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Economics of Innovation and New Technology

ISSN: 1043-8599 (Print) 1476-8364 (Online) Journal homepage: www.tandfonline.com/journals/gein20

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To cite this article: Mario-Davide Parrilli & Yitian Lu (08 Jan 2026): Mission- and challenge-oriented innovation policies and sustainable Multi-Level Innovation Synergy (MLIS) in China, Economics of Innovation and New Technology, DOI: 10.1080/10438599.2025.2608862

To link to this article: https://doi.org/10.1080/10438599.2025.2608862

Published online: 08 Jan 2026.

ECONOMICS OF INNOVATION AND NEW TECHNOLOGY
https://doi.org/10.1080/10438599.2025.2608862

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Mission- and challenge-oriented innovation policies and sustainable Multi-Level Innovation Synergy (MLIS) in China

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ABSTRACT

The consolidated Innovation System (IS) framework is re-discussed with attention to 'levels' and 'missions' that generally respond to 'grand challenges' that affect mankind (e.g. climate change, global health, inclusive economy). Renovated frameworks are required to consider the dynamism of the global scenario where businesses, governmental bodies, other organisations, networks and consumers interact and innovate at different levels, from technological up to institutional and cultural. This debate is mostly applied to competitive economies (e.g. Europe) but not to catching-up economies, their firms, industries and regions. This paper introduces this debate that is applied to two RISs in China. Our findings show that a dynamic IS needs to be based on a Sustainable Multi-Level Innovation Synergy (SMLIS) between regional innovation systems (RIS) and the national innovation system (NIS), where the NIS identifies the national and global 'grand challenges' which are addressed through 'mission-oriented' and 'transformative' innovation policies, while each individual RIS determines the regional direction of this response by designing specific sustainable strategies and actions that address the related 'regional challenges'. This is important in catching-up economies, where the regions often lack adequate resources, skills, and capabilities, while having their institutional and industrial path-dependencies.

ARTICLE HISTORY
Received 11 March 2025
Accepted 17 December 2025

KEYWORDS
Regional innovation systems; national innovation system; sustainable multi-level innovation frameworks; catching-up economies; China

1. Introduction

It is thirty years that innovation is recognised as the key to competitiveness in globalised markets. In 2000, the Lisbon agenda was approved and determined that all countries should invest in R&D 3% of GDP to guarantee sustained and sustainable economic growth (European Commission 2010; Hervás-Oliver et al. 2021) within the Bruntland concept of 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (UNWCED 1987, 8; Wall 2013). Simultaneously, scholars and policy-makers identified the importance to set up

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'Innovation Systems' (IS) to promote the innovation capacity of firms, regions and countries. These are intended as a multiplicity of private and public actors, networks, institutions, technologies and policies interacting with the common purpose to promote the innovation patterns of their territories and agents that are simultaneously 'national' (Lundvall 1992; Nelson 1993), 'regional' (Asheim and Gertler 2005; Cooke 2002; Doloreux and Parto 2005), 'global' (Binz and Truffer 2017; Chaminade and Plechero 2015), 'sectoral' and 'technological' (Bergek et al. 2015; Carlsson and Stankiwewicz 1991; Malerba 2002).

Within this broader innovation literature, recent studies call for the need to take on 'grand challenges' (i.e. inclusive growth, environmental sustainability) that affect the global landscape through 'mission-oriented innovation policies' that can be developed nationally through the synergic work of business agents and institutions (Mazzucato 2018; Mazzucato et al. 2020; Schot and Steinmuller 2018).

Simultaneously to the broader scholarly effort on national innovation systems and 'mission-oriented innovation policies', other scholars who had previously focused on the regionalisation of such framework (Asheim and Gertler 2005; Cooke 2002; Doloreux and Parto 2005) and its evolutionary perspective (Coenen et al. 2017; Isaksen and Trippl 2017) identified the importance of landing these 'grand challenges' and 'missions' regionally through the formation of 'Challenge-Oriented Regional Innovation Systems' (CORIS) that frame the way ISs develop in their territories in relation to their own resources, capabilities, organisations, institutions and networks (Cassiolato and Lastres 2020; Isaksen, Trippl, and Meyer 2022; Todling, Trippl, and Desch 2022).

These two complementary strands of literature on innovation are deemed to activate a 'transformative change', which helps regions and countries to foster new socio-technical systems and sustainable development within the changing global economic scenario (Caliari and Barbieri-Ferreira 2023; Schot and Steinmuller 2018).

These theoretical propositions offer important policy advances that can produce fine-tuned measures also for economies that are catching-up in terms of innovation and competitiveness. It is the case of many southern and eastern European countries that deal with severe budget constraints, which limit their R&D investment to around 1% of their GDP (e.g. southern European countries, Hollanders, Es-Sadki, and Merkelbach 2019). It is also the case of other catching-up economies globally that face even harder resource and capability constraints, while not enjoying from supra-national political frameworks that might introduce specific support mechanisms. Beside the limited resources available for innovation there are other constraints that make catching-up economies a peculiar case for study. At the regional level, institutions are weaker, industries are heterogeneous, and human capital suffers from underinvestment, particularly in relation to education and training towards the regional industrial specialisations (Chaminade and Perez-Padilla 2017; Doloreux and Parto 2005; Haiting 2024; Lundvall et al. 2011; Niosi 2011). These specific conditions raise relevant research questions on what kind of strategies, programmes and actions are more effective to produce change and development in such contexts. This is where the research gap currently lies. Following up on the above contributions of Mazzuccato et al. (2020) and Todling, Trippl, and Desch (2022), we aim at identifying how 'mission-oriented innovation policies' and 'challenge-oriented regional innovation systems' create room for the introduction of institutional mechanisms that provide these countries with the opportunity of developing appropriate 'transformative change' (Schot and Steinmuller 2018). Our argument is that this process requires the

application of a 'Sustainable Multi-Level Innovation Synergy' (SMLIS) which represents an extension of the Multi-Level Policy Framework (MLPF, see Binz and Truffer 2017; Douglas and Radicic 2022; Flanagan, Uyarra, and Laranja 2011) towards the synergic development of functions across NIS and RIS that promote the transformation of sustainable regional development pathways.

For this purpose we focus on China, an emerging power that did not undergo the gradual industrialisation process of the Asian Tigers (World Bank 1993), but leapfrogged ('transformative change') by simultaneously exploiting the low cost advantage of their economy as well as the heavy government investments in R&D and innovation (Bianchi and Labory 2008). China has taken a proactive approach to innovation through a renovated set of 'mission-oriented' innovation policies and programmes (Lu 2021), while complementarily its regions have taken an explicit commitment through their 'challenge-oriented regional innovation systems' so as to address 'grand challenges' and 'regional challenges' based on their geographical, industrial, cultural and institutional specificities (Lu 2021). While China is a peculiar case for the traditional strong central policies, also in this case the problem (shared with many other catching up economies) is double-folded. On the one hand, the central government needs not to overstep across the RIS boundaries, on the other, the regions need to learn to take relevant decisions and pursue the formation of effective RISs with adequate regional decisions and efforts.

Overall, the contribution of this paper is threefold: firstly, it identifies the way in which the national level (NIS) can adopt a 'mission-oriented innovation policy' approach to tackle selected 'grand challenges'. Secondly, it uncovers the way each region can develop its own strategy and 'challenge-oriented regional innovation system' without being overshadowed by central government and NIS plans. Thirdly, it pulls together these two aspects through the 'sustainable multi-level innovation synergy' (SMLIS) that enhances the critical inter-dependencies between NIS and RISs which have not been addressed in the literature on ISs in catching-up economies (Cassiolato and Lastres 2020; Chaminade and Plechero 2015; Lundvall et al. 2011).

In the next section, through the discussion of the literature on innovation systems we develop specific arguments and propositions on how this SMLIS can work in catching-up economies. After a methodological discussion in section three, section four relates the empirical cases of two regions and their innovation pathways framed within the Chinese national innovation system. Section five and six include the relevant discussion and conclusions.

2. Relevant innovation frameworks for regional development

2.1. Broad debate on innovation systems and policy engagement

The concept of 'innovation system' was developed by (Freeman 1987; Lundvall 1992; Nelson 1993; Niosi 2011). Their idea implied that a set of dedicated knowledge organisations, being public and/or private, and their contextual institutions (Doloreux and Parto 2005), were likely to generate meaningful knowledge that – through intense interactions – would be appropriated by the national production system in the form of direct innovation outputs (Lundvall 1992) and knowledge spillovers (Audretsch and Feldman 1996).

A few years later, other scholars identified the importance of the context specificity of such innovation systems, thus creating the framework of regional innovation systems –

RIS – (Asheim and Gertler 2005; Camagni and Capello 2013; Cooke 2002; Doloreux and Parto 2005; Isaksen and Trippl 2017; Niosi 2011; Parrilli, Balavac, and Radicic 2020). Within this approach the regional framework is critical as it is where industries, sectors and the related skills and capabilities concentrate, thus making the work of public and private knowledge-generating organisations more effective and sustainable (Cooke 2002; Doloreux and Parto 2005).

This approach has been integrated within a national and supra-national level in what is called a multi-level policy framework – MLPF – (Binz and Truffer 2017; Douglas and Radicic 2022; Flanagan, Uyarra, and Laranja 2011). In the case of the most advanced economies, the MLPF is applied with a clear preponderance of the regional level, which is well-endowed in terms of resources and capabilities. This has produced several successful RISs, e.g. Baden-Wurttenberg in Germany (Cooke and Morgan 1994), Emilia-Romagna in Italy (Ramaciotti 2008), the Basque region in Spain (Morgan 2017), Medicon Valley in Denmark and Sweden (Grillitsch and Rekers 2016). However, this important approach and debate has hardly been applied to the context of catching-up regions in Europe and globally, where the economic, technological and institutional conditions are different (Cassiolato and Lastres 2020; Chaminade and Plechero 2015; Lundvall et al. 2011; Niosi 2011).

In this paper, we zoom on the MLPF interactions that take place between NIS and RIS to indicate how important this synergy is for the sustainable development of dynamic RISs in catching-up economies. Here, the regional governments have less power and resources to invest in significant innovation strategies, hence they have lower capacity to engage with local firms and stir their investment in innovation-led activities. The thousands of SMEs that populate such regional economies are particularly affected due to their lower capacity to engage with national and global innovation agents (Parrilli and Radicic 2021). Within such context, the RISs need to find synergies with national organisations, policies and programmes, which are also limited in these catching-up contexts (Caliari and Barbieri-Ferreira 2023; Chaminade, Intarakumnerd, and Sapprasert 2012; Lundvall et al. 2011). In any case, the political constraints – which include a limited quality of institutions (e.g. rule of law, effectiveness and accountability, Rodriguez-Pose and Di Cataldo 2015; see also Niosi 2011; and Mosconi and D'Ingiullo 2023), and the lack of resources – demand a MLPF approach to innovation that entails the joint effort of relevant institutional and business actors (Binz and Truffer 2017; Douglas and Radicic 2022; Flanagan, Uyarra, and Laranja 2011), and the selection of the most adequate place-based innovation policy measures (Cassiolato and Lastres 2020; Sotarauta and Beer 2017).

In recent years, the debate on ISs moved towards other key aspects. In particular, scholars identified the importance to dynamise this concept and connect it with the 'transformative change' of industries, the wider economy and their socio-technical systems (Schot and Steinmueller 2018) that is supposed to respond to 'grand challenges' faced by large national and global communities, e.g. climate change, global health, just distribution of resources, services and outcomes (Mazzucato 2018). These considerations imply that innovation extends beyond technological (i.e. product, process) and non-technological (commercial and organisational) patterns, to entail wider institutional and cultural changes (e.g. radical changes in mobility patterns, inclusive economic growth). In practice, these aims, and objectives need to be addressed synergically through wider 'mission-

oriented innovation policies' (Mazzucato 2018; Mazzucato et al. 2020) and through the work of 'Challenge-Oriented Regional Innovation Systems' (CORIS), which apply these missions through region-specific strategies and actions (Isaksen, Trippl, and Meyer 2022; Todling, Trippl, and Desch 2022). This 'Sustainable Multi-Level Innovation Synergy' (SMLIS) represents the crucial coordination that generates effective innovations which lead to sustainable 'transformative changes' across different socio-technical systems (Schot and Steinmueller 2018) and across local communities and industrial districts (Cassiolato and Lastres 2020).

In our view, these theoretical frameworks come together to form a cohesive approach to sustainable regional economic development that entails the independent work of firms and their organisations (trade associations, cluster organisations), the dedicated work of regional innovation organisations (universities, science and technology parks, technology centres), and the proactive engagement of institutional and policy frameworks at the regional, national and supra-national level (Bergek et al. 2015; Binz and Truffer 2017; Chaminade and Plechero 2015; Doloreux and Parto 2005; Flanagan, Uyarra, and Laranja 2011; Laasonen, Kolehmainen, and Sotarauta 2022). This is the centre of this study as it has not been developed thoroughly in the literature on catching-up countries that we are discussing in the next sub-section.

2.2. Shifting focus from advanced economies to catching-up economies

A rich literature on regional innovation systems flourished with a view to represent the sustainable development pathways of different regional contexts (Cassiolato and Lastres 2020; Coenen et al. 2017; Grillitsch and Asheim 2018; Isaksen and Trippl 2017; Parrilli, Balavac, and Radicic 2020). The variety of cases and their pathways is discussed in relation to the regional pool of skills and capabilities, infrastructures, industrial sectors, and also social and institutional frameworks available in these contexts (Isaksen, Trippl, and Meyer 2022; Todling, Trippl, and Desch 2022). Notwithstanding this, not much has been said in relation to the crucial coordination between NIS and RISs (i.e. SMLIS framework here) to create appropriate institutional solutions and economic pathways within catching-up regions (Cassiolato and Lastres 2020; Doloreux and Parto 2005; Flanagan, Uyarra, and Laranja 2011; Lanahan and Feldman 2015). This is central in the context of emerging regions and countries (Caliari and Barbieri-Ferreira 2023; Chaminade and Perez-Padilla 2017; Lundvall et al. 2011; Niosi 2011).

Most RIS literature refers to successful cases that rose thanks to the spontaneous combination of own resources, institutions and industries. It is a bottom-up growth as recognised by Cooke (2002) and Asheim and Gertler (2005) in the so-called grassroots-based or entrepreneurial regional innovation systems. Previous studies also emphasised the possibility to develop 'regionalised national innovation systems' as a downscaling of the NIS at the regional level, a system that includes regional nodes of the NIS that transmit appropriate stimuli from national centres down to the regional economy (Asheim and Isaksen 2002). This insight has not been developed further and yet offers important opportunities to catching-up regions that need more effective synergies between NIS, RIS and local clusters (Caliari and Barbieri-Ferreira 2023; Cassiolato and Lastres 2020).

Among the reasons that explain the divergent position of catching-up economies vis-à-vis the most advanced economies, the quality of institutions is central. As Rodriguez-

Pose and Di Cataldo (2015) argued, the most innovative regions are usually supported by effective and accountable governments, application of rule of law and control of corruption. The quality of institutions bodes well with the assets available in such geographies. In catching-up contexts, regional economies often have limited resources, capabilities, and industries to develop effective RISs (Chaminade and Plechero 2015). It is the case of southern European countries where regions such as Extremadura or Murcia in Spain (Alberdi-Pons, Martíns, and Parrilli 2016), or Calabria and Campania in Italy (Iammarino 2005) or many developing countries' regions that have no critical mass to attain effective outcomes, and benefit neither from the generic national innovation policy nor the missing place-sensitive policy perspective (Iammarino, Rodriguez-Pose, and Storper 2019). The simultaneous lack of financial and physical capital, and the limited human capital (Männasoo, Hein, and Ruubel 2018) and institutional capital (Niosi 2011) available in such contexts constrain their options even further. Therefore, in these contexts the RISs cannot be expected to generate alone the positive impulse that local firms require. The local firms – particularly the SMEs that need external support due to their limited resources – require a sustained and sustainable engagement of both NIS and RISs (Asheim and Isaksen 2002; Cooke 2002; Parrilli, Aranguren, and Larrea 2010). In such contexts, local large firms and multinational enterprises (MNEs) and their global innovation networks can play an important role (Binz and Truffer 2017; Chaminade and Plechero 2015) by developing knowledge inputs and innovations that can be appropriated and exploited commercially by the local SMEs (Cassiolato and Lastres 2020). And yet this cannot be taken for granted as large firms and MNEs may simply try to take advantage of their leading position and impose them harsh supply conditions (Rodrik 2018).

This SMLIS framework has one more theoretical justification. The current dynamic approach to IS that tackles 'grand challenges' through the adoption of 'mission-oriented innovation policies' (Caliari and Barbieri-Ferreira 2023; Mazzucato 2018) oriented to 'transformative change' (Schot and Steinmueller 2018) needs the direct engagement of CORISs to determine the specific direction, strategy and actions that promote regional industrial development (Isaksen, Trippl, and Meyer 2022; Todling, Trippl, and Desch 2022). This responsiveness relies on a SMLIS where the NIS identifies the 'grand challenges' and provide the directives, guidance and 'mission-oriented innovation policies' to address them with chances of sustainable success, while the regional level takes responsibility for identifying and supporting actors, industries, institutions, networks and communities.

The coordination and synergy between national and regional levels (Binz and Truffer 2017; Douglas and Radicic 2022; Flanagan, Uyarra, and Laranja 2011) is not to be taken for granted as there may be a clash of actions and inefficiencies between these levels. This has been found in Medicon Valley (Grillitsch and Rekers 2016), and in several US states (Lanahan and Feldman 2015). This issue becomes even more critical in catching-up economies, where the hypothesised synergies are incipient. In this case our main proposition is that a SMLIS is necessary where regional production systems and RISs are not fully developed (Hervás-Oliver et al. 2021; Hollanders, Es-Sadki, and Merkelbach 2019; Parrilli, Balavac, and Radicic 2020). Here, innovation agents, resources, institutions and networks tend to be centralised while most regions and their SMEs remain peripheral and unserved by such agents (Parrilli, Aranguren, and Larrea 2010). As a result, local production systems can often rely only on their limited industrial and technological endowment, arms-length networks, institutional and organisational support (Chaminade and

Plechero 2015; Lundvall et al. 2011). This gives limited opportunity to develop dynamic RISs that supply their local production systems with key knowledge and innovation inputs. Something needs to change to promote such systems in a sustainable format. This is the enhanced SMLIS framework across different governance levels.

In practice, we argue that the role of the national level is focused on acknowledging the grand challenges the country is facing (e.g. sustainability, inclusion, innovation) and setting up the mission of responding to such challenges through macro instruments such as directives, laws and regulations (Mazzucato 2018; Mazzucato et al. 2020). Instead, the regional level is where the specific challenges and objectives are taken on and precise actions are enacted (Cassiolato and Lastres 2020; Isaksen, Trippl, and Meyer 2022; Todling, Trippl, and Desch 2022). Therefore, the vision and policies designed by the central government together with the resources it can put in place are necessary components of an effective approach to innovation. However, this element needs to be complemented by a bottom-up component of 'entrepreneurial discovery' in which local firms, industries and trade associations within the RIS develop their way into the global market (Foray 2014; McCann and Ortega-Argiles 2015). This process has to be driven by local actors in both private (i.e. SMEs and their associations) and public sector (e.g. regional development agencies) as they know what their long-term assets, skills and routines are (Doloreux and Parto 2005; Nelson and Winter 2002; Rodrik 2018). They also know their (limited) knowledge, technologies, institutions and networks that contributed to the formation of their earlier industry trajectories (Bergek et al. 2015; Niosi 2011). Thus, they can identify better what capabilities they want to promote to move into new, diversified, sustainable and competitive industries (Asheim et al. 2011; Boschma and Capone 2015; Rodrik 2018).

Therefore, the relevant innovation policy levers need to be identified in the specific context to verify whether they are appropriate to promote firm innovation in the selected region (Cooke 2002; Doloreux and Parto 2005; Niosi 2011). Apart from very unique cases, such as for instance the successful RISs in Bangalore and Shanghai that benefited from connections with multinational companies or leading innovation clusters – Silicon valley – (Asheim and Vang 2006), the RIS framework that applies effectively in the most advanced economies is much thinner in catching-up and developing contexts (Chaminade and Plechero 2015; Lundvall et al. 2011; Niosi 2011). For this reason, we purport that political, organisational and institutional engagement at the 'national' level is required to help the regions to develop their industry specialisations according to the challenges and missions identified at the national level (e.g. sustainability, inclusion and innovation). This implies that national authorities (e.g. government departments), institutions (formal and informal), overarching policies and significant resources (e.g. various types of finance and subsidies) are all geared to favour the design and implementation of sustainable development strategies by the relevant regional agents. For this reason, our first proposition follows:

> P1. In catching-up economies the national level (government and NIS) is expected to engage in the identification of the grand challenges and the related 'mission-oriented innovation policies' required to provide regions, industries and firms with adequate guidance, policies and resources that sustain their innovation endeavour.

Within this context and debate, another relevant consideration is required. This refers to the flexible approach that needs to be undertaken regionally within this SMLIS

framework. Within the same country, the geographical, industrial, institutional and cultural specificities are conducive to the development of dissimilar RIS pathways (Bergek et al. 2015; Coenen et al. 2017; Isaksen and Trippl 2017; Niosi 2011). The proactivity of the national level within catching-up economies does not pre-empt the opportunity to develop autonomous innovation pathways based on regionally determined 'CORISs' (Cassiolato and Lastres 2020; Isaksen, Trippl, and Meyer 2022; Todling, Trippl, and Desch 2022). The regions need to autonomously select their own pathways which mirror their industrial, organisational, institutional and cultural specificities that are likely to generate effective and sustainable strategies. This happened in specific cases, where in spite of the limited support received from central governments, regional and industrial strategies benefited from transnational corporations and transnational research communities to drive the outstanding growth of selected industries, e.g. IT and software in Bangalore (Asheim and Vang 2006). Similarly, the Mexican case shows relevant and yet divergent impact of some critical drivers (i.e. governance pattern, industrial specialisation, collective efficiency, and geographic location) for functional and intersectoral upgrading across different regions/states (Martinez-Covarrubias, Lenihan, and Hart 2017), while it is the interaction among firm capabilities and higher-level institutions and market conditions that promotes effective mission-oriented innovation policies in Brazil (Caliari and Barbieri-Ferreira 2023).

Whereas this point reflects critical scholarly considerations on RISs (Asheim and Gertler 2005; Binz and Truffer 2017; Chaminade and Plechero 2015; Cooke 2002; Flanagan, Uyarra, and Laranja 2011; Grillitsch and Asheim 2018; Hervás-Oliver et al. 2021), it is not explicitly discussed and brought to consensus, especially in catching-up developing contexts. Within regional economics, the role of NISs is downplayed to stress the role of autonomous regional communities. Our argument is that in the context of developing/emerging economies an effective IS needs both a proactive 'national' framework (policy, programmes, resources and institutions) and significant regional autonomy to design and implement a 'context specific' and 'challenge-oriented' RIS (see Figure 1), in a fully-fledged SMLIS framework.

Within such SMLIS, central government and NIS take a 'guide role' rather than an 'interventionist' role. They will identify the 'grand challenges', and develop principles, supportive laws and regulations, and broad frameworks (e.g. education system) and resources (e.g. funding) that apply to most regions according to the 'missions' and 'transformations' required to compete sustainably in the market (Mazzucato 2018; Schot and Steinmueller 2018). Simultaneously, the regions must be given the opportunity to develop their own 'entrepreneurial discovery' process, thus their own sustainable trajectories, industry specialisations, and regional institutions in support of the innovation activity of the firms (Foray 2014; McCann and Ortega-Argiles 2015; Todling, Trippl, and Desch 2022; Isaksen, Trippl, and Meyer 2022). This is a central tenet for catching-up economies that want to form effective RISs, and competitive industry clusters and firms. Thus, we purport this proposition:

> P2. Effective and dynamic RISs need to develop their own innovation pathway – in autonomy from central government and NIS –, based on own capabilities, institutions and strategies that help promoting innovation across their distinctive regional production systems (e.g. industry clusters) in accordance with the grand challenges and missions identified at the

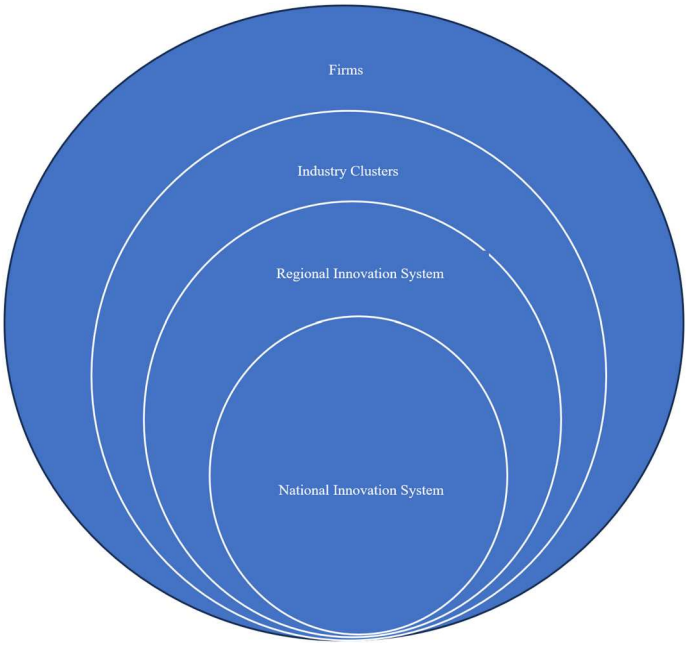

Figure 1. The (MLIS) synergic contribution of national and regional innovation systems to industry clusters and local firms. Source: own elaboration.

national levels (e.g. sustainability, inclusion). This requires an effective SMLIS in place between national and regional level.

3. Case study methodology

China is selected as a representative case for this analysis. It is an emerging power that moved from being one among many developing economies to being a major economy in the global landscape. The GDP per capita of around US$ 500 of the early 1990s has moved up the scale to a much more consistent US$7,600 that in purchasing power parity terms approximate US$ 12,500, joining the category of the high-income countries (UNDP 2023; World Bank 2023). As in many other countries, China presents an important regional heterogeneity as some regions attract important resources (e.g. export processing zones on the East coast) and connect with political power more easily (e.g. capital cities/regions), while others are quite distanced and isolated (e.g. Sichuan or Qinghai in Western China). For this reason, it makes sense to study the way RISs work in this national context and to make an assessment of their effectiveness. Two regions are selected as representative of very different geographical, institutional and production contexts. These are the Yangtze River Delta (YRD) on the eastern coast, and Chengdu-Chonqing Economic Circle (CCEC) in western China.

This study focuses on China that offers a distinctive and valuable empirical setting to explore the Sustainable Multi-Level Innovation Synergy (SMLIS) framework. China's institutional system—characterised by strong national coordination combined with significant regional diversity—enables the observation of both top-down (national, mission-

oriented) and bottom-up (regional, adaptive) innovation dynamics within a single governance architecture. This internal heterogeneity helps to examine how the National Innovation System (NIS) interacts with multiple Regional Innovation Systems (RISs) to address national 'grand challenges' while responding to region-specific socio-economic and industrial conditions. From this perspective, China serves not as an exception but as a representative example of how catching-up economies can operationalise multi-level innovation governance under unified institutional constraints. While Europe and the EU could also provide relevant contexts for testing the SMLIS concept, the Chinese case contributes unique insights into the coordination mechanisms required where innovation capabilities and institutional maturity vary substantially across regions. Therefore, the findings presented here not only validate the conceptual relevance of SMLIS within a single national framework but also offer theoretical and policy implications for other economies seeking to balance national missions with regional innovation diversity.

Methodologically, we adopt the explanatory case study approach (Ridder 2017; Yin 2003) that helps to explain how the selected theoretical framework applies to specific contexts and helps to verify the expected link between the relevant variables and drivers of the phenomenon under study, and the main outcomes generated by such drivers. Validity and reliability are guaranteed through the triangulated use of diverse though consistent information across the different regional cases. The adoption of critical historic trends (i.e. historic method) also ensures consistency in the analysis and interpretation of the development process of the Chinese NIS and RISs.

In practice, we are going to observe the historic evolution of the Chinese innovation system and policy framework to identify relevant sustainable outcomes at the regional level in relation to (1) intermediate (innovation) performance, such as R&D expenditure and personnel, patents, and (2) final (economic) performance, such as GDP or firm creation. This is not the whole analysis as we refrain from taking a linear (non-systemic) approach to innovation. For, (3) we use qualitative information gathered through a large set of local scientific studies about systemic elements of the selected regional innovation and production systems to overcome the limitations of cross-section analysis (Ridder 2017; Yin 2003). This will also help to understand in more depth the sustained evolution of the selected RISs and their interactions with the central government and the NIS through the application of an appropriate multi-level approach (Douglas and Radicic 2022; Flanagan, Uyarra, and Laranja 2011), and more specifically the SMLIS in our case.

4. The Chinese case: national and regional innovation systems

4.1. The Chinese National Innovation System (NIS)

China has a sophisticated, centralised bureaucratic system for policy formulation and implementation (Lieberthal and Oksenberg 1988). The Central Committee of the Communist Party (CCCP) takes key decisions on major domestic and foreign affairs. The State Council of China is the executive body that has responsibility over the implementation of those strategic decisions. In this paper, the central government refers to both roles. In 1978, the CCCP identified the 'grand challenge' of modernising the country and targeted a 'mission-oriented' innovation policy through 'opening-up and reforms'. This

represented a 'transformative change' as it implied a change in the main socio-technical systems (i.e. from a centrally controlled economy to one accompanied by foreign direct investments). China started to form its NIS through the introduction of foreign technologies. In 1985, the CCCP released 'The Reform of the S&T System', which marked the beginning of 30 years of sustained science and technology reforms and a full transformation of relevant socio-technical systems (e.g. economic structure and markets, urbanisation and mobility, among others). The central government enacted a NIS structure that mobilised resources to its priority industries. The central government approved and funded major regional infrastructures, and supported regional development through regulatory and fiscal policies (Ye 2009). These measures were critical for less developed Chinese regions that lacked the necessary resources and capabilities.

Specific 'mission-oriented innovation policies' are recognised as milestones of China's reform. The 'Reform of the S&T System' in 1985 marks the beginning of S&T policy, while its ancillary projects '863' and 'Torch Park' established the concepts of technology market and the economic value of R&D (Ke 2012). The mission-oriented '*Plan for the Development of Science and Technology (2006-2020)*' marked the shift of the nation's innovation strategy towards '*indigenous innovation and leapfrogging in priority fields*' (China 2006). In 2016 the central government issued the '*Outline of the National Strategy of Innovation-Driven Development*', which pledges the 'mission' and determination of China to become a global innovation leader by 2030. This Outline highlights the role of strategic industries, such as digital devices, integrated circuit equipment, smart manufacturing, and robots. It also calls for a shift to the production of higher quality scientific and technological outputs focused on generating radical innovations through the introduction of significant policy incentives (China 2016).

Unlike the bottom-up approach taken by Italy or Germany (locally-driven in Italy and 'lander-driven' in Germany; see Cooke and Morgan 1994; Iammarino 2005), the Chinese government's policy tools became essential for the construction of an effective NIS. Over time the central government framed a system based on factor-led policies, institutional policies, industrial policies, mechanism-led policies, regional policies, etc. (He, Zhou, and Chen 2020), which epitomise the 'mission-oriented innovation policies' at the bases of the NIS framework. They also laid the bases for effective coordination mechanisms across different governance levels by stressing the role of 'regional policies'. Figure 2 displays the innovation policy system in China.

In addition to the critical guidance of the central government (through its 'Outlines'), the Chinese NIS is shaped by the interplay between public research institutions – PRI – (i.e. the Chinese Academy of Science and hundreds of universities), Multinational Corporations (MNCs), and domestic private and public firms. The interplay between these actors is the key to transfer the government's efforts into successful industrial innovations (Cao et al. 2015). In its pathway to technological catching-up, China's production system has benefited from direct R&D investments and technology spillovers from MNCs (Bianchi and Labory 2008; Jia et al. 2020). Many innovative industry clusters have been formed around MNCs (e.g. Zhangjjang High-Tech Park in Shanghai). Within the afore-mentioned 'Indigenous Innovation' initiative, advanced technologies provided by MNCs are indispensable to develop some of China' strategic industries, (e.g. wind turbine industry, Haakonsson and Slepniov 2018). Domestic public and private firms are the largest recipient of the S&T knowledge produced by PRIs and MNCs (Liu et al. 2017), while becoming an

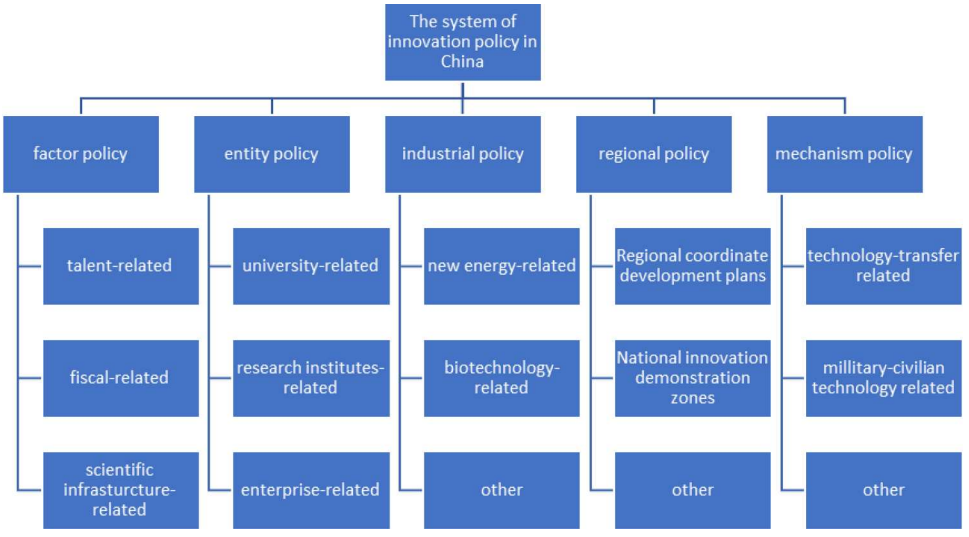

Figure 2. The system of innovation policy in China. Source: Our re-elaboration based on He, Zhou, and Chen (2020).

important producer of industrial knowledge/patents. In 2023 alone, domestic firms submitted 1,364,273 patent applications vis-a-vis the 98,963 submitted by MNCs (NBS 2024).

Today, many MNCs and domestic firms have established R&D partnerships with Chinese PRIs, and their interplay has formed a closed-loop system of knowledge generation that supports industrial innovation. In 2023, the new product sales of Chinese industrial firms have reached US$ 4,949 billion, which is about 15 times larger than in 2004 (NBS 2021). Between 2019 and 2023, China's R&D expenditure rose from 2.24% to 2.65% of the GDP; patents application increased from 2.38 million to 5.56 million; and the export of high-tech products increased from US$730.7 billion to US$842.0 billion (NBS 2021). The sustained success of the Chinese NIS is shown by the evolution of these broad data.

Beyond the above-mentioned innovation and economic performance, the Chinese NIS also brings sustainable services to the public. It is tackling major challenges such as environmental protection, enlarged gaps between urban and rural areas and income inequality; for instance, by designing and launching the *Action Plan of Carbon Dioxide Peaking by 2030* (China 2021), and the *Strategic Outline for the Development of Digital Villages* (China 2019b). These sustainability-driven policies are achieving successful green development and rural revitalisation. By 2022, 3,616 green factories were built together with 267 green industrial parks, i.e. factories and parks with low environmental impacts (MIIT 2023). Through the development of digital infrastructure and smart agriculture, the income gap between urban and rural areas is effectively being reduced (Liu and Liu 2024).

In the next sub-section, the coordination between the national and the regional level is discussed. We have selected two regions that display different characteristics in terms of history, institutions and organisations, resources, and capabilities. They both contribute to the sustainable economic development of China.

4.2. Regional innovation systems of China

4.2.1. Yangtze River Delta (YRD)

YRD region has been at the core of the 'mission-oriented innovation policy' of China for years. YRD consists of three provinces (Jiangsu, Zhejiang, Anhui) and the municipality of Shanghai. From the 1980s, YRD has been economically more developed than inland regions due to its favourable geographical position and the preferential policies of the central government. The policy of attracting MNCs set the early bases for the emerging YRD RIS. In 2016, the central government released the '*Development Planning of YRD City Clusters 2016-2020*' (NDRC 2016) with the proposed mission to boost the convergence between industrial value chains and the rising RIS. In 2018, the central government issued the '*Outline of the Integrated Regional Development of the YRD*' (China 2019a), which aimed at promoting the development of the YRD Community of Science, Technology and Innovation (Figure 3).

However, this is not a top-down system. Regional public and private actors have taken on a set of 'challenge-oriented' steps to promote the sustainable development of YRD RIS (CORIS). For instance, in 2019 the provincial governments and the private sector organised the '*Joint Annual Meeting for the Construction of YRD RIS*' (Government of Wuhu 2019); Jiangsu province promoted '*High-Tech Economic and Technical Development Zones*' aimed at developing clusters of high-tech firms, while Zhejiang province issued the 14th '*Five-Year Plan to Build the Global Advanced Manufacturing Base*' to promote the smart transformation and sustainable upgrading of its manufacturing industries (Zhejiang 2021).

This type of (SMLIS) synergy between NIS and RIS is visible in the automobile industry which has been a leading YRD industry since the 1980s. The State and NIS have promoted outstanding clusters through the national 'Planning of YRD City Clusters' and related guidance and financial programmes. Simultaneously, the RIS has boosted specific actions oriented to support their leading clusters (i.e. automobile and IT, which include thousands

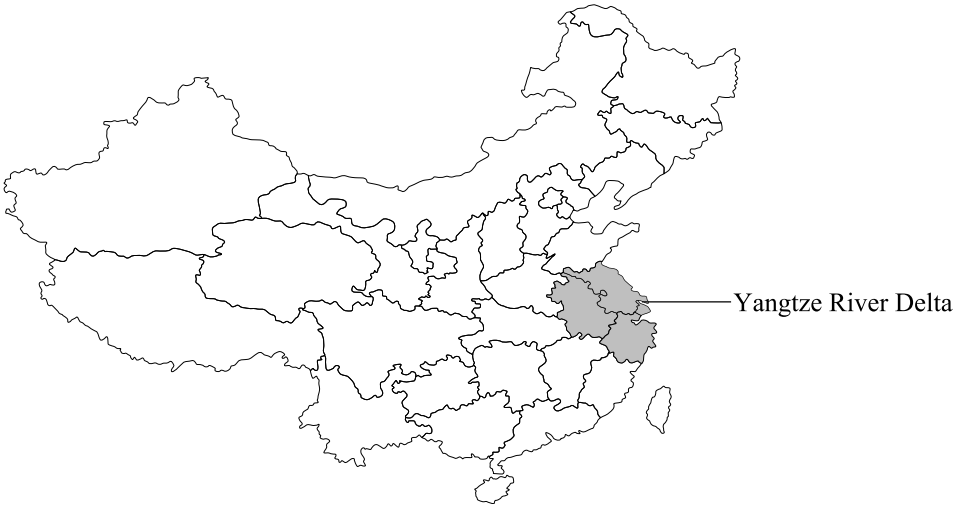

Figure 3. Geographic location of YRD. Source: own elaboration.

of SMEs as part suppliers and service providers) through the formation of the aforementioned 'High-tech economic zones' and the bottom-up effort of the Shanghai Society of Automobile Engineers (SAE-S) which operates as a corporation of scientists and technical workers. With 1,200 individual members and 70 group members, SAE-S is involved in academic exchanges, technical advice and training, and publication of technical reports. SAE-S has been collaborating vigorously with local automobile enterprises including Volkswagen, GM, and NIO (SAE-S 2021). In 2021 alone, SAE-S hosted more than 20 seminars on the most advanced topics in the automobile industry (e.g. hydrogen fuel cells, integrated circuit innovation and intelligent vehicle security) and seminars/programmes to improve management skills and process efficiency of local SMEs (SAE-S 2021).

As a result, the SMLIS has helped to achieve two important 'grand challenges' for China and the YRD region. On the one hand, it has addressed the grand challenge of innovation and growth with distributed gains through these joint efforts and the extensive engagement of SMEs in this and other regional industries. Overall, from 2015 to 2020, the regional automobile industry increased its GDP by around 20%, from US$81 billion to US$103 billion, in spite of the impact of Covid-19 (Shanghai Statistics 2021). On the other hand, the green development grand challenge has also been addressed. The SAE-S has actively participated in raising the standards of the automobile industry by formulating the '*National Standard of Recycling Traction Batteries Used in Electric Vehicles*' (SAE-S 2023). As a result, in 2022 the energy consumption per unit of GDP fell by 17.4% and the sulphur dioxide emission fell approximately 80%, compared to 2015 (NBS 2023).

A second relevant case is the IT industry, which adds to the innovation and growth mission through the prospected industry 5.0. In 2017, China's government formulated the '*New Generation Artificial Intelligence Development Plan*', in which it set out the expected AI development in the country. Its big financial and institutional efforts have led the market value of China's AI industry to reach US$ 72.5 billion in 2023, accounting for nearly 30% of the global market (NSB 2023). YRD accounted for about 40% of China's AI industry, and 50% of China's AI patent filings (NSB 2023). In YRD, Zhejiang province responded by issuing the '*Action Plan for facilitating the development of AI industry in Zhejiang, 2019-2022*'. Simultaneously, the local businesses played a key role. Some world-leading AI companies have risen, such as the unicorn DeepSeek. Founded in Hangzhou in 2023, the company's large language models (LLM) triggered a massive US$1 trillion sell-off in tech stocks within the first week of its release (Okaiyeto et al. 2025). DeepSeek has benefited from the state-backed computing infrastructure, and the Ministry of Industry and IT (MIIT) which allocated industry-specific datasets (e.g. healthcare, transportation) to train DeepSeek's models. At provincial and city level, the advanced AI computing cluster in Zhejiang provides critical infrastructure support for DeepSeek's large-scale model training. Moreover, the city government has granted this industry preferential policies on land-use cost and special testing and R&D tax deductions. In turn, DeepSeek's and its supply chain have been deployed across 240 local governments, thus significantly improving their administrative efficiency.

In this booming IT industry, the division and specialisation of labour has changed as lead firms (e.g. DeepSeek, Alibaba) have now focused on R&D activities, whereas the development of application-scenario and its industrial productions are transferred to capable local SMEs. Thanks to the open-source algorithm models provided by lead

firms, SMEs are now able to adopt new technologies such as robotic warehousing and smart logistics, which significantly reduce their operating costs as well as their carbon footprints. Today, Hangzhou city has become a vibrant home to top AI firms and startups in China.

Within the SMLIS framework, the national/NIS effort focused on cluster promotion and AI development has been complemented by the regional effort, particularly in Zhejiang and Hangzhou, put in place through the special economic zones and the setting up of special institutional opportunities (i.e. public procurement) for the AI industry. The overall outcomes of this SMLIS efforts show (Table 1) the definitive success: 56.1% growth in R&D personnel and 101.5% growth in R&D expenditure show the NIS and RIS commitment towards an innovation-driven economy; 93.2% growth in patents, 84% growth in new product sales and 14.7% growth in exports represent the consistency and effectiveness of their approach to innovation and economic performance, whilst 54.9% growth in GDP per capita and the reduction in the Gini Index (e.g. from 0.509 in 2014 to 0.365 in 2022 in Shanghai), indicate the overall impact in the living standard of the population over the recent 2015–2023 period (NBS 2023; 2024).

4.2.2. Chengdu-Chongqing Economic Circle

The Chengdu-Chongqing Economic Circle (CCEC) covers 15 cities in Sichuan and one centrally administrated municipality, Chongqing. Compared with other driving regions, CCEC shows a smaller economic scale with a GDP per capita of US$ 11,082 in 2023 (vs US$ 18,065 in YRD). Western China has typically been less developed than Eastern China, thus opening room for one of the 'grand challenges' that China is facing, the development of a more inclusive and sustainable growth across the country. Aiming at eliminating poverty fundamentally and attaining a balanced development across regions, the CCCP issued a series of grand policies including the '*Outline of Development-driven Poverty Alleviation in Rural Areas for 2011–2020*' (China 2011) and the '*Guidelines for the Three-Year Action Plan to Win the Battle Against Extreme Poverty*' (China 2018). For the regions, the CCCP established the 'mission' to promote '*Large-scale Development of the Western Regions*' and issued the ambitious '*Outline for Building the Chengdu-Chongqing Economic Circle*' to transform the CCEC into a highland for reforms and opening-up, and a place with a higher quality of life (Figure 4).

The regional CCEC joint government has exploited the instruments created by the Central Government. In collaboration with local organisations, it has promoted 160 industrial projects aimed at responding to the 'regional challenge' of building modern industrial value chains. City governments have also engaged in RIS development. For example, Ziyang and Zigong have set up high-tech development zones focused on electronic devices, biotechnology and equipment manufacturing. The capital city

Table 1. YRD innovation and economic performance (2015 & 2023).

	Innovation input		Innovation output		Economic performance	
Year	Full time R&D personnel	R&D expenditure (10,000 USD)	No. of Patents	New product sales (10,000 USD)	GDP per capita (USD)	Export (10,000 USD)
2015	1,016,656	671,200	959,361	7,750,500	11,661	10,722,800
2023	1,587,328	1,352,300	1,853,921	14,260,900	18,065	12,295,200

Source: China statistics yearbook 2016, 2024.

administration of Chengdu has established the Western Science City (WSC), which is the brain of the RIS, and agglomerates key labs, engineering research centres, the Western Branch of the Chinese Academy of Science, and many private R&D centres of technology giants such as Huawei, IBM and Intel. WSC is home to over 600 SMEs operating in a wide range of industries such as medical science, cloud-computing and digital-creativity (WSC 2022).

Within the 'regional challenges' the growth of the pharmaceutical industry in Chongqing is illustrative. Long ago, the pharma industry in Chongqing was based on traditional medicine (i.e. natural herbs). In the 1990s, Chongqing started to focus on modern pharmaceuticals. Regional universities have greatly contributed to enhancing industry competitiveness. One of the Chinese Covid-19 vaccine inventors and the largest pharma firm in CCEC, Zhifei Biological Products, have been collaborating with Chongqing University of Technology (CUT) on cutting-edge research outputs (e.g. synthetic peptide vaccine and insulin-sensitising) that were then transferred to Zhifei (CUT 2020). Agilent is a global leader in life science and diagnostics technology. It has recently set up a joint lab on maternal-foetal medicine with Chongqing Medical University (CMU). In 2019, the CMU signed a strategic collaboration agreement with the Chongqing government, in which it committed to support the construction of the Chongqing International Biological Zone (CIBZ). CMU also set up a branch of the pharmacy college within CIBZ that bolstered the university-industry collaboration (e.g. industry seminars). In 2019, there were 59 biotech SMEs clustered in CIBZ, and CMU had become the powerhouse for technological innovation across these firms (CIBC 2020). As a result, the gross output value of this industry increased from US$ 8,700 million to US$ 9,269 over the period 2015-2020. The number of employees increased from 1.26 to 1.47 million, and the total GDP of Chongqing moved from US$ 243 million to US$ 387 million (Chongqing Bureau of Statistics 2021).

On a broader level, the regional governments also promoted the development of public services (e.g. infrastructures), and plantation and cultivation projects (e.g. in forestry and food crops), so as to positively affect the poorest segments of the population. These initiatives led to generate stable employment, which helped 622,000 poor people

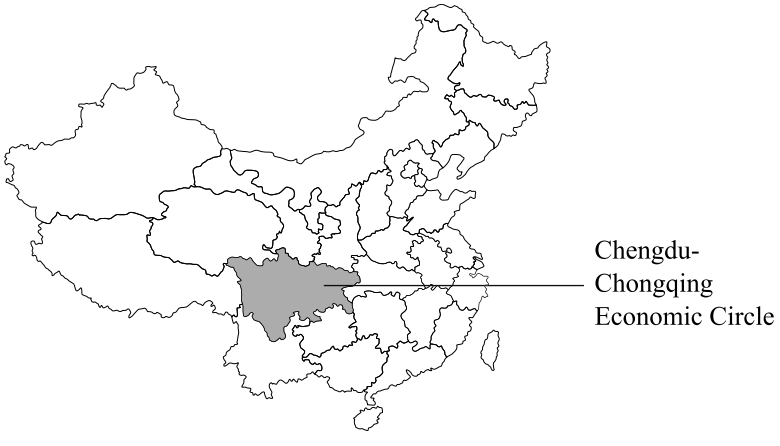

Figure 4. Chengdu-Chongqing location. Source: own elaboration.

to have their precarious houses rebuilt, while 959,000 additional people got access to 'clean water' in the CCEC area (Sichuan Province 2020).

Overall, the SMLIS has attained important results over the recent past. Table 2 shows the significant commitment of NIS and RIS to increase key inputs such as full time R&D personnel (+58.6%), R&D expenditure (+144.2%), and patents (+148.2%), and their effective performance in terms of new product sales (+104.3%) and exports (+69.1%) (NBS 2024). Simultaneously, the increase in GDP per capita (+69.2%) and the overall decline in the GINI index (from 0.43 in 2014 to 0.38 in 2022 in Chongqing, NBS 2023) prove the positive impact on the living standard of the regional population. These data support the image of an effective SMLIS that benefits from the 'mission-oriented policies' of the Central government through their '*Large-scale Development of the Western Regions*' within the '*Outline for Building the Chengdu-Chongqing Economic Circle*' (China 2021), while simultaneously promoting cooperation among the lead regional organisations (provincial council, the two universities, and the WSC) with the local industry so as to form an effective RIS that boosts knowledge exchange projects and activities (e.g. the CIBZ, joint university-industry projects), which benefit the local firms and push them forward in their catching-up pathway.

5. Discussion

The SMLIS synergy between these RISs and the wider NIS in China is essential for a catching-up/developing economy. In the early 1990s, China was among the less developed economies while today, thirty years later, has become a major economy (UNDP 1990, 2020). The 'grand challenges' of sustainable and inclusive growth are pursued through 'mission-oriented policies' framed within specific 'Outlines' focused on innovation, clustering and institutional synergies (Mazzuccato, 2020; Caliari and Barbieri-Ferreira 2023). In this way, the central government has contributed to ignite 'transformative change' (Schot and Steinmuller 2018) through wider national processes that have been complemented by regional-level decisions, coordination, and actions taken by specific regional governments, the 'challenge-oriented regional innovation systems', and their industries and communities (Bianchi and Labory 2008). The SMLIS framework offers a prospective solution to the issue of the poor capacity of the NIS to cater for the needs of the SMEs (Jia et al. 2020), which is due to the usually relevant (geographical and organisational) distance between the leading organisations of the NIS and most SMEs which are often based in peripheral regions (Cooke 2002; Parrilli, Aranguren, and Larrea 2010). Within this approach, the central government is not supposed to formulate specific policies and initiatives; rather, it provides macro guidance frameworks/'Outlines' and resources that leave the regions free to formulate their own context-specific initiatives through the

Table 2. Innovation and economic performance of CCEC (2015, 2020).

	Innovation input		Innovation output		Economic performance	
Year	Full time R&D personnel	R&D expenditure (10,000 USD)	No. of Patents	New product sales (10,000 USD)	GDP per capita (USD)	Exportation (10,000 USD)
2015	191,222	1,101,700	169,506	1,626,600	6,549	877,900
2023	303,328	2,689,900	420,677	3,323,100	11,082	1,484,200

Source: China statistics yearbook 2016, 2023.

participation of regional/local actors, SMEs and industries within a sustainable and place-sensitive approach (Heilmann and Melton 2013; Zhang et al. 2021).

As Figure 5 shows, the Chinese central government and the NIS mainly offer macro-guidance through the definition of wider national development plans. These are framed as 'mission-oriented innovation policies' (Mazzucato 2018) designed to address 'grand challenges' faced by the country such as modernising their production system and promoting sustainable development and more inclusive distribution of income between central and peripheral areas. These boundaries help the RISs to focus on their own 'regional challenges' by putting in place an effective coordination among regional private and public actors through resource sharing and other joint actions (Isaksen, Trippl, and Meyer 2022; Ling and Jiang 2013; Todling, Trippl, and Desch 2022). This decentralisation of power has been crucial in the formation of effective RISs as it lent room to maximising local competitive advantages (Rodriguez-Pose and Ezcurra 2010). Once the macro guidance is set by the central government, regional governments step in by implementing their strategies (Cassiolato and Lastres 2020; Isaksen, Trippl, and Meyer 2022; Todling, Trippl, and Desch 2022). In YRD, the central government set up the 'mission-oriented' '*Outline of the Integrated YRD Regional Development' and its related regulatory and financial instruments*, while the regional government and community developed the specific 'challenge-oriented' G60 Corridor where regional high-tech industries operate alongside a highway that passes across the four provinces (Office of the Joint Annual Meeting of YRD 2020). In the CCEC, the central government issued the 'mission-oriented' '*Outline for building the CCEC*' and its related regulatory and financial instruments, while the regional government and the private agents developed the

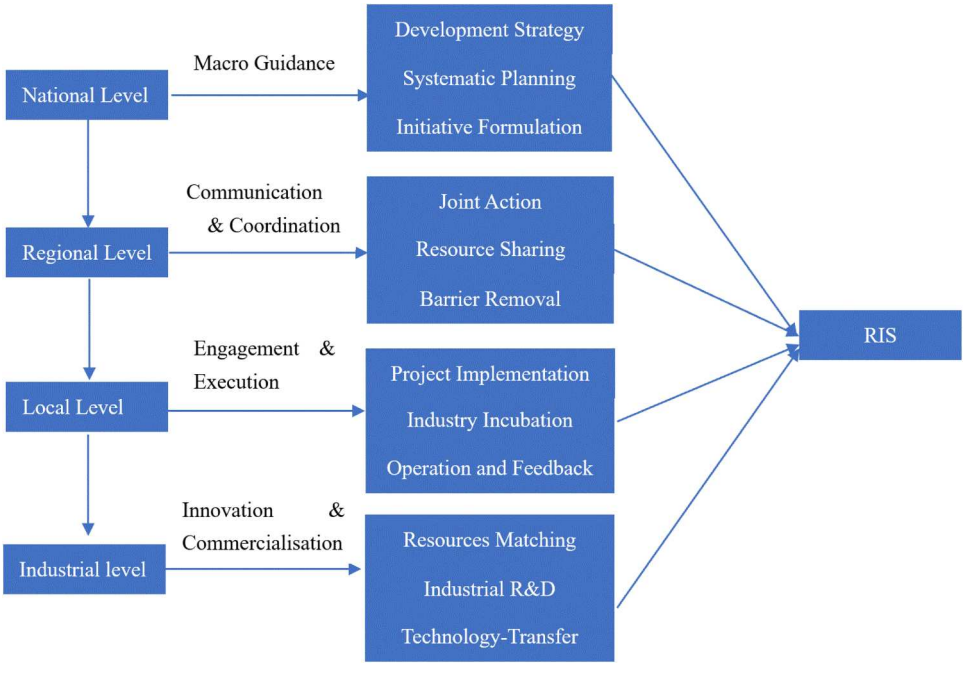

Figure 5. The synergic policy framework for RIS. Source: own elaboration.

'challenge-oriented' Chongqing International Biological Zone to promote the local pharmaceutical industry. China is a powerful catching-up economy that still faces economic and environmental disequilibria that form barriers to the country' sustainable regional development, thus a coordinated design and action is required to break such barriers (Yu 2019). In the YRD region, this is represented by the Joint Annual Meeting, an effective communication and coordination platform where key development decisions and projects are undertaken. In CCEC this mechanism is developed by the Western Science City, which promotes the coordination among regional innovation agents. Through such agents and actions, a RIS is formed, and the benefits of industry agglomeration are distributed across different industries and agents in the region (Cassiolato and Lastres 2020; Iammarino, Rodriguez-Pose, and Storper 2019; Isaksen and Trippl 2017; Isaksen, Trippl, and Meyer 2022; McCann and Ortega-Argiles 2015; Todling, Trippl, and Desch 2022). The implementation takes place at the regional level through project design and practical initiatives (e.g. business incubation). For instance, the industrial associations of Shanghai have been acting as a bridge that connects enterprises into a network of shared information and resources. In this respect, Chinese industry associations play a similar bridging role between government and industry as in advanced economies (Ling and Jiang 2013; Watkins et al. 2015). These regional cases support proposition P1 as they highlight the critical role of the central government and its NIS, and its SMLIS synergy with regional governments and RISs.

Overall, the work of proactive regional and industry actors within the two regions shows a SMLIS framework where the NIS identifies challenges (i.e. in the Chinese case related to environmental sustainability, economic inclusion and technological innovation) and provides missions and instruments while leaving the CORISs free to design and implement their specific sustainable pathway to industrial innovation and sustainable and inclusive economic growth (Cassiolato and Lastres 2020; Isaksen, Trippl, and Meyer 2022; Todling, Trippl, and Desch 2022; Zhang et al. 2021). This synergy is particularly important in catching-up/developing economies where resources and capabilities are limited (Haiting 2024; Männasoo, Hein, and Ruubel 2018), and a synergic (SMLIS) innovation effort is required to bolster sustainable and inclusive regional development. Therefore, proposition P2 is also supported.

This finding extends our knowledge and understanding of the way innovation systems can work effectively in catching-up and developing economies (Asheim and Vang 2006; Lundvall et al. 2011; Niosi 2011; Chaminade, Intarakumnerd, and Sapprasert 2012; Chaminade and Plechero 2015; Caliari and Barbieri-Ferreira 2023) through a SMLIS that entails a dynamic role of the so-called CORISs (Cassiolato and Lastres 2020; Isaksen, Trippl, and Meyer 2022; Todling, Trippl, and Desch 2022) within the protection and promotion exercised by the national government and NIS.

6. Conclusions

This study shows the leadership of some Chinese regions, and simultaneously, the capacity of catching-up regions to become effective RISs. The distance among these regions is significant as in the most advanced economies (US plains vs New York or Silicon Valley, or the UK South-East vis-à-vis the North-West and Wales). However, this study shows the clarity of 'grand challenges' identified at the national level as well as

the important steps that these catching-up regions have undertaken – within a 'mission-oriented' and 'transformative' approach – towards innovation, sustainability and inclusion in the wider national landscape (Caliari and Barbieri-Ferreira 2023; Mazzucato 2018; Schot and Steinmueller 2018).

China is a unique context; we cannot expect pure bottom-up development processes seen in other contexts, e.g. Emilia-Romagna in Italy (Ramaciotti 2008) and Medicon Valley in Sweden and Denmark (Grillitsch and Rekers 2016). In the Chinese context a SMLIS is promoted by the NIS in collaboration with the RISs and the local industry actors, which in most Chinese regions are usually SMEs (Chongqing Bureau of Statistics 2021). Here, we observe the heterogeneous profile of regions that design and develop their own pathway to innovation and growth, and yet maintain a Sustainable Multi-Level Innovation Synergy with the NIS. The regions exploit national plans and policies to develop their own pathways that enhance the living standard of their population. A sustainable and inclusive development process leads the way towards an economic model that combines national and regional policy frameworks (Binz and Truffer 2017; Douglas and Radicic 2022; Flanagan, Uyarra, and Laranja 2011) within a SMLIS where the national level focuses on identifying the relevant 'grand challenges' and sets up appropriate 'mission-oriented' innovation policies for 'transformative change' (Mazzucato 2018; Schot and Steinmueller 2018), while the RISs arrange capabilities, institutions and networks to respond to specific 'regional challenges' for the sake of local industries and the local population (Cassiolato and Lastres 2020; Isaksen, Trippl, and Meyer 2022; Todling, Trippl, and Desch 2022).

In this way, the Chinese case supports the view that in catching-up economies the central government and NIS are key to provide the overarching framework, guidance and resources, while leaving the RISs and their production systems free to develop their own dynamic and sustainable development pathway. In prospect, the Chinese case might moves towards an approach aligned with the European framework of smart specialisation where the local strategies are designed according to the wider institutional framework provided by the EU directives and country strategies (Foray 2014; McCann and Ortega-Argiles 2015). However, the two areas (EU and China) differ in the way they have come to the current position. While for Europe has been mostly driven bottom-up by some leading innovation regions, in China the central government has stirred the process, whilst the provinces/regions have taken it on more lately. This looks pretty aligned with the case of most catching-up and developing countries whose regions have not yet acquired a powerful drive to design their own innovation strategies and pathways.

This whole discussion takes us to new policy considerations about the formation and effectiveness of RISs in the context of catching-up economies. In this case, the role of central governments is more essential than in western economies. While legal legitimacy, macro policy guidance, and public financial resources are needed, only central governments and their NIS can provide them (Lundvall et al. 2011; Flanagan, Uyarra, and Laranja 2011; Mazzucato 2018; Douglas and Radicic 2022). However, these factors need to combine with appropriate bottom-up efforts and capabilities from regional governments, private organisations and firms (i.e. the RIS). This would help to form a SMLIS that permits to arrange effective and sustained engagement and actions from private businesses that are the actors expected to exploit the IS (Isaksen, Trippl, and Meyer 2022; Ling and Jiang 2013; Todling, Trippl, and Desch 2022).

The SMLIS framework that is applied in China is relevant for other catching-up economies in Asia, Africa and Latin America that can produce significant advances in critical technological domains (e.g. IT and AI, energy, machine-tools, automotive). The delicate balance between top-down strategic guidance and bottom-up decisions and actions must be ensured by appropriate institutional synergies and arrangements. For example, the central government may want to focus on providing resources for fundamental research/R&D, while the regional governments take responsibility to channel these activities towards industries and institutional and technological arrangements that can produce effective socioeconomic and environmental impacts (Wenjuan and Zhao 2023). In these contexts, some inter-regional barriers to collaboration may arise in case of conflictual decisions on tax distribution and financial investments. To tackle these challenges, specific mechanisms/institutions can be arranged. In China for instance, the central government established the Central Science and Technology Commission in 2023, to oversee the implementation of large projects, resolving potential inter-regional conflicts around funding (Ibidem). This institutional arrangement acts as a safeguard for an effective SMLIS and provides relevant policy implications for catching-up economies that aim at enhancing the alignment between national priorities and regional capabilities.

These coordination mechanisms may be enhanced through a mapping exercise which helps to identify and monitor NIS-level 'grand challenges', 'mission-led policies', and 'resources', as well as RIS-level selected 'industries', 'regional institutions, organisations and infrastructures', 'skills and capabilities', and local-level 'programmes and resources' arranged to respond to the selected challenges and objectives. The mapping exercise may be completed with a set of broader performance aspects and indicators that show the definitive impact of the SMLIS framework and process on the 'living standards' of the regional population and the 'environmental sustainability', among others, which represent both 'grand challenges' and 'CORIS challenges' (Caliari and Barbieri-Ferreira 2023; Isaksen, Trippl, and Meyer 2022; Todling, Trippl, and Desch 2022). Such a mapping exercise would offer a practical instrument to make the process effective and monitor its attainments over time.

Echoing previous research on this topic (Lundvall et al. 2011), while introducing the more specific argument made here, further research steps need to consider diverse catching-up economies where preliminary efforts are made to develop higher innovation capacity, and new and more demanding 'grand challenges' and 'transformative changes' (e.g. climate change, energy sourcing, and mobility patterns). The interaction between NIS and RISs and actors needs to be studied there. This novel research step would add robustness and extension to the current analysis, and significant policy implications for national decision-makers and international development organisations.

Disclosure statement

No potential conflict of interest was reported by the author(s).

References

Alberdi-Pons, X., J. J. G. Martíns, and M. D. Parrilli. 2016. "Innovation Gaps: A Typology for Spain." In *Innovation Drivers and Regional Innovation Strategies*, edited by M. D. Parrilli, R. Fitjar, and A. Rodriguez-Pose, 45–65. Routledge.

Asheim, B. T., and M. S. Gertler. 2005. The Geography of Innovation: Regional Innovation Systems. In *The Oxford Handbook of Innovation*.

Asheim, B. T., and A. Isaksen. 2002. "Regional Innovation Systems: The Integration of Local 'Sticky' and Global 'Ubiquitous' Knowledge." *The Journal of Technology Transfer* 27 (1):77–86. https://doi.org/10.1023/A:1013100704794

Asheim B., and J. Vang. 2006. "Regional Innovation Systems in Asian Countries." *Innovation* 8 (1-2): 27–44.

Asheim, B. T., R. Boschma, and P. Cooke. 2011. "Constructing Regional Advantage: Platform Policies based on Related Variety and Differentiated Knowledge Bases." *Regional Studies* 45 (7):893–904.

Audretsch, D. B., and M. P. Feldman. 1996. "R&D Spillovers and the Geography of Innovation and Production." *American Economic Review* 86:630–640.

Bergek, A., M. Hekkert, S. Jacobsson, J. Markard, J. Sanden, and B. Truffer. 2015. "Technological Innovation Systems in Context." *Environmental Innovations and Societal Transitions* 16:51–64. https://doi.org/10.1016/j.eist.2015.07.003

Bianchi, P., and S. Labory. 2008. *International Handbook on Industrial Policy*. Cheltenham: Edward Elgar Publishing.

Binz, C., and B. Truffer. 2017. "Global Innovation Systems." *Research Policy* 46:1284–1296. https://doi.org/10.1016/j.respol.2017.05.012

Boschma, R., and G. Capone. 2015. "Institutions and Diversification." *Research Policy* 44:1902–1914. https://doi.org/10.1016/j.respol.2015.06.013

Caliari, T., and M. J. Barbieri-Ferreira. 2023. "The Historical Evolution of the Brazilian Aeronautical Sector: Mission-Oriented Innovation Policy and Sectoral Innovation System." *Economics of Innovation and New Technology* 32 (5):682–699. https://doi.org/10.1080/10438599.2021.2011258

Camagni, R., and R. Capello. 2013. "Regional Competitiveness and Territorial Capital: A Conceptual Approach and Empirical Evidence from the EU." *Regional Studies* 47 (9):1383–1402. https://doi.org/10.1080/00343404.2012.681640

Cao, C., L. Ning, L. Xia, and L. Liu. 2015. "Reforming China's S&T System: A New Perspective." *Journal of Dialectics of Nature* 37 (1): 12–13.

Carlsson, B., and S. Stankiwewicz. 1991. "Technological Systems and Economic Policy." *Research Policy* 23:235–248. https://doi.org/10.1016/0048-7333(94)90036-1

Cassiolato, J. E., and H. M. Lastres. 2020. "The Framework of Local Productive and Innovation Systems and Influence on STI Policy in Brazil." *Economics o Innovation & New Technology* 29 (7):784–798. https://doi.org/10.1080/10438599.2020.1719650

Central Government of China. 2006. *National Medium-and Long-term Program for Science and Technology Development (2006–2020)*. http://www.gov.cn/gongbao/content/2006/content_240244.htm.

Central Government of China. 2011. *The Outline of Development-driven Poverty Alleviation in Rural Areas (2011–2020)*. https://www.gov.cn/gongbao/content/2011/content_2020905.htm.

Central Government of China. 2016. *Outline of the National Strategy of Innovation-Driven Development*. http://www.gov.cn/zhengce/2016-05/19/content_5074812.htm.

Central Government of China. 2018. *Guidelines on the Three-Year Action Plan to Win the Battle Against Extreme Poverty*. https://www.gov.cn/zhengce/2018-08/19/content_5314959.htm.

Central Government of China. 2019a. *Outline of the Integrated Regional Development of the Yangtze River Delta*. http://www.gov.cn/zhengce/2019-12/01/content_5457442.htm.

Central Government of China. 2019b. *Strategic Outline for the Development of Digital Villages*. https://www.gov.cn/zhengce/2019-05/16/content_5392269.htm.

Central Government of China. 2021. *Action Plan of Carbon Dioxide Peaking Before 2030*. https://www.gov.cn/zhengce/content/2021-10/26/content_5644984.htm?eqid=a4b97eeb0002d62b00000003645bab58.

Chaminade, C., P. Intarakumnerd, and K. Sapprasert. 2012. "Measuring Systemic Problems in National Innovation Systems." *Research Policy* 41:1476–1488. https://doi.org/10.1016/j.respol.2012.04.004

Chaminade, C., and R. Perez-Padilla. 2017. "The Challenge of Alignment and Barriers for the Design and Implementation of STI Policies in Developing Countries." In *Research Handbook for Innovation*

Governance for Emerging Economies, edited by S. Kuhlman and M. G. Ordonez, 181–205. Cheltenham: Elgar.
Chaminade, C., and M. Plechero. 2015. "Do Regions Make a Difference?" *European Planning Studies* 23:215–237. https://doi.org/10.1080/09654313.2013.861806
Chongqing Bureau of Statistics. 2021. *Chongqing Statistical Yearbook 2024*.
Chongqing University of Technology. 2020. *News Updates*. https://www.cqut.edu.cn/info/1133/41374.htm.
Chongqing International Biological City (CIBC). 2020. *Introduction* [online]. Accessed April 10, 2024. http://www.cqbiocity.com/ml/pc/news/pc_news.html?columnsCode=0003.
Coenen L., B. Asheim, M. Bugge, & H. Herstad. 2017. "Advancing Regional Innovation Systems: What Does Evolutionary Economic Geography brings to the Policy Table." *Environment & Planning C* 35 (4): 600–620.
Cooke, P. 2002. "Regional Innovation Systems: General Findings and Some New Evidence from Biotechnology Clusters." *The Journal of Technology Transfer* 27 (1):133–145. https://doi.org/10.1023/A:1013160923450
Cooke, P., and K. Morgan. 1994. *Growth Regions under Duress: Renewal Strategies in Baden-Württemberg and Emilia-Romagna*. Oxford: Oxford University Press.
Doloreux, D., and S. Parto. 2005. "Regional Innovation Systems." *Technology in Society* 27:133–153. https://doi.org/10.1016/j.techsoc.2005.01.002
Douglas, D., and D. Radicic. 2022. "Network Additionality and Policy Mix of Regional and National Public Support for Innovation." *Economics of Innovation and New Technology* 31 (3):148–172. https://doi.org/10.1080/10438599.2020.1789277
European Commission. 2010. *Europe 2020: A Strategy for Smart, Sustainable and Inclusive Growth*. Brussels: Office of Publications of the European Commission.
Flanagan, K., E. Uyarra, and M. Laranja. 2011. "Reconceptualising the 'Policy Mix' for Innovation." *Research Policy* 40 (5):702–713. https://doi.org/10.1016/j.respol.2011.02.005
Foray, D. 2014. *Smart Specialisation: Opportunities and Challenges for Regional Innovation Policy*. London: Routledge.
Freeman, C. 1987. *Technology, Policy, and Economic Performance: Lessons from Japan*. London; New York: Pinter Publ.
Government of Wuhu. 2019. *Joint Annual Meeting for the Construction of Innovation System of YRD*. https://tzcjzx.wuhu.gov.cn/zsdt/tpxw/8096135.html.
Grillitsch, M., and B. Asheim. 2018. "Place-based Innovation Policy for Industrial Diversification in Regions." *European Planning Studies* 26 (8): 1638–1662. https://doi.org/10.1080/09654313.2018.1484892
Grillitsch, M., and J. Rekers. 2016. "How Does Multi-scalar Institutional Change Affect Localized Learning Processes? The Med-Tech Sector in South Sweden." *Environment & Planning A* 48:154–171. https://doi.org/10.1177/0308518X15603986
Haakonsson, S. J., and D. Slepniov. 2018. "Technology Transmission across National Innovation Systems: The Role of Danish Suppliers in Upgrading the Wind Energy Industry in China." *European Journal of Development Research* 30:462–480. https://doi.org/10.1057/s41287-018-0128-5
Haiting, C. 2024. "A Study on the Dual Disconnection between Theory and Practice in Vocational Education." *Journal of Exploration of Vocational Education* 1:37–53.
He, D., H. Zhou, and T. Chen. 2020. "Major Achievements and Development Direction in Construction of China's Science and Technology Innovation Policy System." *Science Research Management* 41 (10): 81–88. [in Chinese].
Heilmann, S., and O. Melton. 2013. "The Reinvention of Development Planning in China, 1993–2012." *Modern China* 39 (6): 580–628. https://doi.org/10.1177/0097700413497551
Hervás-Oliver, J.-L., M. D. Parrilli, A. Rodríguez-Pose, and F. Sempere-Ripoll. 2021. "The Drivers of SME Innovation in the Regions of the EU." *Research Policy* 50:104316. https://doi.org/10.1016/j.respol.2021.104316
Hollanders, H., N. Es-Sadki, and I. Merkelbach. 2019. *Regional Innovation Scoreboard, Maastricht*.

Iammarino, S. 2005. "An Evolutionary Integrated View of Regional Systems of Innovation." *European Planning Studies* 13:497–519. https://doi.org/10.1080/09654310500107084
Iammarino, S., A. Rodriguez-Pose, and M. Storper. 2019. "Regional Inequality in Europe." *Journal of Economic Geography* 19:273–298. https://doi.org/10.1093/jeg/lby021
Isaksen, A., and M. Trippl. 2017. "Innovation in Space." *Oxford Review of Economic Policy* 33:122–140. https://doi.org/10.1093/oxrep/grw035
Isaksen, A., M. Trippl, and H. Meyer. 2022. "Regional Innovation Systems in an Era of Grand Societal Challenges." *European Planning Studies* 30:2125–2138. https://doi.org/10.1080/09654313.2022.2084226
Jia, C., X. Tang, and Z. Kan. 2020. "Does the National Innovation System in China Supports the Sustainability of SME Innovation?" *Sustainability* 12 (6): 25–62.
Ke, W. 2012. "Exploring Work: The Interaction between Scientists and Policy-Makers. Case Study of 863 Plan of China." *Journal of Science Communication* 11 (3): 1–6. https://doi.org/10.22323/2.11030304
Laasonen, V., J. Kolehmainen, and M. Sotarauta. 2022. "The Complexity of Contemporary Innovation Policy and Its Governance in Finland." *Innovation* 35 (4): 1–22.
Lanahan, L., and M. Feldman. 2015. "Multi-level Policy Innovation Mix." *Research Policy* 44:1387–1402. https://doi.org/10.1016/j.respol.2015.04.002
Lieberthal, K., and M. Oksenberg. 1988. *Policy Making in China: Leaders, Structures, and Processes*. New Jersey: Princeton University Press.
Ling, Z., and W. Jiang. 2013. "Intergovernmental Cooperation in Cheng-Du Economic Zone: Case Study on Chinese Regional Collaboration under Synergy Governance." *Canadian Social Science* 9:15–23.
Liu, M., and H. Liu. 2024. "The Influence and Mechanism of Digital Village Construction on the Urban–Rural Income Gap under the Goal of Common Prosperity." *Agriculture* 14 (5): 775. https://doi.org/10.3390/agriculture14050775
Liu, X., S. Schwaag Serger, U. Tagscherer, and A. Y. Chang. 2017. "Beyond Catch-Up – Can a New Innovation Policy Help China Overcome the Middle Income Trap?" *Science and Public Policy* 44 (5): 656–669. https://doi.org/10.1093/scipol/scw092
Lu, Y. 2021. *University-Industry Collaboration, Innovation and Firms' Performance: China*. Poole: Bournemouth University.
Lundvall, B. 1992. *Å National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. London: Pinter.
Lundvall, B-Å, K. Joseph, C. Chaminade, and J. Vang. 2011. *Handbook of Innovation Systems and Developing Countries: Building Domestic Capabilities in a Global Setting*. Cheltenham: Edward Elgar Publishing.
Malerba, F. 2002. "Sectoral Innovation Systems and Production." *Research Policy* 31:247–264. https://doi.org/10.1016/S0048-7333(01)00139-1
Männasoo, K., H. Hein, and R. Ruubel. 2018. "The Contributions of Human Capital, R&D Spending and Convergence to Total Factor Productivity Growth." *Regional Studies* 52 (12):1598–1611. https://doi.org/10.1080/00343404.2018.1445848
Martinez-Covarrubias, J. L., H. Lenihan, and M. Hart. 2017. "Public Support for Business Innovation in Mexico." *Regional Studies* 51:1786–1800. https://doi.org/10.1080/00343404.2016.1245414.
Mazzucato, M. 2018. "Mission-Oriented Innovation Policies." *Industrial and Corporate Change* 27 (5): 803–815.
Mazzucato M., R. Kattel, and J. Ryan-Colling. 2020. "Challenge-Driven Innovation Policy." *Journal of Industry, Competition and Trade* 20: 421–437.
McCann, P., and R. Ortega-Argiles. 2015. "The Early Experience of Smart Specialisation." *European Planning Studies* 24:1407–1427. https://doi.org/10.1080/09654313.2016.1166177
Ministry of Industrial and Information Technology. 2023. *White Paper on Green Development of Industry*. https://www.gov.cn/zhengce/2023-01/19/content_5737923.htm.
Morgan, K. 2017. "Nurturing Novelty: Regional Innovation Policy in the Age of Smart Specialisation." *Environment and Planning C* 35:569–583.

Mosconi, F., and D. D'Ingiullo. 2023. "Institutional Quality and Innovation: Evidence from Emilia-Romagna." *Economics of Innovation and New Technology* 32 (5):165–197. https://doi.org/10.1080/10438599.2021.1893140

National Bureau of Statistics. 2021. *China Statistics Yearbook, 2021*. http://www.stats.gov.cn/tjsj/ndsj/2021/indexch.htm.

National Bureau of Statistics. 2023. *China Statistical Yearbook 2023*.

National Bureau of Statistics. 2024. *China Statistical Yearbook 2024*.

National Development and Reform Commision. 2016. *Development Planning of YRD City Clusters 2016–2020*. https://www.ndrc.gov.cn/xxgk/zcfb/ghwb/201606/W020190905497826154295.pdf.

Nelson, R., and S. Winter. 2002. "Technology, Institutions and Innovation Policy." *Research Policy* 31:265–272. https://doi.org/10.1016/S0048-7333(01)00140-8

Nelson, R. R. 1993. *National Innovation Systems: A Comparative Analysis*. New York: Oxford University Press on Demand.

Niosi, J. 2011. "Building Innovation Systems." *Industrial and Corporate Change* 6:1637–1643. https://doi.org/10.1093/icc/dtr064

Office of the Joint Annual Meeting of YRD. 2020. *The Development History*. http://g60.songjiang.gov.cn/WebSite/Introduce_1.aspx.

Okaiyeto, S. A., J. Bai, J. Wang, A. S. Mujumdar, and H. Xiao. 2025. "Success of DeepSeek and Potential Benefits of Free Access to AI for Global-Scale Use." *International Journal of Agricultural and Biological Engineering* 18 (1):304–306. https://doi.org/10.25165/j.ijabe.20251801.9733

Parrilli, M. D., and D. Radicic. 2021. "STI and DUI Innovation Modes in Micro, Small, Medium and Large-Sized Firms: Distinctive Patterns across Europe and the US." *European Planning Studies* 29 (2): 346–368.

Parrilli, M. D., M. J. Aranguren, and M. Larrea. 2010. "The Role of Interactive Learning to Close the Innovation Gap in SME-Based Local Economies." *European Planning Studies* 18:351–370. https://doi.org/10.1080/09654310903497660

Parrilli, M. D., M. Balavac, and D. Radicic. 2020. "Business Innovation Modes and Their Impact on Innovation Outputs: Regional Variations and the Nature of Innovation across EU Regions." *Research Policy* 49 (8):104047. https://doi.org/10.1016/j.respol.2020.104047

Ramaciotti, L. 2008. "The Regional Innovation System in Emilia-Romagna." In *High Technology, Productivity and Networks*, edited by M. D. Parrilli, P. Bianchi, and R. Sugden, 35–56. Palgrave-Macmillan.

Ridder, H. G. 2017. "The Theory Contribution of Case Study Research Designs." *Business Research* 10: 281–305.

Rodriguez-Pose, A., and M. Di Cataldo. 2015. "Quality of Government and Innovative Perofrmance in the Regions of Europe." *Journal of Economic Geography* 15 (4):673–706. https://doi.org/10.1093/jeg/lbu023

Rodriguez-Pose, A., and E. Ezcurra. 2010. "Does Decentralization Matter for Regional Disparities?" *Journal of Economic Geography* 10:619–644. https://doi.org/10.1093/jeg/lbp049

Rodrik, D. 2018. *New Technologies, Global Value Chains, and Developing Economies*. NBER Working Papers, 25164, Cambridge, Massachussets.

Schot, J., and E. Steinmueller. (2018). "Three Frames for Innovation Policy: R&D Systems of Innovation and Transformative Change." *Research Policy*, 47 (9): 1554–1567.

Shanghai Society of Automobile Engineers. 2021. *Introduction*. https://www.sae-sh.com/index.jsp.

Shanghai Society of Automobile Engineers. 2023. *SAE-S Contributes to Drafting the National Standards*. https://www.sae-sh.com/news_details.html?id=1656491241480167426.

Shanghai Statistics. 2021. *Shanghai Statistical Yearbook*. https://tjj.sh.gov.cn/tjnj/20220309/0e01088a76754b448de6d608c42dad0f.html.

Sichuan Province. 2020. *Sichuan's Poverty Alleviation Mission Basically Complete*. https://www.sc.gov.cn/10462/10758/10760/10765/2020/9/11/3e942052430f451ba67cd6b896cd13c8.shtml#:~:text=The%20province%E2%80%99s%20registered%20poor%20population%20dropped%20from%206.25,Ganzi%2C%20Aba%20and%20Liangshan%20have%20shaken%20off%20poverty.

Sotarauta, M., and A. Beer. 2017. "Governance, Agency and Place Leadership." *Regional Studies* 51:210–223. https://doi.org/10.1080/00343404.2015.1119265

Todling, F., M. Trippl, and V. Desch. 2022. "New Directions for RIS Studies and Policies in the Face of Grand Societal Challenges." *European Planning Studies* 30:2139–2156. https://doi.org/10.1080/09654313.2021.1951177

UN World Commission on Environment and Development (UNWCED). 1987. *Our Common Future: From One Earth to One World*. New York: United Nations.

United Nations Development Programme. 1990. *Human Development Report*.

United Nations Development Programme. 2020. *Human Development Report*. New York.

Wall, S. 2013. *Environmental Economics*. Harlow: Pearson.

Watkins, A., T. Papaioannou, J. Mugwagwa, and D. Kale. 2015. "National Innovation Systems and the Intermediary Role of Industry Associations in Building Institutional Capacities for Innovation in Developing Countries." *Research Policy* 44:1407–1418. https://doi.org/10.1016/j.respol.2015.05.004

Wenjuan, S., and K. Zhao. 2023. "Balancing Fiscal Expenditure Competition and Long-Term Innovation Investment." *PLoS One* 18 (11): e0293158. https://doi.org/10.1371/journal.pone.0293158

Western Science City. 2022. *Introduction*. http://www.cdtf.gov.cn/cdtfxq/c133606/kexuecheng.shtml.

World Bank. 1993. *The East Asian Miracle*. New York: O. U. Press.

World Bank. 2023. *World Bank Open Data*. Accessed April 10, 2024. https://data.worldbank.org/.

Ye, L. 2009. "Regional Government and Governance in China and the United States." *Public Administration Review* 69 (1):S116–S121. https://doi.org/10.1111/j.1540-6210.2009.02098.x

Yin, R. 2003. *Case Study Methodology*. London: Sage.

Yu, Q. 2019. "Study on the Guangdong-Hong Kong-Macao Greater Bay Area." *Journal of Modern Economy* 10 (03): 586. https://doi.org/10.4236/me.2019.103040

Zhang, W., N. Zuo, W. He, S. Li, and L. Yu. 2021. "Factors Influencing the use of Artificial Intelligence in Government: Evidence from China." *Technology in Society* 66:101675. https://doi.org/10.1016/j.techsoc.2021.101675

Zhejiang Province. 2021. *the Fourteenth Five-Year Plan of Constructing the Global Advanced Manufacturing Base*. https://www.zj.gov.cn/art/2021/7/19/art_1229019364_2311604.html.