that provinces incorporated earlier translate historical advantages into contemporary excellence primarily through durable investments in Confucian educational institutions: buildings that became modern schools, clusters of teachers from scholarly families, and community identities organized around educational achievement. For foreign language, however, the infrastructure effect is large but the total effect is small and insignificant due to a negative direct component, suggesting that foreign language excellence is shaped by additional, more recent forces that counteract the historical infrastructure channel.

By contrast, the elite density pathway is substantially weaker and less consistent across all subjects. Historical examination elite concentration does not provide a consistently detectable channel, especially relative to the much stronger mediation results for Confucian infrastructure. These asymmetries carry important theoretical implications. Infrastructure mediates through tangible, geographically fixed assets: the physical conversion of temples and exam halls into modern schools, the concentration of teachers descended from scholarly families, and the crystallization of community identities organized around educational achievement. These material legacies persist across regime changes and economic transformations. Elite density, by contrast, was hypothesized to operate via intergenerational transmission within lineages and local scholarly networks that sustain norms around educational investment, tutoring, and examination preparation. The weak mediation results suggest either that this pathway operates through mechanisms not adequately captured by simple density measures, or that elite networks proved more vulnerable to disruption by colonialism, war, socialist land reform, and population displacement than physical infrastructure.

The substantial direct effects remaining after accounting for both mediators point to additional unmeasured pathways. These likely include broader cultural attitudes transmitted through non declarative learning, parenting practices that emphasize discipline and deferred gratification, peer effects within schools and communities, and labor market structures that continue to reward educational credentials in ways that reflect historical status hierarchies. The fact that infrastructure mediates more strongly than elite networks may also reflect measurement limitations: our elite density variable captures formal examination success but misses informal scholarly lineages, tutoring networks, and marriage alliances that transmitted educational values across generations without leaving bureaucratic traces.

These findings fundamentally challenge the epistemological foundations of comparative education research. The conventional approach to studying developing countries begins with an implicit Western template: researchers identify what these countries lack relative to industrialized nations, then search for universal predictors that might close those gaps. This deficit framing systematically misrecognizes the problem. Vietnam does not underperform relative to its structural indicators; it dramatically outperforms them. The real puzzle is not

why Vietnam falls short of Western standards, but why Western centric analytical frameworks fail so spectacularly to account for its success.

The roughly 70 percent of Vietnam's educational performance in [Dang et al. \(2023b\)](#) left unexplained by conventional factors exposes a deeper theoretical and methodology challenges. This is not merely missing data or measurement error to be addressed through more sophisticated controls or better instrumentation. It represents the systematic exclusion of historical processes that fall outside the narrow temporal and conceptual boundaries of modernization paradigms. Standard development indicators assume that educational achievement is primarily a function of contemporary resources: GDP per capita, school infrastructure, teacher qualifications, household wealth. These variables matter, but they explain little of the variance. The remaining might reflects institutional legacies, cultural practices, and cognitive dispositions shaped over centuries, transmitted through mechanisms that remain invisible to frameworks designed to explain Western European industrialization.

When studying Vietnam or other developing nations, researchers face a fundamental choice. They can continue asking which universal indicators best explain outcomes across all contexts, treating historical and cultural specificity as noise to be controlled away in pursuit of generalizable coefficients. Or they can ask what crucial factors from each country's distinctive trajectory are being systematically overlooked by frameworks that privilege recent, quantifiable, policy manipulable variables over deep, qualitative, culturally embedded processes. This study demonstrates that country specific historical trajectories are not just contextual details to acknowledge in a limitations section. They are central causal mechanisms that determine contemporary outcomes in ways that universal frameworks cannot capture.

Universal frameworks offer undeniable advantages: analytical parsimony, cross national comparability, clear policy levers. But these benefits come at a serious cost. By excluding institutional legacies that unfold over centuries rather than decades, cultural transmission that operates through embodied practice rather than explicit instruction, and elite reproduction that persists through informal networks rather than formal credentials, standard models systematically misspecify the causal structure they purport to estimate. The result is not just incomplete explanation but actively misleading inference. Policies designed on the assumption that teacher training or infrastructure investment will produce Vietnamese style performance in other contexts ignore the reality that Vietnamese achievement rests substantially on foundations laid centuries before modern education policy existed.

Understanding these legacies requires reorienting the entire research enterprise. Rather than beginning from deficit thinking, which asks why developing countries underperform relative to Western benchmarks, researchers must explain exceptional performance through historically rooted capacities that conventional indicators fail to measure. Vietnam's strong PISA results reflect a culture of learning institutionalized through imperial examinations, transmitted across generations through both declarative knowledge in texts and rituals and nondeclarative dispositions acquired through immersion in educational communities. These processes predate modern economic development, resist policy manipulation, and operate through channels that remain largely invisible to contemporary institutional analysis.

For policy, the implications are sobering. Efforts to reduce spatial inequalities in education cannot rely exclusively on equalizing resources or improving school quality. The fact that historically Confucian provinces achieve dramatically higher outcomes despite comparable school inputs reveals that household demand and cultural norms, not school supply, constitute

the binding constraint in many contexts. Interventions that ignore these deep rooted differences risk investing heavily in supply side reforms that leave demand unchanged. Policies that reshape beliefs about educational competition, broaden conceptions of merit beyond high stakes examinations, or create alternative pathways to success may be necessary complements to traditional reforms focused on equalizing teacher quality or infrastructure. But such cultural interventions face their own challenges: the very persistence mechanisms that allow Confucian legacies to endure for centuries also make them resistant to deliberate policy change.

Several limitations warrant acknowledgment. The analysis focuses primarily on test scores, leaving open questions about broader outcomes such as years of schooling, tertiary completion rates, or labor market trajectories. While geographic and historical controls are extensive, they remain incomplete. More granular measures of terrain, infrastructure development, and conflict exposure would help further isolate Confucian effects from correlated factors. The transmission mechanisms linking imperial examination institutions to contemporary behavior are inferred from observational patterns rather than directly traced through archival or ethnographic evidence. Future research combining quantitative analysis with qualitative evidence on household decision making processes could sharpen understanding of these mechanisms. Extending the design to additional administrative boundaries or finer geographic units would test whether similar patterns emerge in other contexts and at different spatial scales.

Despite these caveats, the evidence provides robust support for the hypothesis that Sino-Confucian institutional legacies continue to shape educational outcomes in Vietnam. These legacies are heterogeneous rather than uniform. They vary with geographic location, attenuate in ethnically diverse areas, and are mediated by both human capital networks and physical infrastructure. Yet they consistently illustrate how historical state building projects can produce long lived cultural patterns that persist well after the original institutions have formally disappeared, shaping behavior through channels that remain largely invisible to contemporary policy analysis. A truly comparative social science must therefore balance the pursuit of generalizable frameworks with serious engagement with historically grounded, context specific mechanisms. The field cannot continue treating 70 percent unexplained variance as an acceptable cost of analytical parsimony.

Appendix

Data on Vietnamese National High School Examination

To construct a consistent dataset of provincial examination results spanning 2017–2023, I relied on multiple online sources. Because the Ministry of Education and Training does not provide an official open-access archive, data had to be compiled from news portals and community efforts. Each period required a different strategy, as outlined below:

- **2017:** Data were sourced from *Báo Tin Tức* (Tin Tuc Newspaper)³, which was the only outlet providing comprehensive examination results for all 63 provinces and cities in

³<https://baotintuc.vn/tuyen-sinh/tra-cuu-diem-thi-thpt-2017-cua-63-tinh-thanh-pho-tren-baotintucvn-20170706073512672.htm>

YearID	Maths		Literature		Foreign Language	
	Count	Prov.	Count	Prov.	Count	Prov.
2017	843567	62	823731	62	740001	61
2018	811401	63	797705	63	722956	63
2019	874885	63	864825	63	789380	63
2020	877413	63	867155	63	781968	63
2021	1110431	63	1107505	63	987356	63
2022	982726	63	981407	63	870609	63
2023	1003373	63	1008239	63	880997	63
Total	7,004,396	440	6,957,567	440	6,672,268	439

Table 2: Student counts and provincial coverage in 2017–2023

Vietnam. However, the dataset for 2017 remains incomplete: Phú Yên (ID 39) is missing results for Mathematics and Literature, while both Phú Yên and another province (ID 45) are missing for Foreign Language.

- **2018–2020:** Examination data for this period were obtained from *Thông Tấn Xã Việt Nam* (The Vietnam News Agency)⁴, which served as an authoritative and centralized repository for national results. The site hosted multiple years of data prior to 2020, providing continuity and reliability in coverage. Because the data were not directly available in bulk, we employed personal web-scraping methods to extract and compile the provincial-level results.
- **2020–2023:** Data for these years were collected from *Vietnamnet*⁵, a well-established news portal that regularly publishes updated and accurate information on national examination outcomes. The raw datasets were first circulated online through community web-scraping initiatives. I then performed independent verification and conducted additional scraping to fill gaps and ensure the completeness of provincial-level coverage.

Operationalization of Control Variables

This appendix provides detailed information on the construction and sources of all control variables used in the analysis (Table 3). The unit of observation is the province–year. Province identifiers (`prov_key`, `provincial_id`) and year are taken from administrative sources and harmonized across datasets.

⁴<https://diemthi.vnnet.vn>

⁵<https://vietnamnet.vn/giao-duc/diem-thi>

Standardization Procedure

All continuous variables are standardized (z-scored) within the estimation sample to have mean zero and unit variance, as indicated by the `_z` suffix:

$$x_z = \frac{x - \bar{x}}{s(x)},$$

where $\bar{x}$ is the sample mean and $s(x)$ is the sample standard deviation. This transformation facilitates interpretation of coefficients as effect sizes (in standard deviation units) and allows direct comparison of magnitudes across variables measured in different units. Standardization is performed after any logarithmic transformations (e.g. `log_grdp_pc`, `dist_coast_log1p`) and missing-value treatment, consistent with best practices in applied econometrics when comparing coefficients across heterogeneous measures (?).

Geographic characters

Mean elevation (`elev_mean_z`). Average elevation in meters above sea level within the province, derived from a digital elevation model (DEM) using standard terrain operators and aggregated to provinces via area-weighted extraction. Elevation affects agricultural productivity, disease environment, and historical settlement patterns.

Mean slope (`slope_mean_z`). Average terrain slope in degrees within the province, derived from the same DEM. Slope measures the steepness of terrain, which affects agricultural practices and infrastructure development.

Mean ruggedness (`rugg_mean_z`). Terrain ruggedness index calculated following ?, measuring the average absolute difference in elevation between adjacent grid cells. Rugged terrain historically impeded state reach, market integration, and school construction. This geographical control captures historical determinants of prosperity that may not be fully reflected in contemporary measures.

Mean temperature (`temp_mean_z`). Annual mean of monthly WorldClim temperatures (converted to °C), obtained from WorldClim 2.1 gridded climate data (?). Temperature influences agricultural productivity, disease prevalence, and labor productivity, representing a historical determinant of regional development.

Rice suitability (`rice_suit_z`). A continuous measure of agricultural suitability for rice cultivation, computed with the ALUES framework from province-average monthly precipitation and temperature profiles (with a plausible sowing month). The index combines climate, soil, and terrain characteristics to estimate potential rice yields under rain-fed conditions. Higher values indicate greater suitability for rice production, which historically determined population density and surplus available for education. Rice suitability serves as a control for historical determinants of prosperity in the premodern period that are not fully reflected in contemporary socioeconomic indicators.

Distance to coast (`dist_coast_log1p_z`). Great-circle distance (km) from each province's representative point to the nearest coastline, calculated after transforming to a metric coordinate reference system. The variable is transformed as $\log(1 + \text{distance})$ to account for diminishing marginal effects of distance. Coastal proximity proxies for historical maritime trade access and contemporary economic opportunities.

Distance to river (*dist_river_log1p_z*). Great-circle distance (km) from each province’s representative point to the nearest major waterway (river), calculated in a metric coordinate reference system and transformed as $\log(1 + \text{distance})$. Rivers facilitated transportation, communication, and state penetration in pre-modern Vietnam, serving as another key geographical determinant of historical prosperity.

Provincial Characteristics

Population in thousands (*pop_thousands_z*). Provincial population divided by 1,000, obtained from annual population estimates by the General Statistics Office ([General Statistics Office of Viet Nam, 2025](#)) for 2017–2023. Population size reflects market scale and demand for educational services.

Ethnic minority density (*ethnic_density_z*). The proportion of the provincial population belonging to ethnic minority groups (non-Kinh), calculated from the 2019 Population and Housing Census ([Minnesota Population Center, 2020](#)):

$$\text{ethnic_density} = \frac{\text{ethnic_count}}{\text{total_pop}}.$$

Ethnic minorities in Vietnam face structural disadvantages—such as linguistic barriers, geographic isolation, and limited mobility—that may confound the relationship between cultural institutions and educational outcomes. Including this measure helps distinguish cultural divergence from structural exclusion. Ethnolinguistic heterogeneity may independently affect educational performance through mechanisms unrelated to historical Confucian institutions.

Log GRDP per capita (*log_grdp_pc_z*). Natural logarithm of provincial Gross Regional Domestic Product per capita (in constant 2010 Vietnamese dong), obtained from Vietnam’s General Statistics Office ([General Statistics Office of Viet Nam, 2025](#)) for 2017–2023. GRDP per capita is deflated using province-specific consumer price indices to capture real income growth. As the primary indicator of local development, GRDP reflects variation in material resources available for investment in education, consistent with standard practices in the study of regional inequality where subnational GDP is a critical covariate. This measure controls for contemporary economic capacity that may independently affect educational outcomes.

Bombs per km² (*bombs_per_km2_z*). Density of US bombing during the Vietnam War (1965–1975), measured as total tonnage of ordnance dropped per square kilometer. War exposure is constructed from THOR mission records ([United States Air Force, 2016](#)) by spatially assigning each mission to a province polygon, summing `WeaponsLoadedWeight` to obtain `total_bombs`, counting missions for `mission_count`, and normalizing by province area (`area_km2`) computed from GADM level-1 polygons in an equal-area CRS:

$$\text{bombs_per_km2} = \frac{\text{total_bombs}}{\text{area_km2}}.$$

The variable is log-transformed to reduce skewness, following [Le and Nguyen \(2020\)](#). Wartime bombing is known to have long-term consequences for human capital formation through

infrastructure destruction, population displacement, and disruption of educational systems. Including this variable helps isolate the effect of cultural institutions from war-induced underdevelopment and ensures that our estimates do not conflate historical institutional exposure with conflict-related damage.

School input index (*school_input_pca_z*). A composite measure of educational resource availability constructed via principal components analysis (PCA) using annual data from 2017–2023. School inputs are derived from counts of schools, teachers, classrooms, and students by level (primary, lower secondary, upper secondary) from the General Statistics Office ([General Statistics Office of Viet Nam, 2025](#)). These stocks are converted to: (i) densities per 100 km² and per 100,000 people, and (ii) standard ratios (student–teacher, student–classroom, teacher–classroom) plus schools per student, computed overall and by level. After forming the densities and ratios, we standardize the variables and impute occasional missing values with regularized PCA. We then apply PCA and retain the first principal component as our summary measure. This approach improves measurement validity and reduces noise relative to single indicators, following established practices in the economics of education. Higher values indicate greater and/or better educational inputs, reflecting better-resourced educational systems with greater capacity to support student achievement.

Public administration index (*public_admin_pca_z*). A composite measure of provincial governance quality and state capacity, constructed via PCA using data from the Provincial Governance and Public Administration Performance Index (PAPI) for 2011–2023 ([CECODES and UNDP, 2023](#)). PAPI subindices include: (i) participation at local levels; (ii) transparency in decision-making and information disclosure; (iii) vertical accountability and responsiveness to citizen complaints; (iv) control of corruption in public administration; (v) public administrative procedures; (vi) public service delivery; (vii) environmental governance; and (viii) e-governance. We standardize all subindices and apply PCA, retaining the first principal component as our measure of overall administrative quality. This reduces multicollinearity and overfitting while preserving institutional heterogeneity, in line with methods commonly used in cross-country governance research. Higher values reflect stronger administrative capacity and better governance, which may facilitate educational policy implementation and service delivery.

Temporal Controls

Year fixed effects are included in all regressions to absorb time-varying national shocks, including changes in examination difficulty, curriculum reforms (such as the introduction of new textbooks or assessment methods), COVID-19-related disruptions to schooling (particularly in 2020–2021), and macroeconomic conditions affecting all provinces equally. The panel spans 2017–2023 for most variables, with PAPI data available from 2011 onward for robustness checks.

Variable	Provinces	Years	Mean	SD	Min	Median	Max
Time-varying variables (province–year level, $N = 504$)							
Panel A: Education outcomes							
Top performers density: Foreign language	63	8	0.550	1.236	0.000	0.149	9.207
Top performers density: Literature	63	8	0.728	1.197	0.000	0.252	8.234
Top performers density: Mathematics	63	8	0.677	1.103	0.000	0.226	7.062
Panel B: Population, GRDP, school inputs & governance							
Population (thousands)	63	8	1554.308	1452.149	309.900	1233.250	9543.600
GRDP per capita	63	8	74.012	45.614	22.350	61.095	357.230
Public administration (PC1)	63	8	0.000	1.715	-4.825	0.000	5.381
School inputs (PC1)	63	8	0.000	4.109	-13.321	0.000	25.598
Time-invariant variables (province level, $N = 63$)							
Panel C: Historical, cultural, and ethnicity							
Confucian infrastructure index	504	1	0.000	1.151	-0.883	-0.469	4.140
Historical literati density (per 1000 km ²)	504	1	24.949	75.605	0.000	0.000	468.776
Years since annexation (to 2025)	504	1	686.540	357.387	268.000	554.000	1057.000
Ethnic minority population	63	1	26134.921	30715.395	110.000	9192.000	119870.000
Ethnic minority share	63	1	4.166	4.051	0.032	2.815	16.954
Panel D: Geography & climate							
Annual mean temperature (°C)	63	1	24.202	2.387	19.573	23.815	27.730
Distance to coast (km)	63	1	84.495	91.512	1.481	48.940	403.949
Distance to major river (km)	63	1	2.943	2.924	0.049	1.624	11.205
Mean elevation (m)	63	1	250.076	282.753	1.573	166.372	997.862
Mean slope (degrees)	63	1	2.697	2.648	0.027	2.310	9.753
Province area (km ²)	63	1	5226.507	3660.318	821.288	4611.840	16474.602
Rice suitability index (0–1)	63	1	0.417	0.070	0.250	0.435	0.521
Terrain ruggedness	63	1	134.636	129.549	1.893	116.700	476.040
Panel E: War exposure							
Bombing missions (count)	63	1	3.596982e+04	5.266059e+04	46.000	13779.000	265283.000
Bombs per km ²	63	1	8.072857e+04	2.029732e+05	8.652	19263.142	1512900.126
Total bombs (lbs)	63	1	4.027021e+08	9.922445e+08	68476.000	75504313.000	6979012895.000

Table 3: Descriptive statistics, 63 provinces $\times$ 8 years (504 province–year observations)

Province (VN)	Province (EN)	Macro-region	Maths	Literature	Foreign language	GRDP per capita
Bắc Ninh	Bac Ninh	North	8	7	8	8
Đà Nẵng	Da Nang	Central	8	0	8	2
Hải Dương	Hai Duong	North	8	7	7	0
Hà Nội	Hanoi	North	8	8	8	8
Hồ Chí Minh City	Ho Chi Minh City	South	8	6	8	8
Hưng Yên	Hung Yen	North	8	2	8	0
Thái Bình	Thai Binh	North	8	4	8	0
Hải Phòng	Hai Phong	North	7	7	7	8
Nam Định	Nam Dinh	North	7	7	7	0
Hà Nam	Ha Nam	North	5	8	1	0
Vĩnh Phúc	Vinh Phuc	North	4	8	7	8
Ninh Bình	Ninh Binh	North	1	6	0	0
Cần Thơ	Can Tho	South	0	4	0	1
An Giang	An Giang	South	0	2	0	0
Tiền Giang	Tien Giang	South	0	2	0	0
Hậu Giang	Hau Giang	South	0	1	0	0
Phú Thọ	Phu Tho	North	0	1	0	0
Bà Rịa–Vũng Tàu	Ba Ria–Vung Tau	South	0	0	3	8
Bình Dương	Binh Duong	South	0	0	0	8
Đồng Nai	Dong Nai	South	0	0	0	8
Quảng Ninh	Quang Ninh	North	0	0	0	8
Thái Nguyên	Thai Nguyen	North	0	0	0	5

Table 4: Provinces by number of years in the top decile for academic performance and GRDP, 2017–2024

	Mathematics			Literature			Foreign language		
	OLS	Spline OLS	Mixed	OLS	Spline OLS	Mixed	OLS	Spline OLS	Mixed
<i>Historical legacy</i>									
Years since annexation (z)	0.485*** (0.090)	–	0.199 (0.276)	0.605*** (0.112)	–	0.491* (0.243)	0.257*** (0.082)	–	0.075 (0.239)
Annexation spline, basis 1	–	1.207** (0.443)	–	–	1.345* (0.562)	–	–	1.006* (0.410)	–
Annexation spline, basis 2	–	2.195*** (0.347)	–	–	1.832*** (0.441)	–	–	1.070*** (0.322)	–
Annexation spline, basis 3	–	0.425* (0.210)	–	–	0.972*** (0.267)	–	–	0.297 (0.195)	–
<i>Socioeconomic & demographic context</i>									
Population (thousands, z)	0.552*** (0.032)	0.552*** (0.031)	0.841*** (0.079)	0.232*** (0.040)	0.233*** (0.040)	0.302*** (0.073)	0.793*** (0.029)	0.794*** (0.029)	0.912*** (0.067)
Ethnic minority share (z)	-0.090** (0.034)	-0.051 (0.034)	-0.107 (0.107)	-0.050 (0.042)	-0.036 (0.043)	-0.069 (0.092)	-0.001 (0.031)	0.021 (0.032)	-0.013 (0.092)
log GRDP per capita (z)	0.198*** (0.034)	0.168*** (0.035)	-0.069 (0.053)	0.212*** (0.043)	0.204*** (0.044)	0.107 (0.079)	0.196*** (0.032)	0.182*** (0.032)	0.017 (0.039)
<i>School inputs & administration</i>									
School inputs (PC1, z)	-0.039 (0.033)	-0.037 (0.032)	-0.045** (0.014)	0.098* (0.041)	0.099* (0.041)	0.067* (0.031)	-0.046 (0.030)	-0.045 (0.030)	-0.005 (0.010)
Public administration (PC1, z)	-0.065* (0.029)	-0.052 (0.029)	0.009 (0.013)	-0.058 (0.036)	-0.056 (0.037)	0.013 (0.030)	-0.042 (0.027)	-0.037 (0.027)	0.020* (0.009)
<i>War exposure</i>									
Bombs per km ² (z)	-0.096*** (0.028)	-0.126*** (0.034)	-0.051 (0.088)	-0.126*** (0.034)	-0.152*** (0.043)	-0.115 (0.076)	-0.026 (0.025)	-0.059 (0.031)	0.003 (0.077)
<i>Geography & agricultural potential</i>									
Rice suitability (z)	-0.072 (0.037)	-0.049 (0.038)	-0.001 (0.117)	-0.182*** (0.047)	-0.167*** (0.048)	-0.150 (0.102)	0.047 (0.034)	0.068 (0.035)	0.097 (0.102)
Distance to coast, log1p (z)	-0.149*** (0.039)	-0.116** (0.039)	-0.200 (0.125)	0.033 (0.048)	0.044 (0.049)	0.019 (0.107)	-0.190*** (0.036)	-0.172*** (0.036)	-0.220* (0.109)
Distance to river, log1p (z)	0.021 (0.032)	0.008 (0.032)	-0.009 (0.103)	-0.027 (0.040)	-0.026 (0.041)	-0.039 (0.088)	0.053 (0.029)	0.052 (0.030)	0.035 (0.090)
Mean elevation (z)	0.217 (0.111)	0.291** (0.111)	-0.046 (0.335)	0.232 (0.138)	0.249 (0.141)	0.139 (0.297)	0.245* (0.102)	0.275** (0.103)	0.082 (0.289)
Terrain ruggedness (z)	-0.517*** (0.068)	-0.679*** (0.076)	-0.369 (0.215)	-0.696*** (0.085)	-0.750*** (0.096)	-0.653*** (0.186)	-0.127* (0.062)	-0.212** (0.070)	-0.036 (0.186)
Annual mean temperature (z)	-0.071 (0.126)	-0.053 (0.123)	-0.383 (0.390)	-0.051 (0.156)	-0.047 (0.156)	-0.160 (0.341)	0.166 (0.115)	0.172 (0.114)	-0.024 (0.337)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province random intercept	No	No	Yes	No	No	Yes	No	No	Yes
Observations	504	504	504	504	504	504	504	504	504
Provinces	63	63	63	63	63	63	63	63	63

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $p < 0.10$.

Table 5: Determinants of academic excellence: OLS, spline, and mixed-effects models by subject

	Mathematics			Literature			Foreign language		
	$\tau = 0.25$	$\tau = 0.50$	$\tau = 0.75$	$\tau = 0.25$	$\tau = 0.50$	$\tau = 0.75$	$\tau = 0.25$	$\tau = 0.50$	$\tau = 0.75$
<i>Historical legacy</i>									
Years since annexation (z)	0.158* (0.067)	0.413*** (0.080)	0.568*** (0.077)	0.180*** (0.048)	0.338*** (0.065)	0.765*** (0.122)	0.079 (0.042)	0.288*** (0.058)	0.240** (0.075)
<i>Socioeconomic & demographic context</i>									
Population (thousands, z)	0.074 (0.056)	0.391** (0.146)	0.630*** (0.074)	0.074* (0.030)	0.134* (0.053)	0.354* (0.148)	0.083 (0.044)	0.352* (0.161)	0.779*** (0.154)
Ethnic minority share (z)	-0.031* (0.012)	-0.083*** (0.016)	-0.126*** (0.024)	-0.027 (0.015)	-0.034 (0.018)	-0.102* (0.040)	-0.010 (0.008)	-0.038** (0.014)	-0.036 (0.024)
log GRDP per capita (z)	0.092*** (0.027)	0.104*** (0.031)	0.223*** (0.059)	0.055* (0.024)	0.099** (0.033)	0.125* (0.053)	0.090*** (0.024)	0.141*** (0.024)	0.197*** (0.032)
<i>War exposure</i>									
Bombs per km ² (z)	-0.027 (0.015)	-0.079*** (0.013)	-0.127*** (0.013)	-0.036*** (0.010)	-0.072*** (0.014)	-0.173*** (0.027)	-0.008 (0.009)	-0.042*** (0.009)	-0.034* (0.017)
<i>Geography & agricultural potential</i>									
Rice suitability (z)	-0.033 (0.022)	-0.066* (0.032)	-0.046 (0.048)	-0.041* (0.019)	-0.067* (0.027)	-0.210** (0.064)	-0.003 (0.013)	-0.001 (0.021)	0.025 (0.036)
Distance to coast (log, z)	-0.055* (0.026)	-0.154*** (0.035)	-0.283*** (0.056)	-0.014 (0.026)	-0.062 (0.035)	-0.002 (0.084)	-0.033* (0.015)	-0.113*** (0.021)	-0.142*** (0.036)
Distance to river (log, z)	0.016 (0.015)	-0.016 (0.029)	0.040 (0.038)	-0.014 (0.018)	-0.033 (0.021)	-0.023 (0.035)	0.018** (0.007)	0.046 (0.030)	0.046 (0.040)
Mean elevation (z)	0.035 (0.051)	0.168* (0.075)	0.244** (0.074)	0.022 (0.046)	0.117 (0.063)	0.364** (0.115)	0.035 (0.040)	0.166** (0.057)	0.145* (0.072)
Terrain ruggedness (z)	-0.164* (0.065)	-0.421*** (0.055)	-0.498*** (0.063)	-0.210*** (0.046)	-0.320*** (0.052)	-0.569*** (0.096)	-0.071* (0.035)	-0.192*** (0.032)	-0.146** (0.052)
Mean temperature (z)	-0.027 (0.043)	-0.101 (0.111)	-0.104 (0.108)	-0.061 (0.054)	-0.029 (0.070)	0.228 (0.161)	0.011 (0.032)	0.076 (0.082)	-0.002 (0.108)
<i>School inputs & public administration</i>									
School inputs (PCA, z)	0.009 (0.025)	0.017 (0.043)	-0.029 (0.049)	0.040 (0.037)	0.083* (0.039)	0.054 (0.076)	0.010 (0.018)	0.026 (0.033)	-0.024 (0.044)
Public administration (PCA, z)	-0.013 (0.013)	-0.026 (0.019)	-0.002 (0.021)	-0.010 (0.015)	-0.002 (0.019)	-0.003 (0.027)	-0.018* (0.008)	-0.017 (0.012)	-0.002 (0.019)
Observations	504	504	504	504	504	504	504	504	504
All specifications include year fixed effects (coefficients not shown).									

Notes: Dependent variables are standardized densities of students scoring in the top 10% of the national distribution in each subject. Entries report quantile-regression coefficients at $\tau \in \{0.25, 0.50, 0.75\}$ with standard errors in parentheses. All models include the full set of controls listed in the table and year fixed effects (not shown). *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $p < 0.10$.

Table 6: Determinants of academic excellence across the outcome distribution (quantile regressions)

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