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Rethinking Innovation Evaluation in the Age of Artificial Intelligence: Digital Sovereignty as a Dimension of Public Innovation

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Abstract

The swift expansion of national artificial intelligence (AI) strategies has significantly altered the aims of public innovation, broadening them from mere technological progress and economic competitiveness to encompass issues of digital sovereignty, strategic autonomy, and institutional resilience. Nevertheless, current frameworks for evaluating innovation still favour traditional metrics, such as research and development intensity, patent creation, technological outputs, and market performance, thus neglecting the increasingly pivotal role of sovereign digital capacity in influencing national innovation pathways. This article contends that the existing methods for assessing innovation have become theoretically inadequate, as they do not recognize the evolution of innovation from an economic activity to a strategic public capability. Drawing on innovation studies, public innovation theory, and research on digital sovereignty, the article formulates a conceptual framework that redefines digital sovereignty as an essential aspect of public innovation, rather than merely a geopolitical or regulatory aim. Through a comparative analysis of the national AI strategies of India, the European Union, the United States, and China, the paper illustrates that while these regions adopt different institutional models for AI development, each increasingly assesses innovation based on the state's ability to manage digital infrastructures, cultivate domestic technological capabilities, safeguard data ecosystems, and diminish strategic technological reliance. However, current innovation metrics are insufficiently equipped to reflect these institutional changes. Considering this, the article suggests a multidimensional framework for evaluating public innovation that includes four interrelated dimensions: technological capability, economic value generation, institutional capacity, and sovereign digital resilience. By integrating digital sovereignty into the theoretical foundations of innovation evaluation, the article contributes to innovation studies by expanding the conceptual understanding of innovation beyond technological performance and market success. It contends that evaluating innovation in the AI era requires recognising sovereignty not as an external policy outcome but as an intrinsic indicator of public innovation and long-term state capacity. In doing so, the article offers a theoretically grounded framework for rethinking how innovation is conceptualised and evaluated within an increasingly contested digital political economy.

Keywords: Innovation Evaluation; Digital Sovereignty; Public Innovation; Artificial Intelligence; National AI Strategies; Innovation Studies; Strategic Autonomy; Digital Political Economy.

Introduction

Artificial intelligence has revolutionized innovation, shifting it from being primarily an economic issue to a strategic tool of statecraft. While previous generations of innovation policy focused mainly on technological competitiveness, productivity enhancement, and industrial modernization, current national artificial intelligence strategies increasingly frame innovation within the larger context of digital autonomy, infrastructural resilience, data governance, and

geopolitical strength (Mazzucato, 2018; Edler and Fagerberg, 2017). Governments are no longer solely in competition to create superior technologies; they are now striving to assert sovereign control over the digital infrastructures that facilitate the production, deployment, and governance of innovation (Roberts et al., 2021; Couture and Toupin, 2019). As a result, artificial intelligence has evolved into a component of innovation policy, an industrial strategy, and a means of national sovereignty (Breznitz and Murphree, 2011; Roberts et al., 2021). This shift reveals a significant conceptual shortcoming in modern innovation studies. Conventional frameworks for assessing innovation tend to emphasize quantifiable technological outputs, such as research and development spending, patent creation, publication frequency, venture capital funding, startup ecosystems, and productivity improvements (OECD and Eurostat, 2018; Dziallas and Blind, 2019). While these metrics have certainly aided in understanding technological advancement within industrial economies, they fall short of capturing the evolving aims of innovation in a time when states are increasingly investing in artificial intelligence not just to enhance economic competitiveness but also to bolster strategic autonomy, institutional resilience, and digital governance capabilities (Mazzucato, 2018; Edler and Fagerberg, 2017). The evaluation of innovation remains predominantly focused on technological performance, even as innovation policy itself has become more preoccupied with issues of sovereignty (Roberts et al., 2021; Couture and Toupin, 2019).

The rise of national artificial intelligence strategies clearly reflects this conceptual transformation. The United States assesses its AI leadership mainly through advancements in technological research, innovation in the private sector, and superiority in computational capabilities (National Security Commission on Artificial Intelligence (NSCAI), 2021; Roberts et al., 2021). In contrast, the European Union increasingly views innovation through the lens of regulatory power, the establishment of trustworthy artificial intelligence, and the pursuit of strategic digital autonomy (European Commission, 2020; European Commission, 2024). China has woven artificial intelligence into a larger framework of technological self-sufficiency and state-led industrial modernization, where innovation is closely linked to national security and geopolitical power (State Council of the People's Republic of China, 2017; Breznitz and Murphree, 2011). Meanwhile, India has taken a different path by focusing on Digital Public Infrastructure, public digital platforms, and state-supported innovation ecosystems aimed at merging economic inclusion with independent technological capabilities (NITI Aayog, 2018; Ministry of Electronics and Information Technology, 2024). These varied strategies illustrate that innovation is no longer assessed solely based on technological progress; instead, nations are increasingly defining successful innovation by their capacity to maintain control over essential digital infrastructures, institutional capabilities, and governance frameworks (Edler and Fagerberg, 2017; Mazzucato, 2018). Despite these advancements, the field of innovation research has been relatively slow to incorporate sovereignty as a critical evaluative aspect of innovation itself. The existing body of literature has made significant contributions to the understanding of national innovation systems, mission-oriented innovation, responsible innovation, and the creation of public value (Freeman, 1987; Lundvall, 1992; Mazzucato, 2018; Stilgoe, Owen and Macnaghten, 2013; Benington and Moore, 2011). Likewise, the discourse surrounding digital sovereignty has grown significantly across political science, international relations, media studies, and digital governance (Couture and Toupin, 2019; Pohle and Thiel, 2020; Floridi, 2020). However, these two academic traditions have largely evolved independently. Innovation studies continue to focus on technological performance, while research on digital sovereignty primarily addresses issues related to regulatory authority, technological dependency, platform governance, and geopolitical rivalry (Dziallas and Blind, 2019; Couture and Toupin, 2019). Little attention has been directed

toward understanding whether sovereign digital capacity should itself constitute an innovation outcome capable of reshaping the theoretical foundations of innovation evaluation.

The absence of this consideration carries substantial theoretical implications. When innovation is perceived solely through the lens of technological capability and market competitiveness, states that invest in domestic cloud infrastructure, sovereign artificial intelligence models, semiconductor resilience, trusted digital identity systems, public data infrastructures, and national computational capacity seem to be merely enacting technology policy (OECD and Eurostat, 2018; Dziallas and Blind, 2019). This perspective obscures the reality that such investments also embody institutional innovations aimed at reshaping state capacity in the digital era (Mazzucato, 2018; Benington and Moore, 2011). Consequently, the analytical separation between technological innovation and institutional sovereignty becomes increasingly difficult to sustain (Kattel and Mazzucato, 2018; Edler and Fagerberg, 2017). Current AI strategies illustrate that governments innovate not only by developing new technologies but also by establishing new institutional capabilities that foster technological independence (Roberts et al., 2021; European Commission, 2024; Ministry of Electronics and Information Technology, 2024). This article contends that current frameworks for evaluating innovation have become theoretically inadequate, as they continue to emphasize technological and economic metrics while overlooking sovereign digital capacity as a crucial aspect of public innovation (Dziallas and Blind, 2019; Stilgoe, Owen and Macnaghten, 2013). The paper suggests that digital sovereignty should not merely be viewed as a geopolitical goal or regulatory ambition, but rather as an evaluative framework through which public innovation can be analyzed (Couture and Toupin, 2019; Pohle and Thiel, 2020). Sovereign digital capacity includes the institutional capability of states to manage critical digital infrastructures, regulate artificial intelligence, cultivate indigenous technological competencies, maintain strategic oversight of data ecosystems, and diminish structural technological reliance (Floridi, 2020; Roberts et al., 2021). These capabilities increasingly influence whether innovation enhances long-term public resilience rather than simply fostering short-term economic growth (Mazzucato, 2018; Benington and Moore, 2011).

The article articulates this argument through a conceptual and comparative examination of national artificial intelligence strategies implemented by India, the European Union, the United States, and China. Instead of utilizing traditional innovation rankings for comparison, the analysis focuses on how each jurisdiction interprets the interplay between artificial intelligence, state capacity, and digital sovereignty (Edler and Fagerberg, 2017; Floridi, 2020). This comparison reveals that, despite the differing institutional models adopted by these jurisdictions, they collectively signify a broader shift in the aims of innovation policy from technological competitiveness to sovereign capability (Mazzucato, 2018; Kattel and Mazzucato, 2018). Building on this analysis, the article proposes a multidimensional framework for assessing innovation that transcends mere technological performance. It suggests that innovation should be viewed through four interrelated dimensions: technological capability, economic value generation, institutional capacity, and sovereign digital resilience. By integrating the concept of sovereignty into the evaluation of innovation, the paper enhances the field of innovation studies by broadening the conceptual frameworks used to assess public innovation (Benington and Moore, 2011; Dziallas and Blind, 2019). More generally, it posits that future evaluations of innovation must consider not only the technologies that societies develop but also the institutional capacities that govern these technologies in the pursuit of democratic resilience, strategic autonomy, and enduring public value (Mazzucato, 2018; Stilgoe, Owen and Macnaghten, 2013).

Methodology

This article employs a conceptual theory-building research design that is rooted in qualitative doctrinal analysis and comparative institutional inquiry to investigate the evolving foundations of innovation evaluation in the context of artificial intelligence (Jaakkola, 2020; Gilson and Goldberg, 2015). Instead of assessing the effectiveness of national AI strategies or quantifying innovation outcomes through numerical indicators, the research aims to reconstruct the theoretical premises that support modern innovation evaluation. Thus, the study is explanatory and normative in nature rather than empirical (Jaakkola, 2020; MacInnis, 2011). It seeks to illustrate that current innovation evaluation frameworks are still fundamentally based on an economic perspective of innovation, even as state-led AI strategies increasingly emphasize digital sovereignty, institutional resilience, and strategic autonomy as key public goals (Edler and Fagerberg, 2017; Mazzucato, 2018). The article is positioned within the conceptual research tradition of innovation studies, where theoretical progress often arises from a critical reevaluation of prevailing analytical frameworks rather than from the generation of new empirical data (Jaakkola, 2020; Whetten, 1989). Significant contributions to innovation theory have traditionally stemmed from conceptual reinterpretations regarding the nature, purpose, and institutional structure of innovation, starting with Schumpeter's theory of creative destruction and extending through National Innovation Systems, evolutionary economics, mission-oriented innovation, and contemporary studies on responsible and public innovation. This tradition acknowledges that innovation is not a fixed empirical category but rather a socially constructed notion whose significance shifts in tandem with changes in political economy, technological advancement, and institutional governance (Edler and Fagerberg, 2017; Fagerberg, 2005). Consequently, the evaluation of innovation necessitates ongoing theoretical revision as the aims pursued through innovation evolve.

This conceptual framework is especially relevant in the realm of artificial intelligence. AI has significantly transformed the dynamics between technological advancement and state capacity. Modern governments are increasingly utilizing AI not only to boost productivity or foster economic growth but also to enhance public digital infrastructures, regulate key technologies, safeguard critical data ecosystems, and diminish technological reliance on foreign entities (Mazzucato, 2018; Roberts et al., 2021; European Commission, 2024). These changes indicate that the aims of innovation policy have broadened beyond traditional concerns regarding market competitiveness (Edler and Fagerberg, 2017; Kattel and Mazzucato, 2018). Nevertheless, despite these institutional shifts, the conceptual standards by which innovation is assessed remain largely static. Current evaluation frameworks still prioritize quantifiable outputs such as patents, research funding, startup creation, productivity improvements, and technological dissemination, while offering relatively little focus on the institutional capabilities through which states manage and support digital transformation (OECD and Eurostat, 2018; Dziallas and Blind, 2019). Consequently, this article seeks to address a conceptual rather than empirical void by questioning whether sovereign digital capacity should be acknowledged as a valid aspect of innovation assessment. In terms of methodology, the article utilizes comparative institutional analysis to explore how various jurisdictions interpret the connection between innovation and sovereignty within their national AI strategies (Schmidt, 2008; Hall and Taylor, 1996). The comparative analysis is not intended to rank national models or pinpoint institutional best practices. Rather, it serves as a heuristic tool for uncovering broader shifts in the goals of public innovation across diverse political and economic frameworks (Flyvbjerg, 2006). India, the European Union, the United States, and China exemplify distinct yet significant approaches to AI governance.

Each jurisdiction reflects a unique institutional logic of innovation: the United States focuses on technological leadership through market-oriented innovation ecosystems; the European Union emphasizes regulatory governance and strategic digital independence; China incorporates AI within a state-driven model of technological self-sufficiency and industrial policy; and India promotes a progressively distinctive model centred on Digital Public Infrastructure, inclusive innovation, and sovereign digital ecosystems. A comparative analysis of these jurisdictions allows the article to pinpoint converging trends that surpass their institutional disparities, specifically the growing integration of sovereign capability into national innovation strategies. The analytical framework established in this article also relies on interpretive institutionalism, which acknowledges that policy documents serve not only as administrative tools but also as reflections of the evolving state perceptions regarding technological advancement and public governance (Schmidt, 2008; Bevir and Rhodes, 2006). Consequently, national AI strategies are examined not merely as policy commitments but as normative expressions of what governments increasingly perceive innovation to signify. Instead of viewing these documents as indicators of policy success or failure, the analysis interprets them as representations of broader transformations in public innovation paradigms. This methodology enables the article to progress from a descriptive policy comparison to a theoretical explanation by identifying the shifting institutional meanings associated with innovation across various governance contexts. Additionally, the article embraces an interdisciplinary analytical approach by incorporating insights from innovation studies, political economy, public administration, and digital governance (Edler and Fagerberg, 2017; Benington and Moore, 2011).

Innovation studies offer a foundational conceptual vocabulary that has historically been used to assess innovation, encompassing Schumpeterian innovation theory, National Innovation Systems, evolutionary economics, and mission-oriented innovation (Schumpeter, 1934; Freeman, 1987; Lundvall, 1992; Nelson, 1993; Mazzucato, 2018). Research on public innovation provides valuable insights into state capacity, institutional learning, and the creation of public value (Benington and Moore, 2011; Hartley, Sørensen and Torfing, 2013), while studies on digital sovereignty highlight the increasing significance of strategic technological autonomy, governance of digital infrastructure, data sovereignty, and regulatory independence (Couture and Toupin, 2019; Floridi, 2020; Pohle and Thiel, 2020). By integrating these bodies of literature, the article seeks to fill a gap that none of them can adequately address in isolation. Innovation studies have largely neglected the aspect of sovereignty as an outcome of innovation. In contrast, research on digital sovereignty seldom examines how sovereignty influences the foundational concepts of innovation evaluation itself. Thus, the article embarks on a journey of conceptual synthesis (Jaakkola, 2020). Instead of introducing a completely new theory of innovation, it offers a critical reinterpretation of existing theoretical frameworks in the context of the contemporary changes brought about by artificial intelligence. This endeavor entails recognizing the conceptual gaps between traditional innovation evaluation frameworks and the new objectives evident in national AI strategies. While existing theories primarily view innovation through the lens of technological outputs and economic competitiveness, this article posits that AI governance increasingly emphasizes institutional autonomy and sovereign digital capability as equally important measures of successful public innovation. Therefore, the proposed framework enhances rather than dismisses existing innovation theory by adding sovereign digital capacity as an evaluative dimension alongside technological and economic performance.

This methodological framework inherently adopts a normative perspective. The article does not assert that all manifestations of digital sovereignty represent beneficial innovation, nor does it endorse specific geopolitical models of technological governance. Rather, it contends that the

assessment of innovation should accurately mirror the institutional objectives that are increasingly pursued through public innovation policies (Edler and Fagerberg, 2017; Mazzucato, 2018). If governments allocate resources towards AI infrastructures, digital public platforms, computational capabilities, semiconductor resilience, and data governance to enhance sovereign capacity rather than solely focusing on economic efficiency, then the frameworks for evaluating innovation should acknowledge these aims as valid aspects of innovation. The normative assertion presented here is thus conceptual rather than ideological: theories of innovation must adapt to reflect the evolving purposes of innovation itself. Consequently, the remainder of the article unfolds in four distinct stages. The first stage revisits the historical progression of innovation evaluation, tracing its roots from Schumpeterian economics to modern AI governance, to illustrate the persistent prevalence of economically driven evaluation frameworks. The second stage explores the rise of digital sovereignty within public policy, arguing that sovereign capability increasingly serves as an institutional goal of innovation rather than merely a geopolitical issue. The third stage conducts a comparative analysis of national AI strategies in India, the European Union, the United States, and China, demonstrating how various governance systems are progressively incorporating sovereignty into their innovation policies. Finally, the article formulates a multidimensional framework for assessing public innovation that integrates technological capability, economic value generation, institutional capacity, and sovereign digital resilience as interrelated dimensions of innovation in the age of AI.

Innovation Evaluation: From Schumpeter to Artificial Intelligence

The assessment of innovation has historically held a pivotal role in innovation studies, as the methods employed to measure innovation significantly influence the goals pursued by businesses, governmental bodies, and public institutions (Edler and Fagerberg, 2017; Dziallas and Blind, 2019). Innovation is not a neutral or self-evident term; its interpretation has consistently transformed in tandem with shifts in economic organization, technological advancements, and institutional governance (Fagerberg, 2005; Godin, 2015). As a result, the standards used to evaluate innovation have mirrored broader theoretical perspectives on economic development and societal transformation (Godin, 2015). While modern innovation policies increasingly tackle issues related to digital governance, technological independence, and state capacity, the dominant evaluation frameworks remain largely rooted in intellectual traditions that emphasize technological outputs and economic success (OECD and Eurostat, 2018; Edler and Fagerberg, 2017). This historical persistence has led to an expanding gap between the objectives that innovation policies aim to achieve and the indicators of successful innovation recognized by innovation studies. The theoretical underpinnings of innovation evaluation are often linked to the contributions of Joseph Schumpeter, whose economic development theory fundamentally reshaped the comprehension of technological change (Schumpeter, 1934; Schumpeter, 1942). By rejecting the neoclassical notion of equilibrium, Schumpeter framed innovation as the essential mechanism through which capitalist economies experience structural transformation (Schumpeter, 1934). Innovation was perceived not solely as technological invention but as the market introduction of new products, production methods, organizational structures, markets, and supply sources that disrupted existing economic frameworks through the process of creative destruction (Schumpeter, 1934; Schumpeter, 1942). In this context, innovation gained its importance as it fostered economic growth by perpetually reorganizing productive capacity and establishing new competitive advantages.

Consequently, evaluation became intrinsically linked to economic transformation, with technological innovation gaining significance primarily through its impact on productivity,

industrial competitiveness, and market growth (Fagerberg, 2005). While later advancements in innovation studies greatly expanded the institutional perspective on innovation, they preserved Schumpeter's fundamental premise that innovation should ultimately be assessed based on its contribution to economic outcomes (Freeman, 1987; Lundvall, 1992). The introduction of the National Innovation Systems (NIS) framework in the late twentieth century marked a notable shift away from exclusively firm-focused theories of innovation. Researchers such as Christopher Freeman, Bengt-Åke Lundvall, and Richard Nelson illustrated that innovation arises not merely from entrepreneurial efforts but from the interactions among universities, governmental bodies, research institutions, financial systems, and industrial participants functioning within nationally embedded institutional contexts (Freeman, 1987; Lundvall, 1992; Nelson, 1993). Thus, innovation was reconceptualized as a systemic process rather than an individual one. However, despite the analytical shift towards institutions, the primary criteria for evaluating innovation largely remained consistent. National innovation systems continued to be evaluated based on research intensity, technological capability, industrial competitiveness, patent generation, and knowledge dissemination, thereby reinforcing an economic perspective of innovation even as it adopted a more institutional focus (Lundvall, 1992; Nelson, 1993). This perspective became further institutionalized through global innovation measurement frameworks. The OECD's Oslo Manual, along with innovation indices created by the World Intellectual Property Organization, the World Bank, and other international entities, offered increasingly refined tools for assessing innovation across different nations (OECD and Eurostat, 2018; Dziallas and Blind, 2019).

These frameworks have significantly enhanced the comparability and empirical assessment of innovation by integrating indicators related to research investment, technological diffusion, organizational innovation, and knowledge production. However, their conceptual framework has remained largely economic in nature. Innovation has continued to be viewed as an activity that produces quantifiable enhancements in productivity, competitiveness, firm performance, and economic growth (Fagerberg, 2005; Edler and Fagerberg, 2017). Institutional quality has been incorporated into these frameworks primarily as a facilitating factor for innovation, rather than as an outcome of innovation that warrants independent assessment. The acknowledgement of the shortcomings of market-centric innovation evaluation led to several crucial theoretical advancements in the early twenty-first century. Investigations into public innovation have contested the notion that innovation is predominantly a product of private entrepreneurial efforts, revealing that governments act as proactive innovators rather than merely passive regulators of technological progress. Scholars in public administration have increasingly contended that innovation within the public sector ought to be assessed based on enhancements in governance capacity, public service delivery, democratic engagement, and institutional learning, rather than solely on commercial profitability (Hartley, Sørensen and Torfing, 2013; Moore, 1995). In a similar vein, mission-oriented innovation, notably promoted by Mariana Mazzucato, has redefined innovation as a collective societal effort aimed at addressing intricate public challenges through coordinated state intervention Mazzucato, 2018; Kattel and Mazzucato, 2018). As a result, innovation has come to be linked not only with technological progress but also with the state's ability to mobilize institutions towards long-term societal goals.

The recent developments have notably broadened the understanding of innovation's purposes; however, they have maintained a crucial conceptual distinction between innovation and governance. Public institutions are increasingly acknowledged as key players within innovation ecosystems, yet the evaluation of innovation continues to focus predominantly on the technological or economic results facilitated by public intervention. Aspects such as governance capacity, institutional resilience, and regulatory effectiveness are typically regarded as

supportive conditions that enhance innovation, rather than being seen as forms of innovation themselves. As a result, the institutional transformation of the state has remained conceptually secondary to the evaluation of innovation, even as governments have taken on greater responsibilities in directing technological progress. The rise of responsible innovation has further advanced this trajectory by addressing escalating concerns about the social and ethical implications of swift technological progress. Responsible innovation has redirected analytical focus from mere technological outputs to aspects such as anticipation, inclusion, reflexivity, and responsiveness within the innovation processes (Stilgoe, Owen and Macnaghten, 2013; Owen, Bessant and Heintz, 2013). Consequently, innovation can no longer be assessed solely based on economic achievements; it increasingly necessitates an evaluation of societal acceptability, ethical legitimacy, environmental sustainability, and democratic engagement (Stilgoe, Owen and Macnaghten, 2013). This shift signifies a significant normative broadening of innovation evaluation, recognizing that technological advancement must be judged against wider public values rather than market success alone. Nonetheless, responsible innovation has primarily aimed to enhance the governance of innovation rather than to reevaluate the conceptual underpinnings of innovation itself. While ethical governance has emerged as an additional evaluative standard, innovation continues to be fundamentally linked to technological development.

The swift proliferation of artificial intelligence (AI) has highlighted significant shortcomings in traditional frameworks for evaluating innovation. Unlike many previous technological advancements, AI functions simultaneously as a general-purpose technology, a critical infrastructure, and an increasingly important geopolitical asset (Calvino, Haerle and Liu, 2025; Srivastava and Bullock, 2024). Governments are therefore increasingly directing investment towards AI not only to enhance economic productivity, but also to strengthen national security, develop sovereign computational infrastructures, safeguard strategic data resources, regulate digital markets, modernise public administration, and reduce dependence on foreign technology platforms (UNCTAD, 2025; OECD, 2025). Consequently, AI is redefining innovation as an instrument for building institutional capability rather than merely as a means of achieving technological progress.

Assessing AI innovation solely through indicators such as patents, scientific publications, start-up activity, or productivity gains therefore provides only a partial perspective on the objectives that contemporary governments increasingly seek to achieve. Although such indicators remain important measures of technological and economic performance, the general-purpose and infrastructural characteristics of AI require broader approaches to assessing national capabilities (Calvino, Haerle and Liu, 2025; OECD, 2026). Recent efforts to develop more comprehensive AI measurement frameworks similarly recognise the importance of infrastructure, policy implementation, skills, research and development, and broader national AI capabilities alongside conventional innovation indicators (OECD, 2026).

National AI strategies exemplify this conceptual shift. Across different political and institutional systems, governments are increasingly concerned with developing trusted digital infrastructures, expanding domestic computing capacity, strengthening semiconductor and AI supply-chain resilience, securing critical data ecosystems, and retaining regulatory authority over emerging technologies (UNCTAD, 2025; OECD, 2025). AI infrastructure itself is becoming a strategic policy concern because advanced AI development depends upon access to computing resources, semiconductors, data centres, networks, and related physical infrastructure (OECD, 2025). Similarly, emerging debates on digital and AI sovereignty emphasise the capacity of states to

exercise meaningful control over the infrastructures and technological systems on which their economies and public institutions increasingly depend (Srivastava and Bullock, 2024).

These objectives transcend traditional conceptions of technological competitiveness because they concern the institutional and infrastructural conditions necessary to sustain innovation over time. In this context, innovation can increasingly be understood as the development of public capabilities that enable states to maintain strategic autonomy within digitally interconnected economies (Ding, 2022; UNCTAD, 2025). This perspective is particularly relevant because AI development depends not only on technological invention but also on the coordination of infrastructure, data, skills, institutions, and policy capabilities. UNCTAD (2025), for example, identifies infrastructure, data, and skills as critical leverage points for national AI readiness and emphasises the need to align AI strategies with broader industrial, science, technology and innovation policies.

However, existing frameworks for evaluating innovation still tend to prioritise technological and economic indicators that originated in earlier phases of industrial development. Patent counts, publication output, venture-capital activity, and productivity measures capture important dimensions of innovation, but they do not fully capture a state's ability to build and sustain the infrastructures, regulatory capabilities, computational resources, and strategic autonomy required for AI development (Hötte et al., 2022; OECD, 2026). The emergence of AI therefore calls for a broader conception of innovation in which institutional capacity, infrastructural resilience, technological sovereignty, and strategic autonomy are considered not merely as conditions surrounding innovation, but also as potential outcomes of innovation itself.

This conceptual delay indicates a more profound theoretical premise inherent in innovation studies: namely, that innovation has traditionally been understood primarily as an economic phenomenon whose value is derived largely from its contribution to productivity, economic growth, and competitiveness (Schumpeter, 1934; Freeman, 1987; Lundvall, 1992). Although this perspective has been highly productive in explaining technological change and economic development, it becomes increasingly insufficient as technological systems themselves become essential infrastructures of governance. Artificial intelligence complicates the conventional separation between technological innovation and institutional capability because its effective development and deployment increasingly depend upon institutional capacities for data governance, digital infrastructure, skills development, regulation, investment, and public-sector coordination (OECD, 2025; OECD, 2026). Consequently, innovation can no longer be understood exclusively in terms of technological artefacts; it must also be considered in relation to the institutional arrangements and public capabilities that enable those technologies to be developed, implemented, governed, and sustained.

The preceding analysis indicates that innovation studies have progressively broadened their conception of innovation, moving beyond a narrow emphasis on entrepreneurial activity and technological outputs towards systemic interactions, institutional conditions, public value, and responsible governance (Lundvall, 1992; Kattel and Mazzucato, 2018; OECD, 2022). The innovation systems literature, for example, demonstrates that innovation emerges from interactions among firms, governments, research organisations, infrastructures, institutions, and wider socio-economic structures rather than from isolated technological invention (Freeman, 1987; Lundvall, 1992). Similarly, research on public-sector innovation increasingly recognises that governments require organisational capabilities, resources, skills, institutional arrangements, and enabling environments to generate and sustain innovative outcomes (Kaur et al., 2022; OECD, 2024). Nevertheless, one important dimension remains comparatively

underdeveloped: the systematic incorporation of sovereign digital capacity into the evaluation of innovation itself.

This gap becomes increasingly significant as states invest in AI infrastructures not only to achieve technological or economic advantages, but also to strengthen institutional autonomy and resilience within an increasingly contested digital political economy. Contemporary AI governance depends upon access to reliable data, computational infrastructure, digital skills, investment capacity, procurement systems, regulatory institutions, and mechanisms of accountability (OECD, 2025). These capabilities are not merely external conditions surrounding innovation; they can themselves constitute durable public capacities through which innovation is enabled, scaled, governed, and sustained. The OECD's recent work on government innovation similarly emphasises that innovation requires institutional capacities and must become embedded within the systems, rules, processes, and mechanisms through which government operates (Kaur et al., 2022). More recent assessments of digital government further demonstrate that digital infrastructure, data governance, institutional capabilities, and AI governance are becoming core components of state capacity rather than peripheral technological concerns (OECD, 2026).

Therefore, the assessment of innovation should move beyond narrowly technological and economic metrics towards a more comprehensive understanding of public capability. Such an approach would incorporate the institutional capacities through which digital transformation is governed, including the ability to manage strategic data, maintain critical digital infrastructure, develop computational capabilities, regulate emerging technologies, and preserve meaningful institutional control over essential digital systems (OECD, 2025; OECD, 2026). This does not imply that conventional indicators such as patents, publications, productivity, or entrepreneurial activity should be abandoned. Rather, it suggests that these measures should be complemented by indicators capturing the institutional capabilities that allow states to translate technological innovation into sustainable public and strategic outcomes.

It is precisely within this theoretical context that the concept of digital sovereignty gains analytical significance. Digital sovereignty is increasingly concerned with the capacity of states and public institutions to retain meaningful control over critical digital infrastructures, technologies, data, and governance arrangements rather than becoming structurally dependent upon external technological systems. From this perspective, digital sovereignty should not be treated exclusively as an external geopolitical objective or a security-oriented policy concern. It can also be conceptualised as an institutional expression of public innovation: the capacity of public institutions to develop, govern, and sustain the technological foundations required for autonomous and resilient digital transformation. Such an interpretation extends existing approaches to innovation by treating institutional autonomy and sovereign digital capacity as potential dimensions of innovative capability rather than merely as contextual conditions.

The theoretical implication is therefore significant. If innovation is understood as a process through which societies develop new capabilities to address economic, social, and institutional challenges, then the creation of sovereign digital capabilities may itself constitute an innovative outcome. States that develop trusted digital infrastructures, resilient computational ecosystems, strategic data capabilities, and effective regulatory institutions are not simply adopting innovations produced elsewhere; they are developing the institutional capacity required to shape, govern, and sustain technological transformation (OECD, 2024; OECD, 2025). Recognising this dimension consequently reorients the foundations of innovation evaluation from a predominantly output-oriented model towards one that also considers capability,

resilience, institutional autonomy, and long-term strategic capacity. The following section develops this argument by examining digital sovereignty as a distinctive paradigm of public innovation and by considering how the recognition of sovereign digital capacity can broaden the theoretical foundations of innovation evaluation.

Digital Sovereignty as Public Innovation

The conceptual development of innovation illustrates that its assessment has gradually broadened from a narrow focus on technological invention towards systemic interactions, the creation of public value, and responsible governance (Freeman, 1987; Lundvall, 1992; Kattel and Mazzucato, 2018). However, the preceding analysis indicates that innovation research continues to place substantial emphasis on technological capability, productivity, and economic performance as primary evaluative criteria. The emergence of artificial intelligence (AI), however, is transforming the institutional objectives pursued through innovation policy. Governments are increasingly investing in AI not only to enhance productivity and industrial competitiveness, but also to develop and maintain control over the digital infrastructures that underpin economic activity, public administration, and wider systems of governance (OECD, 2025; OECD, 2026). AI therefore contributes to an institutional reconfiguration of innovation in which sovereign digital capacity increasingly constitutes a significant public policy objective.

The central argument advanced in this article is that this transformation cannot be fully captured by existing frameworks of innovation evaluation because these frameworks generally treat sovereignty as an external political or institutional condition rather than as a potential outcome of innovation itself. This distinction becomes increasingly problematic as technological infrastructures acquire strategic significance. Digital infrastructure, data resources, computing capacity, semiconductor supply chains, and cloud systems increasingly determine the capacity of governments and societies to participate effectively in the digital economy (OECD, 2025). Consequently, the question of who controls, governs, and maintains these capabilities is no longer separable from the question of how innovation capacity is created and sustained.

Over the last decade, digital sovereignty has emerged as an increasingly important concept in debates surrounding digital governance, strategic autonomy, technological dependence, and geopolitical power. Although the concept remains contested and lacks a universally accepted definition, much of the literature associates digital sovereignty with the capacity of political communities to exercise meaningful control over critical digital infrastructures, data, technologies, standards, and regulatory arrangements (Madiega, 2020; Pohle, 2020). Digital sovereignty therefore differs from traditional conceptions of territorial sovereignty because it is exercised within transnational technological ecosystems characterised by platform interdependence, global supply chains, cross-border data flows, and privately controlled digital infrastructures. Sovereignty in the digital era consequently does not necessarily imply technological isolation or complete self-sufficiency; rather, it concerns the capacity to participate in global technological networks while retaining meaningful strategic autonomy over critical digital capabilities (European Parliament, 2020; European Commission, 2026).

Existing studies can broadly be organised around three analytical perspectives. The first conceptualises digital sovereignty primarily as regulatory autonomy. From this perspective, sovereignty concerns the capacity of states to establish and enforce rules governing digital markets, data, artificial intelligence, cybersecurity, privacy, and cross-border digital activities. The European Union provides an important example of this approach. Its digital policy agenda has sought to strengthen European strategic autonomy through regulation, standards, data

governance, and market rules, thereby allowing the EU to exercise influence over global technological development despite its comparatively limited position in some segments of the global technology industry (Madiega, 2020; European Commission, 2026). Digital sovereignty in this context is therefore closely connected to the capacity to shape the institutional rules governing digital technologies rather than simply to their domestic production.

The second perspective interprets digital sovereignty as technological and infrastructural self-reliance. This approach focuses on domestic capabilities in areas such as semiconductor manufacturing, cloud computing, artificial intelligence research, telecommunications, data centres, and other critical technological infrastructures. Such concerns have become particularly visible in China's technology strategy, where technological capability, industrial policy, supply-chain resilience, and national security have increasingly become interconnected policy objectives. China's efforts to strengthen domestic semiconductor capabilities, for example, have been reinforced by international restrictions on advanced semiconductor technologies, accelerating policy efforts towards technological localisation and supply-chain resilience (Shivakumar, Wessner and Howell, 2026). In this perspective, digital sovereignty is closely associated with the capacity to reduce strategically significant technological dependencies and maintain domestic capabilities across critical layers of the digital stack.

The third perspective frames digital sovereignty through digital public infrastructure (DPI). Rather than prioritising complete technological self-sufficiency, this approach emphasises the development of open, interoperable, and publicly governed digital systems that enable broad participation while reducing dependence on proprietary platforms. India's digital public infrastructure model provides an important illustration of this approach, particularly through interoperable systems for digital identity, payments, and data exchange. DPI can therefore be understood not merely as a mechanism for delivering digital public services, but as an institutional infrastructure capable of supporting innovation, inclusion, and state capacity while preserving greater public control over essential digital systems (Chatham House, 2025). This perspective is particularly important for developing economies because it demonstrates that digital sovereignty can be pursued through interoperable public infrastructures rather than through complete technological autarky.

Despite these contributions, research on digital sovereignty has remained comparatively disconnected from mainstream innovation theory. Existing studies have primarily examined sovereignty as a regulatory objective, geopolitical strategy, technological-security concern, or governance framework, rather than systematically examining its implications for how innovation itself should be conceptualised and evaluated (Madiega, 2020; Pohle, 2020). Conversely, innovation research has generally continued to evaluate innovative capacity through technological outputs, research and development intensity, entrepreneurial activity, productivity, and economic competitiveness (Freeman, 1987; Lundvall, 1992). Within this framework, sovereignty tends to appear as an external institutional condition that can facilitate or constrain innovation rather than as a potential outcome of innovation.

This separation reflects a broader disciplinary divide. Innovation has traditionally been analysed through the economics and sociology of technological change, while sovereignty has predominantly been examined through political science, international relations, law, and security studies. The rise of AI increasingly makes this separation analytically difficult to sustain because technological capability and institutional autonomy are becoming mutually dependent dimensions of public capability. AI is not simply an individual technological product; it is increasingly embedded within extensive infrastructures and supply chains whose control has

implications for economic and political power. Advanced AI development depends upon access to computational resources, advanced semiconductors, data centres, energy systems, cloud infrastructure, high-capacity networks, datasets, digital platforms, and regulatory institutions capable of governing increasingly complex algorithmic ecosystems (OECD, 2025; OECD, 2026). The OECD consequently identifies AI compute as a strategic national-capacity issue, noting that countries increasingly need to align compute capacity with national AI strategies and domestic requirements (OECD, 2026).

These infrastructures should therefore not be understood merely as technological inputs into innovation. They also embody the institutional, organisational, and infrastructural capabilities through which innovation becomes possible, scalable, governable, and sustainable. Control over compute, data, digital infrastructure, and critical technology supply chains can influence a state's capacity to develop and deploy AI independently, while regulatory and institutional capabilities determine how these technologies are incorporated into public and economic systems. Recent scholarship on AI infrastructure sovereignty similarly argues that meaningful AI sovereignty increasingly depends upon operational control over the physical infrastructures that support AI systems, including data centres, networks, and energy systems (Cruzes, 2026). This reinforces the broader theoretical proposition advanced here: as AI becomes increasingly infrastructure-dependent, the boundaries between technological innovation and sovereign institutional capacity become progressively less distinct.

Accordingly, the emerging relationship between AI and digital sovereignty creates a theoretical opportunity for innovation studies. Rather than treating sovereign digital capacity solely as an external condition that shapes innovation performance, it can be conceptualised as a potential dimension and outcome of public innovation. A state that develops resilient computing infrastructure, secure data ecosystems, interoperable public digital systems, domestic technological capabilities, and effective regulatory institutions is not merely creating favourable conditions for innovation; it is generating new institutional capabilities through which technological transformation can be governed and sustained. The analytical challenge, therefore, is to extend innovation evaluation beyond conventional measures of technological and economic output and towards the institutional capabilities that determine whether societies can retain meaningful agency over the technologies on which their future development increasingly depends.

As a result, governments that invest in sovereign computational infrastructure, reliable public data systems, domestic semiconductor capabilities, or interoperable digital public platforms are not merely facilitating technological innovation; they are also engaging in forms of institutional innovation that can alter the state's capacity to participate in and shape the digital political economy. Understanding digital sovereignty as a form of public innovation therefore requires a reconceptualisation of the relationship between technological advancement and state capacity. Research on public-sector innovation has increasingly challenged the assumption that governments function primarily as regulators or adopters of innovations generated externally. Instead, the state can act as an active producer and shaper of innovation by creating institutional arrangements, infrastructures, policies, and capabilities that influence the conditions under which technological development occurs (Kattel and Mazzucato, 2018; OECD, 2022). Public innovation is consequently concerned not only with improvements in administrative efficiency or service delivery, but also with the development of new institutional capabilities through which governments can respond to complex and evolving societal challenges (Kaur et al., 2022).

The emergence of artificial intelligence significantly strengthens this perspective. States are no longer innovating exclusively through improvements in public-service delivery, administrative processes, or digital government platforms; they are increasingly developing the technological and institutional infrastructures required to govern AI and sustain long-term national capabilities. Investments in computing infrastructure, data ecosystems, digital public infrastructure, semiconductor capacity, cybersecurity, and AI skills can therefore be interpreted as efforts to build the institutional foundations through which technological transformation can be governed and sustained (OECD, 2025; OECD, 2026). From this perspective, digital sovereignty can be understood as a form of institutional innovation through which governments reorganise and strengthen public capabilities within increasingly digitally mediated societies.

This perspective also requires a broader interpretation of public value. Public innovation literature has traditionally associated public value with improvements in service quality, administrative responsiveness, citizen participation, policy effectiveness, and the capacity of public institutions to address societal needs (Moore, 1995; Bason, 2018). While these objectives remain important, the growing strategic significance of AI introduces additional dimensions of public value, including technological resilience, strategic autonomy, cybersecurity, infrastructural reliability, and the capacity to reduce critical technological dependencies. The management of AI increasingly depends upon governments' ability to establish reliable digital infrastructures, maintain technological expertise, govern data, regulate digital markets, and exercise institutional authority over essential technological systems (OECD, 2025). These capabilities can generate public value not only through economic performance and improved public services, but also through strengthening the resilience and autonomy of public institutions.

The reconceptualisation of digital sovereignty as a dimension of public innovation has important implications for the evaluation of innovation. Conventional innovation metrics tend to emphasise measurable outputs such as patents, research and development expenditure, scientific publications, start-up formation, venture-capital investment, and productivity growth. These indicators remain important for assessing technological and economic performance, but they provide only a partial representation of contemporary public innovation (OECD, 2026). A state may make substantial progress in developing sovereign digital capabilities while demonstrating relatively modest performance according to conventional innovation rankings. Investments in sovereign cloud infrastructure, interoperable digital identity systems, national AI computing facilities, public data exchanges, cybersecurity capabilities, and semiconductor resilience can generate institutional capacities that are not adequately captured by conventional measures of innovation.

Evaluating innovation exclusively through technological and economic outputs therefore risks understating the significance of institutional transformation. Recognising digital sovereignty as a form of public innovation does not require abandoning established economic approaches to innovation. Rather, it extends them by acknowledging that technological capabilities increasingly depend upon institutional structures capable of supporting, governing, and sustaining technological development over the long term. Innovation and sovereignty can consequently be conceptualised as mutually reinforcing rather than analytically separate processes. Sovereign digital capacity can strengthen innovation by reducing critical technological dependencies, supporting long-term public investment in essential infrastructures, strengthening regulatory and institutional capabilities, and enabling governments to pursue technological development in accordance with publicly defined policy objectives. Conversely, innovation can strengthen sovereignty by expanding domestic technological competencies, generating institutional

learning, developing specialised skills, and enhancing the governance capabilities of the public sector (Kattel and Mazzucato, 2018; OECD, 2024).

The relationship is therefore recursive rather than hierarchical: innovation can strengthen sovereign capacity, while sovereign capacity increasingly influences the conditions under which innovation can be developed, adopted, and sustained. This reciprocal relationship suggests a broader theoretical evolution in the meaning of innovation itself. Traditionally, innovation has been associated with technological novelty, entrepreneurial activity, systemic interactions, and the creation of economic or public value (Schumpeter, 1934; Freeman, 1987; Lundvall, 1992). The emergence of AI signals a further stage in this conceptual development by demonstrating that innovation increasingly concerns the institutional capacities through which societies govern technological change. The object of innovation is consequently no longer limited to products, markets, or production systems; it increasingly encompasses the infrastructures, institutions, and governance arrangements that structure digitally mediated societies.

Digital sovereignty can therefore be conceptualised not merely as an additional policy objective, but as a potential institutional expression of public innovation through which states develop resilient technological and governance capabilities. The theoretical implication is that innovation studies should move beyond assessing only the technologies that societies produce and adopt towards greater consideration of the institutional capabilities through which those technologies are governed, sustained, and strategically controlled. Within this broader framework, sovereign digital capacity can be proposed as a distinct dimension of innovation evaluation because it captures a state's capacity to support technological development, maintain strategic autonomy, build institutional resilience, and generate enduring public value in increasingly contested digital environments.

This reconceptualisation does not replace established technological and economic indicators; rather, it complements them by incorporating institutional resilience and sovereign capability into the evaluation of innovation. A more comprehensive framework would therefore evaluate innovation across multiple dimensions, including technological performance, economic value, public value, institutional capability, and sovereign digital capacity. Such an approach recognises that, in the context of AI, the ability to innovate increasingly depends upon the ability to govern the infrastructures through which innovation is produced and deployed.

The subsequent section develops this theoretical proposition through a comparative analysis of national AI strategies in India, the European Union, the United States, and China. Rather than comparing technological performance alone, the analysis examines how these cases frame AI innovation through different configurations of sovereign capability, including regulatory autonomy, technological capacity, infrastructural resilience, data governance, and public digital infrastructure. Despite substantial differences in political institutions, economic structures, and technological capabilities, the cases demonstrate a common tendency: contemporary public innovation increasingly extends beyond technological competitiveness towards the development of resilient digital governance capabilities. These patterns provide an empirical basis for examining the proposition that digital sovereignty has become an increasingly important, yet insufficiently recognised, dimension of innovation evaluation.

Comparative Analysis: National AI Strategies and the Emergence of Sovereign Public Innovation

The previous sections have argued that the evaluation of innovation has traditionally privileged technological performance and economic competitiveness while giving comparatively limited attention to the institutional capabilities through which technological development is governed. If digital sovereignty has emerged as an important dimension of public innovation, this transformation should be observable in contemporary national AI strategies. Rather than treating artificial intelligence solely as a technological sector, governments increasingly employ AI policy to strengthen strategic autonomy, protect critical digital infrastructures, develop domestic technological capabilities, and enhance state capacity (OECD, 2025; OECD, 2026). A comparative examination of the AI strategies of India, the European Union, the United States, and China reveals that, despite substantial differences in political systems, economic structures, and regulatory approaches, all four cases increasingly situate AI innovation within broader institutional frameworks associated with national capability and strategic autonomy. These developments provide empirical support for the article's central proposition that innovation evaluation requires a theoretical expansion beyond conventional technological and economic indicators.

Although the four jurisdictions pursue different governance models, they increasingly recognise that AI constitutes critical infrastructure for economic competitiveness, public administration, national security, and geopolitical influence. Consequently, innovation policy is expanding beyond research and technological development to incorporate data governance, computational infrastructure, semiconductor resilience, cybersecurity, digital public infrastructure, regulatory capacity, workforce development, and international technological cooperation. The contemporary policy landscape therefore suggests a shift in the object of innovation policy: innovation is increasingly concerned not only with the technological outputs generated within an economy, but also with the state's capacity to organise, govern, and sustain the technological ecosystems through which those outputs become possible. This development is particularly visible in national AI strategies that explicitly connect technological development with infrastructure, security, resilience, and strategic autonomy (OECD, 2025; OECD, 2026).

India: Digital Public Infrastructure and Inclusive Sovereign Innovation

India exemplifies a distinctive model of sovereign public innovation in contemporary AI policy, centred less on technological self-sufficiency alone than on the development of Digital Public Infrastructure (DPI) and inclusive digital ecosystems. The country's digital transformation has been built around systems including Aadhaar, the Unified Payments Interface (UPI), DigiLocker, Account Aggregator, and the Open Network for Digital Commerce (ONDC), while the IndiaAI Mission extends this infrastructural approach into artificial intelligence. These initiatives illustrate an institutional conception of innovation in which the state acts not simply as a regulator or purchaser of technology but as an architect of interoperable digital ecosystems. DigiLocker, for example, provides a government-backed digital platform for storing and sharing official documents, while the broader DPI approach creates common digital infrastructure upon which public and private actors can build services (Government of India, 2026).

The significance of this model extends beyond digital service delivery. India's DPI architecture can be interpreted as institutional innovation because it reorganises relationships among citizens, markets, and public institutions through interoperable digital systems. Shared digital infrastructure can reduce transaction costs, facilitate interoperability, broaden access to services, and create common technological foundations upon which private-sector innovation can develop. In this respect, public infrastructure does not merely support innovation after it has occurred; it helps construct the institutional environment in which innovation becomes possible.

India's evolving AI strategy reinforces this institutional orientation. The IndiaAI Mission, approved in 2024, is organised around seven pillars covering compute capacity, foundation models, datasets, application development, future skills, start-up financing, and safe and trusted AI. The government's current implementation describes the mission explicitly in terms of developing domestic AI capacity and technological sovereignty. By 2026, IndiaAI reported the establishment of substantial AI compute capacity, the development of AIKosh as a national dataset and model platform, and initiatives supporting indigenous foundation models and AI skills (MeitY, 2026).

The Indian case therefore illustrates a form of sovereign innovation in which technological advancement is pursued through the construction of public digital capabilities. Sovereignty is not expressed primarily through technological isolation, but through the creation of domestic, interoperable, and publicly governed infrastructures that reduce dependence on external technological ecosystems while enabling broad participation in digital innovation. India's experience consequently supports the proposition that public innovation increasingly resides not only in technological products but also in the creation of institutional infrastructures capable of sustaining technological development over the long term.

European Union: Regulatory Sovereignty as Innovation Capacity

The European Union represents a different but equally significant model of sovereign public innovation in which regulatory and institutional capacity constitutes a central component of technological strategy. Compared with the United States and China, the EU has historically possessed less influence over leading global digital platforms and frontier AI firms. Nevertheless, it has sought to exercise influence over the development of digital technologies through regulatory frameworks, standards, market rules, and institutional coordination. The General Data Protection Regulation (GDPR), Digital Markets Act, Digital Services Act, Data Governance Act, AI Act, and Digital Decade framework collectively illustrate an approach in which governance capacity is treated as an important component of Europe's digital strategy (European Commission, 2026).

The EU's AI Act is particularly significant because it demonstrates how regulation can function simultaneously as a governance mechanism and an innovation-enabling framework. The legislation establishes a risk-based regulatory system intended to protect fundamental rights, safety, and democratic institutions while providing legal certainty for AI developers and users. The European Commission explicitly presents the AI framework as part of a wider policy package designed to support trustworthy AI, investment, adoption, and innovation (European Commission, 2026).

This regulatory approach has increasingly been complemented by investments in technological and infrastructural capacity. The EU's 2026 Technological Sovereignty Package includes initiatives concerning semiconductors, cloud infrastructure, AI, and open-source technologies, while the proposed Cloud and AI Development Act explicitly links AI capacity with European sovereignty, competitiveness, infrastructure, and reduced dependence on non-EU cloud providers (European Commission, 2026). The 2026 Digital Decade assessment likewise identifies technological sovereignty, computing capacity, digital infrastructure, and strategic dependencies as central components of Europe's digital transformation agenda.

The European experience therefore demonstrates that sovereign innovation need not depend primarily upon domestic technological dominance or the possession of globally dominant technology companies. It can also emerge through the capacity to establish regulatory and

institutional arrangements that shape technological development. Conventional innovation indicators may capture Europe's research, entrepreneurial, and technological performance, but they do not fully capture the influence generated through regulatory capacity and institutional rule-setting. From the perspective developed in this article, this regulatory capability constitutes an important form of public innovation because it establishes the institutional conditions under which AI and digital technologies are developed and deployed.

United States: Technological Leadership and Strategic Innovation

The United States has traditionally represented a model of innovation centred on technological entrepreneurship, scientific excellence, venture capital, private-sector dynamism, and globally competitive firms. Silicon Valley and the wider American technology ecosystem exemplify this model, while federal investment in universities, basic research, defence technology, and scientific infrastructure has historically complemented private-sector innovation. Conventional innovation metrics therefore tend to capture many of the characteristics of the American model through indicators such as patents, scientific publications, start-up formation, venture investment, and market performance.

However, contemporary U.S. AI policy increasingly demonstrates that technological leadership depends upon public institutional capabilities as well. The National Artificial Intelligence Initiative Act established a coordinated federal framework for AI research, development, standards, education, and workforce preparation, explicitly recognising the federal government's role in coordinating public, academic, and private resources (U.S. Congress, 2020). The National Artificial Intelligence Research Resource (NAIRR) provides a particularly clear example of this shift: it creates national research infrastructure through which researchers can access computing, software, data, models, and expertise necessary for AI research and development (NSF, 2026).

Semiconductor and supply-chain policy further demonstrates the increasing convergence of innovation and strategic capability. The CHIPS and Science Act linked semiconductor research, manufacturing, workforce development, and supply-chain resilience to American technological leadership. More recent U.S. policy has continued to connect semiconductor capacity directly with economic and national security. In January 2026, for example, the U.S. government described domestic semiconductor production and manufacturing capacity as critical to economic and national security and introduced measures intended to reduce dependence on foreign sources and supply chains (White House, 2026).

AI policy itself has similarly become increasingly connected to critical infrastructure and national security. A June 2026 White House executive action described AI innovation as central to cybersecurity, critical-infrastructure protection, and continued U.S. leadership, while subsequent national-security policy defined the AI technology stack to include chips, servers, accelerators, data-centre storage, cloud services, networking, data pipelines, models, and cybersecurity systems (White House, 2026).

The American case therefore illustrates a model in which sovereignty is expressed through technological leadership and the strategic capacity to maintain critical positions across the AI value chain. Unlike the European model, where regulatory capacity is particularly prominent, the U.S. approach places greater emphasis on technological leadership, private-sector dynamism, research infrastructure, semiconductor capacity, and national-security capabilities. Nevertheless, both cases reveal the same broader transformation: technological innovation

increasingly requires institutional capabilities that extend beyond conventional measures of commercial and scientific performance.

China: State Capacity and Technological Self-Reliance

China represents the most explicit integration of AI innovation with state capacity and technological self-reliance among the cases examined here. Its approach places artificial intelligence within a broader national development strategy that connects technological innovation, industrial policy, digital infrastructure, scientific research, economic transformation, and national security. China's 2017 *New Generation Artificial Intelligence Development Plan* established a long-term strategy for developing AI capabilities, integrating AI with economic and social development, strengthening national innovation capacity, and supporting national security (State Council of the People's Republic of China, 2017).

The Chinese approach consequently treats AI not simply as a commercial technology but as a strategic capability embedded within a wider national innovation system. The 2017 plan called for the development of an open and coordinated AI innovation system, the construction of intelligent infrastructure, the integration of AI with national defence, and the creation of an ecosystem linking research, industry, talent, and institutional support (State Council of the People's Republic of China, 2017). More recent Chinese policy continues to emphasise self-reliance and independent innovation. In 2025, China's leadership explicitly stressed self-reliance and the use of national resource-mobilisation capabilities in AI development, while 2026 policy statements continued to emphasise independent innovation alongside international cooperation (State Council of the People's Republic of China, 2025; State Council of the People's Republic of China, 2026).

China's expanding computational infrastructure also demonstrates the material dimension of this strategy. By the end of 2025, official Chinese data reported the construction of numerous intelligent-computing clusters, while 2026 policy initiatives continued to emphasise high-capacity intelligent computing infrastructure, data, ecosystems, talent, and standards as components of AI development (State Council of the People's Republic of China, 2026).

From the perspective of innovation studies, the Chinese case highlights the importance of institutional coordination as a component of innovation capability. Public investment, long-term planning, research institutions, industrial policy, infrastructure development, and state coordination are integrated into a broader strategy aimed at strengthening domestic technological capabilities and reducing strategically significant dependencies. The political characteristics of this model are analytically distinct from the question of what it demonstrates about innovation policy. Regardless of one's assessment of China's governance model, its AI strategy provides clear evidence that contemporary innovation policy can encompass the deliberate construction of sovereign technological ecosystems rather than focusing exclusively on technological outputs or short-term economic returns.

Taken together, the four cases demonstrate different pathways through which sovereign capability is becoming embedded within contemporary innovation policy. India emphasises digital public infrastructure and inclusive ecosystem-building; the European Union emphasises regulatory and institutional sovereignty; the United States emphasises technological leadership, research infrastructure, and strategic supply-chain capacity; and China emphasises state coordination and technological self-reliance. These differences are analytically important because they show that sovereign digital capacity does not constitute a single institutional

model. Rather, it can be expressed through different combinations of infrastructure, regulation, domestic technological production, public investment, and institutional coordination. The common feature across the cases is therefore not a uniform conception of sovereignty, but the growing recognition that the capacity to govern and sustain critical technological systems has become an integral component of national innovation capability.

This comparative evidence consequently supports the article's broader theoretical proposition: innovation in the age of AI increasingly encompasses the institutional capabilities through which technological ecosystems are developed, governed, secured, and sustained. Conventional indicators of technological and economic performance remain necessary, but they are insufficient to capture these emerging dimensions of public innovation. A more comprehensive evaluation framework should therefore consider sovereign digital capacity alongside technological capability, economic performance, research intensity, entrepreneurship, and public value. Such a framework would allow innovation assessment to capture not only what states and societies invent, but also their capacity to retain meaningful agency over the infrastructures and technologies upon which future innovation increasingly depends.

Towards a Sovereign Innovation Evaluation Framework

The comparative analysis reveals that national AI strategies are increasingly oriented towards objectives that transcend technological competitiveness and economic productivity. Across different institutional settings, governments are investing in digital infrastructures, computational capacity, regulatory systems, public data ecosystems, skills, and technological resilience, treating these capabilities as strategic foundations for long-term innovation. UNCTAD (2025) similarly identifies infrastructure, data, and skills as foundational requirements for countries seeking to develop and adopt AI, while emphasising that effective AI strategies require coordination across science, technology and innovation, industry, education, infrastructure, and trade policy.

However, established approaches to innovation evaluation continue to rely heavily on indicators developed around earlier understandings of innovation, in which technological invention, firm-level activity, and market performance constituted the principal objects of measurement. This creates a growing gap between the objectives pursued by contemporary innovation policy and the conceptual assumptions underlying innovation evaluation. Rather than proposing a new composite innovation index, this article advocates a conceptual broadening of innovation evaluation in which sovereign digital capacity is recognised as a substantive dimension of public innovation.

The central limitation of existing evaluation approaches is therefore not necessarily the indicators themselves, but the theoretical assumptions concerning what constitutes an innovation outcome. Patents, research and development expenditure, scientific publications, venture-capital investment, productivity growth, and technological diffusion provide valuable evidence of innovative activity and technological performance (OECD/Eurostat, 2018). Nevertheless, they are less capable of capturing institutional transformations involving digital governance, strategic autonomy, infrastructural resilience, and public technological capability. The issue is consequently one of analytical scope: conventional indicators measure important dimensions of innovation, but they do not exhaust the range of capabilities through which contemporary states increasingly pursue innovation.

In the context of artificial intelligence, the object of innovation increasingly extends towards the development and management of complex technological ecosystems. AI development depends upon interconnected systems of computing infrastructure, data, networks, energy, skills, research institutions, digital platforms, regulatory arrangements, and supply chains. UNCTAD (2025) emphasises precisely this interaction among infrastructure, data, and skills as a foundation for national AI preparedness and development. The capacity to organise these systems therefore becomes an important determinant of whether technological innovation can be developed, adopted, scaled, and sustained.

On this basis, this article proposes a multidimensional framework for assessing public innovation consisting of four interrelated dimensions: technological capability, economic value generation, institutional capacity, and sovereign digital resilience. These dimensions should not be understood as competing measures or as independent categories. Rather, they represent complementary layers through which contemporary public innovation operates. Together, they provide a broader analytical framework that connects technological performance with the institutional capabilities required to sustain technological transformation.

The first dimension, technological capability, represents the conventional foundation of innovation evaluation and remains indispensable. Innovation continues to depend upon scientific research, technological invention, engineering expertise, computational resources, advanced manufacturing, and knowledge generation. Relevant indicators include research and development intensity, patent activity, scientific publication output, AI model performance, technology diffusion, research collaboration, computing capacity, and the development of advanced technological capabilities (OECD/Eurostat, 2018). The proposed framework does not reject these indicators. Instead, it positions technological capability as one component of a wider innovation ecosystem. Technological excellence remains an essential prerequisite for innovation, but it should not be treated as a sufficient measure of innovation in isolation.

The second dimension concerns economic value generation, which captures the extent to which innovation contributes to productivity, industrial competitiveness, employment, entrepreneurship, investment, and sustainable economic development. This dimension incorporates important insights from Schumpeterian innovation theory, evolutionary economics, and national systems of innovation (Schumpeter, 1934; Freeman, 1987; Lundvall, 1992). Economic performance remains a central indicator of innovation because technological change can reshape production, investment, employment, and market structures. Nevertheless, evaluating innovation exclusively through economic outcomes risks reducing public innovation to commercial success. This is particularly problematic when governments invest in infrastructures or capabilities whose primary benefits may involve resilience, inclusion, security, public value, or long-term institutional capacity rather than immediate commercial returns. Economic value should therefore remain an essential component of innovation evaluation while being interpreted alongside wider public objectives.

The third dimension is institutional capacity. Public innovation increasingly depends upon governments' ability to establish institutional arrangements capable of managing technologically complex societies. Institutional capacity includes regulatory competence, administrative coordination, digital public infrastructure, public-sector innovation, intergovernmental cooperation, policy learning, procurement capacity, skills, and adaptive governance. These capabilities enable governments not merely to adopt technologies but to integrate them into public institutions in ways that improve governance while maintaining accountability and long-term resilience. The OECD's framework for government innovative capacity explicitly emphasises

systemic conditions, institutional arrangements, leadership, coordination, and governing mechanisms as components of public innovation capacity (Kaur et al., 2022).

Within this dimension, investments in interoperable digital platforms, trusted identity systems, AI regulatory institutions, public data infrastructures, and national digital systems can therefore be interpreted as innovation outcomes rather than merely as enabling conditions for innovation. This represents an important conceptual shift. Institutional arrangements are not simply the environment in which innovation takes place; under certain circumstances, the creation of new institutional capabilities constitutes innovation itself. The framework consequently treats institutional transformation as an observable dimension of public innovation.

The fourth and most distinctive dimension is sovereign digital resilience. This article defines sovereign digital resilience as the institutional capability of states to retain meaningful autonomy over essential digital infrastructures, strategic technologies, data ecosystems, computational resources, and regulatory authority while remaining embedded within globally interconnected technological systems. This definition deliberately avoids equating sovereignty with technological autarky. Contemporary digital economies are characterised by extensive international interdependence, global supply chains, cross-border data flows, multinational technology firms, and transnational research networks. Complete technological self-sufficiency is therefore neither a realistic nor necessarily desirable objective.

Sovereign digital resilience instead refers to the capacity to participate in global technological networks without becoming structurally dependent upon external actors for essential public functions and strategically significant capabilities. This interpretation is consistent with contemporary discussions of technological sovereignty, which increasingly emphasise the ability to design, develop, scale, control, and protect critical digital capabilities while retaining openness, interoperability, and international cooperation (European Parliament, 2025). Thus, sovereign resilience should be understood as institutional autonomy rather than technological isolation or economic nationalism.

Evaluating sovereign digital resilience requires extending innovation assessment towards capabilities that are largely absent from conventional innovation rankings. Relevant dimensions may include the robustness of digital public infrastructure, domestic and accessible computational capacity, semiconductor supply-chain resilience, governance of strategic data infrastructures, regulatory autonomy, cybersecurity capabilities, public investment in foundational technologies, technological skills, and the capacity to maintain critical innovation ecosystems during geopolitical or technological disruptions. These factors increasingly shape whether technological innovation produces sustainable public capability or instead deepens structural technological dependence. UNCTAD's emphasis on infrastructure, data, and skills similarly demonstrates that technological development cannot be separated from the underlying capabilities required to sustain it.

Sovereign digital resilience should therefore be understood as an institutional outcome generated through continuing public innovation rather than as an external geopolitical objective disconnected from innovation. A government that develops resilient computing infrastructure, secure public data systems, interoperable digital platforms, domestic technological expertise, and adaptive regulatory capacity is not merely creating conditions for future innovation. It is generating new forms of institutional capability that alter its capacity to govern technological transformation.

The relationship among the four dimensions is cumulative and mutually reinforcing rather than strictly hierarchical. Technological capability generates knowledge, inventions, and technological opportunities. Economic value generation translates these opportunities into productive, commercial, and socially beneficial outcomes. Institutional capacity establishes the governance arrangements necessary to coordinate and embed technological transformation. Sovereign digital resilience helps ensure that these technological, economic, and institutional capabilities remain viable under conditions of strategic uncertainty and technological interdependence. A weakness in any one dimension can consequently constrain the effectiveness of the others.

For example, highly advanced technologies may fail to generate durable public value where institutional governance is inadequate. Conversely, a technologically sophisticated economy may remain strategically vulnerable if critical computing infrastructure, semiconductors, cloud services, or data systems are excessively dependent upon external actors. The four dimensions should therefore be assessed relationally rather than through a single measure of technological success. This approach is consistent with the broader systems perspective in innovation studies, where innovation is understood as emerging from interactions among technological, organisational, institutional, and economic components (Freeman, 1987; Lundvall, 1992).

The framework also contributes to ongoing debates concerning public value within innovation studies. Public-sector innovation has traditionally been evaluated in terms of efficiency, service quality, administrative responsiveness, citizen engagement, and improved policy outcomes (Moore, 1995; Bason, 2018). These objectives remain important. However, AI introduces additional dimensions of public value associated with resilience, democratic oversight, infrastructural security, technological autonomy, and strategic independence. The growing importance of these dimensions reflects the fact that AI increasingly affects the institutional infrastructures through which public authority is exercised.

Public innovation should therefore also be evaluated according to its capacity to preserve the institutional conditions under which democratic societies can exercise meaningful authority over technological development. Sovereign digital resilience expands the concept of public value by recognising that innovation increasingly affects not only administrative performance but also the institutional foundations of collective self-governance. This does not imply that every investment in digital sovereignty automatically constitutes innovation. Rather, sovereign capabilities should be considered innovative outcomes when they involve the creation, transformation, or substantial enhancement of institutional capacities that enable societies to govern technological change more effectively and sustainably.

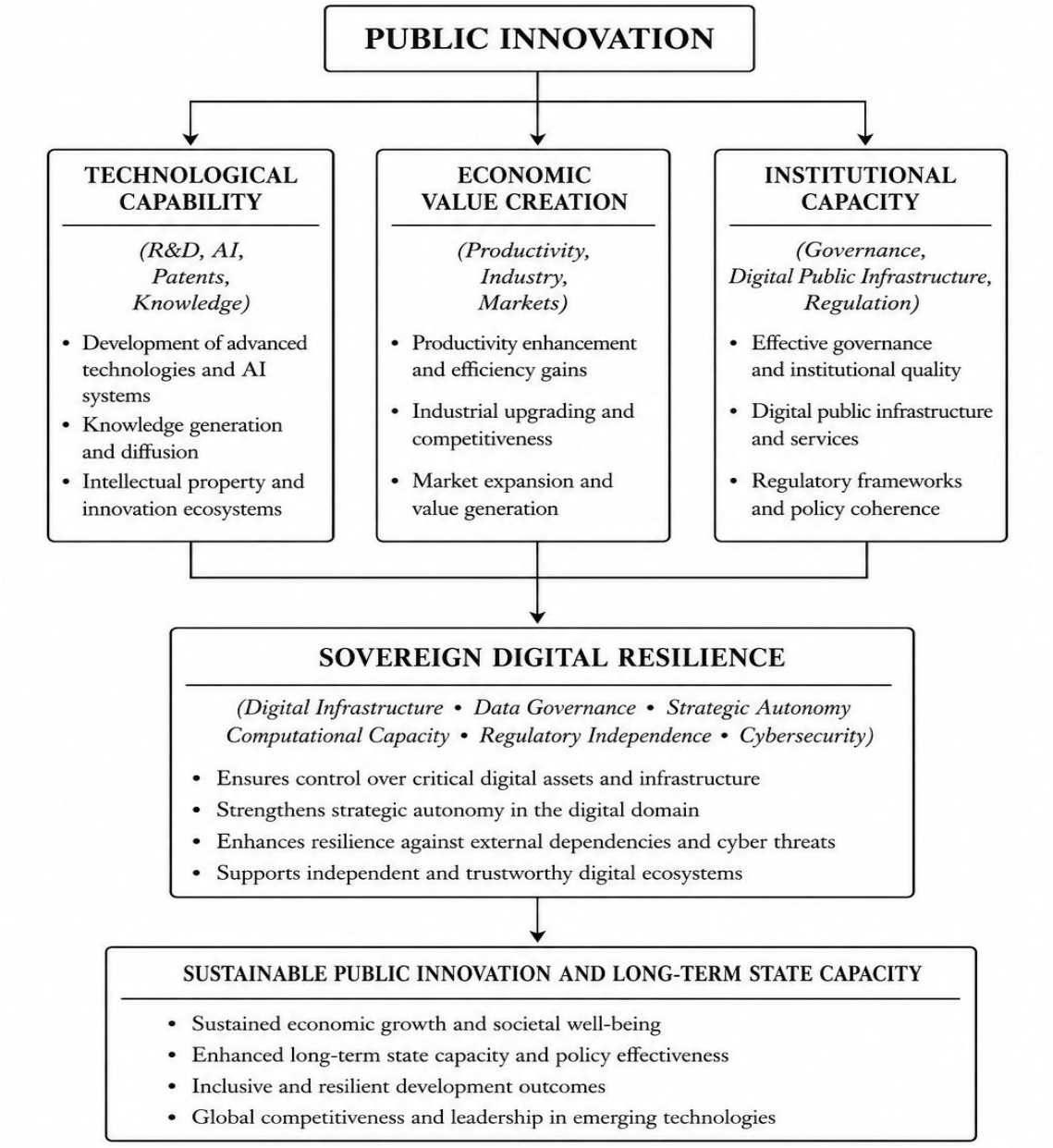
Importantly, this framework does not propose replacing existing innovation indices or abandoning established quantitative indicators. Instead, it argues for a conceptual expansion that aligns innovation evaluation with the changing objectives of innovation policy. Conventional measures remain essential for assessing technological and economic performance, but they provide an incomplete representation of public innovation when institutional transformation and sovereign capability become explicit policy objectives. Future innovation assessments should therefore combine established quantitative indicators with qualitative and institutional assessments capable of capturing governance capacity, infrastructural resilience, technological autonomy, and strategic capability.

The implications of this framework extend beyond artificial intelligence. Technologies such as quantum computing, advanced semiconductors, digital identity systems, biotechnology,

synthetic biology, cloud computing, and critical communications infrastructure are increasingly situated at the intersection of technological capability, institutional governance, and geopolitical strategy. As these technologies become embedded within public administration, economic development, and democratic governance, innovation studies will need to reconsider whether technological output alone provides an adequate representation of innovative capacity. The emergence of digital sovereignty can consequently be understood not merely as a temporary response to geopolitical rivalry, but as evidence of a broader transformation in the relationship between innovation and state capacity.

The framework articulated in this article therefore signifies a transition from understanding innovation primarily as technological and economic performance towards understanding innovation also as a measure of public capability. This transformation reflects the contemporary institutional dynamics of AI governance, in which technological advancement increasingly depends upon governments' capacity to develop robust digital ecosystems that support innovation while maintaining public value, institutional legitimacy, strategic resilience, and long-term technological capability. The evaluation of innovation should consequently move beyond quantifying the technologies produced by societies towards assessing the institutional capabilities through which those technologies are governed, coordinated, sustained, and strategically deployed.

Figure 1. Conceptual Framework:
Public Innovation, Sovereign Digital Resilience, and Sustainable State Capacity



Conclusion

Artificial intelligence has transformed the landscape of innovation, shifting its significance from a predominantly technological and economic phenomenon towards an increasingly institutional and strategic capability. Although innovation studies have progressively broadened their analytical focus from entrepreneurial and technological innovation to systemic interaction, public innovation, and responsible innovation, the conceptual frameworks used to evaluate innovation have changed more slowly (Freeman, 1987; Lundvall, 1992; Kattel and Mazzucato, 2018). Existing evaluation models continue to emphasise technological outputs, research intensity, patents, productivity, and market competitiveness as major indicators of innovative performance (OECD/Eurostat, 2018). While these measures remain essential, they do not fully capture the institutional objectives that increasingly shape contemporary innovation policy.

National AI strategies demonstrate that governments are pursuing innovation not only to accelerate technological development, but also to strengthen digital infrastructures, enhance regulatory capacity, secure data ecosystems, develop computational capabilities, and maintain strategic autonomy (OECD, 2025; UNCTAD, 2025). Innovation has consequently become increasingly connected to questions of public capability and sovereign governance.

This article has argued that this transformation reveals an important theoretical limitation within existing approaches to innovation evaluation. Conventional methodologies continue to assess innovation predominantly through technological and economic outcomes, even as state-led innovation strategies increasingly incorporate objectives associated with sovereign digital capability. Consequently, existing frameworks can overlook an institutional transformation in which governments innovate through the creation and reconfiguration of governance structures capable of supporting technological development under conditions of digital interdependence and geopolitical uncertainty. In this context, sovereignty should not be understood exclusively as a political objective external to innovation. Rather, the development of sovereign digital capabilities can constitute an institutional outcome of public innovation.

The article addressed this theoretical gap by bringing together insights from innovation studies, public-sector innovation, and digital sovereignty within a unified conceptual framework. Rather than treating digital sovereignty solely as a regulatory or geopolitical concern, it conceptualised sovereign digital capacity as a potential dimension of public innovation. This perspective challenges the assumption that innovation should be evaluated principally through technological performance and economic outcomes. Instead, it proposes that innovation in the age of AI increasingly depends upon the institutional capabilities through which societies develop, govern, and sustain technological systems. Innovation can therefore be understood more broadly as a form of public capability encompassing technological development, institutional transformation, strategic resilience, and the creation of long-term public value.

The comparative analysis of AI strategies in India, the European Union, the United States, and China provides empirical support for this theoretical proposition. Despite substantial differences in political institutions, economic structures, and governance philosophies, all four cases increasingly incorporate dimensions of sovereign capability within their approaches to AI development. India illustrates the innovative potential of Digital Public Infrastructure and interoperable public digital ecosystems; the European Union demonstrates how regulatory institutions can constitute strategic capabilities for shaping technological development; the United States increasingly links innovation policy with technological resilience, industrial capacity, research infrastructure, and national security; and China integrates technological advancement within a broader strategy of state coordination and technological self-reliance. These cases demonstrate that sovereign innovation does not represent a single institutional model. Rather, sovereign capability can be pursued through different combinations of public infrastructure, regulation, industrial policy, technological development, and state coordination.

Building on these comparative findings, the article has proposed a multidimensional framework consisting of four interconnected dimensions of innovation: technological capability, economic value generation, institutional capacity, and sovereign digital resilience. The framework does not reject conventional innovation metrics. Rather, it extends them by recognising that technological advancement increasingly depends upon institutional arrangements capable of supporting innovation over time. Technological capability captures scientific and technological performance; economic value generation captures productivity, competitiveness, entrepreneurship, and economic development; institutional capacity captures the ability of

governments to create and manage effective governance arrangements; and sovereign digital resilience captures the capacity to maintain meaningful autonomy over strategically important digital infrastructures, technologies, data, computing resources, and regulatory systems.

The conceptual contribution of this framework lies in shifting the analytical perspective from innovation as primarily measurable technological output towards innovation as a broader form of public capability. This reorientation enables innovation studies to incorporate institutional transformations that conventional evaluation frameworks may overlook while retaining the analytical importance of established economic and technological indicators. It therefore represents an extension rather than a rejection of existing approaches to innovation measurement. The framework also contributes to wider debates concerning the relationship between the state and innovation. Innovation studies have traditionally examined the state as a facilitator, regulator, funder, or coordinator within innovation systems (Freeman, 1987; Lundvall, 1992). Contemporary AI governance, however, demonstrates that governments are increasingly becoming active participants in technological transformation through the creation of institutional infrastructures that directly shape the possibilities for innovation.

From this perspective, digital identity systems, public data infrastructures, sovereign or strategically controlled cloud and computing capabilities, AI governance institutions, semiconductor strategies, cybersecurity systems, and regulatory frameworks should not automatically be treated merely as background conditions for innovation. Where these systems involve the creation or substantial transformation of public capabilities, they can also constitute outcomes of institutional innovation. Recognising this possibility expands the analytical boundaries of public innovation and highlights the increasingly foundational role of technological governance in contemporary states.

The framework introduced in this article is deliberately conceptual and should therefore be regarded as the beginning rather than the conclusion of a broader research agenda. Several limitations require acknowledgement. First, the article does not operationalise sovereign digital resilience through a comprehensive set of empirical indicators. Future research should therefore develop qualitative and quantitative approaches capable of measuring sovereign digital capability across different institutional and political contexts. Such work could examine dimensions including computational capacity, critical infrastructure resilience, semiconductor dependencies, data governance, regulatory autonomy, cybersecurity, public digital infrastructure, and the capacity to maintain technological capabilities during periods of geopolitical disruption.

Second, the comparative analysis is restricted to four prominent AI jurisdictions: India, the European Union, the United States, and China. Although these cases provide substantial variation in political systems, economic structures, and approaches to technological governance, they do not capture the full diversity of national experiences. Future research should extend the framework to middle-income countries, developing economies, regional organisations, and smaller states whose strategies for achieving digital sovereignty may rely on different combinations of international cooperation, public infrastructure, regional integration, and technological specialisation. Such comparative research would also help determine whether sovereign digital resilience represents a broadly applicable dimension of innovation or one whose relevance varies according to national technological and institutional conditions.

Third, although this article has focused primarily on public innovation, future research should examine the relationship between sovereign digital capacity and private-sector innovation

ecosystems. Contemporary digital economies are characterised by complex public-private interdependencies, particularly in relation to cloud computing, semiconductors, AI models, data infrastructure, cybersecurity, and digital platforms. Sovereign digital resilience cannot therefore be understood exclusively as a function of state ownership or direct government control. Future studies should examine how governments can maintain strategic autonomy while simultaneously participating in globally interconnected markets and leveraging private-sector technological capabilities.

Digital sovereignty should consequently be understood not merely as an external policy objective, but as a potential and increasingly important dimension of public innovation itself. Reframing innovation evaluation in this manner does not discard the economic foundations of innovation studies. Instead, it extends them by recognising the changing relationship between technological progress, state capacity, institutional resilience, and public value within an increasingly interconnected and contested digital political economy. The central implication is therefore not that technological or economic indicators have become irrelevant, but that they are no longer sufficient on their own. In the age of AI, understanding innovation increasingly requires asking not only what technologies societies produce, but also what institutional capabilities they develop to govern, sustain, and exercise meaningful agency over those technologies.

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