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Institutional structure and governance capability in universities: an empirical study from the perspectives of time, space, and quantity dimensions

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Institutions are pivotal in university governance, symbolizing stable organizational power reflective of governance capacity. The strategic organization of a university's internal structures aims to align with its developmental goals. The effectiveness of these arrangements is evaluated by their congruence with the university's characteristics and norms, aiming to enhance governance for growth and sustainability. Thus, the primary aim of this study is to determine whether this layout can strengthen the university's governance ability, enhancing its prospects for survival and development. This study introduces a novel theoretical framework across the dimensions of time, space, and quantity, utilizing governance elements to assess the impact of institutional layouts on governance capabilities. Data were gathered through a self-developed survey questionnaire, with a total of 742 valid responses collected, and by employing a high-dimensional fixed-effects model, we found that the three-dimensional institutional layouts significantly impact governance capabilities, with effects varying by the institution's affiliation. Furthermore, the mechanism analysis shows that university governance capabilities are also manifested through different configurations of governance elements under institutional layout, and are influenced by the responsiveness, collaboration, and expansion of the entire institutional system. Moreover, our analysis indicates a threshold effect in the tenure of institutional members, where both excessive and insufficient enthusiasm impact governance capabilities differently. This suggests the importance of a strategic institutional layout that aligns with the governance elements' dynamics of timeliness, flexibility, distribution, and scarcity across time, space, and quantity. Achieving an optimal arrangement enhances the university's governance efficiency significantly. In light of these findings, policy implications were proposed.

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Introduction

In China's rapidly developing higher education sector, universities are facing challenges that demand effective governance and institutional structures capable of adapting to changing circumstances (Liu, 2020; Chen et al., 2022; Wang and Liu, 2023). The critical need to navigate financial constraints, shifting student demographics, and the need for innovation has become paramount for survival and sustained development (Kezar, 2004; Mok, 2005; Jakovljevic, 2018). This backdrop highlights the increasing recognition of the pivotal role played by institutional structure and governance capability in securing the long-term viability and prosperity of Chinese universities.

The concept of governance capability encompasses the capacity of an institution to make and implement strategic decisions, allocate resources effectively, and respond to internal and external stakeholder demands (Shattock, 2012; Huang, 2015). Historically, Chinese universities have employed various governance models, ranging from traditional hierarchical structures to more decentralized and participatory approaches (Duan et al., 2023; Green, 2023). However, the suitability and effectiveness of these models in the face of contemporary challenges remain a subject of ongoing debate and empirical inquiry.

A three-dimensional analysis examines the influence of time, space, and quantity on governance processes (Bennich-Björkman, 2007; Soongsawang, 2018). Each dimension plays a crucial role in shaping governance structures and their effectiveness. The temporal (Time) dimension is concerned with how governance structures change over time, taking into account how past decisions, current development paths, and goals for the future affect institutional structures and governance practices (Khalifa et al., 2023; Mok and Lo, 2002). This aspect is essential for understanding how universities adapt their governance systems to address new challenges and opportunities as they undergo various phases of growth and transformation. In order to accommodate these changes throughout time, institutional layouts need to be versatile and flexible. A university that has developed its research capacity over many years, for instance, could have to reallocate funds and modify its decision-making procedures in order to accommodate fresh interdisciplinary projects and technology innovations.

The spatial (Space) dimension acknowledges that there is no one-size-fits-all governance model; rather, models must be customized to the unique political, cultural, and socioeconomic circumstances of each institution (Cao et al., 2023). Chinese universities are embedded in diverse local and regional ecosystems, and their governance structures may be impacted by these unique environments. Effective governance necessitates an awareness of various spatial contexts in order to create models that respond to local requirements and situations. This viewpoint recognizes that governance mechanisms fit for one region or locale may not be acceptable for another, demanding a personalized approach to governance that is aligned with the distinctive spatial dynamics of each institution. For instance, a university in a metropolitan area may need different governance strategies compared to one in a rural setting, addressing issues such as urban resource constraints or rural community engagement.

The quantitative (Quantity) dimension investigates the relationship between institutional size, resource allocation, and governance effectiveness in Chinese universities (Seeber, 2020; Shu et al., 2021). Institutional scale, as measured by student enrollment, faculty size, and financial resources, can have a substantial impact on governance structures and decision-making processes. Large, complex institutions may require different governance techniques than smaller, more specialized ones. Ensuring quality governance involves creating institutional layouts that can manage resources efficiently and respond to the needs of a diverse stakeholder base. This dimension emphasizes the need for governance structures that can scale appropriately with the size and resource availability of the institution, ensuring that larger institutions can maintain effective governance without becoming overly bureaucratic or inefficient. For example, a major university may utilize decentralized administrative entities to better manage its diversified and broad operations, whereas a smaller institution may adopt a more centralized model to speed decision-making and retain close-knit community links. These dimensions are supported by four essential moderators: responsiveness, coordination, expansion, and organizational conformance. Each of these criteria contributes significantly to university institutions' governance capabilities, ensuring that governance elements are appropriately handled and optimized.

In addition to these dimensions, the role of technology in governance processes cannot be overlooked. The digital revolution has resulted in new ways of administering and organizing higher education institutions, ranging from digital platforms for stakeholder involvement to data-driven decision-making procedures (Kuldosheva, 2021; Butler-Henderson and Crawford, 2020). The incorporation of technology into governance systems has the potential to increase efficiency, transparency, and responsiveness. However, it also presents challenges related to cybersecurity, data privacy, and the digital divide. To effectively use technology in governance, universities must manage these concerns carefully (Marginson and Considine, 2000). However, the framework for university governance capability is shown in Fig. 1, which shows how time, space, and quantity contribute to institutional layout requirements and governance capabilities, which in turn lead to convergence-integration and recognition-grasping capabilities that provide strategic advantages.

In this context, the question of how to improve university governance capacity has been naturally integrated into the broader reform system of comprehensive national governance and has emerged as a critical area of reform in the new stage of China's higher education development. This alignment highlights the necessity for a comprehensive approach to governance reform, one that encompasses not only the immediate operational needs of universities but also aligns with the national agenda for comprehensive governance reform. Therefore, this study makes a significant contribution to the body of literature on governance discourse in higher education, developing a detailed analytical framework to explore the relationship between institutional structure and governance capability within universities, examined through the dimensions of time, space, and quantity. Unlike existing models, this framework offers a multidimensional perspective, integrating temporal, spatial, and quantitative factors to provide a comprehensive understanding of governance dynamics. Furthermore, the study addresses the critical question: can institutional arrangements influence the university's governance capacity? If so, the study seeks to identify the types of layouts that can enhance governance capacity within universities. Moreover, by employing a high-dimensional fixed-effects model to investigate these relationships, the study not only enriches theoretical discussions about governance's role in promoting institutional agility, integration, and strategic growth but also significantly informs the development of governance frameworks. Additionally, the study employed threshold analysis to uncover a significant effect related to the tenure of institutional members, the critical balance between engagement and overzealousness in influencing governance efficacy. Hence, the main objective of this study is to ascertain whether this organizational structure can enhance the governance capabilities of universities, thereby improving their prospects for sustained growth and development.
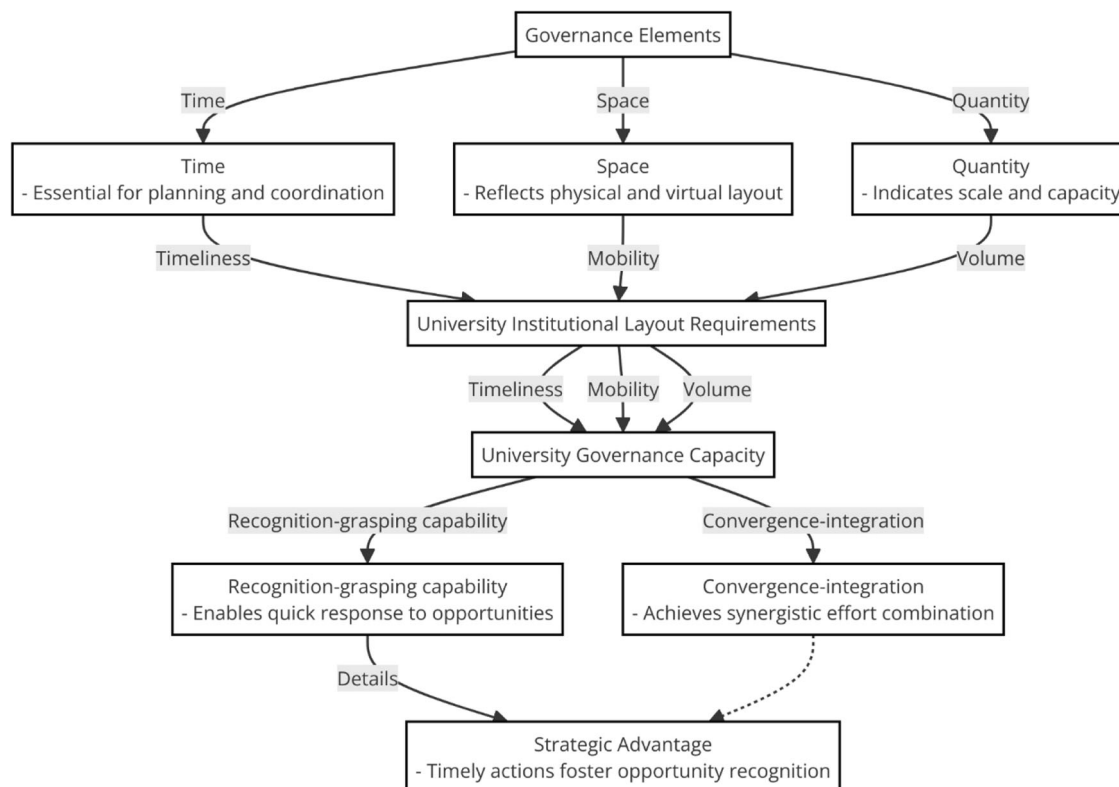
Fig. 1 Framework for university governance capacity and strategic advantage. This figure illustrates how time, space, and quantity contribute to institutional layout requirements and governance capabilities, which in turn lead to convergence-integration and recognition-grasping capabilities that provide strategic advantages.

The remainder of the paper is organized as follows: the theoretical framework and research hypotheses are presented first, followed by the methodology. Next, the results are interpreted, then discussed, and finally, the conclusion is provided.

Theoretical framework and research hypotheses

Theoretical framework. The institutional structure and governance capability of universities have been extensively explored through diverse theoretical perspectives, providing a rich foundation for understanding these dynamics. Particularly, the institutional theory posits that governance structures are deeply embedded within the norms and cultural practices of the educational sector (Bleiklie and Kogan, 2007; De Boer et al., 2007; Scott, 2013). This perspective emphasizes the role of historical and social conditions in creating governance approaches. For instance, colleges in various nations have diverse governance models that reflect their distinct cultural and institutional histories, indicating how ingrained norms influence structural decisions (Meyer and Rowan, 1977; DiMaggio and Powell, 1983). According to empirical research, colleges in Scandinavian countries that emphasize democratic values have more participatory governance models than those in more hierarchical societies such as the United States (Bleiklie and Kogan, 2007). This viewpoint is supported by resource dependency theory, which contends that external resource requirements greatly influence universities' governance models and, in turn, their autonomy and ability to make strategic decisions (Pfeffer and Salancik, 2015). According to Aldrich and Pfeffer (1976) and Tolbert (1985), this approach emphasizes how dependent universities are on outside financial sources, such as government grants and business collaborations, which in turn affect governance policies and operational priorities. For example, a university heavily reliant on government funding may align its strategic goals closely with national educational policies and priorities. Empirical evidence from a study by Jongbloed and Vossensteyn (2001) indicates that Dutch universities, that receive substantial government funding, often prioritize compliance with governmental educational reforms to ensure continued financial support. Furthermore, stakeholder theory emphasizes the complexities of balancing multiple interests in university governance, stressing the delicate negotiation processes required to satisfy students, faculty, government, and industry partners (Freeman, 2010). This paradigm highlights the multiple characteristics of governance, in which universities must manage and balance competing demands from many stakeholders (Donaldson and Preston, 1995; Mitchell et al., 1997). For instance, the desire to secure research money from industry partners may clash with academic independence, necessitating careful discussion and compromise. Empirical study by Mainardes et al. (2010) supports this view, illustrating that Brazilian universities often face tensions between maintaining academic standards and fulfilling the expectations of industry stakeholders.

To provide a more detailed understanding, we introduce a new theoretical framework that integrates these perspectives across three dimensions: time, space, and quantity. The time dimension considers the historical evolution of governance structures within universities, examining how past decisions, policies, and cultural practices influence current governance models (North, 1990). Empirical examples include the shift towards more decentralized governance structures in response to increased calls for academic autonomy and accountability over time. For instance, Clark (1998) discusses the "entrepreneurial university" model that emerged in the late 20th century, reflecting a move towards greater self-reliance and less dependence on state control. Furthermore, the space dimension explores the geographical and cultural contexts of university governance, assessing how

location-specific factors, such as national policies, regional educational priorities, and local cultural practices, shape governance structures (Geertz, 1973; Hofstede, 1984). For instance, universities in countries with centralized educational systems may have different governance capabilities compared to those in more decentralized systems. Empirical analysis by Marginson and Rhoades (2002) reveals that universities in federal systems like the US and Germany often exhibit more complex governance structures due to the interplay between state and federal regulations. Moreover, the quantity dimension focuses on the quantitative aspects of governance, such as the scale of resources, number of stakeholders, and breadth of governance activities. It analyzes how the volume of resources and stakeholders impacts governance complexity and effectiveness (Cyert and March, 2015; Thompson, 2017). For example, larger universities with diverse funding sources and numerous stakeholders might face greater challenges in maintaining cohesive governance structures. Empirical studies, such as those by Johnstone (2004), have shown that larger institutions often struggle with bureaucratic inefficiencies and stakeholder management issues compared to smaller universities.

Moreover, empirical studies across time reveal a dynamic evolution of governance structures, with historical shifts from collegial to more corporatized models in response to changing societal and economic pressures (Rüegg, 1992–2010). Comparative spatial analyses further demonstrate how geographic and cultural contexts influence governance strategies, emphasizing the variability and adaptability of institutional governance across global higher education landscapes (Mok and Jiang, 2017; Ferlie et al., 2008: Clark, 1986). The dimension of quantity, involving scale and complexity, challenges universities to adapt governance mechanisms to manage resources efficiently, fostering innovations in administration and pedagogy to meet the demands of expanding student populations and digital transformation (Chen et al., 2022). However, in the domain of domestic academic discourse concerning the structural organization of university institutions, there has been a noticeable lack of comprehensive research, occasionally exacerbated by a lack of governmental involvement. This gap primarily arises from the prevalent research paradigms and perspectives, which have historically conceptualized universities either as monolithic entities or dissected them into distinct administrative, academic, and other major components, rather than acknowledging the university as a cohesive organism composed of intricately interconnected institutions (David et al., 2019; van Gend and Zuiderwijk, 2023). However, within the limited scope of extant literature, two predominant research perspectives have been defined. First, the quantitative perspective critiques the institutional configuration of universities, focusing specifically on the numerical proliferation of internal institutions. This viewpoint posits that an inflated institutional structure precipitates an overly segmented division of labor, suboptimal coordination, and, consequentially, inefficiency within the university setting. Proposals to rectify these issues predominantly advocate for the streamlining of institutional frameworks through processes of abolition, amalgamation, and co-location of institutions, aiming to enhance operational efficacy. Second, the growing power perspective interrogates university institutional layouts through the prism of power dynamics. This innovative approach encompasses a spectrum of reformative strategies: stimulating the upper levels of decision-making to institute a power equilibrium mechanism within the university; obviating the hierarchical consciousness and administrative predilection of functional departments to foreground their "service" and "supervision" roles; and endorsing "decentralization" within the university's institutional apparatus to effectuate a downward redistribution of managerial authority.

The two research perspectives on the issue of university institutional arrangements mentioned above, although reasonable to some extent, fail to address the practical problems existing in university governance. For instance, the first approach has successfully reduced the number of institutions through mergers and co-locations in practice. However, this has not effectively led to adjustments in the organizational structure or changes in work functions, failing to escape the vicious cycle of streamlining and expansion without real progress (Barrier and Musselin, 2016). Regarding the second approach, although it has enhanced academic power and reduced the management burden of university-level institutions in practice, it has weakened the overall coordination of disciplines in schools. This has led to an increase in the management hierarchy at the department level and the phenomenon of institutional expansion (Romanenko and Froumin, 2020; Savović, 2020). As a result, the efficiency of university management has not been improved. In light of these observations, this paper seeks to explore the issue from a new angle, namely, the perspective of elements.

In the practice of university governance, the capacity for governance cannot simply be conjured; it relies on numerous supporting conditions such as geographical space, institutional structures, power, personnel, funding, facilities, and norms, collectively referred to in this paper as 'governance elements'. In practical governance, these elements manifest in more specific forms such as policies, workspace, funding, staffing, positions, titles, honorary titles, bonuses, and other distinct elements. Whether considering the entire governance system of a university or a specific institution within it, university governance essentially involves the combination and representation of these governance elements at a certain level. Recognizing this facilitates a deeper understanding of university institutional arrangements, which fundamentally are the school's various configurations of its internal governance elements. This includes establishing institutions and managing inter-institutional relationships through the identification, circulation, transfer, combination, and allocation of certain governance elements. For instance, collaborative relationships between departments in university arrangements can be understood as the management and circulation of information and other governance elements between institutions (Favero, 2003; Emerson et al., 2012; Taylor, 2013). Based on this, this paper starts from the perspective of governance elements and breaks through the conventional practice in the existing research literature, which is limited to the spatial dimension of element analysis. It examines university institutional arrangements and their impact on university governance capacity from three dimensions of governance elements namely; time, space, and quantity. A theoretical framework for this research is shown in Table 1.

In the dimension of time, governance elements possess timeliness. This means that universities require dynamic governance rather than static governance, being able to take corresponding measures as internal and external conditions change to achieve dynamic alignment between university governance and the internal and external environment. This further suggests that in their institutional arrangements, universities need to consider whether governance elements can be transmitted and transferred smoothly between internal and external institutions to avoid blockages. This enables universities to have the governance capacity to identify and seize certain resources at the first opportunity when opportunities or needs arise, reflecting the foresight, initiative, planning, and strategizing of universities in their affairs. Secondly, in the dimension of space, governance elements possess mobility and discreteness, meaning they are in a non-equilibrium and separate state. This implies that universities can timely adopt methods such as transfer and connection to

Table 1 Framework of university institutional structure and governance capacity.

Governance elements		University institutional layout requirements	University governance capacity
Dimension	Characteristic		
Time	Timeliness	The governance elements can be transmitted and transferred smoothly between internal and external institutions, avoiding blockages.	Recognition-grasping capability
Space	Mobility Discreteness	The governance elements are distributed reasonably between internal and external institutions, producing a holistic linkage effect, and avoiding excessive compartmentalization, departmentalism, or factionalism.	Convergence-integration capability
Quantity	Scarcity	The governance elements accumulate, transform, and convert continuously between internal and external institutions, avoiding idleness, waste, and 'spinning in one place.'	Exploration-extension capability

Source: Author computation.

aggregate governance elements within a certain spatial range. This also indicates that in their institutional arrangements, universities need to consider whether governance elements can be distributed reasonably between internal and external institutions to produce a holistic linkage effect, avoiding excessive compartmentalization, departmentalism, or factionalism. This enables universities to have the governance capacity to aggregate and integrate resources from various aspects. Lastly, in the dimension of quantity, governance elements possess scarcity, meaning universities mainly adopt methods such as transformation and development to create more resources for the survival and development of the university. This also shows that in their institutional arrangements, universities need to consider whether governance elements can accumulate, transform, and convert continuously between internal and external institutions to avoid idleness, waste, or stagnation. This enables universities to have the governance capacity to explore existing resources and develop new ones.

The above three dimensions suggest that in reorganizing university institutions, we should move beyond merely adjusting the number of institutions or balancing power among various entities. Instead, our focus should be on ensuring that the organizational structure of universities facilitates governance by optimally configuring elements across time, space, and quantity. Our goal is to achieve an ideal state where the university operates smoothly, resources are distributed fairly, and community engagement is effectively concentrated within the school. In this way, the university can layout a set of optimized, coordinated, and efficient institutional systems. The governance capacity of the university, encompassing recognition-grasping, convergence-integration, and exploration-extension capabilities, has been significantly enhanced.

Research hypotheses
University institutional arrangement and governance capacity: Time dimension of governance elements. The timeliness of governance elements in the time dimension requires universities to possess the ability to identify and seize opportunities through institutional arrangements. This means they should be able to acquire various types of latest information in the first instance, quickly form recognizable situational analysis results, and then come up with targeted solutions. In other words, universities should be able to timely grasp and analyze various social information according to changes in the internal and external environment, foresee future development trends and patterns, timely evaluate and reflect on the implementation of existing policies and their actual operational effects, and make timely corrections to achieve work results that are in line with expected goals. Based on this, the following research hypothesis is proposed:

H1: *When governance elements are limited and their mobility and discreteness remain constant, grasping the timeliness of governance elements through institutional arrangements can enhance the university's ability to identify and seize opportunities.*

University institutional arrangement and governance capacity: Space dimension of governance elements. The mobility and discreteness of governance elements in the spatial dimension require universities to possess the ability to aggregate and integrate through institutional arrangements. The achievement of university governance goals relies on the coordination, cooperation, and joint action of various governance elements. The deficiency or absence of any type of governance element is unlikely to effectively realize the overall function of governance. Only by possessing the ability to aggregate and integrate can universities create a synergistic effect in governance where $1 + 1$ is greater than 2. Based on this, the following research hypothesis is proposed:

H2: *When governance elements are limited and their timeliness remains constant, increasing the mobility of governance elements and reducing their discreteness through institutional arrangements can enhance the university's ability to aggregate and integrate.*

University institutional arrangement and governance capacity: Quantity dimension of governance elements. The scarcity of governance elements in the quantity dimension requires universities to possess the ability to explore and expand through institutional arrangements. The highest realm of university governance is to make the best use of resources and talents, achieving maximum governance effectiveness based on existing conditions. This means that university institutional arrangements should not only upgrade and fully utilize their existing governance elements but also actively seek new governance elements, thereby increasing the quantity or variety of governance elements. Otherwise, universities may not only fail to make the best use of resources and talents but also lack vitality and vigor. Based on this, the following research hypothesis is proposed:

H3: *When the timeliness, flexibility, and discreteness of governance elements remain constant, overcoming the scarcity of governance elements through institutional arrangements can enhance the university's capacity for exploration and expansion.*

Research methodology
To conduct an in-depth and detailed analysis of the relationship between university organizational structures and their governance effectiveness, it is essential to utilize a survey tool that reflects aspects related to governance. This tool would enable the assessment and improvement of universities' organizational designs, specifically focusing on governance capabilities. Despite the importance of this investigation, a customized survey questionnaire designed to examine these specific dynamics has not yet been developed. Therefore, developing a questionnaire or scale is
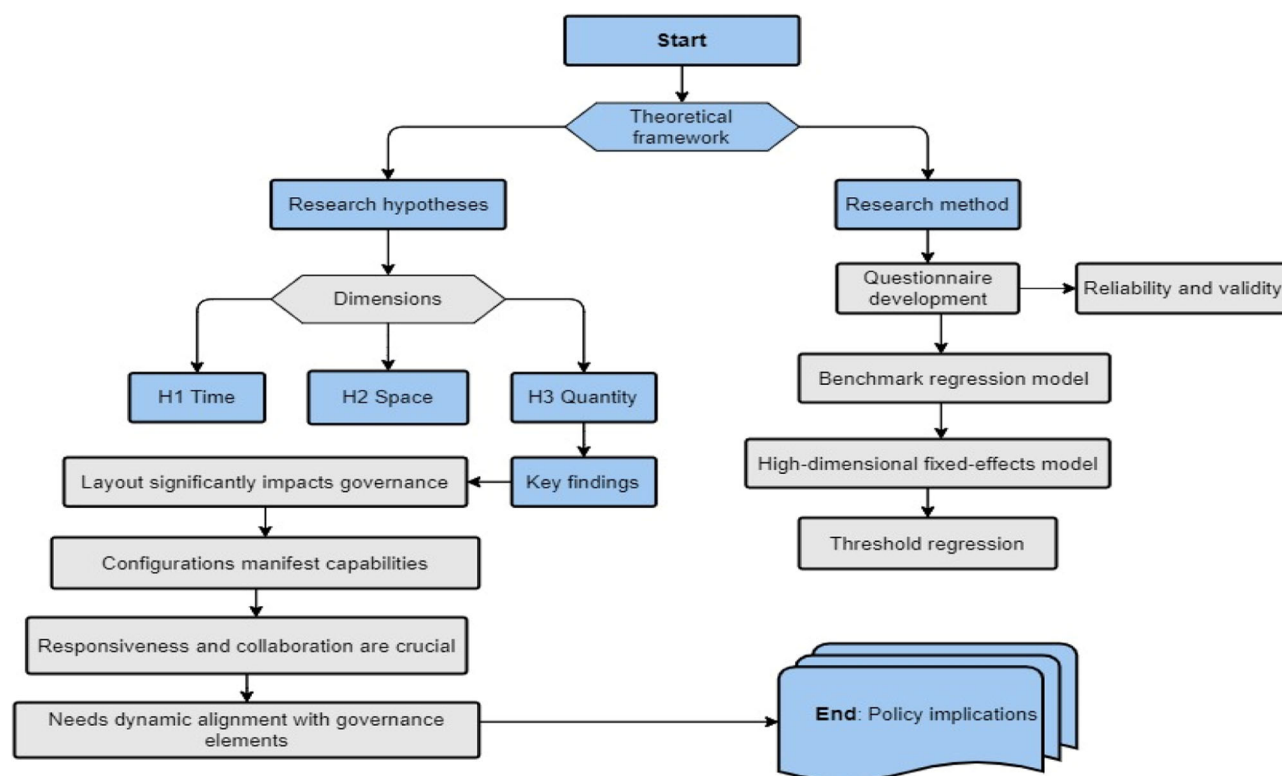
Fig. 2 Flowchart of the study. This figure presents the step-by-step process of our research, outlining the sequence of methodologies, data collection, analysis phases, key findings, and policy implications.

a fundamental and important task for this study. Figure 2 shows the flowchart of our study.

Questionnaire development and variable measurement. Since institutions are the mainstay of university governance capability, the governance capabilities of various internal institutions within the university reflect and present the governance capability of the entire university. Therefore, this study, based on the three dimensions of time, space, and quantity constructed from theory, employed a 7-point Likert scale to score the self-developed "University Governance Capacity Questionnaire." The initial questionnaire comprised 40 questions. After a focused discussion in the research group meeting, each question's wording, expression of meaning, sentence structure, and other aspects were modified, adjusted, polished, and rewritten. Questions that were too long, unclear, semantically redundant, or weakly related to the research objectives were deleted, resulting in 35 refined questions. Furthermore, among them, 5 single overall assessment questions were used as criteria. After calculating and testing normality indicators, variance values, item-total correlation coefficients, extreme group differences, and factor loadings, questions that did not meet the predefined standards were removed. This process ensured that the remaining questions were deemed valid based on critical values or decision criteria. The final questionnaire consists of 32 items, categorized into three dimensions: time, space, and quantity. Governance capability in the time dimension is evaluated using 10 items, including "My department can promptly follow up on directives from higher authorities." Governance capability in the space dimension is evaluated using 10 items, including "There are no issues of shirking responsibility or shifting blame among departments when our university advances relevant work or reforms." Governance capability in the quantity dimension is evaluated using 8 items, including "My department frequently introduces new

models to optimize work processes." Furthermore, the questionnaire includes four items serving as a criterion tool, the "Single Overall Assessment Scale," to evaluate an individual's perception of the university's (university institutions') responsiveness, coordination, expansiveness, and institutional alignment. These items are: "Overall, communication and execution are smooth and strong within the university," "Overall, the division of labor among various institutions in the university is reasonable, and collaboration is strong," "Overall, the potential of each department in the university is fully realized, and work efficiency is high," and "Overall, the institutional setup of the university meets current educational needs." Maximal rotation of variance revealed that four items belonged to a common factor, with commonalities ranging from 0.709 to 0.8133 and factor loadings from 0.842 to 0.901, which explained 77.884% of the total variance of the items. This indicates that the quality of the data reliability in the study is high.

Sample characteristics. This study collected primary data through a questionnaire survey, targeting faculty and staff from higher education institutions across 30 provinces (autonomous regions and municipalities) in China, excluding Qinghai. This indicates that the survey data is representative. To minimize common method bias, this study conducted the questionnaire survey in multiple stages, collecting core variable data at five different points in time: June, September, October, November of 2022, and January of 2023. All questionnaires were distributed and collected through the "Questionnaire network" platform. Furthermore, the researchers clearly explained the purpose of the survey to the respondents to alleviate any psychological concerns and patiently answered any questions they had during the questionnaire completion process. A total of 1,491 questionnaires were collected in this survey. To ensure the authenticity of the survey data, responses with a completion time of less than three

Table 2 Pearson correlations and AVE square roots.				
Factor	**Time dimension**	**Space dimension**	**Quantity dimension**	**Overall capacity**
Time dimension	0.748			
Space dimension	0.602	0.689		
Quantity dimension	0.716	0.724	0.635	
Overall capacity	0.817	0.726	0.743	0.841

minutes, those with the same answer for all items, or those displaying a certain pattern or shape were considered invalid and excluded. After this screening process, 742 valid responses remained, yielding an effective recovery rate of 49.77%. Regarding sample characteristics: the survey included 412 individuals with intermediate titles or below, 198 with deputy high titles, and 132 with high titles. Examining the administrative hierarchy, there were 377 individuals without administrative titles, 208 in the basic position (section chief and officer), 152 in the middle position (division chief/deputy division chief, dean/deputy dean), and 5 at the senior position (president/vice-president). From the perspective of professional engagement, there were 258 front-line teaching and research staff, 394 individuals from political institutions, faculty, and logistics roles, and 135 key responsibility holders both managing and teaching. The composition was further segmented into 262 individuals from administrative, supporting staff, and logistics roles, 379 individuals from faculties and scientific research institutions, and 101 individuals from other organizations. According to the types of schools, there were 319 persons from comprehensive universities, 148 from science and technology universities, 105 from normal universities, 32 from agriculture and forestry universities, 7 from language universities, 1 from a sports university, 56 from medical universities, 33 from finance universities, 8 from politics and law universities, 4 from art universities, 4 from ethnic universities, and 25 from other universities. There were 246 teachers from universities affiliated with the Ministry of Education, 44 teachers from universities affiliated with other ministries, 408 from universities affiliated with provinces or municipalities directly under the central government, and 95 from universities affiliated with local municipalities.

Reliability and validity analysis

Reliability test. The reliability test results show that Cronbach's α coefficients of the three factors of time, space, and quantity dimension under the university governance capacity questionnaire and the internal consistency of the single general comment questionnaire were 0.852, 0.898, 0.867, and 0.905 respectively. Given that all reliability coefficients exceeded 0.8, this indicates a high level of internal consistency and reliability for the research data. The corrected item-total correlation (CITC) between the factors of university governance and the total items of the total questionnaire was more than 0.4, which indicated that the analysis items exhibit a strong correlation with the overall construct and contribute positively to the instrument's reliability. The split-half reliability α coefficients of each factor and the total university's institutional governance questionnaire were 0.860, 0.858, 0.822, and 0.905 respectively. The McDonald's omega coefficients for each factor and the overall university's institutional governance questionnaire were 0.917, 0.915, 0.810, and 0.934, respectively. Given that all values exceed 0.8, this indicates a high level of reliability in the research data. These coefficient indicators indicate that the reliability quality level of the questionnaire is high and can be further analyzed. The factor load number of each latent variable in the dimension of time, space, and quantity corresponding to each item is greater than 0.7, indicating that each latent variable is highly representative of the

corresponding item. The mean-variance of each latent variable AVE is greater than 0.5, and the combined reliability CR is greater than 0.8, indicating that the reliability is ideal.

Validity test. The results of the Pearson correlation analysis are shown in Table 2. The correlation coefficient between the total score of the questionnaire and its three factors ranges from 0.726 to 0.841, and the correlation coefficient between the three factors ranges from 0.602 to 0.724. It can be seen that the correlation between the total score of the questionnaire and the factors is higher than that between the factors, indicating that the structural validity of the questionnaire is very good. The discrimination validity shows that the AVE square root value of the time dimension is 0.748, which is smaller than the maximum value of the absolute value of the correlation coefficient between the factors, 0.817, indicating that the discrimination validity is average. The AVE square root value of the spatial dimension is 0.689, which is less than the maximum value of the absolute value of the correlation coefficient between the factors 0.726, which means that its discrimination validity is average. The AVE square root value of the quantitative dimension is 0.635, which is less than the maximum value of the absolute value of the correlation coefficient between the factors 0.743, indicating that its discrimination validity is average. For the total score of ability, the AVE square root value is 0.841, which is greater than the maximum value of the absolute value of the correlation coefficient between factors, 0.817, indicating that it has good discrimination validity.

Common method bias test. Common method bias refers to the distortion or exaggeration of relationships between different variables due to the use of the same method or source in a survey (Podsakoff et al., 2003). While this study employed multi-stage surveys, anonymous measurements, and cross-arranged items to reduce the influence of common method bias, the single-source nature of the respondents and the primary use of questionnaire surveys necessitate further statistical tests to ensure data reliability.

This study used Harman's single-factor test to identify potential common method bias in the data. The test results extracted eight factors, cumulatively explaining 66.312% of the total variance, with the largest factor explaining 36.738% of the variance (<40%), preliminarily indicating that common method bias does not account for most of the variance among variables (Bagozzi and Yi, 1990). Furthermore, confirmatory factor analysis results showed that compared to the hypothesized four-factor model in this study ($\chi^2/df = 1.982$, $TLI = 0.929$, $CFI = 0.932$, $IFI = 0.906$, $RMSEA = 0.089$), the single-factor model had the worst fit ($\chi^2/df = 10.394$, $TLI = 0.577$, $CFI = 0.608$, $IFI = 0.609$, $RMSEA = 0.158$), further proving that common method bias is not a serious issue in this study.

Model specification and variable selection

Construction of benchmark regression model. The empirical task of this study is to explore how the allocation of factors such as response, transfer, connection, and development affect the governance capacity of university institutions based on the time,

space, and quantity dimensions of the factors and their corresponding characteristics (timeliness, mobility, dispersion, and scarcity). Therefore, it is feasible for this study to construct a benchmark regression model based on high-dimensional fixed effects to analyze the influence of institutional layout on university governance ability in time, space, and quantity dimensions, and it can be shown as follows:

$$Y_{iuds} = \beta_0 + \beta_1 X_{iuds} + \beta_2 Controls_{iuds} + \alpha_i + \lambda_u + \gamma_d + \delta_s + \varepsilon_{iuds} \tag{1}$$

In Eq. 1, the subscript i represents the individual sample, while u, d, and s represent the individual's university type, institutional department, and identity category. Y_{iuds} is the dependent variable, representing the governance capability of universities. A higher score indicates a stronger governance capability within the university. β_0 is the constant term; X_{iuds} is the explanatory variable, representing the organizational layout condition in time, space, and quantity. The higher the score, the greater the rationality and effectiveness of the organizational layout. $Controls_{iuds}$ is a group of control variables that affect the ability of university governance, because individual's working years, administrative duties (no administrative duties, basic position (section chief and officer), middle position (division chief/deputy division chief, dean/deputy dean) and high-level (vice-school-level and school-level), and professional titles (intermediate titles or below, deputy high and high titles) may affect individual's perception of university governance ability, therefore, they are taken into the econometric model as control variables. β_1 and β_2 represent the coefficient vectors of the explanatory variables and control variables, respectively. α_i represents individual fixed effects, which account for unobserved factors related to individuals, controlling for differences that are not easily observed and do not vary over time. λ_u represents the fixed effect of the type of institution, which is used to control for the macro-level variations brought about by the type of institution where the individual is located (comprehensive universities, science and engineering universities, normal universities, agricultural and forestry universities, language universities, sports universities, medical universities, financial and economic universities, political and legal universities, art universities, ethnic universities, and other types of universities). γ_d is the fixed effect of the organizational department, which is used to control the evaluation of university governance ability by the departments (party, league, government, teaching and logistics, departments, scientific research institutions, and others). δ_s is the fixed effect of the identity category, which is used to control the evaluation of university governance ability by individual identity (party, league and government, teaching and assistant, logistics personnel, front-line teaching, and research personnel, key responsibility holders both managing and teaching. ε_{iuds} is a random perturbation term.

Threshold regression model construction. While the baseline regression model with high-dimensional fixed effects can provide us with an overall estimate of the impact of institutional layout on university governance capabilities in terms of time, space, and quantity dimensions, the influence of institutional layout on university governance capabilities in these three dimensions may be non-linear due to the impact of individual work experience. The functional form may depend on a variable (threshold variable) such that the threshold effect is traditionally determined subjectively by the researcher, without estimating the threshold value or statistically testing its significance. This approach often yields unreliable estimates. Hansen (1999) was the first to propose the threshold regression model, which aims to minimize the sum

of squared residuals (SSR) to conditionally identify the threshold value and test its significance, thus addressing the issue of bias associated with subjectively setting structural breakpoints. Hansen's further elaboration on sample splitting and threshold estimation (Hansen, 2000) as well as subsequent methodological advancements and applications in econometrics (Caner and Hansen, 2004; Seo and Shin, 2016) have significantly contributed to the robustness of threshold models. The general expression of the econometric model is as follows:

$$\begin{cases} Y_{it} = \mu_i + \beta_1' X_{it} + \varepsilon_{it}, & if \, q_{it} \leq \gamma \\ Y_{it} = \mu_i + \beta_1' X_{it} + \varepsilon_{it,} & if \, q_{it} > \gamma \end{cases} \tag{2}$$

By constructing the indicator function in Eq. 3 and based on the research question, the threshold regression model expression in Eq. 4 can be written as:

$$I(q_{it} \leq \gamma) = \begin{cases} 1 & if \quad q_{it} \leq \gamma \\ 0 & if \quad q_{it} > \gamma \end{cases}; \; I(q_{it} > \gamma) = \begin{cases} 0 & if \quad q_{it} \leq \gamma \\ 1 & if \quad q_{it} > \gamma \end{cases} \tag{3}$$

$$Y_{iuds} = \beta_1' X_{iuds} \cdot I(q_{iuds} \leq \gamma) + \beta_2' X_{iuds} \cdot I(q_{iuds} > \gamma) + \beta_3 Controls_{iuds} + \alpha_i + \lambda_u + \gamma_d + \delta_s + \varepsilon_{iuds} \tag{4}$$

In Eq. 4, Y_{iuds} is the dependent variable, representing the governance capacity of university institutions. X_{iuds} is the core explanatory variable, representing the institutional layout conditions in time, space, and quantity. $Controls_{iuds}$ is a set of control variables. β_1', β_2' and β_3 represent coefficient vectors of the explanatory variables and control variables, respectively. $I(\cdot)$ is an indicator function, and q_{iuds} is a threshold variable. In this study, individual work experience is chosen as the threshold variable. γ is the threshold value to be estimated; the disturbance term ε_{iuds} is independently and identically distributed; the other vectors are consistent with Eq. 1. The descriptive statistics for each variable are shown in Table 3.

Interpretation of the results
To ensure the robustness of our model, we utilized the variance inflation factor (VIF) to assess multicollinearity in the model. The results show that the mean VIF of 1.97, with values for individual variables well below the critical threshold of 10, indicating no significant multicollinearity issues in our metrological model estimation. Therefore, we have confidence in the reliability of the model estimation results, as shown in Table 4.

Baseline regression results. Table 5 displays the regression analysis results of the impact of organizational structure on university governance. Overall, the integration of governance elements through organizational structure significantly promotes the improvement of university governance capabilities. This indicates that the organizational structure in the three dimensions is indeed the core variable explaining the improvement of university governance capabilities. Specifically, the results of models (1) and (2) show that the impact of organizational structure on university governance in the time dimension has a significant positive effect at the 1% significance level, with coefficient estimates of 0.8283 and 0.8190, respectively. After controlling for variables such as work experience, administrative positions, and professional titles, the positive impact of organizational structure on university governance remains significant. This suggests that improving university governance requires adjusting the organizational structure, timely grasping and analyzing various social information, insight into future development trends and rules, evaluating and reflecting on the implementation of existing

Table 3 Descriptive statistics (N = 742).

	Variable	Definition	Mean	SD	Min	Max
Dependent variable	Overall assessment of university governance ability	Overall score of university governance ability	3.1043	0.9918	0	4.8
Explanatory variables	Time dimension	Time-dimensioned organizational layout conditions measured by the recognition-capture capability score.	3.9394	0.9713	0.6	6
	Space dimension	Space-dimensioned organizational layout conditions measured by the aggregation-integration capability score.	3.9918	1.2175	0.7	6.7
	Quantity dimension	Organizational layout conditions in the quantity dimension measured by the exploration-expansion capability score.	3.7370	0.9358	0.875	6.375
Control variables	Years of work experience	Length of employment in years at universities	12.2251	9.6312	1	42
	Administrative position	4 = no administrative post; 5 = basic position (section chief and officer); 6 = Middle position (division chief/deputy division chief, dean level/vice-dean level); 7 = high position (president, vice-president)	4.7102	0.8104	4	7
	Professional titles	3 = Intermediate and below; 4 = sub-high; 5 = positive high	3.6226	0.7691	3	5

policies, and timely correcting them to achieve work results that are consistent with expected goals.

The results of models (3) and (4) show that in the spatial dimension, the enhancement of governance element flexibility and the reduction of dispersion have a significant positive impact on university governance at the 1% level, with coefficient estimates of 0.5801 and 0.5686, respectively. This shows that the spatial dimension of organizational structure has a significant impact on university governance. To put it differently, when universities reorganize their structures based on the flexibility of elements, they gather and integrate relevant elements to produce synergistic effects. This implies that in the process of organizational restructuring, universities can only integrate different elements by fully realizing the transfer, aggregation, and connection of elements, enabling governance elements to interact with each other, thereby forming resources that meet the sustainable development of university organizations.

The results of models (5) and (6) show that the impact of organizational structure in the quantity dimension on university governance is significantly positive at the 1% significance level, with coefficient estimates of 0.7693 and 0.7560, respectively. Even after controlling for variables such as years of work experience, administrative positions, and professional titles, the positive impact of organizational structure in the quantity dimension on university governance remains significant. This indicates that based on the scarcity of elements in the quantity dimension, improving university governance requires organizational structures to have the ability to explore and expand, mainly by adjusting organizational structures through transformation and expansion based on existing stock elements. This means that if organizational structures can appropriately and effectively use transformation and expansion as ways to address the issues of element idleness and scarcity, university organizations can achieve the highest level of element allocation, making the most of available resources and achieving maximum governance effectiveness within existing constraints.

Regarding the covariates, in the process of organizational structuring in the time, space, and quantity dimensions, both years of work experience and professional titles have a negative impact on the evaluation of university governance. The longer an individual's tenure (1–42 years) and the higher their professional titles while working in university institutions, the more criticisms and shortcomings in university governance they are likely to identify. When these governance issues persist without resolution for an extended period, indicating a lack of rationality and effectiveness in organizational structure, university governance naturally deteriorates. It is worth noting that, in the process of organizational structuring in the time dimension, administrative positions do not have a positive impact on university governance. However, in the processes of organizational structuring in the space and quantity dimensions, administrative positions have a positive impact on university governance, reaching a significance level of 10% in the spatial dimension. This suggests that individuals without administrative positions, at the basic position (section chief and officer), at the middle position (division chief/deputy division chief, dean/deputy dean), and at the senior position (president/vice-president), can adjust the organizational structure to varying degrees, improve the fluidity of elements, reduce the dispersion of elements, and overcome the scarcity of elements. This, in turn, leads to different impacts on university governance. For example, senior-level personnel can mobilize more resources, and their vast social networks can better gather and connect various elements. Through organizational restructuring, they can overcome the scarcity of governance elements, effectively integrate various elements in different configurations, and thus enhance university governance.

Table 4 VIF of each explanatory variable.						
Variable	Time dimension	Space dimension	Quantity dimension	Years of work experience	Administrative position	Professional titles	Mean
V IF	2.16	2.21	2.85	1.78	1.23	1.59	1.97
1/VIF	0.4626	0.4532	0.3515	0.5631	0.8101	0.6278	

A deeper analysis reveals that each dimension affects governance capability differently. In the time dimension, universities that adapt structures to capture and analyze information timely, foresee trends, and evaluate policies see improved governance. In the spatial dimension, reducing element dispersion and increasing flexibility, such as through interdisciplinary research centers, enhances governance. In the quantity dimension, expanding resources and investing in facilities and faculty development optimizes resource use and governance. Furthermore, experienced and higher-ranked personnel often identify more governance issues, indicating a need for ongoing structural adjustments. Administrative roles, especially at higher levels, positively impact governance by mobilizing and integrating resources. This highlights the necessity for dynamic, flexible, and expansive organizational structures for optimal governance.

Mechanism analysis. Table 6 presents the results of a study investigating the moderating effects of organizational layout on university governance capability, focusing on three dimensions: time, space, and quantity. While the baseline regression results confirmed that the organizational structure in the dimensions of time, space, and quantity is a core variable explaining university governance capability, the governance capability of universities is also manifested through the effective allocation of governance elements in the three dimensions of organizational structure. However, how does the organizational structure affects university governance capability through configuration methods such as response, transfer, connection, and exploration to match the timeliness, flexibility, discreteness, and scarcity of governance elements implicit in the three dimensions, remains unclear. The mechanism analysis introduces interaction terms by combining the factors of time, space, and quantity in the "University Governance Capability Questionnaire" with the responsiveness, coordination, expansion, and organizational conformity in the "Single Overall Assessment Form," and includes them in the baseline regression model to identify the moderating effects of the organizational structure in the three dimensions on university governance capability. This analysis aims to elucidate the mechanism through which the two are related.

The results from models (1) to (4) reveal that both the primary effects and interaction terms are meaningful, with the combined analysis further confirming their significance. This suggests a pathway through which organizational structure in the time dimension impacts university governance capability. The accurate grasp of governance element timeliness by organizational structure can directly affect the responsiveness, coordination, expansion, and organizational conformity of university institutions, thereby affecting the level of university governance capability. For instance, the higher the organizational conformity, the smoother the governance elements can be transferred between institutions, leading to stronger university governance capability. Put another way, there is a moderating effect of responsiveness, coordination, expansion, and organizational conformity in the mechanism pathway of the influence of organizational structure in the time dimension on university governance capability.

The findings from models (5) to (8) reveal that the primary effects are statistically significant. Notably, in comparison to the baseline regression, there has been a shift in the effect's direction from positive to negative. The interaction terms and the joint test both show significance, indicating a mechanistic pathway through which the organizational structure's spatial dimension impacts university governance capability. This suggests that the positive impact of organizational structure in the spatial dimension on university governance capability is mediated through the responsiveness, coordination, expansion, and organizational conformity of the university institutional system, thereby indirectly promoting the improvement of university governance capability. That is to say, in the spatial dimension, the responsiveness, coordination, expansion, and organizational conformity reflecting the organizational structure play a role as moderating variables affecting university governance capability, thereby accelerating the fluidity of governance elements, reducing their discreteness, and enhancing the integration capacity of university institutions.

The results of models (9) to (12) demonstrate that the primary effects are significant, revealing a shift in the effect's direction from positive to negative when compared to the baseline regression. Furthermore, both the interaction terms and the joint test are significant, pointing to a mechanistic pathway through which the organizational structure's quantity dimension influences university governance capability. When organizational structure in the quantity dimension can effectively overcome the scarcity of governance elements, the improvement of responsiveness, coordination, expansion, and organizational conformity of the organizational structure can indirectly promote the improvement of university governance capability. Simply put, in the quantity dimension, the improvement of university governance capability requires the enhancement of responsiveness, coordination, expansion, and organizational conformity of organizational structure to be the channel of action, so as to achieve the full utilization of existing governance elements and actively explore new governance elements.

A more thorough examination identifies the precise processes by which every dimension influences governance capacity. In the time dimension, timely adaptation of structures to capture and analyze information, foresee trends, and evaluate policies enhances governance. In the spatial dimension, reducing dispersion and increasing flexibility, as seen through interdisciplinary centers, fosters collaboration and improves governance. In the quantity dimension, expanding resources and investing in facilities and faculty development optimize resource use and governance. Experienced and higher-ranked personnel identifying more issues indicate a need for ongoing adjustments. Administrative roles, especially at higher levels, positively impact governance by mobilizing and integrating resources, emphasizing the necessity for dynamic, flexible, and expansive organizational structures for optimal university governance.

Heterogeneity analysis. Table 7 displays the results of a heterogeneity analysis concerning how the institutional layout's dimensions—time, space, and quantity—affect university governance capabilities. In the context of "Catch-up" countries aiming to become powerhouses in higher education, the strategy to elevate Chinese universities to world-class status involves

Table 5 Results of organizational structure: time, space, and quantity dimensions.

Variables	University governance capacity					
	(1)	(2)	(3)	(4)	(5)	(6)
Time dimension	0.8283*** (0.0219)	0.8190*** (0.0221)				
Space dimension			0.5801*** (0.0213)	0.5686*** (0.0217)		
Quantity dimension					0.7693*** (0.0266)	0.7560*** (0.0271)
Work years		−0.0082*** (0.0029)		−0.0050 (0.0035)		−0.0050 (0.0034)
Administrative position		−0.0125 (0.0312)		0.0690* (0.0378)		0.0231 (0.0368)
Professional titles		−0.0115 (0.0356)		−0.0438 (0.0434)		−0.0366 (0.0421)
Constant	−0.1591** (0.0888)	0.0781 (0.1890)	0.7887*** (0.0887)	0.7293*** (0.2267)	0.2291** (0.1022)	0.3635 (0.2241)
Observations	741	741	741	741	741	741
R-squared	0.6852	0.6921	0.5373	0.5421	0.5662	0.5689
School type	YES	YES	YES	YES	YES	YES
Department	YES	YES	YES	YES	YES	YES
Identity	YES	YES	YES	YES	YES	YES

Note: Standard errors in parentheses; *, **, *** indicate significance levels of 10%, 5%, and 1%, respectively.

Table 6 Moderating effects of organizational layout on university governance capability: time, space, and quantity dimensions.

Model	University governance capacity											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Time dimension	0.0236** (0.0345)	0.0995*** (0.0322)	0.1208*** (0.0295)	0.1717*** (0.0343)								
Space dimension					−0.2751*** (0.0335)	−0.0353 (0.0353)	−0.1994*** (0.0337)	−0.1359*** (0.0344)				
Quantity dimension									−0.1945*** (0.0337)	−0.1726*** (0.0385)	−0.1382*** (0.0365)	−0.0497*** (0.0391)
×Responsiveness	0.1006*** (0.0039)				0.1203*** (0.0043)				0.1282*** (0.0039)			
×Synergy degree		0.0956*** (0.0037)				0.1115*** (0.0045)				0.1238*** (0.0045)		
×Expansion degree			0.0925*** (0.0033)				0.1097*** (0.0043)				0.1178*** (0.0041)	
×Degree of compliance with institutional settings				0.0859*** (0.0039)				0.1041*** (0.0045)				0.1094*** (0.0046)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	1.2235*** (0.1430)	1.3853*** (0.1458)	1.2241*** (0.1379)	0.9673*** (0.1524)	1.8965*** (0.1618)	2.0702*** (0.1759)	1.9672*** (0.1706)	1.5948*** (0.1754)	1.6840*** (0.1475)	1.9706*** (0.1666)	1.8047*** (0.1620)	1.4383*** (0.1729)
Observations	246	43	407	95	246	43	407	95	246	43	407	95
R-squared	0.6788	0.7870	0.6787	0.8278	0.5128	0.6092	0.6180	0.5854	0.5562	0.5651	0.5955	0.6915
School type	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Department	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Identity	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: Standard errors in parentheses; **, *** indicate significance levels of 5%, and 1%, respectively. The control variables are consistent with the baseline regression. The estimation results for the control variables are not reported here for brevity but are available upon request.

Table 7 Heterogeneity analysis of the institutional layout in the dimensions: time, space, and quantity on university governance capabilities.

Variables	University governance capabilities											
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UDUME	UAOM	PU	MU	UDUME	UAOM	PU	MU	UDUME	UAOM	PU	MU
Time dimension	0.8025*** (0.0409)	0.8876*** (0.1067)	0.8094*** (0.0313)	0.8442*** (0.0528)								
Space dimension					0.5267*** (0.0397)	0.5256*** (0.1061)	0.6170*** (0.0276)	0.4878*** (0.0634)				
Quantity dimension									0.7327*** (0.0450)	0.8812*** (0.2016)	0.7640*** (0.0359)	0.7282*** (0.0704)
Years of work experience	−0.0027 (0.0059)	−0.0155 (0.0130)	−0.0103** (0.0040)	−0.0179** (0.0081)	−0.0035 (0.0059)	−0.0288 (0.0176)	−0.0075 (0.0045)	−0.0080 (0.0126)	0.0008 (0.0057)	−0.0375* (0.0192)	−0.0043 (0.0046)	−0.0119 (0.0108)
Administrative position	−0.0210 (0.0538)	0.0307 (0.1472)	0.0039 (0.0457)	0.0271 (0.0759)	−0.0194 (0.0663)	0.1222 (0.2027)	0.0926** (0.0852)	0.3233*** (0.1107)	−0.0040 (0.0632)	0.1020 (0.2135)	0.0222 (0.0513)	0.2531** (0.0964)
Professional titles	−0.0465 (0.0623)	−0.0763 (0.1452)	−0.0176 (0.0503)	−0.0546 (0.0933)	−0.0711 (0.0767)	0.1487 (0.1953)	−0.0802 (0.0545)	−0.0901 (0.1450)	−0.0088 (0.0735)	0.2343 (0.2083)	−0.0619 (0.0561)	−0.0688 (0.1250)
Constant	0.2961 (0.3536)	−0.0307 (0.7834)	−0.0994 (0.2778)	0.1205 (0.3722)	1.4489*** (0.4160)	0.3527 (1.0944)	0.4253 (0.2966)	0.1796 (0.5941)	0.4398 (0.4236)	−1.0372** (1.3991)	0.3660 (0.3073)	−0.2760 (0.5193)
Observations	246	43	407	95	246	43	407	95	246	43	407	95
R-squared	0.6788	0.7870	0.6787	0.8278	0.5128	0.6092	0.6180	0.5854	0.5562	0.5651	0.5955	0.6915
School type	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Department	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Identity	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
SUR Estimation	1% significance level				5% significance level				1% significance level			

Note: UDUME stands for universities directly under the Ministry of Education.
UAOM Universities affiliated with other ministries, *PU* provincial universities, *MU* municipal universities.

focusing on the development of key universities. This approach results in varying conditions for running schools, which in turn produces distinct development levels between affiliated and non-affiliated institutions. Such variations in organizational layout could be the source of heterogeneity in university governance. The CPC Central Committee's decision on educational system reform in 1985 highlighted the importance of dividing and decentralizing "Organizing Power" and "Management Power," shifting from a "Single-Track System" to a "Multi-Track System." This shift aimed to bolster the autonomy of local governments and higher education institutions, engaging a broader range of stakeholders in the development of local universities. The goal was to transform the macro-management system of higher education and implement management at both central and local levels. However, the asymmetry between the financial power and administrative authority of local governments might lead to disparities in the resources available to "universities affiliated with provinces or municipalities directly under the central government" Such differences in institutional layout can also affect university governance capacity, illustrating the complexity of education reform's impact on university governance and resource allocation. Therefore, this research divides the universities into "Ministry of education-affiliated universities", "Other ministries-affiliated universities", "universities affiliated with provinces or municipalities directly under the central government" and "State or municipal-affiliated universities", the heterogeneity of key explanatory variables was analyzed by grouping regression.

The regression results for models (1) to (4) show that in the time dimension, the institutional layout of various types of colleges and universities can positively influence university governance capabilities. Furthermore, these effects are all statistically significant at the 1% level. The between-group coefficient difference test using SUR estimates rejects the null hypothesis at the 1% significance level, indicating that the group regression coefficients can be compared. The impact of the institutional layout of various types of colleges and universities on university governance capabilities is ranked as follows: "Other ministry-affiliated universities" (0.8876) > "State or municipal universities" (0.8442) > "Provincial or municipal universities" (0.8094) > "Ministry of education-affiliated universities" (0.8025).

The regression results for models (5) to (8) show that the institutional layout in the spatial dimension has a positive impact on the improvement of university governance capabilities. The between-group coefficient difference test using SUR estimates rejects the null hypothesis at the 5% significance level, indicating that the group regression coefficients can be compared. The impact of the institutional layout of various types of colleges and universities on university governance capabilities is ranked as follows: "Provincial or municipal universities" (0.6170) > "Ministry of education-affiliated universities" (0.5267) > "Other ministry-affiliated universities" (0.5256) > "State or municipal universities" (0.4878). It is worth noting that administrative positions have a positive impact on the governance capabilities of "Provincial or municipal universities" and "State or municipal universities" at the 5% and 1% significance levels, respectively. For these institutions, overcoming the challenges of accessing preferential policies, such as those offered by the "985 project," "211 project," and "Double First-Class" initiative, necessitates the development of administrative networks. These networks are crucial for gathering and integrating governance elements, fostering new synergies, and ultimately enhancing university governance capabilities.

The regression results for models (9) to (12) show that in the quantity dimension, the institutional layout of various types of colleges and universities has a positive impact on university governance capabilities, and all reach a statistically significant

level. The between-group coefficient difference test using SUR estimates rejects the null hypothesis at the 1% significance level, indicating that the group regression coefficients can be compared. The impact of the institutional layout of various types of colleges and universities on university governance capabilities is ranked as follows: "Other ministry-affiliated universities" (0.8812) > "Provincial or municipal universities" (0.7640) > "Ministry of education-affiliated universities" (0.7327) > "State or municipal universities" (0.7282). At the same time, administrative positions also influence the exploration and development capabilities of "Provincial or municipal universities" and "State or municipal universities." When institutional leaders hold higher administrative positions, it is more conducive to the appropriate and effective use of both transformation and development approaches to resource integration, thereby improving university governance capabilities.

In-depth analysis reveals that institutional layout's time dimension requires universities to adapt their structures to timely capture and analyze information, foresee trends, and evaluate policies. In the spatial dimension, reducing element dispersion and increasing flexibility through interdisciplinary centers enhances governance. In the quantity dimension, expanding resources and investing in facilities and faculty development optimizes resource use and governance. Furthermore, experienced and higher-ranked personnel often identify more governance issues, suggesting the need for ongoing adjustments. Moreover, administrative roles, especially at higher levels, positively impact governance by mobilizing and integrating resources, emphasizing the necessity for dynamic, flexible, and expansive organizational structures for optimal governance.

Threshold effect. The influence of working years on the organization layout is non-linear, which affects the improvement of university governance. In order to better explore the non-linear relationship between the distribution of institutions and university governance capacity in time, space and quantity dimensions, the threshold effect regression model was used to further analyze the relationship, the results of threshold number and the threshold value are shown in Table 8.

The results of the segmented estimation based on the threshold values are shown in Table 9. Results for models (1) and (2) indicate that as individuals' years of work experience increase, the improvement in institutional layout may exhibit a "diminishing returns" effect, thereby affecting university governance capability. When individuals have less than 7 years of work experience, they are highly motivated to grasp the timeliness of governance elements in the institutional layout process, ensuring the smooth transfer of elements between institutions and avoiding blockages, ultimately enhancing university governance capability. However, as the length of work experience increases, i.e., when individuals have more than 7 years of work experience, they may experience work fatigue when facing governance challenges, leading to a decrease in work enthusiasm and hindering the adjustment of institutional layout.

The results of models (3) and (4) show that as individuals' work experience increases, their ability to establish a network of relationships and accumulate experience enables them to better gather and integrate relevant elements, leading to synergistic effects. When an individual's work experience is less than 3 years, due to lack of experience, they are constrained and unable to fully realize the transfer, aggregation, and linkage of elements, making it difficult to improve the flexibility and reduce the discreteness of governance elements in the institutional layout process. Consequently, the slow improvement in the aggregation and integration capacity of institutions also hinders the improvement of university governance capabilities. When an individual's work experience exceeds 3 years, with the establishment of a resource network and the accumulation of institutional layout experience, they can fully realize the transfer, aggregation, and linkage of elements, integrate different elements, enable governance elements to interact, and thus form resources that meet the sustainable development of university institutions, driving the improvement of university governance capabilities.

The results of models (5) and (6) show that as individuals' work experience increases, the improvement of institutional layout in the quantity dimension may exhibit an "inverted U-shaped" pattern in enhancing university governance capabilities. When an individual's work experience is less than 21 years, they are highly motivated to overcome the scarcity of governance elements and integrate scattered resources in the institutional layout process, thereby improving university governance capabilities through effective utilization of existing resources and resource development. However, as work experience increases, when an individual's work experience exceeds 21 years, they tend to become path-dependent, no longer inclined to explore new paths, and find it difficult to construct long-term, robust governance innovation mechanisms, leading to a lack of motivation for themselves and the entire school to access more resources.

A deeper analysis of these results reveals specific mechanisms through which work experience affects governance capability. In the time dimension, individuals with less than 7 years of experience are proactive in ensuring the timeliness of governance elements, while those with more experience face diminishing enthusiasm. In the spatial dimension, individuals with less than 3 years of experience struggle with element integration due to lack of experience, but those with more experience can effectively transfer and link elements, improving governance. In the quantity dimension, individuals with less than 21 years of experience actively integrate resources, but those with more experience tend to become complacent and less innovative, hindering long-term governance improvements. This analysis highlights the importance of dynamic and adaptable institutional layouts to influence the varying impacts of work experience on university governance capabilities.

Conclusion and discussion
This study contributes significantly to the field of higher education governance by exploring the impact of institutional layouts on

Table 8 Significance test of threshold effects.						
Dependent variable	**Explanatory variables**	**Threshold variable**	**Number of thresholds**	**Threshold value**	**95% confidence interval**	
					Lower	**Upper**
University governance capacity	Time	Years of work experience	Single threshold	7	3	26
	Space			3	1	37
	Quantity			21	2	24

Table 9 Threshold effect results of organizational layout and university governance capability: time, space, and quantity dimensions.

Model	University governance capabilities					
	(1)	(2)	(3)	(4)	(5)	(6)
Time (years of work experience <7)	0.8885*** (0.0335)					
Time (years of work experience >7)		0.7919*** (0.0321)				
Space (years of work experience <3)			0.5172*** (0.0463)			
Space (years of work experience >3)				0.5940*** (0.0224)		
Quantity (years of work experience <21)					0.7885*** (0.0312)	
Quantity (years of work experience >21)						0.7802*** (0.0559)
Administrative position	0.0177 (0.0603)	−0.0548 (0.0310)	0.0981 (0.1215)	0.0614* (0.0344)	0.0226 (0.0380)	−0.0240 (0.0635)
Professional titles	−0.1550 (0.0742)	−0.0442 (0.0367)	0.0281 (0.1735)	−0.0703*** (0.0336)	−0.0034 (0.0410)	−0.3446*** (0.0772)
Sample size	296	446	195	547	615	127
R-squared	0.7136	0.6455	0.3880	0.5647	0.5469	0.6314

Note: Standard errors in parentheses; *p < 0.10, ***p < 0.01.

university governance capabilities. In the transforming framework of the university governance system, institutions are the most stable organizational force through which the governance capability of a university is manifested. Understanding how to carry out a reasonable institutional layout within the university to adapt to the needs of improving governance capability has become an important subject in the new stage of modernization of university governance. In this study, time, space, and quantity are three dimensions and variables in the institutional layout of universities, which affect the efficiency of governance element allocation and constitute the three basic coordinates for observing the governance capability of universities. To analyze these complex relationships, we employed a high-dimensional fixed-effects model. The investigation used a rich dataset of 742 questionnaires, drawn from a wide range of university types and administrative roles across 30 provinces in China. The findings emphasize the substantial influence of strategic institutional layouts on governance capabilities, demonstrating variations by the institution's affiliation and the tenure of its members. Key insights include the identification of a threshold effect in tenure length, which affects governance capabilities at different intensity levels. These results affirm the critical role of timely, flexible, and strategically distributed governance elements within university structures.

The institutional layout and the governance capability of universities in the time dimension. In the dimension of time, university institutions need to have the ability to identify and capture certain elements promptly when opportunities or needs arise, through analysis and response, to demonstrate the institution's foresight, initiative, planning, and strategizing regarding its affairs. Therefore, to enhance governance capability, the institutional layout needs to have a good grasp of the timeliness of governance elements. The baseline regression results also confirm that the institutional layout in the time dimension has a significant positive impact on university governance capability. This indicates that to improve governance capability, institutions in university organizational structures need to timely grasp and analyze various social information, anticipate future development trends and patterns, assess and reflect on the implementation of existing policies and their actual operational effects, and make timely adjustments to achieve work results that are in line with the expected goals. Furthermore, the mechanism analysis results show that the responsiveness, coordination, expansion, and institutional compliance of university institutions act as moderating effects, strengthening the impact of institutional layout in the time dimension on university governance capability. This confirms the validity of hypothesis H1.

The policy implications of these findings suggest that universities should address the timeliness of governance elements through rational institutional arrangements, enabling them to identify and seize certain governance elements promptly. Without this, they risk missing opportunities by not timely using governance elements or struggling to distinguish urgent from non-urgent issues and setting priorities, impairing the cohesive role of governance elements. Based on the timeliness of governance elements, universities should set as few institutional levels as possible in their institutional layout to minimize the radius of governance element flow and increase its circulation speed, that is, responsiveness. For example, to minimize transmission and reception distances, universities can adopt a "General Manager, Team Leader, and Member" model within departments, moving away from the layered "Director-Deputy Director-Section Chief-Deputy Section Chief-Staff" approach. Furthermore, to eliminate the "element congestion" phenomenon caused by the long-term accumulation of governance elements,

universities can merge and reduce the number of discussion platforms as much as possible. Moreover, by merging and reorganizing functions, new departments can be formed to transform inter-departmental negotiation relationships into administrative relationships within departments.

The institutional layout and the governance capability of universities in the space dimension. In the space dimension, due to the flexibility and discreteness of governance elements, it is necessary for the institutional layout to utilize various educational resources such as personnel, finance, and facilities from different times and spaces through aggregation, connection, and integration. This means that elements can only maximize their effects and generate more usable resources when they flow smoothly without obstacles. The baseline regression results also show that, after controlling for a series of influencing factors, in the process of institutional layout in the spatial dimension, the enhancement of the flexibility and the reduction of the discreteness of governance elements have a significant positive impact on university governance capability at the 1% significance level. At the same time, the mechanism analysis results indicate that enhancing the flexibility and reducing the discreteness of governance elements through institutional layout adjustments can strengthen the university's ability to gather and integrate resources. This, in turn, affects the responsiveness, coordination, expansion, and institutional setting compliance of the university, thereby indirectly promoting the improvement of university governance capability. This confirms the hypothesis H2.

The policy implications of these findings highlight the need for universities to integrate dispersed governance elements both from within and outside the campus through institutional layout, selecting suitable tools to enhance synergistic effects in obtaining development resources. Universities face governance fragmentation, seen in "departmentalism," where departments operate independently, and "factionalism" in disciplines, hindering integration. These issues arise from not managing the fluidity and discreteness of governance elements effectively. To address this, universities must establish strong, comprehensive governance to ensure effectiveness, and directive unity, and prevent arbitrary actions, thereby reducing excessive departmentalization. The university party committee should oversee development, integrate departmental efforts, and ensure effective micro-level management. To facilitate the smooth flow of governance elements, spatial barriers should be minimized, functions with similarities consolidated, and departments encouraged to collaborate, and share resources, and responsibilities, thereby forming a cohesive network. Establishing technical support for data management will further ease the workload on institutions and enhance information technology use.

The institutional layout and the governance capability of universities in the quantity dimension. The improvement of university governance is closely related to the sustainable acquisition of educational resources. In the quantity dimension, the institutional layout needs to overcome the scarcity of governance elements, which is a core factor in enhancing university governance. Therefore, institutional layout not only needs to integrate and utilize existing resources but also actively explore new avenues, enhance exploration and expansion capabilities, and find long-term, stable resource channels to acquire more resources for both themselves and the entire institution. The baseline regression results show that the impact of institutional layout on university governance in the quantity dimension is positively significant at the 1% level. Furthermore, the mechanism analysis results indicate that the response, synergy, expansion, and

institutional conformity of university institutions as moderating effects can strengthen the influence of institutional layout on university governance in the quantity dimension. If universities can overcome the scarcity of governance elements through the improvement of exploration and expansion capabilities, and continuously pursue the improvement of response, synergy, expansion, and institutional conformity in their institutional layout by constructing governance innovation mechanisms, then the governance capacity of universities will be further strengthened. This confirms the hypothesis H3.

The policy implications of these findings are that, in addition to avoiding the underutilization of governance elements caused by multiple management and duplicate construction, the institutional layout of universities should also actively seek new governance elements, thereby increasing the quantity or variety of governance elements. Otherwise, institutions and the entire school risk wasting resources, failing to fully utilize materials and talents, and will merely "spin in circles," resulting in a lack of vitality and developmental stagnation. In this regard, universities should not only achieve efficiency in the new institutional layout but also promote and maintain the openness of institutions. This allows each institution to form a positive interactive relationship with organizations and individuals inside and outside the school. Generally speaking, an open environment for negotiation and communication, as well as the open flow of information, can promote institutions to continuously absorb new ideas and methods from the outside world while optimizing the allocation of resources. At the same time, it allows them to acquire new development resources. If institutions are closed, each department may not pay attention to or even be aware of the organizational goals and overall interests of the school. They may only focus on controlling internal information resources to maintain their own interests and power. In such a situation, it is difficult for the school to achieve effective integration and utilization of resources.

Threshold effect (Years of work experience), organizational layout, and university governance capabilities. The threshold regression model constructed a single threshold with length of work experience, examining the threshold effects of organizational layout on university governance capabilities in the dimensions of time, space, and quantity. For time and quantity dimensions, on one hand, as individuals accumulate more experience and become more familiar with governance issues and practices in university organizational layout over time, they are more likely to have the initiative to grasp the timeliness of governance elements and overcome scarcity, which is conducive to improving the organizational layout and enhancing university governance capabilities. On the other hand, if these governance issues persist and remain unresolved for a long time, individuals may experience work fatigue, leading to a decline in their enthusiasm for organizational layout adjustments, which may ultimately hinder the improvement of university governance capabilities. However, in the spatial dimension, the length of work experience is an important variable for individuals to accumulate experience and establish relationship networks. When the length of work experience exceeds 3 years, individuals can effectively handle the transfer, aggregation, and linkage of governance elements in the process of organizational work.

The policy implications of these findings are that, as the main body of organizational layout, the work experience and initiative of individuals determine the success or failure of organizational restructuring. Furthermore, the work experience and initiative of individuals are closely related to their length of work experience, and they manifest differently in the dimensions of time, space,

and quantity. Therefore, adjustments to the organizational layout of universities should focus on the training, management, and motivation of staff. First, new employees should receive pre-job training and regular training after taking up their positions. They should be helped to accumulate work experience and establish relationship networks as quickly as possible through the "learn from the experienced" approach, so as to fully realize the excavation, transfer, and connection of governance elements. Second, attention should be paid to the work enthusiasm of organizational personnel. When an individual's length of work experience is too long (more than 7 years) and there is a prevalence of work fatigue, the work environment should be changed through a job rotation system to alleviate the individual's negative emotions. Lastly, by establishing incentive mechanisms, the enthusiasm of employees should be increased, especially regarding the scarcity of governance elements in the quantity dimension. At the same time, considering the differences in educational resources among different types of colleges and universities (those under the Ministry of Education, those under other ministries, those under provinces or municipalities, and those under prefectures or cities), and the fact that administrative positions contribute to the development of educational resources for colleges and universities under provinces or municipalities and prefectures or cities, senior leaders should actively collaborate with various sectors of society to overcome the scarcity of governance elements.

Research limitations and future research directions. This study's investigation into the complex dynamics of university governance, focusing on time, space, and quantity dimensions, offers valuable insights but has limitations. The study's scope is limited to universities in China, which may affect the generalizability of the findings. While it highlights the significant internal impact of institutional layout on governance capability, it may overlook other external factors such as policy changes, market demand, and political, and economic influences that also play pivotal roles in governance effectiveness. Therefore, future research should expand the scope of this study to include universities globally, and examine the impact of external factors like policies and market demands, and political, and economic influences on governance.

Data availability
The data used and materials are available upon request.

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Author contributions

Competing interests
The authors declare no competing interests.

Ethical approval
Our research project has been approved by the relevant ethics committees (Jing Hengyi School of Education) and review boards associated with the Institute of China Innovation and Entrepreneurship Education, Research Center of Philosophy and Social Sciences of Zhejiang at Hangzhou Normal University, Hangzhou, Zhejiang, China (Approval Number: HNU-2024030). Ethical approval was requested and granted by these committees before the commencement of the study.

Informed consent
All participants involved in our research project provided informed consent in accordance with the guidelines established by the (Jing Hengyi School of Education), Institute of China Innovation and Entrepreneurship Education, Research Center of Philosophy and Social Sciences of Zhejiang at Hangzhou Normal University, Hangzhou, Zhejiang, China. Informed consent was requested and obtained from each participant before their involvement in the study. The process included providing participants with a detailed information sheet and consent form, which they read and signed prior to participation.

Additional information
Supplementary information The online version contains supplementary material available at https://doi.org/10.1057/s41599-024-03558-5.

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