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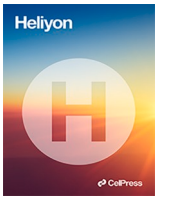

Research article

Navigating the innovation policy dilemma: How subnational governments balance expenditure competition pressures and long-term innovation goals

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ABSTRACT

In the pursuit of economic growth, the role of innovation has become increasingly important, posing dilemmas for subnational governments as they navigate the balance between expenditure competition and long-term investments in innovation. This study aimed to investigate the intricate relationship between fiscal pressures and the pursuit of innovation goals faced by regional authorities. To achieve this, a systematic literature review was conducted, synthesizing more than 150 studies published within the past 15 years. Keyword searches were conducted across multiple databases, and additional scholarly articles were incorporated through citation tracking. Rigorous qualitative analysis techniques, including inductive coding and thematic analysis, were employed to distill conceptual insights from the literature. The analysis performed in this review reveals extensive discussions regarding the influence of competition on innovation outcomes, encompassing a wide range of perspectives. The potential advantages of localization are emphasized by some viewpoints, while others caution against the risks of inadequate investment. The effective coordination of policies across multiple levels of governance to maximize synergies between national and subnational innovation systems emerges as a complex yet crucial challenge. It is observed that collaborative networks, which facilitate knowledge exchange through industrial clustering and public-private linkages, play a significant role in leveraging regional innovation assets. Strategic approaches that successfully balance competition with long-term capacity development have been demonstrated by leading jurisdictions. These findings highlight the significance of tailored policy frameworks that account for the unique contexts of each region, providing opportunities to harness competitive motivations while sustaining investments in innovation. Ongoing coordination is essential to strike a balance between responsiveness and coherence across diverse territories. This study offers practical guidance and academic insights on strategies to align decentralized imperatives, aiming to optimize prosperity through knowledge creation within evolving multi-level innovation systems. By shedding light on these strategies, the research contributes to both practical and academic understandings of how to effectively navigate and capitalize on the dynamics of such systems.

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1. Introduction

The acknowledged importance of innovation and technological progress in fostering economic growth and development is well-documented [1–4]. Governments at various levels have recognized the significance of investing in research, development, and innovation to enhance productivity, competitiveness, and living standards, leading to a prominent agenda of promoting sustainable economic progress through innovation policy [2,5,6]. The growing scholarly attention to subnational governments is apparent within this context [7,8]. Operating as decentralized governance entities in close proximity to local businesses, universities, and civil society, regional and local governments possess a distinct position to facilitate grassroots innovation and address localized needs. However, subnational governments face complex policy dilemmas as they strive to balance the pressures of short-term expenditure competition with the imperative of investing in long-term innovative capacity [9–11].

Expenditure competition denotes strategic spending policies designed to attract mobile factors of production or retain local tax bases [12]. Such competition among jurisdictions encompasses various expenditures, including business incentives, public services, and amenities. While it may yield potential efficiency benefits, uncoordinated expenditure competition also carries the risk of triggering detrimental "races to the bottom" that undermine broader societal well-being [13].

Tax-based competition, known as fiscal competition, is a specific aspect of expenditure competition that centers around utilizing tax rates and incentives to attract investments and skilled individuals [14]. Given their significant autonomy over taxation and public spending, subnational governments are particularly susceptible to engaging in fiscal competition [15]. Nevertheless, intense fiscal competition can hinder long-term development objectives by depleting resources allocated for crucial investments such as education, infrastructure, and innovation [16–18].

While previous studies have separately examined innovation policies and expenditure competition, there is limited research exploring their intersection specifically at the subnational government level. As economic growth increasingly relies on innovation and knowledge creation, understanding this relationship becomes crucial [8,19]. However, most of the existing research primarily focuses on national policies, paying less attention to regional and local contexts [20]. Consequently, there exists a research gap concerning the innovation policy challenges faced by decentralized subnational governments. Within the framework of multi-level governance, the coordination between national and subnational policies is crucial to ensure coherence [7]. However, empirical evidence reveals gaps and inconsistencies between centralized and localized innovation policies [21]. This highlights the necessity of shedding light on the subnational dimension of innovation policy. As argued by Van Aswegen et al. [22], the regional scale provides advantages for joining up policy and implementation through proximity, local knowledge, and networks. Therefore, conducting dedicated analysis on how regional and local governments navigate the dilemmas of innovation policy holds significant value.

Acquiring knowledge about the strategies implemented by exemplary subnational governments to synchronize competition-driven expenditures with the advancement of innovation capacity would yield valuable practical insights. Exploring exemplary cases could illuminate potential policy instruments and institutional frameworks that effectively harness localized competition forces to foster long-term innovation objectives rather than impeding them. Conducting a comparative analysis of diverse approaches could yield transferable lessons for subnational innovation policymaking. However, there is a paucity of studies that provide such applied perspectives [23–25].

The primary objective of this study is to thoroughly investigate the complex interplay between the pressures stemming from subnational government expenditure competition and the pursuit of long-term innovation objectives. While fiscal and expenditure competition may yield localized advantages, uncoordinated approaches carry the potential to undermine overall innovation capacity. Consequently, a critical policy challenge arises: how can subnational governments effectively strike a balance between competition-driven expenditures and strategic investments in innovation?

To address this research objective, a systematic literature review will be conducted to synthesize current scholarly knowledge on subnational government expenditure and fiscal competition, the imperatives of innovation investment, and localized innovation policies. By analyzing key patterns, debates, and issues highlighted in previous studies, this review will establish a conceptual foundation for understanding the innovation policy dilemma faced by regional and local governments. The methodology will involve comprehensive searches of academic databases to identify relevant articles and studies published within the last 15 years. Materials will be selected based on criteria such as relevance, rigor, and contribution to knowledge. The findings will then be analyzed to distill core insights, identify trends, and ascertain implications. Through integrating and expanding upon established scholarship, this study aims to develop a more nuanced understanding of the innovation policy dilemma at the subnational level.

In light of the deepening decentralization worldwide, addressing the innovation policy dilemma confronted by subnational governments is both timely and significant. Regional and local governments face increasing pressure to foster innovation ecosystems amidst fiscal and expenditure competition [7]. However, uncoordinated competition risks impeding the development of vibrant and resilient regional economies driven by innovation and knowledge creation. Therefore, elucidating strategies to reconcile short-term expenditure competition pressures with long-term innovation investments holds great practical and scholarly importance. Previous research has explored the connections between subnational governance, expenditure policies, and innovation outcomes. However, there is a lack of an integrated theoretical framework to analyze the complex policy challenges faced by decentralized authorities. To fill this gap, we propose a multi-dimensional analytical perspective by drawing upon relevant concepts from the fields of regional innovation systems, fiscal federalism, and knowledge economies.

The regional innovation systems approach views innovation as a result of interactions among diverse actors within an economy, emphasizing linkages, knowledge flows, and supportive institutions within a specific geographical area [26,27]. In addition, theories of fiscal federalism examine the economic motivations and governance challenges related to tax and expenditure decentralization among subnational jurisdictions [16]. Moreover, endogenous growth models highlight the importance of knowledge accumulation and

human capital development as drivers of long-term prosperity [28], particularly in the context of transitioning towards knowledge-intensive economies [29].

While prior research has provided valuable insights into subnational governance, expenditure policies, and innovation linkages as separate topics, there is a notable dearth of integrated theoretical frameworks that examine the intersection between fiscal decentralization, the pressures of expenditure competition faced by subnational governments, and their long-term innovation goals collectively. This study endeavors to fill a significant research gap and overcome the limitations of existing literature by proposing a unique multi-dimensional analytical perspective that incorporates relevant concepts from regional innovation systems, fiscal federalism, and knowledge economy frameworks. Through an exhaustive systematic review and qualitative synthesis of over 150 scholarly sources published within the past 15 years, this study aims to develop a more comprehensive and coherent understanding of the complex challenges associated with effectively managing these policy dynamics. The identification of four overarching thematic lenses arising from the data analysis, namely the debates surrounding the impacts of fiscal decentralization, the challenges of coordinating across multiple levels, the importance of collaborative networks, and the exemplification of strategic policy designs, contributes original theoretical insights. As a result, this study represents an innovative endeavor to comprehend the policy dilemmas encountered through international case studies that adopt a balanced strategic approach, with the aspiration of providing both academic and practical guidance on optimizing innovation-driven prosperity within evolving multi-scalar systems.

By integrating insights from these complementary perspectives, we propose an analytical framework that enables a comprehensive understanding of the intricate policy trade-offs faced by subnational authorities. Fig. 1 illustrates this multi-dimensional perspective, which examines various factors influencing regional innovation systems at different levels. This framework encompasses policy approaches and frameworks at the meso-level, as well as micro-level processes and interactions among key components of the innovation system. Through this unified theoretical viewpoint, we gain a holistic understanding of the complex connections that shape innovation dynamics within specific territories. The anticipated findings and value-added of this study are threefold. Firstly, it will underscore the importance of policy coordination among subnational governments to strike a balance between competition and strategic innovation investments. Secondly, it will highlight the significance of collaborative networks for knowledge exchange and the leveraging of regional innovation assets. Lastly, it will elucidate strategies and best practices employed by leading subnational governments in aligning competition-driven expenditures with building innovation capacity.

2. Theoretical framework

2.1. The role of innovation policy

In the current era of the knowledge economy, the significance of innovation in driving economic growth and development cannot be overstated. Consequently, governments worldwide are placing increasing importance on innovation policy as a means to enhance national and regional competitiveness [30–32]. This section will explore fundamental concepts and frameworks related to innovation policy, encompassing national and regional systems of innovation, the triple helix model, public-private partnerships, and indicators of innovation capacity.

The systems of innovation approach perceives innovation as an outcome of intricate interactions among various actors and institutions operating within an economy [33–35]. Unlike linear models, this approach recognizes innovation as an evolutionary and non-linear process that is influenced by systemic factors. The concept of national systems of innovation investigates how policies, connections, resources, and competencies shape the performance of innovation at the national level [34,36,37]. Similarly, regional innovation systems employ a comparable perspective to comprehend the dynamics of innovation within smaller geographical boundaries [26,38].

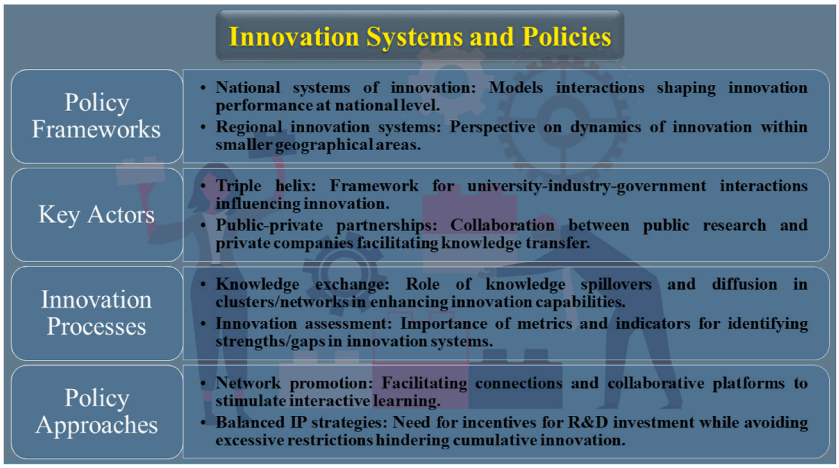

Fig. 1. A multi-dimensional framework for analyzing relationships influencing regional innovation systems.

The systems perspective emphasizes the importance of linkages and knowledge exchange among key stakeholders, such as firms, universities, research institutes, government agencies, and financiers, in driving innovation. Cooke [38] identifies essential components of regional innovation systems, including knowledge generation and diffusion, business innovation, and governance mechanisms that shape collective learning. Policy implications involve facilitating network connections, promoting research collaboration, and establishing platforms for interactive learning [26]. With the increasing adoption of open and distributed innovation models, coordinated efforts among multiple actors become crucial [39–41]. The triple helix model, as a seminal framework, provides valuable insights into the dynamics between universities, industry, and government that shape innovation processes [42]. This model posits that the interconnected roles and hybrid organizations formed by these three entities play a crucial role in knowledge capitalization and fostering innovation. Although some critics contend that the model may place excessive emphasis on hybridization [43], it nevertheless highlights the significance of collaborative platforms such as science parks, incubators, and public-private consortia in facilitating innovation [44,45].

Collaborations between public research institutions and private companies can effectively facilitate the transfer of knowledge and technologies, yielding mutual advantages [46]. While public science often lacks channels for commercialization, businesses require cutting-edge expertise [47]. Therefore, strategic partnerships that leverage complementary strengths can expedite the diffusion of innovation. Common partnership models encompass research contracts, consulting services, personnel exchanges, shared facilities, and cooperative R&D [48]. Policy measures like R&D tax credits, voucher systems, and collaborative grants serve as incentives for fostering such linkages (OECD, 2020). However, challenges related to intellectual property (IP), divergent timeframes, and cultural disparities must be addressed [49].

Assessing innovation capacity is crucial for identifying strengths, gaps, and opportunities to enhance regional innovation systems. Standard metrics include R&D expenditure, patent activity, the share of high-tech employment, and the creation of new businesses [50, 51]. Composite indexes like the Global Innovation Index also serve as benchmarks for evaluating national and regional innovation performance [52]. While these quantitative indicators are valuable, they have limitations in capturing informal innovation, organizational innovations, and contextual specificities [53,54]. Incorporating qualitative assessments can provide deeper insights into the functioning of innovation systems [55]. Moreover, the analysis should be adapted to different types of regions based on their innovation assets and economic structures. Ultimately, metrics should guide policy decisions rather than becoming an end in themselves.

The exchange and diffusion of knowledge within clusters and networks are paramount in fostering innovation. Knowledge spillovers, characterized by the transfer and dissemination of knowledge among actors, play a crucial role in enhancing innovation capabilities [56]. Silicon Valley serves as an illustrative case of a region characterized by dense knowledge externalities, where the diffusion of information among firms fosters collective learning. Although localized knowledge spillovers tend to attenuate with distance, global connectivity can facilitate international knowledge flows [57]. As a result, promoting knowledge sharing through collaborative platforms and facilitating mobility emerge as pivotal priorities in innovation policy [58–60].

Nevertheless, knowledge exchange also poses challenges regarding appropriability and intellectual property rights. Firms require incentives to invest in research and development, necessitating mechanisms for protection. However, excessive restrictions on intellectual property can hinder cumulative innovation, highlighting the need for balanced approaches [61]. The complexity and interconnectedness of knowledge networks make it difficult to trace spillover channels, thereby complicating the design of effective policies [62]. Further research is needed to optimize knowledge flows and spillovers to enhance regional innovation.

Therefore, adopting systemic and interactive perspectives underscores that innovation emerges from complex formal and informal linkages among various actors, such as firms, universities, research centers, and government agencies. Innovation policy should transcend linear models that solely focus on individual elements like R&D funding or intellectual property protection. Embracing a holistic approach that emphasizes strengthening collaborations, facilitating knowledge exchange, and establishing shared platforms and infrastructures holds greater promise for enhancing regional innovation capacity. Fig. 1 shows a comprehensive framework that classifies the fundamental aspects found in research literature, which have an impact on the performance of regional innovation. It examines various factors at different levels, encompassing policy approaches and frameworks at the meso-level, as well as the micro-level processes and interactions among the essential components of the innovation system. The aim of this unified viewpoint is to offer a complete comprehension of the intricate connections that shape innovation dynamics within regions.

2.2. Fiscal decentralization and expenditure competition

Fiscal federalism offers a valuable framework for analyzing the dynamics of tax and expenditure competition among decentralized subnational governments. The concept of fiscal decentralization involves granting lower levels of government the authority to tax, spend, and regulate [16,63,64]. By bringing decision-making closer to the citizens, its objective is to improve efficiency, responsiveness, and accountability in the delivery of public services [65]. However, decentralization also intensifies fiscal competition as subnational jurisdictions strive to attract investments and skilled individuals [15]. This section will examine key themes in the academic literature on fiscal federalism concerning the challenges faced by subnational governments.

A fundamental argument supporting fiscal decentralization is rooted in the economic advantages derived from jurisdictional competition [66,67]. This perspective posits that the mobility of capital and labor compels subnational governments to engage in competition by efficiently providing public goods. Citizens have the option to relocate to jurisdictions that align with their preferences, thereby exerting pressure on subnational governments to tailor policies and services to local needs [68–70]. Moreover, competition incentivizes fiscal discipline and cost-effective governance, as taxpayers retain the choice to depart from regions burdened by high taxes [71,72]. Through these competitive forces, decentralization is believed to engender localized efficiencies. Nevertheless, critics argue that uncoordinated competition can lead to a detrimental "race to the bottom," where subnational governments decrease tax

rates and expenditures to levels below optimal [16,73,74]. The literature emphasizes the prevalence of tax competition among subnational governments aiming to attract mobile capital and high-income workers [75,76]. Property taxes and corporate taxes tend to be particularly affected due to the mobility of their tax bases [77]. While this benefits businesses and high-income taxpayers, it reduces the revenue available for public services and investments, including initiatives to promote innovation [78,79]. Consequently, intense tax competition risks hindering broader developmental objectives [80].

However, empirical evidence concerning the effects of tax competition is varied and context-dependent. Studies conducted on OECD countries reveal limited indications of races to the bottom in terms of average tax rates [75,81]. Institutional constraints and voter preferences may restrict extreme tax reductions [82]. Furthermore, different tax types appear to be affected unequally. Corporate taxes experience more significant reductions compared to individual income and sales taxes, as the latter rely on less mobile bases [77]. This nuanced perspective challenges the notion of universally declining races driven by competition.

The existing body of literature underscores the significance of strategic expenditure policies aimed at attracting investments and skilled individuals [83]. Subnational governments employ a range of measures, including incentives, public services, infrastructure, and amenities, to signal favorable business environments [84,85]. These expenditures encompass diverse aspects such as economic development incentives, infrastructure development, education, parks, and marketing initiatives. While expenditure competition holds the potential to enhance localized welfare, critics argue that it carries the risk of excessive investment in certain regions at the expense of others [86]. For instance, offering substantial incentives to attract businesses may divert resources away from public services [84]. Empirical evidence suggests that countries with decentralized systems tend to exhibit higher levels of public spending, reflecting the competitive pressures faced by subnational governments [83,87,88].

However, empirical studies emphasize that the impacts of such competition depend significantly on the institutional context. Strong intergovernmental frameworks that encourage cooperation and policy coordination prove effective in mitigating the adverse effects of tax and expenditure competition [89]. Grant programs that share costs also help internalize the spillover effects of subnational policies [90]. Moreover, the design of intergovernmental transfers can influence competition incentives, with more flexible transfers often intensifying competition [91,92]. Therefore, while fiscal decentralization can potentially exacerbate competition, the implementation of appropriate policy coordination mechanisms serves to harness its productive elements while curbing excessive outcomes. The impact of subnational expenditure policies on efficiency and broader welfare depends on their nature and composition. Investments in education, infrastructure, and innovation capacity may generate positive spillover effects that justify public spending, even in the face of competition pressures [93]. Empirical evidence from the United States suggests that decentralized states prioritize developmental investments over consumption-oriented policies like business incentives [86]. This highlights the importance of carefully analyzing subnational expenditure patterns. Competition also stimulates innovation in local governance and public service delivery, potentially enhancing efficiency, although the factors contributing to successful outcomes are not extensively studied [94–97].

Regarding strategic expenditures, the effectiveness of business incentives in attracting investments is questionable. Reviews indicate limited evidence that incentives significantly influence firms' location decisions, with factors such as labor skills and infrastructure playing more decisive roles [98,99]. This suggests that indiscriminate use of incentives may lead to excessive spending. However, selectively and strategically deploying incentives aimed at high-multiplier investments can lead to localized benefits [100]. This underscores the importance of striking a balance between competition and coordinated approaches when designing business incentive policies. Moreover, collaboration with neighboring jurisdictions through initiatives like free trade zones can help avoid detrimental "races to the bottom".

In summary, the literature on fiscal federalism offers valuable insights into the complexities associated with tax and expenditure competition confronted by decentralized subnational governments. While interjurisdictional competition has the potential to enhance efficiency, uncoordinated approaches pose risks to public services and long-term development investments. The effectiveness of

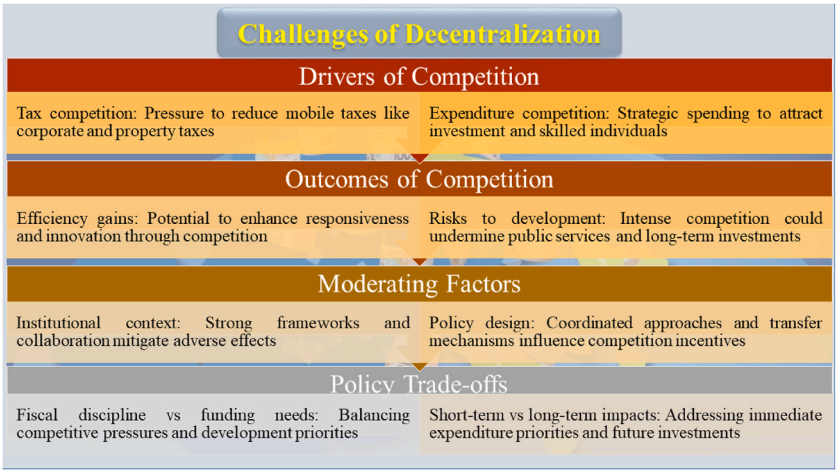

Fig. 2. A framework for examining policy trade-offs in decentralized governance systems.

intergovernmental frameworks and the direction of competition incentives through policy design are crucial considerations. Competition pressures can be utilized to stimulate policy innovation and specialization based on local strengths. However, addressing spillover effects and achieving an optimal balance across different policy domains remain ongoing challenges. Clear trade-offs exist between short-term expenditure competition and long-term investments in human capital and innovation capacity. The literature suggests that combining competition with coordinated policy networks and strategic investments ultimately enhances the performance of decentralized governance. Expenditure and tax policies should strike a balance between localized responsiveness and the avoidance of excessive interregional disparities. Further comparative research can contribute to identifying best practices for harmonizing competition and policy coordination, offering valuable insights for studying how subnational governments navigate competition-driven expenditures and strategic investments in innovation. Fig. 2 illustrates a comprehensive framework that consolidates pivotal elements identified in previous studies, which have an impact on the outcomes of competition within decentralized systems. This framework lays the foundation for the subsequent analyses conducted in this research, with the objective of enhancing our comprehension of strategic decision-making within fiscal federalism through detailed case examinations. By capturing integrated perspectives on drivers, moderators, and trade-offs, as depicted in Fig. 2, this framework enables systematic comparative evaluations of policy dynamics across different contexts.

2.3. The knowledge economy transition

The emergence of the knowledge-based economy, characterized by economic growth driven by knowledge-intensive activities, has significantly transformed the landscape of innovation policy [101]. This section will explore the growing importance of knowledge and innovation in economic development, the essential features of knowledge economies, and the challenges faced by local governments seeking to promote competitive regions driven by innovation.

One significant contribution made by endogenous growth theory was its emphasis on the central role of knowledge accumulation, technological advancements, and human capital in fostering long-term economic expansion [28,102]. Unlike earlier perspectives that considered technological progress as an external factor, this theory integrated innovation and knowledge generation within economic models. Subsequent empirical research has consistently demonstrated a robust correlation between investments in research, development, and human capital, and economic growth across different countries [103,104].

The growing importance of knowledge-intensive sectors is evident through various indices and metrics. For example, the World Bank's Knowledge Economy Index assesses countries based on their performance in education, innovation, IT infrastructure, and economic incentives [105,106]. OECD data reveals a significant rise in knowledge-intensive services, which accounted for more than 22 % of total value-added in member countries by 2009, up from around 11 % in 1970 [7]. This shift towards knowledge-intensive and technology-driven economic activities is observed across advanced, emerging, and developing economies [107,108]. Fundamentally, a knowledge economy relies on the creation, dissemination, and utilization of knowledge as the primary driver of productivity, competitiveness, and economic growth [29]. While earlier perspectives often considered knowledge and technological innovation as exclusive assets of individual firms, the systems of innovation approach recognizes their emergence from interactions, connections, and knowledge exchange among diverse stakeholders and institutions across the economy and society [34,109].

Knowledge economies are characterized by a range of interconnected factors. Firstly, they rely on intellectual assets as the primary driver of productivity, rather than relying heavily on physical inputs and natural resources [110–112]. Secondly, the development of knowledge-workers through a strong emphasis on human capital and education takes precedence over manual labor. Thirdly, both the private and public sectors increasingly invest in knowledge-generation through R&D and innovation activities [113].

Fourthly, the growing importance of knowledge-intensive and high-technology industries, accompanied by the emergence of new technologies such as information and communication technologies (ICTs) and biotechnology, is a notable characteristic [114]. Fifthly, innovation processes are becoming more complex, with open and distributed models surpassing traditional proprietary in-house R&D [39]. Sixthly, learning, knowledge exchange, networks, and the benefits of agglomeration play a central role in driving innovation [115]. Seventhly, institutions, policies, and governance are crucial in facilitating the flow of knowledge and shaping the performance of innovation [116].

Consequently, the transition towards a knowledge economy requires comprehensive and interconnected approaches that encompass education, innovation, technology, and institutional frameworks. As highlighted by Powell and Snellman [29], the focus should not solely be on increasing knowledge inputs, but rather on effectively integrating knowledge into economic activities through interrelated policy, governance, and institutional reforms.

For subnational governments, fostering competitive knowledge-based economies presents both opportunities and challenges. Regions endowed with robust knowledge assets and innovation capabilities can leverage these advantages to develop high-technology clusters and ascend the value chain [117]. However, the shift towards more knowledge-intensive activities often generates disruptive consequences such as skill mismatches, job turnover, and labor market polarization, necessitating adaptive policy responses [118,119]. In addition, it is crucial for innovation policies and investments to be tailored to the specific contexts and capabilities of each region. Regions that lag behind in terms of innovation capacity may initially focus on absorbing and applying existing knowledge and technologies before progressing towards knowledge creation [120]. Metropolitan regions can foster radical innovation through the establishment of clusters and networks, while peripheral regions may prioritize localized knowledge diffusion. Consequently, the strategies for developing competitive knowledge economies vary across different regions [121].

Knowledge externalities and spillovers play a vital role in stimulating innovation and growth, necessitating policy interventions that facilitate the flow of knowledge and capitalize on synergies among various stakeholders [56]. However, the mere existence of networks and formal collaborations is insufficient without the capacity to absorb knowledge and translate it into tangible economic

outcomes [122]. Therefore, policies aimed at developing regional skills, enhancing human capital, and strengthening institutional capacities become equally indispensable. Smaller peripheral regions face persistent challenges in creating vibrant innovation ecosystems due to difficulties in achieving the necessary scale and density [123]. This highlights the importance of external connectivity and participation in broader networks to access knowledge resources. However, relying solely on external knowledge inflows carries the risk of being locked into existing paradigms without fostering internal renewal [124]. Consequently, policies need to strike a balance between strengthening internal capacity and fostering external linkages.

Regarding firm-level innovation, large metropolitan regions characterized by diverse knowledge sources and flows tend to foster radical product innovations, while peripheral regions often focus on incremental process innovations [125]. Large firms benefit from concentrated metropolitan locations that provide a rich array of knowledge externalities. Conversely, small peripheral firms often rely more on public knowledge infrastructures to support their innovation endeavors [126]. As a result, innovation policies should be tailored to align with the prevailing firm structures and knowledge environments within each region. The coordination of policies and the establishment of linkages among various actors across institutional realms and territorial boundaries pose governance challenges [127]. Effectively governing decentralized knowledge networks necessitates flexible collaborative platforms that go beyond traditional hierarchical governance structures [115]. Achieving multi-level coordination between national, regional, and local innovation policies becomes crucial to ensure coherence and capitalize on synergies.

Nevertheless, empirical studies indicate gaps and inconsistencies between centralized and decentralized policies in practical implementation [21]. Regional authorities often have limited discretion over resources and policy autonomy compared to central governments, which restricts their ability to tailor innovation policies to local contexts [128]. However, metropolitan regions are increasingly recognized as significant nodes within national innovation systems. This underscores the importance of establishing effective governance mechanisms across multiple scales.

An important challenge within the knowledge economy is the potential for increasing spatial disparities between leading and lagging regions [116]. Metropolitan areas endowed with strong knowledge bases and innovation systems often experience higher economic growth, thus leading to regional divergence [129–131]. The concentration of knowledge-intensive activities in major cities benefits from agglomeration effects and knowledge externalities, contributing to polarization pressures. However, targeted innovation policies for peripheral and lagging regions play a crucial role in addressing this issue [132]. The smart specialization policy implemented by the European Union aims to promote localized innovation advantages across all regions to foster inclusive growth [133]. Nonetheless, critics argue that this approach overlooks power imbalances that allow core regions to capture a significant share of innovation-related resources [134]. Effectively addressing regional divergence necessitates comprehensive strategies that encompass innovation, industrial, and cohesion policies. The emergence of social inequality resulting from the impact of skill-biased technological change raises significant concerns, as it disproportionately benefits highly skilled workers [135]. Adapting education and training systems can help equip workers with the necessary skills for knowledge-based activities [136,137]. However, solely upgrading skills cannot fully address the need for quality employment opportunities. Therefore, strategies for knowledge economies must be complemented by labor market interventions, social protection measures, and redistributive policies to ensure that the benefits are shared widely [138].

Consequently, the transition to knowledge-driven economies presents both opportunities and challenges for subnational governments. Realizing the productivity and competitiveness enhancements from knowledge-intensive activities requires investments in human capital, research, innovation, and supportive institutional frameworks. However, to fully harness these benefits, policies must be tailored to the specific contexts and capabilities of each region. Governing multi-actor innovation networks across different institutional spheres poses complex coordination challenges. The concentration of knowledge activities in certain areas and the uneven distribution of skill-biased growth patterns raise equity concerns that demand integrated policy responses. Therefore, fostering sustainable knowledge economies necessitates aligning competitiveness objectives with social inclusion. Ultimately, the development of

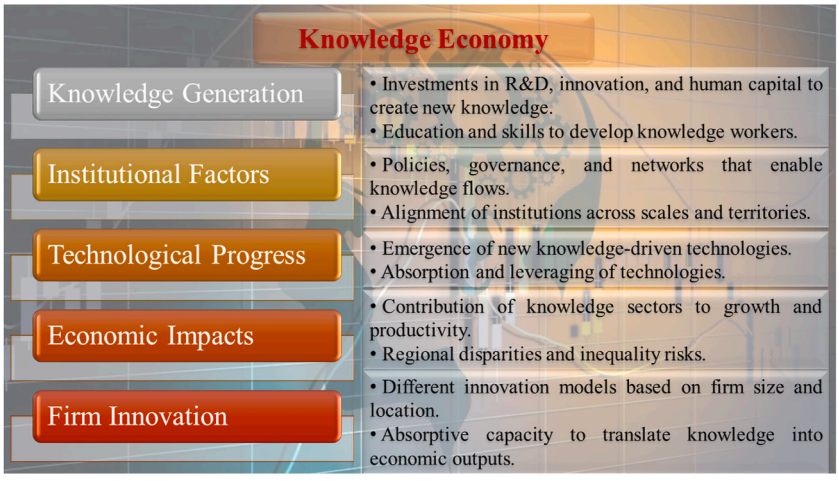

Fig. 3. A multidimensional systems perspective on knowledge economies.

competitive yet balanced knowledge-based regions relies on coherent policy blends that leverage regional strengths while promoting quality employment, capabilities, and connectivity across all territories. To effectively navigate the path towards competitive and inclusive knowledge-based economies, it is crucial to embrace a multidimensional systems perspective that recognizes the intricate and interconnected nature of this transformation. As depicted in Fig. 3, this approach involves examining various aspects, including the processes involved in knowledge generation, the supportive institutional and policy frameworks, the role of technological capabilities and channels for knowledge absorption, the resulting economic and spatial impacts, and the diverse innovation models employed by different firms.

While the aforementioned conceptual frameworks provide a theoretical foundation, it is crucial to account for the institutional contexts that shape policy outcomes. Prior research indicates that the effects of tax and expenditure competition are substantially influenced by governance structures, with coordinated frameworks yielding more favorable outcomes in terms of balanced progress [75]. Previous studies reveal limited evidence of aggressive tax reductions, indicating that the impacts of competition are contingent upon specific political economies [139]. Moreover, the nature and composition of subnational expenditures also influence whether competition fosters productive specialization or undermines welfare [84,86].

Expenditure policies aimed at enhancing regional innovation assets, such as initiatives for skills development, science parks, and targeted R&D subsidies, can justify public investments despite competitive pressures by leveraging local strengths [140,141]. However, the impact of business incentives on firm location decisions is questionable, indicating that their indiscriminate use risks excessive spending that diverts resources [98,99]. The effectiveness of place-based policies ultimately depends on coordination between different levels of governance, with integrated frameworks being most conducive to progress through customized multi-level governance [142,143]. Coordinated multi-actor platforms also facilitate the flow of knowledge, which is critical for fostering innovation [42].

3. Research methodology

To gain a comprehensive understanding of the innovation policy challenges faced by regional and local governments, a systematic literature review was undertaken. This review aimed to synthesize existing scholarly knowledge on the connection between subnational government expenditure competition and innovation policy goals. By analyzing previous studies, this review identified important patterns, debates, and issues, establishing a conceptual framework for comprehending the innovation policy dilemma. The methodology employed a thorough search of academic databases to locate pertinent articles and studies published within the past 15 years.

3.1. Search strategy

A structured keyword search was conducted across several leading databases in the fields of social sciences, public policy, economics, business, and innovation studies. The databases utilized for this search included Web of Science, Scopus, EBSCO, JSTOR, and Google Scholar. By employing multiple databases, a wide range of literature from relevant disciplines was covered. The search strategy involved combining keywords related to three main themes: 1) subnational governments, 2) competition and expenditures, and 3) innovation. Boolean operators were used to connect keywords within each theme.

For the first theme focusing on subnational governments, search terms such as "subnational government," "regional government," "local government," "state government," "provincial government," "municipal government," and "city government" were utilized. The second theme, which explored competition and expenditures, included search terms such as "expenditure competition," "fiscal competition," "tax competition," "public spending," "strategic investment," "business incentives," and "economic development incentives." Finally, the third theme centered on innovation and incorporated keywords such as "innovation policy," "innovation investment," "research and development," and "knowledge economy".

To ensure a focused and comprehensive literature review, the search process implemented additional filters and limitations. The time frame was confined to articles published between 2008 and 2023, allowing for a 15-year overview of the literature. The search specifically targeted scholarly articles, conference papers, and policy reports, while excluding books to maintain a specific emphasis on journal articles. Additionally, the search was restricted to English-language material. After removing duplicates, the initial database search yielded a set of 263 potentially relevant articles. These articles were imported into reference management software for screening. In the first round of screening, the titles and abstracts were reviewed based on the inclusion criteria, which required that the articles addressed subnational government policies, discussed competition/expenditures, and involved concepts of innovation. In the second round, the full texts of the remaining articles underwent a thorough assessment to determine their eligibility for explaining the relationship between subnational expenditure competition and innovation policy goals. This two-step screening process resulted in a final selection of 103 articles for comprehensive review and analysis.

In addition to the database search, a comprehensive approach was employed to enhance the literature review. Backward and forward citation tracking techniques were utilized to identify additional relevant articles. Initially, a careful reading of the sample articles obtained from the database search enabled the identification of key pieces. The reference lists of these articles were thoroughly examined to uncover earlier studies that may have been missed in the database search. Similarly, forward citation tracking using Google Scholar was employed to identify more recent articles that cited the key pieces. As a result, an additional set of 36 relevant articles was gathered for further review.

Moreover, targeted searches were conducted for policy reports using search engines and government databases to incorporate insights from applied research. Specific terms such as "subnational innovation policy," "regional innovation case studies," and "local

innovation best practices" were employed, along with advanced techniques including site-specific searches. This approach yielded a collection of policy documents from reputable organizations such as the OECD, European Union, national innovation agencies, and subnational governments. A total of 14 pertinent policy reports were selected to provide contextual examples and supporting evidence.

Hence, the search methodology employed a comprehensive approach that integrated a systematic keyword search of academic databases with additional strategies including reference scanning and targeted policy report identification. This meticulous process resulted in a diverse and extensive sample of 153 documents focusing on the relationship between subnational expenditure competition and innovation policy. The sample encompassed various types of literature, including 103 journal articles, 36 articles obtained through citation tracking, and 14 policy reports. These documents were sourced from a range of disciplines, such as public policy, economics, economic geography, urban studies, and regional science, offering a multidimensional framework for investigating the research objective.

3.2. Review and analysis approach

A rigorous research methodology was implemented to conduct a comprehensive examination of the existing literature concerning the relationship between competition in subnational government expenditure and the objectives of innovation policy. The methodology employed a combination of inductive coding techniques, thematic analysis methods, and synthesis of findings to extract valuable insights from a diverse range of studies. Inductive coding was systematically utilized to categorize and organize the data collected from

Table 1
Summary selected studies on subnational governance, expenditure policies, and innovation: methodological approaches and key findings.

Study	Methodology/Sample	Location	Findings
[150]	Semi-structured interviews	Western Norway	Importance of intermediaries in enabling knowledge flows between regional industries.
[151]	Secondary data analysis	European regions	Disparities in innovative capacity between core and peripheral areas.
[152]	Review of regional strategic plans	EU regions	Need for place-based innovation strategies tailored to local conditions.
[116]	Statistical analysis of patents	European regions	Positive R&D spillovers within regions strengthened by university-industry knowledge transfers.
[134]	Case studies	UK cities	"Place blind" approaches fail to leverage local innovation potential.
[153]	Econometric analysis	European regions	Universities play important roles in regional innovation but require strategic coordination.
[57]	Interviews & document analysis	Baden-Württemberg region	Dense local & global networked linkages foster interactive learning within clusters.
[21]	Review & analysis of policy documents	EU	Disjointed national & subnational policies fail to optimize synergies.
[154]	Statistical data & interviews	Finland	Inter-municipal cooperation enhances capacity for innovation.
[155]	Meta-analysis of impact evaluations	Spain & others	Public R&D funding generally has a positive effect on private investment.
[156]	Case study	Newcastle upon Tyne city region	"Catapult centers" foster business collaboration but coordination is lacking.
[157]	Literature review and policy analysis	Europe	Decentralized innovation policies require coordination and place-sensitivity.
[158]	Interviews and statistical analysis	US Metro Areas	University-industry partnerships drive regional economic growth.
[159]	Review and analysis of innovation strategies	EU regions	Smart specialization adapts open innovation to decentralization.
[160]	Statistical analysis of public R&D spending	EU regions	Impacts of R&D expenditures differ across regions based on capabilities.
[161]	Econometric analysis of firm data	Chinese cities	Collaboration between firms and universities enhances regional innovation.
[162]	Regression analysis	Eurozone regions	Importance of tertiary education and industrial specialization for regional innovation.
[140]	Comparative cluster case studies	Italy	Localized learning through cluster interactions depends on cluster characteristics.
[163]	Semi-structured interviews	Basque Country	Knowledge-intensive clusters require collaborative innovation strategies.
[164]	Mixed-methods case studies	UK city-regions	Place-based innovation policies should consider multi-scalar linkages and systems.
[165]	Literature review and policy analysis	EU	Crafting regional innovation policies requires an understanding of industrial structures.
[166]	Statistical analysis	UK local authorities	Innovation outcomes differ across lagging/leading regions due to capabilities.
[167]	Literature review and framework development	–	Knowledge spillover theory applies to understanding variety within regional innovation.
[168]	Longitudinal case study	Brazil–Finland–Germany	University-industry links depend on intermediaries focused on industrial problems.
[169]	Statistical modeling	Portuguese regions	R&D investment impacts innovation most in regions with skilled labor pools.
[170]	Economy-wide patent data analysis	OECD nations	Industry-university links through labor mobility aid technically diverse innovation.
[171]	Statistical analysis	EU nations	Firms leverage regional spillovers through open innovation strategies.
[172]	Comparative cluster analysis	Spain	The embeddeness of clusters influences collaboration and innovation outcomes.

an extensive sample of literature. Initially, a set of broad open codes was developed, aligning with the research objectives and conceptual framework. These codes encompassed key themes related to subnational governments, expenditure competition, fiscal competition, innovation policy, factors influencing the knowledge economy, collaborative networks, policy strategies, and their outcomes. Subsequently, the complete texts of 103 journal articles and other relevant studies underwent meticulous examination through multiple readings to identify pertinent text segments that represented these phenomena. This thorough approach ensured a comprehensive understanding of the relevant content and facilitated the extraction of relevant insights from the literature.

During the analysis, an iterative and comparative approach was adopted to allow for the emergence of new codes directly from the literature. Each text excerpt was carefully examined and assigned one or more codes based on the underlying concepts and ideas found within [144]. This open inductive coding method enabled the systematic extraction of data-driven concepts without imposing predefined categories at the outset. To ensure the robustness and reliability of the coding framework, memo-writing was conducted simultaneously to define codes, compare assigned text segments, and capture analytical reflections.

Once all the literature had been thoroughly coded, the indexed codes were systematically organized into categories that represented overarching themes. This process involved iterative discussions among the research team, aiming to refine the initial categories through merging, splitting, and renaming based on comparative analysis. As a result, 22 coherent categories emerged, encompassing sub-themes such as different types of expenditure competition, innovation policy instruments, governance challenges, factors influencing impact assessment, and strategic responses.

Following the establishment of the finalized coding structure along with its corresponding definitions, a comprehensive codebook was created. To ensure the reliability of the codes, a subsample of the data was independently coded by multiple researchers. The intercoder agreement exceeded 90 %, confirming the consistency in the application of the codes. The structured codebook served as a valuable tool for organizing and retrieving the coded data segments, facilitating subsequent thematic analysis.

Thematic analysis was employed to uncover patterns of meaning within the coded dataset and extract overarching themes that encapsulated the literature [145]. This data-driven and inductive approach involved comparing the coded data across different categories to identify relationships between various constructs. The utilization of mind-mapping software aided in visually mapping the codes under potential themes and sub-themes, which were continuously refined through an iterative process. To ensure accuracy and comprehensiveness, a constant comparative analysis method was implemented, involving the comparison of data segments with existing categories and making necessary adjustments as required [146].

To consolidate the findings of the review, relevant data segments pertaining to the identified themes underwent a comprehensive groupwise comparison and abstraction process [147,148]. The inclusion of contextual variables from various studies facilitated the examination of converging, diverging, and innovative perspectives. To gain a comprehensive overview, a summative content analysis approach was employed to generate frequency counts of sub-themes [149]. By linking the empirical evidence back to the conceptual frameworks, critical interpretations of the implications were provided. The examination of data saturation confirmed that an adequate amount of literature had been reviewed, as no new codes or themes emerged during the final coding iterations of additional studies. In summary, the combination of inductive coding and thematic analysis facilitated a constant comparison between codes, categories, and themes, allowing for the systematic distillation and synthesis of insights from the diverse sample of literature. This approach ensured a rigorous yet adaptable methodology for developing a comprehensive conceptual understanding of the investigated topic beyond the scope of individual studies.

Table 1 below offers a concise overview of the main studies examined using the analytical methodology described. It presents a selection of 25 studies, providing key information on sample and location characteristics, methodology used, and notable findings. The chosen studies represent a range of well-cited research exploring various aspects of subnational governance, expenditure policies, innovation linkages, and strategic policy approaches across different global contexts. The purpose of this table is to summarize the methodological and outcome details of each study, thereby illustrating the breadth of perspectives encompassed within the comprehensive review process.

Table 1 encompasses a wide range of methodological approaches, including quantitative studies analyzing extensive datasets, policy impact assessments, case studies, qualitative comparative analyses, and literature reviews. The selected studies cover various regions, such as Europe, North America, Asia, and South America. Noteworthy findings in these studies revolve around policy mix design, strategies for skills development, the impact of networking, trajectories of industry specialization, and the factors that influence differentiation in innovation performance across different territories.

The application of rigorous qualitative content analysis methods significantly enhanced both the credibility and the depth of insights derived from the extensive literature review conducted. The implementation of inductive coding facilitated the systematic organization of a substantial volume of literature, while thematic analysis revealed the interrelationships between different conceptual dimensions. The constant comparison method ensured analytical rigor, and the entire process was thoroughly documented, ensuring transparency. The formalization of codes and categories further fortified the dependability of the findings, supported by inter-coder reliability testing. By linking the findings back to established theories, the conceptual coherence of the study was strengthened. This multifaceted iterative methodology provided valuable insights into the intricate challenges confronted by subnational governments as they navigate the intersection of expenditure competition and innovation objectives.

Through the comprehensive analytical process, four dominant thematic perspectives emerged from the literature: 1) debates surrounding the impact of competition on innovation investment and outcomes, 2) issues related to coordination in policymaking across different institutional levels, 3) the significance of collaborative networks for knowledge exchange, and 4) the strategic policy approaches adopted by leading subnational jurisdictions. A deeper exploration of these overarching themes can provide valuable perspectives on the challenges encountered and strategies pursued in this context. The subsequent sections will delve into a detailed discussion of each theme, drawing insights from the review findings and discussing their implications.

In summary, to develop a comprehensive understanding of the complex policy dynamics, we conducted a systematic literature review that synthesized more than 150 peer-reviewed studies, reports, and empirical analyses published in the last 15 years. Our search strategy involved a structured approach across multiple databases to identify sources that addressed the relationships between subnational expenditure policies, fiscal competition, and innovation objectives. The selection of materials was based on their relevance and rigor, and we also incorporated additional citations through backward and forward tracking. Through inductive coding, we organized the literature into conceptual categories, and thematic analysis allowed us to identify interrelationships between different constructs through constant comparison.

By linking the evidence to our theoretical frameworks, we were able to strengthen the conceptual coherence of our study. From the data, four overarching thematic lenses emerged: debates on the impacts of fiscal decentralization on innovation investments, challenges associated with coordinating policymaking across multiple levels, the importance of collaborative networks for knowledge exchange, and exemplary strategic policy designs. By conducting an in-depth analysis of each perspective and synthesizing diverse disciplinary views over time, our methodology provided valuable insights into effectively navigating the complex policy dilemmas faced by subnational authorities. The use of rigorous qualitative methods enhanced the credibility and depth of understanding derived from this extensive body of scholarship.

In conclusion, a comprehensive examination of the intricate relationship between subnational government expenditure competition pressures and long-term innovation objectives is sought in this study. To achieve this aim, a multi-dimensional analytical perspective is proposed, informed by the integration of insights from relevant theoretical lenses. The conceptual basis of this study is rooted in regional innovation systems theory, fiscal federalism, and frameworks conceptualizing knowledge-based economic transformation. Knowledge diffusion is viewed within regional innovation systems as emerging from actor linkages within specific geographies. The challenges of tax and expenditure decentralization among subnational jurisdictions are examined through the lens of fiscal federalism. Perspectives from the knowledge economy highlight the significance of knowledge accumulation, technological progress, and human capital development as primary drivers of productivity and prosperity. By drawing upon concepts from these complementary domains, the analytical viewpoint presented in this study offers a unified theoretical lens for analyzing the intricate policy trade-offs faced by decentralized authorities as they navigate the intertwined imperatives of competitiveness and innovation.

4. Findings and discussion

The examination of existing literature has uncovered extensive discussions within academic circles regarding the intricate relationship between fiscal decentralization, the pressures of expenditure competition faced by subnational governments, and the strategic long-term investments in innovation. While policies aimed at attracting mobile capital and skilled labor through competitive incentives have the potential to generate localized efficiencies, critics argue that unrestricted approaches exacerbate interregional disparities and undermine overall innovation capacity [78,80]. However, empirical evidence suggests that the impacts of tax and expenditure competition significantly depend on the institutional context, with coordinated frameworks proving to be more effective in mitigating adverse effects [75,139].

Furthermore, the nature and direction of subnational expenditures play a crucial role in determining whether competition enhances productive specialization or hampers welfare. Investments that target the enhancement of regional innovation assets through initiatives such as skills development, collaborative infrastructure, and targeted R&D subsidies can justify public spending despite competitive forces by leveraging local strengths [140,141]. However, the indiscriminate use of business incentives risks excessive spending that diverts resources, and its impact on firm location decisions remains questionable [98,99]. Coordinated multi-actor platforms also facilitate the critical knowledge spillovers necessary for fostering innovation [42]. Zhan et al. [173] conducted a recent empirical study utilizing the SBM-GML model to assess green total factor productivity. Panel data from 30 Chinese provinces spanning the period of 2012–2018 was employed to investigate the effects of various dimensions of fiscal decentralization on green productivity. The findings of the study revealed that both fiscal revenue and expenditure decentralization exhibited a significant detrimental impact on improvements in green productivity. Furthermore, the study highlighted that the negative influence of fiscal decentralization on green productivity was more pronounced in central and western regions compared to their eastern counterparts. Notably, the study also identified that local government competition played a moderating role, attenuating the adverse effects of fiscal decentralization on green productivity. Consequently, this rigorous quantitative investigation provided valuable insights into the intricate relationship between decentralization and sustainable development in China.

The existing literature does not present a consensus on these matters, highlighting the multidimensional and context-dependent nature of these relationships. Our findings contribute to these debates by delving deeper into diverse empirical cases and conceptual frameworks, allowing for a nuanced understanding of the policy dilemmas faced by subnational authorities.

4.1. Debates on the impacts of competition on innovation investments

The examination of existing literature has revealed extensive discussions in academic circles regarding the intricate connection between competition in subnational expenditure and strategic investments in innovation. While policies aimed at attracting mobile capital and skilled labor have the potential to generate localized efficiencies, critics argue that uncoordinated approaches exacerbate interregional disparities, which undermine long-term innovation objectives [12,16,174,175]. This section aims to present a comprehensive analysis and synthesis of perspectives found in the review findings, in order to provide a well-rounded viewpoint on the multidimensional discourse.

While there is ongoing extensive discourse regarding the impacts of fiscal decentralization, it is imperative to consider the influence

of institutional contexts that shape the actual outcomes. As pointed out by Winner [75], various empirical studies conducted in different nations have provided limited evidence of aggressive tax reductions. This suggests that the effects of competition are significantly contingent upon specific political economies. In addition, coordinated intergovernmental frameworks have demonstrated their effectiveness in mitigating adverse consequences by internalizing spillovers [139,176]. However, the direction of subnational expenditures also plays a crucial role in determining whether competition enhances productive specialization or undermines welfare. Research conducted in the United States has indicated that decentralized states prioritize developmental investments over consumption-oriented policies such as business incentives, underscoring the significance of expenditure composition [86].

Allocating resources towards enhancing regional human capital, infrastructure, innovation capacity, and targeted business support can justify public spending despite competitive forces by generating positive externalities [140,141]. However, the indiscriminate use of incentives risks excessive spending that diverts funds without decisively impacting location choices [98,99]. Coordinated multi-actor platforms also play a crucial role in facilitating knowledge spillovers critical for innovation among firms, universities, and policy spheres [42]. The effectiveness of place-based interventions ultimately relies on multi-level cooperation between authorities to ensure coherence and optimize synergies across different scales.

Advocates of fiscal decentralization emphasize the significance of competition in stimulating innovative policies that cater to the strengths of specific regions [177–180]. Through exerting downward pressure on tax rates and public service costs, competition between jurisdictions disciplines subnational governments and compels them to adopt differentiated responses that align with the diverse preferences of citizens [181–184]. This specialization enables optimization based on territorial assets, thereby improving allocative efficiency [185].

While previous research has provided valuable insights, a deeper exploration of strategic policy designs implemented by prominent subnational jurisdictions can offer practical perspectives on navigating these intricate dynamics. Noteworthy cases demonstrate the benefits of tailoring competitive incentives to promote regional strengths that align with localized industrial foundations. Similarly, the establishment of specialized science parks connected German Länder with agglomeration advantages derived from mechanical and electrical engineering [80].

Coordinated R&D subsidies have also stimulated private sector investment multipliers among competitive yet collaborative devolved regions in the United Kingdom [186]. These examples illustrate strategic approaches that effectively balance competition with long-term capacity building through place-sensitive coordination [142]. Flexible yet accountable frameworks tailored to institutional contexts and regional attributes hold promise for aligning competitive pressures with equitable and sustainable progress.

Numerous studies conducted in specific regions validate the role of competition in driving specialization aligned with local industrial foundations. Rodríguez-Pose and Gill [80] establish a connection between competitive science parks in German Länder and agglomeration advantages. However, some raise doubts about attributing causality solely to competition, as other factors such as pre-existing resource endowments may confound the results [8]. Simultaneously, critics argue that competition undermines collaborative capacity-building due to the occurrence of "races to the bottom," which lead to significant reductions in essential public revenues and services [16,187,188]. Observational evidence supports the notion that intensified tax reductions divert funding away from education, infrastructure, and innovation in decentralized systems [83,189]. Fiscal restraint disproportionately affects disadvantaged groups due to reduced redistribution [79,190,191]. In extreme cases, policy convergence dilutes territorial diversity [192,193].

The aforementioned negative consequences stem from the presence of spillover externalities that cloud the broader societal costs associated with subnational decisions [185]. The exchange of knowledge between regions plays a crucial role in promoting innovation in underdeveloped areas, facilitated by mobility and collaboration enabled by accessible public goods. This underscores the collective significance of interregional knowledge flows [37,62]. Consequently, unrestricted competition fails to internalize the interdependencies necessary for achieving balanced regional development [93,194]. However, more nuanced perspectives highlight that the impact of competition varies depending on institutional contexts. Notably, studies conducted by Winner [75] and Prichard [176] have found limited evidence of aggressive tax reductions within OECD countries. Additionally, Parker et al. [139] have associated minimal effects with coordination practices that mitigate excessive competition. These findings imply that competition outcomes are significantly influenced by governance frameworks and policy design [195–198].

In terms of expenditures, strategic utilization aimed at promoting innovation capabilities can arguably justify public investments despite competitive pressures [199,200]. Targeted spending that leverages localized knowledge foundations through the establishment of science parks, incubators, and skills enhancement initiatives strengthens regional capacity in the long term [201,202]. Directing incentives towards high-multiplier activities amplifies productivity spillovers and enhances access to global innovation networks [57,189]. Empirical evidence supports the strategic role of expenditures. McCann [141] establish a link between R&D subsidies provided by competitive UK devolved administrations and private investment multipliers. Giuliani [140] observes that clustering interactions foster localized learning, which depends on the presence of supportive infrastructure. Regional authorities that align competitive strategies with smart specialization goals demonstrate an ability to reconcile short-term gains with long-term sustainability [133,203,204]. However, amidst targeted approaches and unrestricted subsidy races, conceptual ambiguities and measurement challenges arise for both proponents and critics of competition. Expenditure policies that intensify competition encompass a wide range of areas, including education, urban development, and business incentives [205,206]. The impacts of these policies vary from productive to counterproductive, depending on their forms, scales, and level of coordination [86]. Quantitative assessment also poses difficulties due to complex attribution issues and the presence of multiple interacting drivers [207,208].

The diversity of perspectives highlights the necessity and complexity of optimizing intergovernmental policy design. Effective decentralization relies on customized frameworks that encourage the positive aspects of competition while mitigating negative externalities [185]. Coordinated multi-level approaches that offset subnational narrow-mindedness with integrated problem-solving

prove to be most conducive to balanced progress [30,127,151]. Flexible formats that allow for place-sensitive calibration are integral to this process [209].

Therefore, the relationship between fiscal decentralization, expenditure competition, and strategic innovation investments remains a dynamic topic in academic discourse. While competition pressures localize policies, unrestricted races pose a threat to investments that underpin the innovation systems necessary for prosperity. However, competition can yield localized benefits when it disciplines and targets the enhancement of territorial capabilities, particularly in lagging areas through interaction. Harnessing competition requires a multi-level calibration that balances responsiveness, spillovers, and coordination to accommodate diversity while fostering cohesion. Therefore, the impacts of competition are contingent and require customized governance approaches that balance pressures to achieve equitable and sustainable regional development. This section explores the intricate relationship among fiscal decentralization, expenditure competition, and strategic innovation investments, necessitating a comprehensive synthesis of various perspectives. To visually represent this dynamic, Fig. 4 aims to conceptualize the following aspects highlighted in the literature: 1) the potential advantages of competition in driving localized policy responsiveness and efficiency gains; 2) the limitations associated with reduced coordination and negative externalities; 3) the mediating role of institutional context in these impacts; and 4) the possibilities for utilizing public expenditures strategically to foster regional innovation capabilities.

4.2. Challenges of policy coordination across multiple levels

The examination of existing literature underscores the importance of addressing multi-level governance concerns and coordinating policies across various institutional levels to ensure policy coherence in decentralized innovation systems. With the growing prominence of knowledge-based economic activities spread across different regions, the integration of national, regional, and local innovation initiatives becomes crucial [210–212]. Nonetheless, empirical studies also uncover inconsistencies, both conceptually and practically, between centralized and decentralized approaches to innovation strategies [21]. This section aims to offer a thorough examination and discourse on the governance obstacles involved, drawing insights from the findings of the review.

At the core of the systems of innovation framework lies the concept of national innovation systems, which investigate how macroeconomic factors, institutions, and policy interventions influence the creation and dissemination of knowledge at the national level [34,36,37]. Within a multi-level framework, national governments continue to have a vital role in areas such as fundamental research, higher education, the development of large-scale infrastructure, funding for scientific endeavors, and maintaining macroeconomic stability to facilitate the commercialization of knowledge [210,211]. This centralized control over "public goods" allows for nationwide coherence and the optimization of synergies between regions [8].

However, the decentralization of territories grants subnational authorities closer proximity, contextual expertise, and implementation mandates, empowering them with unique influence over the "club goods" of innovation, such as industry-specific skills training, regional infrastructure projects, support structures for clusters, and tailored incentive mechanisms [7,213]. This approach to "regional innovation governance" emphasizes the customization of innovation systems to the strengths and needs of specific territories, aligning with the principles of "smart specialization" [134,214].

Achieving integration between national and subnational systems necessitates the implementation of "multi-level governance," which entails establishing a networked partnership that assigns responsibilities based on the principle of "subsidiarity," thereby allocating functions to the lowest capable administrative level [7,215]. However, coordinating these efforts presents intricate challenges in reconciling top-down priorities with bottom-up advancements. Policy documents indicate persistent conceptual disparities between centralized priority-setting and localized strategies [216–218]. One contributing factor to fragmented governance is the unequal discretion granted to regional authorities in terms of budgets and strategic autonomy, in comparison to central governments

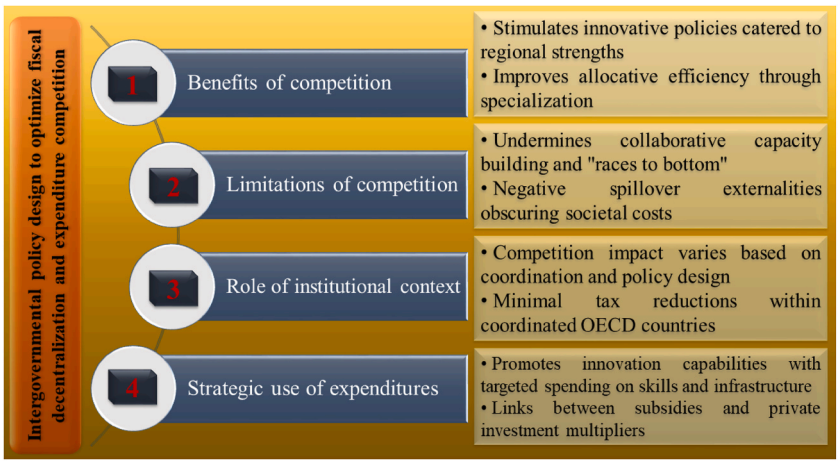

Fig. 4. Analytical framework for examining the interplay between fiscal decentralization, competition dynamics, and strategic innovation investments.

[219,220]. Insufficient collaboration across multiple levels of governance poses a risk of diluting entire systems rather than harnessing complementary strengths, as coordination mechanisms strategically distribute responsibilities based on capabilities across different scales [8,127]. Reviews specific to each country further support the notion that optimizing synergies requires tailoring frameworks to institutional contexts by striking a balance between centralized steering and localized experimentation [142].

For example, Finland, a top-ranked innovator, adopts an incremental, networked model that continuously adjusts national priorities and regional differentiation in collaboration with industry partners [59,221]. Similarly, the decentralized approach in Germany integrates regional innovation policies within a nationally coordinated high-tech strategy, effectively reconciling federalism with system-wide coherence [7]. These examples highlight the value of flexible yet coordinated policy learning across different levels of institutions.

The establishment of collaborative platforms involving authorities, businesses, universities, and communities is essential for jointly formulating objectives, aligning tools, and assessing impacts towards shared goals [189,213]. Coordinated projects, contracts, and integrated funding incentivize cooperation across divisions, promoting collaboration instead of zero-sum competition between territories [127,152].

Regional administrations have shown greater success in leveraging forums that facilitate vertical collaborations, such as science parks, innovation networks, and hybrid organizations that mediate between different actors [158]. Targeted intermediaries play a crucial role in aligning incentives, navigating multi-stakeholder priorities, building capacities, and capturing technological spillovers that benefit regions that are falling behind (Howells, 2006; Rodríguez-Pose et al., 2013).

In addition to vertical coordination, spatial integration supplements collaboration through cross-border partnerships that harness agglomeration effects at larger scales. This is exemplified by initiatives like EU macro-regions and Benelux initiatives that coordinate complementary specializations [222–224]. However, territorial imbalances pose dilemmas for policymakers who must balance the concentration of innovation capacities with the goal of inclusive progress [225]. Addressing polarization requires strategies that optimize inter-regional knowledge flows and upgrade local capabilities [141,226].

Therefore, multi-level coordination is a critical imperative in knowledge-driven systems that span diverse territories. National frameworks provide coherence through macroeconomic stability and investments in basic research, while subsidiarity assigns specific roles to subnational authorities based on their localized expertise. However, inadequate collaboration risks disrupting rationales, as decentralized powers face resource limitations that call for flexible yet accountable partnership frameworks. Customizing collaborative governance based on institutional specificities, through collective priority-setting, integrated funding schemes, and networking platforms, becomes pivotal to optimize synergies between different levels. Strategic coordination, tailored to diverse territorial contexts and innovation architectures, holds promise for aligning scattered yet interconnected elements toward balanced regional development.

To delve deeper into the strategies for policy coordination, Table 2 presents a synthesis of the main approaches identified in the systematic literature review that address the challenges faced by subnational governments in navigating innovation policy dilemmas.

The literature review uncovered numerous jurisdictions that effectively utilized these coordination approaches. For example, collaborative networks facilitated localized learning through interactions within industrial clusters, as observed in Italian wine valleys [140]. In Spain, networked intermediaries supporting the Mondragon cooperative contributed to industrial upgrading by aligning skills and technologies [227]. Moreover, coordinated R&D subsidies among competitive yet collaborative devolved regions in the United Kingdom stimulated private sector investment [186].

Place-sensitive priority coordination between governments played a pivotal role in positioning German Länder as global leaders in mechanical and electrical engineering by combining federal frameworks with tailored regional initiatives [228]. In Ontario, multi-level policy coordination facilitated university-industry collaborations, resulting in enhanced regional innovation performance [158].

These international experiences underscore the significance of approaches that harness synergies between strategic policy coordination strategies to optimize complementarities between centralized and decentralized dimensions of complex innovation systems across diverse territories. Flexible yet accountable frameworks that assign responsibilities based on institutional specificities and regional attributes hold promise for reconciling specialized advancements with integrated progress. Effectively managing intricate multi-level innovation architectures necessitates understanding and balancing the interaction between divergent policy perspectives and mechanisms at both centralized and decentralized levels [229–233]. In this section, we present Fig. 5, which offers a conceptualization of the key elements involved in this process. The figure begins by outlining the principles of multi-level governance and the significance placed on regional strategies, followed by an exploration of the inherent challenges in achieving coordination. Subsequently, various mechanisms discussed in the literature are synthesized, including collaborative networks and integrated funding approaches, which aim to address inconsistencies. By systematically organizing the multifaceted discussion, Fig. 5 presents an analytical framework for assessing the strategies employed by different jurisdictions to establish policy coherence across diverse

Table 2
Coordination strategies for navigating innovation policy dilemmas.

Strategy	Explanation
Policy coordination	Coordinated priority-setting between different levels of government; aligning tools and targets to achieve common goals.
Collaborative networks	Platforms that connect the public and private sectors, facilitating knowledge exchange and joint problem-solving.
Clustering	Leveraging the benefits of agglomeration through networks that support localized industry strengths.
Targeted innovation investments	Strategically aligning expenditures to enhance territorial innovation capacities.

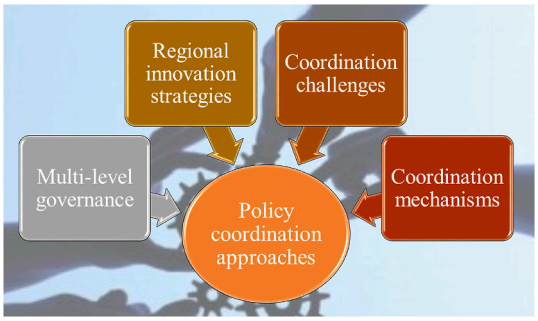

Fig. 5. A framework for examining approaches to policy coordination in decentralized innovation systems.

institutional scales.

Fig. 5 presents an analytical framework that organizes several key themes from the literature concerning the coordination of innovation policies across multiple levels of governance. A closer examination of these elements provides valuable insights into the complexities of this process. For instance, the challenges associated with delineating responsibilities between centralized and localized actors underscore the necessity of collaborative approaches. Moreover, effectively leveraging regional expertise while maintaining overall system coherence requires striking a balance between specialized advancements and integrated objectives. The synthesized mechanisms also emphasize the significance of adaptable yet accountable frameworks that reconcile top-down priorities with bottom-up initiatives. Together, this categorization provides a conceptual roadmap for evaluating the intricate nature of institutional contexts and the internationally adopted coordination strategies aimed at optimizing synergies within diverse territories encompassed by multi-dimensional innovation architectures.

4.3. The significance of collaborative networks for knowledge exchange

Collaborative networks have a crucial role in facilitating the exchange of knowledge and promoting innovation within decentralized regional innovation systems. These networks enable interactive learning between various actors, including companies, universities, and public agencies. Well-structured networks can effectively utilize the complementary strengths of these actors to encourage collaboration both within and across different territories [234–238]. This section provides a comprehensive analysis of the existing literature on networking strategies that leverage regional resources by establishing clusters and fostering public-private linkages.

One significant approach employed by regions to optimize their local advantages involves the establishment of industry clusters. These clusters are characterized by the concentration of interconnected firms, suppliers, and associated institutions within specific sectors [239]. By bringing together expertise and facilitating knowledge exchange among collaborators, clusters serve as the foundation for innovation ecosystems [240,241]. They also create opportunities for knowledge spillovers and foster competitive pressures that drive collective improvement [8]. According to Kontovas et al. [242], clusters that focus on specialized skills or domains act as central hubs that bring together diverse stakeholders within innovative environments. Additionally, natural assets such as access to ports or tourism amenities can further enhance cross-industry connections by providing shared infrastructure or social capital [123].

Knowledge exchange within industrial clusters occurs through a variety of formal and informal interactions. For instance, in Italian valleys, competing wine companies collaborated and engaged in joint experimentation and problem-solving [140]. Similarly, Danish biotech ventures and equipment suppliers embarked on codevelopment initiatives, leading to mutually beneficial innovations [243]. Tacit information sharing thrives within tightly-knit clusters that adhere to shared social norms of trust and reciprocity [140,244]. It is worth noting that approaches that maintain trust through moderate competition tend to be more sustainable than strategies solely focused on intense rivalry [245].

Networking platforms play a crucial role in amplifying the benefits of agglomeration by facilitating organized interactions. Science parks, for example, enhance knowledge spillovers by locating firms in close proximity to universities and laboratories, as observed in notable Chinese clusters [210]. Innovation centers provide opportunities for serendipitous collaboration and access to technical resources [246,247]. Virtual networking sites complement physical co-presence by connecting dispersed members, enabling global idea sharing and coordinated activities [248]. However, Giuliani et al. [140] caution that excessive control and integration can undermine the spontaneous flows that foster localized learning within industrial districts.

Cluster governance plays a crucial role in facilitating interactions to enhance regional innovation systems [249]. Coordinating bodies are responsible for bringing together stakeholders to engage in joint foresight exercises, provide support services, and guide training programs. Matchmaking events are conducted to introduce potential collaborators based on their expertise and profiles [250]. Systematic gathering of intelligence helps identify technological trends and future opportunities, aligning them with the regional capabilities to identify areas that require collaborative investments [251]. Network secretariats also play a role in directing funding towards collaborative R&D consortia, which pool resources to address ambitious challenges.

Multi-actor platforms further expand the benefits of networking by integrating both public and private sectors. Triple helix models formalize cooperation among universities, industries, and government agencies to facilitate knowledge transfer through joint

educational programs, infrastructure sharing, and mediation between partners [252]. The evolution of quadruple helix frameworks extends involvement to include contributions from civil society in areas such as public awareness and community service initiatives. However, it is important to note the caution raised by Grandori and Furnari [253] regarding the potential risks of excessive engineering and hybridization, which may lead to bureaucratization and hinder the organic processes of clusters that rely on local ties and contexts.

Effective intermediaries play a pivotal role in facilitating interactions among academia, industry, and policy spheres. Technology transfer offices, for example, contribute to the establishment of public-private research partnerships by identifying applied projects, protecting intellectual property, and commercializing innovations [254]. Industry centers serve as pivotal hubs for collaborative R&D efforts, securing long-term commitments and investments from private sector partners to address precompetitive challenges [156]. In Norway, regional strategy organizations oversee inter-cluster networking to align regional skills bases. Traditional linear approaches to commercialization are gradually being replaced by iterative learning facilitated by interactive intermediation, enabling feedback loops between researchers and end-users [255].

Despite the proliferation of physical and virtual platforms, challenges persist in terms of their optimal structuring and governance. The effectiveness of networks relies on establishing trust through transparency, accountability, and inclusive participation that fosters long-term societal support [256]. Coordinating dispersed collaborations necessitates clearly defining roles and incentivizing cooperation over competition through joint monitoring of outcomes and providing rewards for contributors [257]. Furthermore, dispersed members require flexibility to maximize benefits by spontaneously forming subgroups based on complementary interests within broader frameworks [258–261].

Additional considerations arise in sustaining clusters that face external disruptions and realignments. The presence of power imbalances poses a risk of concentrating advantages in already developed regions, unless untapped synergies and knowledge transfer initiatives are implemented to uplift lagging areas [262]. Countercyclical strategies play a crucial role in helping clusters navigate economic fluctuations and continuously diversify beyond dominant niches that are vulnerable to volatility, by proactively anticipating emerging technologies [263,264]. Adaptive governance practices enhance resilience by supporting structural adjustments, workforce retraining, and fostering new collaborative opportunities [124].

Furthermore, spatial integration across larger functional economic areas brings forth advantages that cannot be achieved through isolated specialization alone. Clusters, while maintaining their distinct identities and managerial autonomy, benefit from networking complementarities across neighboring territories, as evident in macro-regions within Europe [265]. Cross-border innovation agencies play a vital role in connecting regions divided by political boundaries, enabling large-scale manufacturing through international collaborations, as seen in conglomerations between Germany and the Netherlands [266]. Virtual marketplaces transcend geographical constraints by linking globally distributed niche specialized small and medium-sized enterprises (SMEs) with multinational supply chains and networks of clientele.

Hence, networking within industrial clusters plays a vital role in nurturing local strengths through interactive learning and knowledge sharing among collaborators. Coordinated platforms bring together stakeholders to foster opportunities from the initial stages of idea generation to the final stages of commercialization. Effective intermediaries facilitate relationships across academia, the private sector, and policy realms. To ensure resilience in the face of disruptions, networks require adaptive governance that supports adjustments and leverages untapped interconnections to uplift underperforming areas. Additionally, spatial integration across functional economic regions amplifies the impact by pooling diverse yet complementary synergies. Collectively, collaborative networks offer significant potential to capitalize on regional assets and foster resilient innovation ecosystems through coordinated knowledge exchange. Previous studies have indicated that optimizing regional resources through collaborative networks relies on several crucial factors. These include concentrating relevant expertise within industry clusters, establishing both formal and informal platforms to encourage interaction, implementing coordinating bodies and governance structures to guide joint activities, facilitating connections

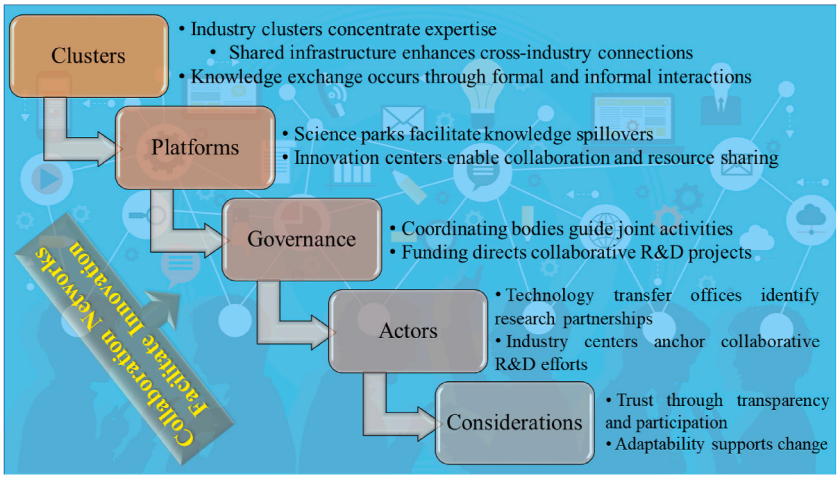

Fig. 6. A conceptual framework for understanding the multidimensional mechanisms involved in facilitating regional innovation outcomes through optimized collaborative networks.

between academia, private industry, and policy actors through intermediaries, and adopting adaptive practices to cope with disruptions. By effectively combining these complementary mechanisms, localized innovation systems can maximize their local advantages while ensuring widespread benefits. Fig. 6 provides a comprehensive overview of the main strategies identified in the literature for promoting regional innovation through collaborative networks.

4.4. Strategic policy approaches for balancing competition and innovation

The examination of existing literature revealed various strategic methods employed by prominent regional governments in order to effectively manage both competitive spending and long-term investments in innovation. This section provides a more comprehensive exploration of these approaches, offering instances of policies that utilize competition to achieve innovation objectives. Additionally, it elucidates the analytical techniques utilized to consolidate insights derived from the extensive literature analysis.

An essential discovery that surfaced was the importance of policy harmonization across numerous levels of institutions. The synchronization of priorities between governments played a critical role in optimizing the harmonious integration of centralized and decentralized policy aspects. Table 3 tabulates the key strategies of coordination identified through the deductive coding process.

The literature review suggests that jurisdictions that adeptly employ a blend of these coordination approaches have showcased the capability to reconcile immediate competitive pressures with enduring investments in innovation. For instance, collaborative networks have facilitated localized learning through structured and persistent interactions within clustering governance [140]. Furthermore, coordinated R&D subsidies have stimulated private investment multipliers among decentralized yet cooperative regions in the United Kingdom [186]. Additionally, Germany has harnessed place-sensitive priority coordination through its industrial foundations [267].

Moving beyond theoretical frameworks, in-depth examinations of empirical cases have provided valuable examples of strategic policy designs implemented in various contexts. Table 4 shows instances of subnational practices that emphasize targeted investments and customized incentives.

The case of Emilia-Romagna exemplifies the strategic allocation of expenditures towards enhancing regional innovation assets based on localized capabilities, facilitating specialization aligned with industrial foundations [268]. Similarly, in Korea, innovation centers have bridged the gap between universities and industries, fostering niche innovation in underdeveloped regions. Coordinated priority-setting among Tasmanian ministries has reinforced knowledge-sharing networks, integrating local knowledge with national priorities [58,110].

These examples illustrate the advantages of tailoring investments and cooperation frameworks to the strengths of each region, showcasing the ability to reconcile competitive motivations with long-term advancements. However, conducting a comprehensive evaluation of their impact is challenging due to complexities in attribution. Quantitative assessment also presents difficulties in disentangling the interactions among multiple concurrent drivers within diverse policy combinations [148].

A rigorous methodology was employed to extract valuable insights from the extensive body of literature. The process of inductive coding facilitated the organization of more than 100 studies into conceptual categories, capturing various themes such as different types of expenditure competition, policy instruments, and strategic responses. Thematic analysis revealed connections between these constructs, as codes were mapped under evolving themes through iterative refinement. The analytical process maintained rigor by adopting a constant comparative approach, which involved comparing coded segments against established categories.

By synthesizing evidence from diverse disciplinary perspectives over a longitudinal period, this review achieved a comprehensive understanding of the innovation policy dilemma. Four overarching thematic lenses emerged: discussions on fiscal decentralization and investments; challenges related to multi-level coordination; the significance of collaborative networks; and exemplary strategic policy designs. By linking these findings to established frameworks, the review enhanced conceptual coherence. This methodology provided crucial insights into effectively navigating the tensions between competition and innovation imperatives in various contexts.

Several important considerations emerge from this analysis. The challenge of policy calibration requires ongoing mutual adjustments between decentralized authorities and coordination instances. It is crucial to develop flexible yet accountable frameworks that are tailored to the specific characteristics of different territories, as this approach holds greater promise for optimizing synergies across different scales. Strategic proximity offers advantages in designing place-based approaches that are attuned to localized capabilities and assets. However, it is important to avoid neglecting wider networks, as doing so may result in missed opportunities and potentially worsen polarization.

Taking a balanced perspective involves recognizing the influences of competition while cautioning against attributing causality solely to bottom-up pressures. Coordination, as a means of building relationships, ensures continuous learning to adapt guidelines that are responsive to evolving dynamics at the local and global levels. Voluntary cooperation, grounded in regional expertise, fosters the

Table 3
Strategies for addressing innovation policy dilemmas.

Strategy	Explanation
Policy coordination	Involves coordinated priority-setting among different levels of government, aligning tools and targets to achieve common goals.
Clustering	Utilizes the advantages of agglomeration by supporting localized industry strengths through networks.
Collaborative networks	Establishes platforms that connect the public and private sectors, facilitating knowledge exchange and joint problem-solving.
Targeted innovation investments	Strategically aligns expenditures to enhance territorial innovation capacities.

Table 4
Examples of subnational best practices in innovation policy.

Location	Program Description	Objectives, Outcomes
Emilia-Romagna, Italy	Made strategic investments in logistics infrastructure for automotive clusters.	Leveraged strengths to prioritize competitive sectors and interconnect regional specializations.
Korean regions	Nurtured indigenous firms through collaboration with universities in innovation centers.	Strengthened capacities of lagging areas and small and medium-sized enterprises (SMEs) through intermediation.
Tasmania, Australia	Coordinated knowledge dissemination across ministries to reinforce industries.	Optimized spillovers through forums aligning localized expertise with centralized frameworks.

development of contextually-grounded routines that sustain momentum even in the face of changing boundaries. Interpersonal connections play a pivotal role in mediating divisions during periods of adaptation to disruption. Thus, a customized approach to multi-level coordination, tailored to institutional contexts and regional attributes, represents the most conducive pathway for aligning competition and innovation imperatives.

There are several ways to enhance conceptual understanding in this area. Qualitative case comparisons can yield valuable lessons that are applicable across diverse innovation frameworks. Impact evaluations that utilize mixed methodologies can overcome limitations in attribution. Longitudinal analyses provide insights into policy trajectories and adjustments throughout cycles of disruption. It is important to explore the challenges of inclusiveness in rural-urban divides and lagging peripheries. Comparative policy experiments can validate coordination instruments and hypotheses. Continuously refining conceptual frameworks and conducting iterative research helps to enhance strategic guidance for navigating the complexity of real-world scenarios.

Hence, there are various strategic approaches aimed at balancing competitive pressures with long-term support for innovation. Fig. 7 offers a conceptual representation of the main policy challenges and choices discussed in the literature. Previous research has emphasized the significance of coordinating horizontally and vertically across different levels of governance, as well as making targeted investments to enhance regional innovative capabilities. Moreover, empirical case studies demonstrate the implementation of location-specific strategies. The analysis further underscores the importance of dynamic policy adjustment and collaborative relationships to sustain progress amidst evolving economic landscapes. By synthesizing key themes and insights from a comprehensive review of more than 100 sources using robust qualitative methods, Fig. 7 presents a comprehensive framework for understanding how tensions in innovation policy can be effectively addressed in various institutional contexts.

To summarize, the existing literature extensively discusses the complex relationship between fiscal decentralization, expenditure competition faced by subnational governments, and long-term investments in innovation. While competitive incentives aim to attract mobile capital and skilled labor, unrestricted approaches pose a risk of inadequate investment in innovation systems that are crucial for economic prosperity. However, the outcomes of competition depend significantly on governance structures, and coordinated frameworks have been found to mitigate adverse effects. Moreover, the nature and direction of subnational expenditures play a role in determining whether competition enhances productive specialization or hampers welfare.

Investments that target the enhancement of regional innovation assets through skills development, infrastructure, research and development, and targeted business support can justify expenditures despite competitive forces by leveraging localized strengths. On the other hand, the indiscriminate use of subsidies carries the risk of excessive spending that does not decisively impact location choices. Coordinated multi-actor platforms also facilitate the critical knowledge spillovers necessary for fostering innovation. Prominent cases demonstrate the strategic customization of competitive incentives to promote regional strengths aligned with

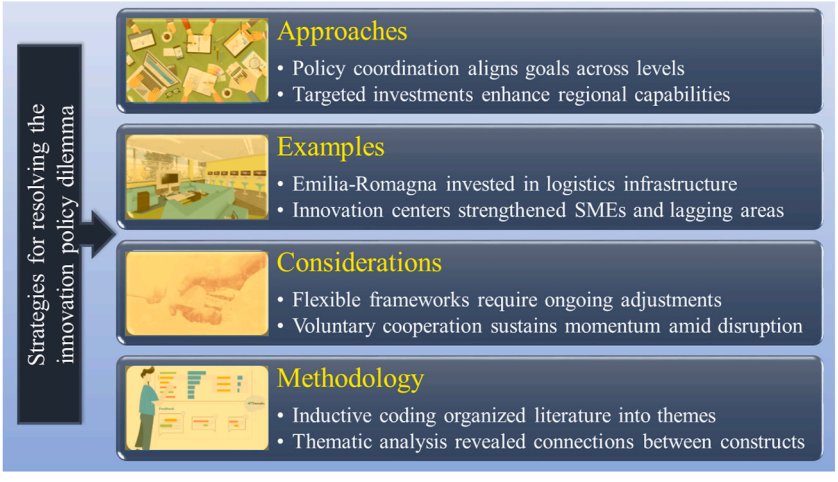

Fig. 7. A conceptual framework for reconciling innovation policy dilemmas through coordinated multi-level governance and targeted regional development strategies.

industrial foundations through place-sensitive coordination. Flexible yet accountable multi-level frameworks, tailored to diverse institutional contexts and regional attributes, hold promise for optimizing prosperity based on knowledge.

5. Conclusion

Subnational governments that are part of complex multi-level innovation systems face complex challenges in balancing the immediate need for expenditure competition with their long-term strategic innovation objectives. The examination of the relationship between knowledge-intensive activities and economic prosperity in diverse regions holds significant academic and practical relevance. Understanding this relationship becomes increasingly important as global trends towards decentralization and fiscal competition continue to shape the innovation policy challenges faced by subnational authorities. This study aimed to shed light on the intricate connection between expenditure competition pressures encountered by subnational governments and their long-term innovation goals. By conducting a comprehensive and systematic review of more than 150 peer-reviewed studies, policy reports, and empirical analyses published over the past 15 years, valuable insights were gained into this complex policy interplay. The research established a conceptual framework for understanding the innovation policy dilemma at the subnational level, analyzing the key debates, patterns, and issues that have emerged in previous scholarship.

The analysis of the data employing inductive coding and thematic analytical techniques yielded noteworthy findings. The scholarly discourse extensively explores the discussions surrounding the impact of competition on innovation investments and outcomes. The challenges associated with coordinating multi-level policymaking across diverse institutional spheres emerged as a prevalent theme. Additionally, collaborative networks that foster knowledge sharing and leverage regional assets through clustering were prominently highlighted. Importantly, exemplary strategic policy designs, effectively balancing competition and innovation, were demonstrated by leading subnational jurisdictions.

This study has several implications for advancing innovation policymaking. By emphasizing the importance of ongoing multi-level coordination in decentralization reforms, policymakers can ensure that frameworks account for diverse local conditions to effectively navigate the pressures faced by subnational administrations. Tailoring coordination approaches through flexible yet principled designs that assign roles based on capabilities holds promise for achieving balanced progress. In practical terms, incorporating environmental goals into officials' performance assessments can guide balanced regional development by motivating local competitive behaviors to incorporate sustainability.

Methodologically, this study offers insights for future research on subnational governance challenges. The utilization of rigorous qualitative content analysis techniques, such as inductive coding and thematic analysis, distilled valuable insights from extensive scholarship in a robust yet adaptable manner. This demonstrates an effective approach for comprehending intricate multi-faceted policy dynamics through comprehensive literature synthesis. Substantively, the in-depth case analyses and identification of the moderating impacts of competitive forces provide applied perspectives with tangible strategic implications.

Theoretically, this study contributes a novel multidimensional analytical perspective by integrating concepts from regional innovation systems, fiscal federalism, and knowledge economy frameworks. This comprehensive lens examines interrelated challenges across scales and actors to enhance understanding of the complex policy trade-offs faced by subnational authorities. Advancing knowledge in this area responds to calls for integrated theoretical frameworks that analyze the intersection of fiscal decentralization with innovation objectives.

By examining each perspective in depth, a comprehensive understanding emerged, acknowledging both the positive and negative effects of competition. Localizing competition pressures through specialization can align with strengths, but uncontrolled competition can undermine investments in innovation systems. Coordinated multi-level frameworks that distribute responsibilities based on capabilities optimize the synergies among dispersed yet interconnected elements of knowledge-driven systems. Knowledge exchanges within collaborative platforms foster local advantages through interactive learning and effective governance of clustering. Targeted expenditures that strategically enhance regional capabilities justify public investments despite the presence of competition.

In summary, the comprehensive review of more than 150 scholarly sources from the past 15 years has yielded valuable insights into the intricate policy challenges faced by subnational authorities as they strive to balance expenditure competition with strategic investments in innovation. Through qualitative analysis, four key thematic perspectives have emerged: debates surrounding the impact on innovation investments, the challenges of multi-level coordination, the importance of collaborative knowledge networks, and exemplary strategic approaches. By delving into each dimension and synthesizing diverse disciplinary perspectives over time, our methodology has provided a more nuanced understanding of these complex policy dynamics.

However, it is important to acknowledge certain limitations. While the sample encompassed various global contexts, case studies focusing on specific jurisdictions could provide deeper contextualization. Employing quantitative impact evaluations with mixed methodologies may help address attribution challenges. Longitudinal analyses tracking policy adjustments could offer insights into dynamic cycles. Exploring the challenges faced by peripheral and rural territories would enhance the discussion on inclusiveness. Comparative policy experiments could validate hypothesized coordination mechanisms. Addressing these gaps through iterative research presents opportunities to further refine strategic guidance for subnational authorities navigating complex multi-scalar innovation architectures.

Various policy implications can be derived from the study. Effective governance should involve continuous mutual adjustments between authorities and coordination platforms, tailored to the specific context, to achieve the most favorable outcomes. The flexibility to calibrate strategies in a place-sensitive manner while ensuring accountability is crucial for optimizing synergies across diverse territories. Strategic proximity plays a vital role in developing context-sensitive approaches that consider localized capabilities. Neglecting broader networks can lead to missed opportunities and polarization, highlighting the importance of spatial integration to

pool dispersed complementarities. Coordinated efforts foster continuous learning and enable open yet principled cooperation, ensuring sustained momentum despite changes in circumstances.

This comprehensive review yields several implications for theory, methodology, and practice. Theoretically, the integration of insights from various frameworks such as regional innovation systems, fiscal federalism, and knowledge economies provides an analytical lens to understand the complex relationships that shape subnational policy challenges. Methodologically, rigorous qualitative content analysis has distilled key insights from a vast body of literature, enhancing credibility and deepening our understanding.

In practice, the customization of multi-level coordination approaches that consider diverse institutional contexts and regional characteristics emerges as the most promising strategy to optimize synergies within knowledge-driven systems that span multiple territories. Flexible yet accountable frameworks that assign functions based on capabilities have the potential to reconcile bottom-up initiatives with top-down coherence. Strategic proximity allows for tailored place-based strategies, while connectivity across boundaries prevents missed opportunities and polarization. Continuous learning sustains momentum in the face of disruptions by fostering adaptive relationships grounded in regional expertise.

While valuable insights have been obtained, it is important to acknowledge several limitations in this study. To enhance the conceptual rigor of future research, it is suggested to conduct qualitative analyses that compare diverse regional innovation architectures and employ complementary methodologies for impact evaluations. Longitudinal examinations would enable the capturing of adjustment cycles' dynamics over time. Exploring rural-urban dichotomies and addressing peripheral challenges would contribute to shedding light on issues of inclusiveness. Comparative experiments could be conducted to validate the effectiveness of coordination instruments hypothesized in the study. The research process should be iterative, allowing for constant refinement of strategic guidance. Moreover, there is a risk of concept proliferation, underscoring the need to consolidate findings into coherent integrated frameworks.

This study has the potential to provide significant contributions in four key areas. Theoretical contributions will be made by examining the interconnections between regional systems, fiscal federalism, and frameworks related to knowledge economies, thereby shedding light on policy dilemmas. Methodologically, a thorough qualitative synthesis of extensive literature will be conducted, offering a comprehensive lens for analysis. Substantively, the study will present in-depth contextual examples of strategic approaches, providing practical guidance. Additionally, the study will emphasize the crucial role of coordination and put forth actionable recommendations to optimize governance in multi-scalar innovation systems driven by knowledge.

In conclusion, it is of utmost importance to comprehend the approaches that effectively balance expenditure competition and sustainable innovation investments, particularly considering the increasing reliance on knowledge creation that spans various jurisdictions for economic growth. In order to achieve improvements in productivity and competitiveness, investments must be directed towards fostering human capital, research, and innovation, while being supported by flexible yet accountable frameworks that are tailored to the specific institutional contexts and regional characteristics. Subnational governments need to actively engage in continuous learning in order to harness competition for localized benefits, while strategically investing in long-term innovation capacity through optimized cooperation across diverse territories. A comprehensive understanding of these multi-dimensional relationships is crucial for optimizing prosperity based on knowledge, particularly within the context of dynamically decentralizing global innovation systems.

Therefore, understanding the strategies that effectively balance competition in expenditures with sustainable investments in innovation becomes increasingly vital as economic prosperity relies on knowledge creation across different jurisdictions. While competitive incentives are designed to attract mobile resources, unregulated competitions present a potential drawback of inadequate investment in innovation systems crucial for long-term growth. Coordinated multi-level governance strategically maximizes the synergies between centralized and decentralized dimensions by employing customized frameworks. Knowledge networks play a pivotal role in enhancing regional advantages by enabling localized interactions within industrial clusters. Noteworthy examples illustrate how competitive motivations can be effectively aligned with targeted capacity development through place-sensitive coordination.

To achieve improvements, it is necessary to direct investments towards the development of human capital, research collaboration, and innovation infrastructure, supported by adaptable yet principled multi-level partnerships that consider the diversity across contexts. Subnational authorities need to engage in continuous learning to leverage competition for community-scale benefits through optimized cooperation across territories. Future research should address gaps through case-focused approaches, mixed methods, and longitudinal analyses to further enhance strategic guidance on navigating the complexities of decentralized innovation policy and governance. This will contribute to progress built on knowledge within complex multi-scalar systems.

Ethics declarations

Review and/or approval by an ethics committee was not needed for this study because it does not involve animal experiments or human and behavioral studies. Instead, the study is based on the analysis of existing literature.

Data availability statement

The conclusion of this study is based on the data presented and discussed within the text of the article.

CRediT authorship contribution statement

Wenjuan Song: Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Conceptualization. **Kai Zhao:** Writing – original draft, Visualization, Validation, Methodology, Investigation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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