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Subnational Variations in AI Policy: Insights from German States

in the study program of Public Governance across borders

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Abstract

The rapid integration of Artificial Intelligence (AI) across various sectors presents both unprecedented opportunities and significant challenges, necessitating robust governance frameworks. This thesis investigates the AI governance strategies of German federal states, focusing on how these strategies reflect the roles these states assume within a theoretical governance framework. By exploring the intersection of AI governance and federalism, this study provides a nuanced understanding of the diverse approaches employed by subnational entities within Germany. The theoretical framework underpinning this research draws on multi-level governance theory and the concept of AI federalism, emphasizing the dual role of federal states as independent policymakers and integral components of national AI strategies. This study employs a comparative case study design, incorporating a mixed methods approach that combines qualitative content analysis with fuzzy-set qualitative comparative analysis (fsQCA). Data were collected from AI strategies, digital strategies, coalition agreements, and cabinet reports of seven German federal states. The analysis reveals significant variations in the activity levels and strategic focuses of different states. The findings underscore the importance of subnational entities in shaping AI governance, reflecting the principles of AI federalism and highlighting the complex interplay between different governance levels.

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1. Introduction

The rapid development and integration of Artificial Intelligence (AI) into various sectors highlight its potential to revolutionize not only how we interact with technology but also how societies function and are governed. AI's capabilities, from improving public administration efficiency to personalizing user experiences across services, present unparalleled opportunities for progress (Robles, 2023). However, the advancements come with their share of challenges and risks, necessitating robust governance frameworks to navigate the ethical, legal, and social implications. Effective AI governance is pivotal not only in maximizing AI's benefits but also in mitigating its risks, ensuring that AI development aligns with societal values and norms. As such, the importance of AI governance cannot be understated, as it serves as a crucial mechanism for balancing innovation with responsibility, safeguarding public welfare in the face of rapid technological change (Wirtz, Weyerer, & Sturm, 2020).

While AI governance is still a relatively new policy field, there are already extensive efforts to understand intervention strategies on national and international levels, demonstrating a concerted effort to create and shape the frameworks that guide AI development and deployment (Djeffal, Siewert, & Wurster, 2022). Scholars and policymakers alike have contributed to a rich body of literature that outlines the diverse approaches to AI governance, ranging from regulatory frameworks to ethical guidelines, highlighting a global endeavor to navigate the multifaceted implications of AI technologies (Butcher & Beridze, 2019).

Recent literature indicates the importance of a multi-level governance perspective in AI governance (Liebig et al., 2022; Choung et al. 2023). While AI governance research has traditionally emphasized national and international frameworks, the subnational dimension, especially within federal structures like Germany, emerges as a pivotal arena for policy innovation and implementation (Jobin et al., 2021). This focus on the federal level is not only due to the distribution of competences in areas such as research and economic policy between the national and subnational levels but also because these levels play an active role in shaping AI policies within their jurisdictions (Liebig et al., 2022). The concept of "AI-Federalism" highlights the unique contributions and challenges at the subnational level, underscoring the potential of federal structures to drive policy innovation in the governance of AI (Jobin et al., 2021).

This perspective reveals a critical gap in our understanding: despite the acknowledged importance of subnational efforts in shaping AI governance, detailed insights into how federal states within Germany, or similar federated systems, design and perceive their governance roles are missing. Addressing this gap requires a nuanced examination of subnational AI policy-formulation, exploring the chosen policy instruments within AI policy documents across Germany's federal states.

This leads us to the following research question:

How do the AI governance strategies of German federal states compare, and what does this reveal about the roles these states assume within the theoretical governance framework of AI?

With the following sub-questions:

1. *What policy mixes are employed by different German federal states in their AI governance strategies?*

Understanding the policy mixes used by different states is crucial for identifying effective strategies and best practices in AI governance. This sub-question addresses the gap in knowledge about how states balance different policy instruments to achieve their AI governance objectives. As AI technologies rapidly evolve, it is urgent to understand the landscape of policy instruments deployed to manage their development and impact. This sub-question seeks to provide insights that can help understanding the current state of AI policy design in german federal states.

2. *Are there patterns and outliers in AI governance strategies across German federal states, and to what extent do they reflect elements of AI-Federalism?*

Identifying and describing notable similarities and differences is essential for understanding regional variations and their implications. This sub-question fills the gap in our knowledge about the diversity of AI governance approaches within a federated system. Building on the concept of „AI-Federalism“, this sub-question seeks to reveal the degree to which policy innovation is driven by different policy mixes.

3. *How do these governance strategies reflect the role of the states in the context of AI governance?*

This sub-question is significant because it helps to elucidate the roles that federal states play in AI governance, contributing to a deeper understanding of multi-level governance in this field. It addresses the gap in knowledge about how federal states perceive and enact their responsibilities in AI governance. Understanding their perceived roles is urgent for developing coordinated and coherent AI governance frameworks that integrate efforts at both national and subnational levels. This sub-question aims to provide insights into the alignment of state-level strategies with broader governance objectives.

This study’s scientific relevance is based on its unique focus on the intersection of AI governance and federalism within Germany. By comparing AI governance strategies across German federal states, this research contributes to the evolving field of AI policy studies by providing empirical insights into decentralized policy-making processes. This comparative analysis is essential, as it will help to highlight how regional variations in policy approaches can influence the broader trajectory of AI development and its governance at national and international levels. Scientifically, the findings will extend current understandings of multi-level governance theories by applying them to the rapidly evolving domain of AI, offering a detailed examination of how federal structures can shape technological policy and innovation.

On a societal level, this study addresses the pressing need for effective AI governance frameworks that can ensure AI technologies are developed and deployed in ways that are beneficial and fair to society. By investigating the roles that federal states play within the

broader governance landscape, this research will shed light on the effectiveness of different governance models in addressing ethical, legal, and social implications of AI. This is particularly critical given the potential of AI to impact a wide range of societal aspects, from employment and privacy to security and inequality.

To answer the research questions, this study employs a comparative case study design combined with qualitative content analysis. The comparative case study approach allows for an in-depth examination of AI governance strategies across different German federal states, providing a nuanced understanding of the variations and commonalities in policy instruments and governance roles. This methodology is particularly suited for analyzing contemporary phenomena within real-life contexts where the boundaries between the phenomena and context are not clearly evident (Yin, 2018).
The data for this study will be collected from a variety of policy documents issued by the selected federal states. These include coalition agreements, digital strategies, AI strategies, and cabinet reports. These documents are chosen because they provide comprehensive insights into the states' strategic directions, policy priorities, and implementation mechanisms related to AI governance.

The thesis is structured as followed:

Chapter 1 introduces the background of the problem, formulates the research questions and subquestions, and outlines the significance of the study. Chapter 2 delves into the theoretical frameworks underpinning the study, including AI governance and AI federalism, and explains how these theories are applied to the research questions. In Chapter 3, the research design, data collection methods, and data analysis techniques used in the study are detailed. Chapter 4 presents the findings of the comparative analysis of AI governance strategies across the selected federal states, addressing the research questions and subquestions. Finally, Chapter 5 summarizes the key insights from the research, discusses the implications for theory and practice, and suggests directions for future research.

By employing this research approach, the study aims to provide a detailed and systematic examination of AI governance strategies within Germany's federal structure, contributing valuable empirical insights to the field of AI policy studies.

2. Theory

The aim of this chapter is to theorize the research question and to embed it into a greater theoretical context. By examining these two dimensions, the chapter provides a comprehensive foundation for understanding how different governance models and federal structures influence the development and implementation of AI policies.

This chapter begins by exploring the broader concept of AI governance, which involves the design and implementation of policies, ethical norms, legal frameworks, and standards to guide AI development and deployment. This section will delve into the various challenges and strategies inherent in AI governance, setting the stage for a deeper discussion of specific models and frameworks later in the chapter.

Following this, the chapter introduces the concept of AI federalism, which recognizes the complex layers of governance that influence AI policy within federal systems. By examining the role of subnational entities, such as the German federal states, this section will provide insights into how decentralized policymaking contributes to a multi-layered national AI governance discourse. This approach emphasizes the dual role of federal states as independent policymakers and integral parts of the overarching AI strategy.

To achieve its aim, this chapter will connect different theoretical concepts and frameworks, including policy instruments typologies and governance roles. By integrating these perspectives, the chapter will create a coherent storyline that links the elements of AI governance and federalism. This theoretical foundation will support the empirical analysis in subsequent chapters, providing a structured framework for examining AI governance strategies across German federal states.

2.1. Definition of Artificial Intelligence (AI)

Artificial Intelligence (AI) refers to the ability of machines to perform tasks that would normally require human intelligence. While there are a variety of definitions of AI, this thesis adopts the definition provided by the European Commission. According to the European Commission, AI is defined as "systems that display intelligent behavior by analyzing their environment and taking actions – with some degree of autonomy – to achieve specific goals." These systems can be based on machine learning, deep learning, and rule-based approaches, among others. (European Commission, 2020).

This definition is chosen for several reasons. The European Commission's definition is framed within the context of policy and governance, aligning directly with the focus of this thesis on AI governance strategies. It provides a clear and comprehensive description, encapsulating various AI technologies and their applications across different sectors. Additionally, the European Commission is a leading authority on AI policy and regulation in Europe, lending credibility and relevance to the definition.

2.2. AI Governance

AI governance is a rapidly evolving field, reflecting the dynamic and multifaceted nature of AI technologies. The theoretical landscape around AI governance is characterized by various models, frameworks, and strategies aimed at managing the complex interplay between technological innovation and societal impacts. This section highlights key aspects of this evolving landscape.

AI governance is a multidimensional concept that encompasses the design and implementation of policies, ethical norms, legal frameworks, and standards to guide the development and deployment of Artificial Intelligence (AI). This includes the dual challenge of promoting technological innovation while simultaneously safeguarding public interest, addressing ethical concerns, and maintaining democratic values (Ulnicane et al., 2020; Erdelyi & Goldsmith, 2018). Central to effective AI governance is the establishment of mechanisms that can balance the fast-paced growth of AI capabilities with societal norms and regulations. This includes not only the crafting of rules and guidelines but also the fostering of an ecosystem where AI can be developed and used responsibly. It necessitates proactive governmental engagement to anticipate future implications of AI, devise adaptive policies, and implement strategies that can evolve with the technology's advancement (Floridi & Cowls, 2022). Moreover, AI governance is not a static set of policies but a dynamic process that reflects the shifting landscape of AI as it intersects with various sectors. It requires a collaborative approach among stakeholders—ranging from policymakers, technologists, researchers, to the civil society—to negotiate the terms of AI's societal integration (Mittelstadt, 2019).

Subsequently, scientific research on AI governance is marked by a wide range of models and frameworks designed to understand and categorize occurring dynamics as well as guide the ethical and effective development of AI. These frameworks often integrate the analysis of policy design, ethical norms, legal standards, and oversight mechanisms. Notable models include the "Ecosystem Framework of AI Governance" by Wirtz, Langer, and Weyerer, which describes AI as an ecosystem with dynamic interactions among diverse processes, presenting a five-level governance model. The "Governing AI Systems for Public Values: Design Principles and a Process Framework" by Chen and Ahn, which focuses on aligning public AI systems with public values through a lifecycle-scoped approach. The "AI Loyalty by Design Framework" by Aguirre et al., which advocates for the consideration of loyalty in AI design, ensuring that AI systems transparently benefit their end users. The "Integrated AI Governance Framework for Public Administration" by Wirtz, Weyerer, and Sturm, which provides a guide for regulatory processes in government and public administration to keep pace with AI advancements.

2.3. AI-Federalism

De AI-Federalism is a concept grounded in multi-level governance (MLG) theory (Jobin et al., 2021). Multi-level governance (MLG) is a dynamic concept that has evolved significantly since its inception, focusing on the dispersion of authoritative decision-making across multiple territorial levels and involving a variety of actors. This theory provides a framework to understand the complex interdependencies and interactions between different levels of

government, ranging from the supranational to the subnational. MLG blurs the traditional hierarchical distinctions between different levels of government, promoting a more fluid interaction where local, regional, national, and supranational entities share governance responsibilities. Beyond government entities, MLG incorporates non-governmental organizations (NGOs), civil society groups, and private sector stakeholders in the governance process, reflecting a broader and more inclusive approach to decision-making. The interactions within MLG are not static but continuously evolving, reflecting the changing dynamics of political mobilization, policy-making, and institutional restructuring (Piattoni, 2009). Historically, MLG was first introduced by Gary Marks in the early 1990s to describe the emerging governance patterns within the European Union (EU). It challenged the traditional state-centric models of governance, highlighting the role of subnational actors and the interaction between various levels of government (Piattoni, 2009).

In the context of AI governance, MLG offers a valuable lens to examine how different governmental levels and stakeholders collaborate and compete in shaping AI policies. On a national and transnational level the „Nationale KI-Strategie“ (National AI-Strategy) by Germany and the European AI Act serve as prime examples of multi-level governance in the context of AI governance.

Looking at the subnational level, the article “AI Federalism: Shaping AI Policy within States in Germany” by Jobin et al. (2021) revealed that subnational entities such as the German federal states actively devise AI strategies tailored to their respective regional contexts, contributing to a multi-layered (trans-)national AI governance discourse. This federalist approach emphasizes the role of the federal states both as independent policymakers and as an integral part of the overarching AI strategy in Germany. AI federalism thus serves as a conceptual framework to examine how the German federal states, within their unique economic and innovation ecosystem, pursue AI policies that are consistent with their regional identity and ambitions while aligning with overarching national and EU strategic goals (Jobin et al., 2021; Härtel, 2017).

Building on this new perspective, the analysis by Liebig et al. (2022) delves into the specific goals, narratives, and schemes utilized by the German federal states in their AI policy documents. The study identifies five key areas within subnational AI policy: the interconnection of economic and research endeavors, cooperation frameworks, ethical principles, areas of AI application, and rhetorical strategies.

Firstly, research and economic activities are highlighted as central themes, with states focusing on knowledge transfer between research institutions and industry. States employ various methods, such as creating hubs and platforms, to facilitate this transfer. Secondly, cooperation with selected entities is emphasized. States establish partnerships with other states, European universities, and the private sector to advance AI development. This cooperation often involves public-private partnerships and aligns with national and European strategic goals. Thirdly, ethical principles and citizen consultation are significant components of the states' AI strategies. Many states derive their ethical frameworks from the German national AI strategy and

emphasize values such as transparency, non-discrimination, and human-centric AI. Fourthly, specific areas of AI application reflect the regional economic identities of the states. These include public administration, healthcare, education, and sustainability. States use their AI policies to enhance their economic positions and address local needs. Lastly, the rhetoric and narratives used in subnational AI strategies often mirror those found in national policy documents. States aim to establish a distinct brand for their AI initiatives. These narratives emphasize the competitive and innovative aspects of AI development (Liebig et al., 2022).

Unknowns pertain to the actual policy mixes each state employs to achieve their AI governance objectives and how these vary across different states. Understanding these differences and their implications is crucial for identifying best practices and effective strategies in AI governance.

2.4. Connecting both concepts

Bringing the concepts of AI Governance and AI-Federalism together, this thesis will analyze AI government strategies by German federal states. Following this goal, a policy instruments typology proposed by Christian Djeffal, Markus B. Siewert, and Stefan Wurster in their article "Role of the state and responsibility in governing artificial intelligence: a comparative analysis of AI strategies." (see Appendix 1), which they base on the foundational work of Hood & Margetts (2007) and Howlett (2019), will be employed. This typology categorizes policy instruments as means, techniques, or mechanisms by which governments aim to achieve their AI-related policy objectives. The findings will be used to descriptively answer sub-question one and two.

In the following, I will again draw upon the insightful work of Christian Djeffal, Markus B. Siewert, and Stefan Wurster. Their "Role of the state" framework lays the foundation to explanatory answer the third sub-question.

The framework delineates two central dimensions of state roles in AI governance, inspired by foundational contributions from scholars such as Borrás & Edler (2020), Erdelyi & Goldsmith (2018), Gasser & Almeida (2017), Kuhlmann et al. (2019), Mandel (2009), Marchant et al. (2020), Sarewitz (2011), and Ulnicane et al. (2020). Firstly, it distinguishes between proactive and passive state interventions. Proactive roles are characterized by direct involvement in AI development, fostering innovation and technological advancement, whereas passive roles are marked by minimal intervention, allowing market forces and private entities to drive AI's evolution. Secondly, it contrasts the regulatory stance, focused on managing AI's risks, with the *stimulation approach*, which emphasizes promoting AI deployment for societal benefit and in contrast *the enclosure-and-control approach*, which emphasizes the state's role in regulating the potential risks associated with AI technologies.

Within this conceptual landscape, four distinct governance regimes emerge: the entrepreneurial state, advocating for robust public investment in AI; the market-oriented state, favoring minimal interference; the regulatory state, emphasizing stringent oversight; and the self-regulation-promoting state, which delegates governance to industry stakeholders. These categories are

rooted in the theoretical works of Mazzucato (2011), who celebrated the state's role as a dynamic innovator, and further nuanced by insights from Bisson et al. (2010), Kim (2007), Braithwaite (2011), and Majone (1997), among others.

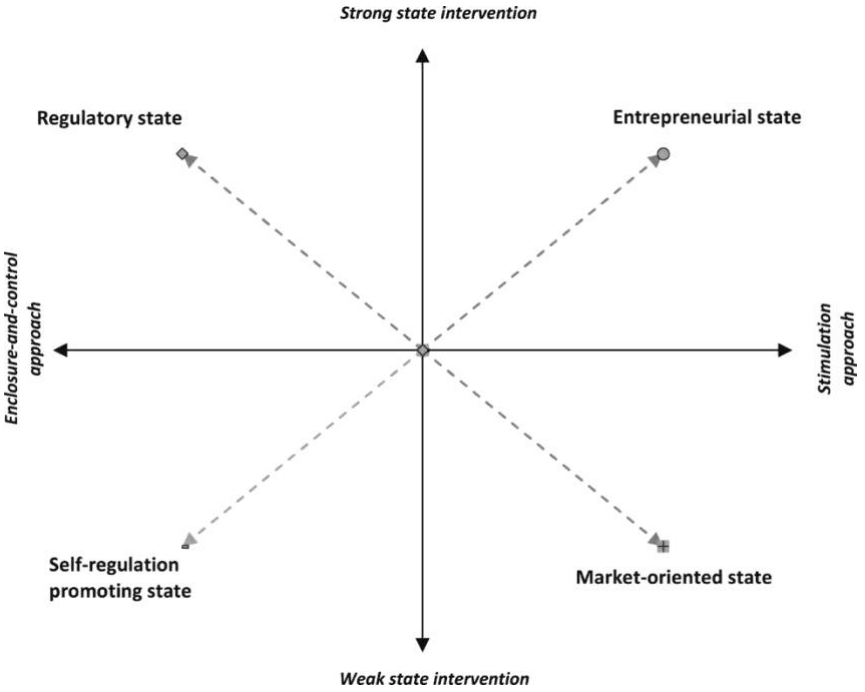

Figure 1. Governance dimensions of AI and resulting state types (Djeffal, Siewert, & Wurster, 2022)

2.5. Conclusion

In summarizing the key theoretical insights gained from this chapter, it is clear that AI governance and AI federalism are complex and multi-dimensional concepts embedded within a broader theoretical landscape.

These insights provide a crucial foundation for the empirical analysis in the subsequent chapters. By understanding the diverse frameworks and models that underpin AI governance and federalism, we can better analyze how different German federal states develop and implement their AI strategies. The theoretical frameworks discussed, including policy instruments typology and the "Role of the State" framework, will guide the descriptive and explanatory analysis of AI policy mixes and governance roles.

Overall, this theoretical framework sets clear expectations for interpreting the findings of the research. It underscores the importance of considering the interplay of different governance levels and the role of subnational entities in shaping AI policies. By embedding AI governance and federalism within a deeper theoretical context, this research aims to provide valuable insights that can inform policymakers and stakeholders involved in AI development and implementation.

3. Methods

The aim of this chapter is to outline the methodological approach employed in this study to analyze AI governance strategies across selected German federal states. Following this goal, the chapter will systematically present the research design, describe the case selection, detail the methods of data collection and analysis, and conclude with a summary of the planned research activities. This comprehensive approach ensures a robust framework for understanding the variations in AI policy instruments and strategies across different states.

3.1. Research design

This study employs a comparative case study design, augmented with a mixed methods approach, to analyze the AI governance strategies across German federal states. The comparative case study approach is chosen for its strength in examining contemporary phenomena within real-life contexts, particularly when the boundaries between phenomena and context are not clearly evident (Yin, 2018). This approach enables an in-depth examination of policy documents and strategies across the states, leading to a nuanced understanding of how subnational differences reflect broader governance frameworks and theoretical concepts of AI governance and federalism. To enhance the robustness of this analysis, the study integrates qualitative content analysis with fuzzy-set qualitative comparative analysis (fsQCA). This mixed methods approach leverages the strengths of both qualitative and quantitative methods to provide a comprehensive examination of AI governance strategies.

3.2. Case selection

Following the logic of an *intensity sampling* this study focuses on seven German federal states: Nordrhein-Westfalen, Bayern, Baden-Württemberg, Niedersachsen, Hessen, Hamburg, and Schleswig-Holstein. These states were selected based on their leading roles in AI politics, as identified by Anne Goldmann (2022). According to Goldmann, these states have well-established institutional frameworks for AI governance, making them suitable cases for analyzing diverse AI policy instruments and strategies.

The selected states represent a mix of economic powerhouses, innovation leaders, and regions with significant political influence in Germany. Nordrhein-Westfalen, for instance, is Germany's most populous state and a major industrial hub, while Bayern and Baden-Württemberg are known for their strong economic performance and innovation capabilities. Niedersachsen and Hessen play crucial roles in logistics and financial services, respectively. Hamburg, as a city-state, is a significant port and trade center, and Schleswig-Holstein represents a state with a strategic focus on sustainable energy and environmental policies. It has to be noted that there is no east German federal state included.

3.3. Data collection

To systematically collect relevant data, this study examines several key policy documents from each selected state. These documents are crucial for understanding the policy instruments employed in AI governance and the strategic priorities of each state. The data collection focused on the following types of documents:

AI Strategies: These documents serve as a form of 'meta-governance' and are playing a crucial role in setting core objectives for AI deployment and signaling commitment to various stakeholders within the AI ecosystem. They might include the state's vision for AI development, ethical considerations, regulatory frameworks, and investment priorities. (Casado-Asensio & Steurer, 2014; Rayner & Howlett, 2009).

Digital Strategies outline the states' approaches to digital transformation, including AI-related initiatives. Digital strategies serve as comprehensive roadmaps for policy implementation, detailing specific actions, milestones, and timelines. In the context of AI governance they gain special importance, they gain special importance as AI policy is often seen as an extension of digital policy. Particularly in terms of coordination, it is evident that digital strategies build on the experiences and frameworks developed through previous digital policy efforts (Goldmann, 2022). This connection underscores the relevance of digital strategies in understanding the broader context of AI governance within each state.

Coalition Agreements provide insights into the policy priorities of the current state governments. They highlight the strategic directions and commitments towards a policy field, reflecting the political consensus and agenda-setting at the beginning of the legislative period. Through its form as a binding agreement, it can additionally serve as a control mechanism between coalition partners (Klüver, Bäck, & Krauss, 2023).

Cabinet Reports provide updates on the quickly evolving field of digital and AI policies. These reports are valuable for understanding the dynamic aspects of policy execution and the responsiveness of states to emerging issues. They document the operational aspects of policy initiatives and serve as a feedback mechanism for continuous improvement in policy implementation (Alexiadou, 2016). For this study only cabinet reports, which mentioned (new) AI-related instruments were included into the data set.

Additionally, a comparison was conducted with the Political Strategy and Transfer Centers segment of "Plattform Lernende Systeme," a website dedicated to monitoring the AI ecosystem in Germany. Only projects and initiatives that are (partially) funded by the state were included. This offers further insights into the states' AI-related activities and investments.

3.3.1. Data Set

Following the described data collection criteria, the table below provides an overview of the key policy documents collected for the seven German federal states:

State	Coalition Agreement	Digital Plan	AI Strategy	Cabinet Reports
Nordrhein-Westfalen	X (2022)	X (2021)	/	/
Bayern	X (2023)	X (2023)	/	X (2018-2024)
Baden-Württemberg	X (2021)	X (2022)	X (2018)	X (2021-2023)
Niedersachsen	X (2022)	X (2018)	X (2022)	/
Hessen	X (2024)	X (2021)	X (2022)	/
Hamburg	X (2020)	X (2020)	/	/
Schleswig-Holstein	X (2022)	X (2024)	X (2022)	/

Table 1. Data Set

The results indicate that all selected states have up-to-date coalition agreements and digitization strategies, reflecting a strong commitment to digital transformation. Four out of the seven states have specific AI strategies, highlighting a focused approach to AI governance. However, only Bayern and Baden-Württemberg have available cabinet reports, which provide detailed insights into the implementation and progress of their digital and AI policies. This variability suggests differences in how states document and monitor their AI initiatives, with some still embedding AI within broader digital policies and others treating it as a distinct policy area.

3.4. Data Analysis

In The data analysis for this research will be conducted in two primary steps. The first step, addressing sub-questions 1 and 2, is based on a qualitative content analysis. Following this, the third sub-question will be answered with the help of a fuzzy set ideal type analysis.

3.4.1. Qualitative Content Analysis

The coding was conducted using the policy instrument typology outlined by Djeffal, Siewert, and Wurster. This typology categorizes policy instruments into classes and types such as Authority, Finance, Organization, and Information, providing a systematic method for identifying and comparing the policy mixes used by the different German federal states in their AI governance strategies.

The category of Authority includes direct regulations, which cover various forms of *direct regulation* through legislation, binding agreements, and executive actions. *Governmental strategies* within this category refer to planning tools such as government white papers, policy guidelines, strategies, frameworks, and roadmaps.

The Finance category includes *public investments* and *financial incentives*. Public investments encompass all kinds of instruments related to public investments, such as funding for R&D, education, or infrastructure. Financial incentives include market-based instruments like tax incentives, loans, grants, and the creation of investment funds or voucher systems.

The Organization category covers *institutions* and *networks*. Institutions pertain to the creation of new bodies and entities tasked with AI-related policymaking or research, such as ethical councils and research centers. Networks involve activities related to the creation of networks and platforms for public-private partnerships, public consultations, and other participatory tools.

Lastly, the Information category consists of *data and monitoring*, *certificates and labels*, and *outreach and literacy*. Data and monitoring tools aim to collect, share, and analyze AI trends, while certificates and labels involve voluntary standardization activities and the publication of labels for AI technologies. Outreach and literacy include public outreach activities to increase AI awareness and literacy through campaigns, websites, and literacy programs.

The unit of analysis was the individual policy instrument, defined as techniques of governance involving the utilization or conscious limitation of state resources to achieve policy goals (Howlett & Rayner, 2007). Each policy instrument was coded only once, even if mentioned multiple times in different documents or contexts. For instance, the creation of an advisory body listed in the AI-Strategy and in the Coalition Agreement was coded as one policy instrument. Conversely, separate measures such as the establishment of research centers and the creation of an advisory council for these centers were coded independently.

Special considerations were taken for the following three aspects:

Often, initiatives are not directly launched by the ministry but by public-private partnerships or state-funded organizations. In such cases, only the directly funded part explicitly mentioned in the document is coded as an instrument. For example, if a document mentions a state-funded research center established by a PPP, only the direct funding and explicit mention are coded as an instrument. AI is frequently treated as part of broader digitization projects, such as the expansion of 5G infrastructure being seen as a prerequisite for widespread AI applications. Therefore, only projects specifically designed for AI applications are coded. For instance, a project explicitly aimed at developing AI technologies for healthcare is coded, while a general 5G infrastructure project is not, even if it indirectly supports AI. Sometimes states allocate resources to a funding line, from which new initiatives emerge. Projects that originate from an already coded funding program are not coded separately. This ensures that the analysis does not double-count the impact of a single funding source. For example, if a funding program for AI research has been coded, individual projects funded by this program are not coded again as separate instruments.

Any ambiguous segments were marked and resolved through careful consideration and adherence to the established coding rules.

Atlas.ti was employed as the primary software tool for this part due to its robust coding capabilities, intuitive interface for organizing and categorizing data, and its ability to facilitate a nuanced analysis of large volumes of textual information (Friese, 2019). The software supports detailed and systematic coding, allowing for efficient data retrieval and comprehensive analysis, which is crucial for handling the complex data involved in this study.

3.4.2. Fuzzy Set Ideal Type Analysis

To answer the third sub-question, the methodological approach follows the framework used by Djeffal, Siewert, and Wurster (2022) for national AI strategies as presented in the theory part. This approach will be adapted to the context of German federal states, assessing their level of activity in AI governance and the types of policy instruments employed. This step will systematically categorize the German states according to the expected policy instrument mix of the four state types as outlined in Figure 1: entrepreneurial state, market-oriented state, regulatory state, and self-regulation-promoting state (Djeffal, Siewert, & Wurster, 2022).

In this analytical phase, the number and types of policy instruments identified in the previous coding phase using Atlas.ti will serve as indicators of the level of activity of each state. These instruments will be quantitatively assessed to determine the intensity of governance activity. For instance, a high frequency of direct regulations and governmental strategies might suggest a regulatory or entrepreneurial approach, whereas a focus on financial incentives and networks could indicate a market-oriented or self-regulation-promoting stance (Djeffal, Siewert, & Wurster, 2022).

The expected policy instrument mix for each state type, as shown in the provided table below, will then guide the classification of German federal states. This classification will rely on the relative emphasis each state places on different categories of policy instruments. For example, if a state's policy documents predominantly feature instruments like public investments and institutions, this might signal an alignment with the entrepreneurial state model. In contrast, a prevalence of incentive-based financial instruments and voluntary standards could indicate a market-oriented state (Djeffal, Siewert, & Wurster, 2022).

Dimensions	Entrepreneurial state	Market-oriented state	Regulatory state	Self-regulation-promoting state
Authority				
Direct regulations	neutral	low	high	low
Governmental strategies	high	neutral	neutral	low
Finance				
Public investments	high	low	neutral	low
Financial incentives	neutral	high	neutral	neutral
Organization				
Institutions	neutral	neutral	high	low
Networks	high	neutral	low	high
Information				
Data & Monitoring	neutral	neutral	high	neutral
Certificates & Labels	neutral	high	neutral	high
Outreach & Literacy	high	neutral	neutral	neutral

Table 2. Expected policy instrument mix of the four state types (Djeffal, Siewert, & Wurster, 2022)

To execute this analysis, the research will first transform the previously coded policy instruments into fuzzy-set data. This transformation involves assigning values between 0 and 1, where 0 indicates full non-membership and 1 indicates full membership in the set. The value of 0.5 will serve as the threshold demarcating the point of maximum ambiguity. The calibration of data will follow an empirical strategy, using the mean score of each policy instrument, adjusted to exclude outliers more than 1.5 standard deviations from the mean, to set the 0.5 threshold. Scores above this mean will indicate a tendency towards the entrepreneurial or regulatory state types, whereas scores below suggest an affinity towards the market-oriented or self-regulation-promoting state types (Djeffal, Siewert, & Wurster, 2022).

Subsequently, each German federal state will receive a score for each state type based on the calibrated values of the corresponding policy instruments. In line with the methodological precedents, if a low number of a particular instrument type is theoretically associated with a state type, the negated fuzzy set score will be used. Drawing on Djeffal, Siewert, and Wurster (2022) the following formula will be utilized:

For the *entrepreneurial state*, the mean value will be calculated from the number of instruments related to governmental strategies, public investments, networks, and outreach & literacy. This captures the essence of an entrepreneurial state as proactive and facilitative in various aspects of AI development and governance.

The *market-oriented state* score will be derived from the mean value of the negated number of instruments for direct regulations and public investments, emphasizing market-driven dynamics, and the straightforward count for financial incentives, certificates, and labels, which are indicative of a state that encourages market solutions and self-regulation.

The *regulatory state* will be quantified by averaging the number of instruments in direct regulation and institutions, showing the state's role in direct oversight, and the negated count for networks, reflecting a lesser focus on decentralized governance approaches. The data & monitoring instruments will be counted normally, consistent with the regulatory state's focus on oversight and control.

For the *self-regulation-promoting state*, the formula includes the negated numbers for direct regulations, governmental strategies, public investments, and institutions to reflect this state type's preference for minimal direct intervention. The regular counts for networks, certificates, and labels will be included, demonstrating an emphasis on fostering self-regulatory environments.

Neutral permutations will not factor into these calculations as they do not conclusively align with any specific state type. A detailed script can be provided upon request.

The software tools utilized for this phase will be R's QCA package and the SetMethods package, which facilitate the calibration and computation of the fuzzy-set scores. These tools provide the necessary functions for accurately assigning fuzzy values and analyzing the resulting data to produce a compatibility score for each state type (Djeffal, Siewert, & Wurster, 2022).

The analysis will yield a compatibility score for each German federal state against the four ideal-typical state types. These scores will indicate the proximity of the state's actual policy instrument mix to the theoretical expectations, effectively mapping the empirical governance patterns onto the predefined state types. By examining these patterns, the research will identify the predominant governance modes and their alignment with the theoretical constructs, enriching the understanding of multi-level governance in the AI policy domain (Djeffal, Siewert, & Wurster, 2022).

3.4.3. Sensitivity Analysis

In order to ensure the robustness and reliability of the fuzzy set ideal type analysis, a sensitivity analysis was conducted. Sensitivity analysis is a critical methodological step used to examine how the results of a model or analysis respond to variations in the parameters or input data. For this study, the calibration thresholds, which define the fuzzy set membership scores, were systematically varied to test the stability of the state type classifications. The original calibration thresholds were adjusted by ±20% in the analysis. This range of adjustments allows us to observe how sensitive the membership degrees of each country are to changes in the thresholds. By applying these adjustments, we can determine whether the identified state types remain consistent or if they exhibit significant fluctuations, thus validating the robustness of our findings.

4. Analysis

4.1. Individual Policy Mixes

Answering the first research question (*What policy mixes are employed by different German federal states in their AI governance strategies?),* the following paragraphs provides an overview of the instrument use and resulting policy mix by each individual state, highlighting their individual approaches to AI governance. The states can be group into three categories:

4.1.1. High activity states

Hessen stands out with the highest number of individual policy instruments, totaling 57. This includes eight Certificates & Labels, ten Data & Monitoring tools, two Direct Regulations, one Financial Incentive, 15 Governmental Strategies, eleven Institutions, 19 Networks, 16 Outreach & Literacy programs, and 13 Public Investments. The high use of Governmental Strategies, Networks, and Outreach & Literacy highlights Hessen's comprehensive approach to AI governance. The significant presence of Public Investments, particularly in conjunction with Networks and Institutions, suggests a strategic emphasis on fostering collaboration and knowledge transfer between (state and research) institutions and economic actors. This multifaceted strategy indicates that Hessen is positioning itself as a leader in AI innovation through substantial state-supported initiatives.

Niedersachsen employs 53 individual policy instruments, reflecting a robust AI governance framework. The state's distribution includes one Certificate & Label, three Data & Monitoring tools, zero Direct Regulations, five Financial Incentives, ten Governmental Strategies, seven Institutions, 15 Networks, nine Outreach & Literacy programs, and a notable 31 Public Investments. The exceptionally high number of Public Investments underscores Niedersachsen's commitment to funding AI initiatives, potentially to boost regional competitiveness and innovation. The significant investment in Networks also points to a strategy aimed at enhancing collaboration between academia and industry, facilitating the practical application of research findings.

4.1.2. Medium activity states

Bayern, with 36 individual policy instruments, demonstrates a balanced approach to AI governance. The state's distribution includes two Certificates & Labels, three Data & Monitoring tools, one Direct Regulation, zero Financial Incentives, six Governmental Strategies, 12 Institutions, 17 Networks, five Outreach & Literacy programs, and ten Public Investments. Bayern's emphasis on Institutions and Networks suggests a strategic focus on establishing strong research foundations and promoting collaborative efforts. The moderate use of Public Investments and Governmental Strategies indicates a balanced approach that combines strategic planning with targeted investments to support AI development.

Baden-Württemberg employs 29 individual policy instruments, characterized by a relatively high number of Networks (20) and Outreach & Literacy programs (14). The state's distribution moreover includes two Certificates & Labels, five Data & Monitoring tools, one Direct Regulation, zero Financial Incentives, four Governmental Strategies, seven Institutions, and 18

Public Investments. The strong emphasis on Networks and Outreach & Literacy highlights a strategy focused on public engagement and collaborative innovation. The substantial Public Investments, often linked with Institutions and Networks, suggest significant state support for establishing research centers and fostering public-private partnerships.

Schleswig-Holstein utilizes 22 individual policy instruments, with a notable emphasis on Governmental Strategies (seven) and Financial Incentives (two). The state's distribution includes two Certificates & Labels, four Data & Monitoring tools, zero Direct Regulations, two Financial Incentives, seven Governmental Strategies, two Institutions, five Networks, five Outreach & Literacy programs, and four Public Investments. This relatively conservative use of Public Investments, combined with a higher focus on strategic planning and financial incentives, indicates a strategic approach that leverages planning and market-based instruments to support AI development.

Hamburg employs a total of 19 individual policy instruments, with a strong emphasis on Governmental Strategies (11). The state's distribution includes three Certificates & Labels, five Data & Monitoring tools, zero Direct Regulations, zero Financial Incentives, eleven Governmental Strategies, one Institution, four Networks, two Outreach & Literacy programs, and seven Public Investments. Hamburg's high use of Governmental Strategies and Data & Monitoring suggests a resource-saving approach, focusing on strategic monitoring and planning over direct financial support or extensive collaboration initiatives.

4.1.3. Low activity states

Nordrhein-Westfalen stands out with the fewest policy instruments, totaling 14. The state's distribution includes two Certificates & Labels, three Data & Monitoring tools, one Direct Regulation, zero Financial Incentives, two Governmental Strategies, three Institutions, six Networks, six Outreach & Literacy programs, and six Public Investments. The balanced yet minimalistic approach may indicate either a strategic focus on a few key areas or an early stage in developing its AI governance framework. The second option could be supported by the very limited data set of Nordrhein-Westfahlen which did not include an AI Strategy or Cabinet Reports.

4.2. Patterns and Outliers

With the goal of identifying common patterns and their outliers respectively, this study will analyze the data comparatively. In the following the results will be used to answer sub-question two: *Are there patterns and outliers in AI governance strategies across German federal states, and to what extent do they reflect elements of AI-Federalism?*

4.2.1. Instrument type distribution

In this study, a total of 230 individual policy instruments across seven German federal states were coded. Looking at the distribution across the different instrument types (see Figure 2.), Public investments has the highest frequency with a total of 89 occurrences (mean per state:

12.71), followed closely by Networks which appears 86 times (mean per state: 12.29). Outreach & Literacy is the next most frequent category with 57 instances (mean per state: 8.14), and Governmental strategies are documented 55 times (mean: 7.86). Institutions are mentioned 43 times (mean per state: 6.14), while Data & Monitoring shows up 33 times (mean: 4.71). Certificates & Labels are reported 20 times (mean per state: 2.86). Financial incentives have a total of 8 instances (mean per state: 1.14), and Direct regulations are the least frequent with 5 occurrences (mean per state: 0.71).

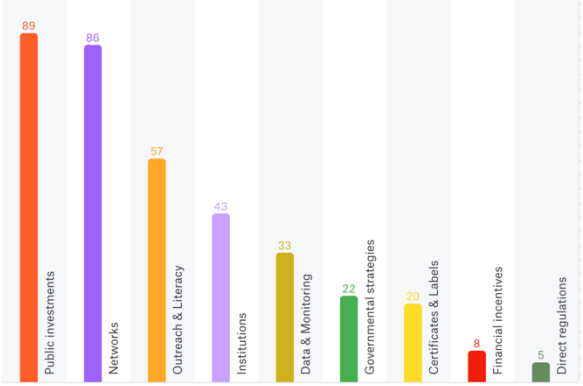

Figure 2. Results Coding

4.2.1.1. Variability across states

Diving deeper into the instrument type distribution across states the variability, as indicated by standard deviations, reveals significant differences in how states approach AI governance. Public investments and networks exhibit the highest variability, suggesting that these instrument categories are employed very differently across states. Some states, like Niedersachsen, heavily invest in public funding (31). In contrast, states like Schleswig-Holstein (4) show a more conservative approach to public investments. Similarly, the use of networks varies widely, with Baden-Württemberg (20) and Hessen (19) showing a strong emphasis on collaborative efforts, while Hamburg (4) and Schleswig-Holstein (5) employ fewer network initiatives.

4.2.1.2. Correlation

The correlation analysis between the total number of individual instruments and each instrument type provides further insights into these strategic approaches. Strong positive correlations between the total number of instruments and categories like networks ($r = 0.787$), outreach & literacy ($r = 0.822$), and public investments ($r = 0.817$) suggest that states with a higher overall instrument count tend to emphasize collaborative, educational, and investing initiatives. Moderate correlations with data & monitoring ($r = 0.662$), governmental strategies ($r = 0.618$), and institutions ($r = 0.541$) indicate that states with more instruments also value strategic planning, empirical evidence, and established institutions. Weaker correlations with direct regulations ($r = 0.436$) and financial incentives ($r = 0.361$) suggest that these instruments are less central to the overall strategic approach of states with higher instrument counts.

4.2.2. Instrument Design

Another important aspect of the policy mix is the design of the individual instrument. This brings us back to the total of 230 individual policy instruments. The addition of the instrument type numbers from Figure 2. and application to the individual policy instruments total reveals

a trend around instrument design. A mean of 1.72 instrument types per individual instrument highlights the importance of multi-use instruments in subnational AI governance.

4.2.2.1. Variability across states

In examining the instrument use across states, it is evident that there are significant differences in how individual instruments are designed. The ratio of instrument categories per individual instrument serves as a measure of how states design their policy instruments. Baden-Württemberg, with a ratio of approximately 2.45, indicates a high degree of flexibility, using its policy instruments across multiple categories. In contrast, Schleswig-Holstein, with a ratio of about 1.41, appears to use its instruments in a more focused manner. Other states, such as Bayern (1.56), Hamburg (1.74), Hessen (1.67), Niedersachsen (1.53), and Nordrhein-Westfalen (1.64), show moderate levels of multi-use instrument design, balancing between focused and broad approaches.

4.2.2.2. Code co-occurrence

The code co-occurrence analysis further elucidates the patterns of multi-instrument use. High co-occurrences between certain instrument types suggest strategic combinations that states employ to achieve their governance objectives. For instance, the significant co-occurrence between networks and public investments (43) highlights a strategic focus on investing collaborative projects. Typical initiatives include Public-Private-Partnerships in forms of Competence Centers, Transfer Hubs or Startup support structures. Similarly, the high co-occurrence between networks and outreach & literacy (30) underscores the importance of engaging and educating the public through collaborative platforms. Typical initiatives would be outsourced public consultation efforts or networking events to promote a new AI project.

Moderate co-occurrences, such as those between institutions and networks (22) and institutions and public investments (25), suggest an integrative approach where (newly created) institutions, mostly research centers, are closely connected to the regional economic sphere to transfer knowledge into innovative companies. The moderate co-occurrence between governmental strategies and data & monitoring (9) indicates that strategic planning often involves a strong emphasis on data collection and analysis, ensuring that policies are informed by empirical evidence and can adapt to evolving technological landscapes.

Conversely, low or zero co-occurrences highlight areas where is it ether not possible to mix certain types of instruments or states just prefer not to. For example, the minimal overlap between certificates & labels and direct regulations (1) suggests that standard-setting measures are typically used independently of regulatory interventions. For example, labels like “KI made in Bavaria” are concepted as a marketing brand instead of an obligatory industry norm. On the other hand, the lack of co-occurrence between financial incentives and institutions (0) is clearly explainable by the fact, that financial incentives are reserved to market-based initiatives and not for state institutions.

4.2.3. Key findings

Through a comparative analysis, several key findings could be identified: Firstly, significant differences in activity levels exist, with states like Hessen and Niedersachsen having extensive policy mixes, while Nordrhein-Westfalen and Hamburg lag behind. Secondly, the use of certain instrument types, particularly Public Investments and Networks, varies greatly across states and correlates with their overall activity levels. This could indicate that states, which already have a development AI ecosystem, are trying to create and fund collaborative efforts to further advance their leadership position. On the other hand, Direct regulations and financial incentives are employed very limited across all states. This can be explained by the character of AI governance, as a new emerging field, with little to none best practices for regulation and an underdeveloped economic sphere which could make use of financial incentives. Combined, these findings indicate that activity versus passiveness is a strong cleavage across states. While there are significant outliers across the states (see Hamburg's extensive use of governance strategies or Schleswig-Holstein in their use of financial incentives), most states set their priorities more moderately.

Additionally, the design of policy instruments is diverse, with a general trend towards multi-use instruments, although the extent of diversification varies (e.g., Baden-Württemberg vs. Schleswig-Holstein). Code-occurrence analysis highlights that combinations like networks/public investments and networks/outreach & literacy drive multi-use instrument design, underscoring the tailored approaches to AI governance across the states. This can also be explained by the character of AI governance, as AI is a cross-cutting technology which requires highly flexible instruments.

4.3. Role of the State

Answering the third sub-question (*How do these governance strategies reflect the role of the states in the context of AI governance?*), this chapter dives into the results of the fuzzy set ideal type analysis.

Hessen stands out with very high scores in entrepreneurial state (0.86) and regulatory state (0.97), indicating a highly proactive role in both fostering AI development and ensuring strict regulatory oversight. The moderate market-oriented state score (0.74) further suggests that Hessen supports market mechanisms alongside its robust public interventions. The low self-regulation promoting state score (0.10) implies that the state does not heavily rely on industry self-regulation. Hessen's approach exemplifies a strong, centralized governance model where the state actively shapes AI development through substantial investments and stringent regulations. This model aims to harness the benefits of AI while tightly controlling potential risks.

Niedersachsen`s governance strategy features a high entrepreneurial state score (0.79) and a moderate market-oriented state score (0.54), indicating a strong emphasis on public investment and innovation. The balanced scores in regulatory state (0.39) and self-regulation promoting state (0.44) suggest a mixed approach where the state also values regulatory measures and some

degree of industry self-regulation. This hybrid model aims to foster innovation while maintaining a reasonable level of oversight and stakeholder involvement. By blending different governance elements, Niedersachsen strives to create a supportive environment for AI development that also addresses regulatory needs.

Bayern, presents a more conservative approach with lower scores in entrepreneurial state (0.39) and market-oriented state (0.36) categories, coupled with higher scores in regulatory state (0.68) and self-regulation promoting state (0.43). This indicates that Bayern places significant emphasis on regulating AI technologies to mitigate risks, while still fostering some degree of market-driven innovation. The state's strategy likely aims to balance the need for innovation with stringent safety measures, ensuring that AI developments do not compromise public welfare. This cautious approach might be driven by a desire to avoid potential pitfalls associated with rapid, unchecked technological advancement.

Baden-Württemberg`s strong scores in both the entrepreneurial state (0.71) and regulatory state (0.73) categories indicate a dual approach to AI governance. This state not only invests heavily in innovation and public projects but also ensures robust regulatory oversight. The moderate market-oriented state score (0.50) and self-regulation promoting state score (0.41) suggest a balanced strategy where the government plays an active role in guiding AI development while also allowing market mechanisms to operate. This blend of proactive state intervention and regulatory control positions Baden-Württemberg as a leader in ensuring both innovation and safety in AI technologies.

Schleswig-Holstein`s low scores in entrepreneurial state (0.15), market-oriented state (0.29), and regulatory state (0.12) contrast sharply with its high self-regulation promoting state score (0.86). This reflects a predominant reliance on self-regulatory frameworks where the state's role is largely supportive rather than directive. The high self-regulation score indicates strong confidence in private sector-led governance and collective industry standards. While this approach maximizes flexibility and innovation potential, it requires robust mechanisms within the private sector to ensure accountability and address public concerns effectively.

Hamburg`s governance strategy is distinctive, with low scores in entrepreneurial state (0.27), market-oriented state (0.22), and regulatory state (0.18), but a high self-regulation promoting state score (0.72). This suggests that Hamburg relies heavily on industry and market actors to self-regulate AI technologies, with minimal direct state intervention. The high self-regulation score reflects a trust in the capability of private stakeholders to manage risks and innovate responsibly. This approach could be effective in fostering a dynamic and flexible AI ecosystem, though it may also pose challenges in ensuring consistent standards and addressing public concerns about AI safety and ethics.

Nordrhein-Westfalen shows a low entrepreneurial state score (0.11) and moderate scores in market-oriented state (0.31) and regulatory state (0.26), but a high self-regulation promoting state score (0.78). This indicates a preference for minimal direct state intervention in AI governance, relying more on market mechanisms and self-regulation by industry stakeholders. The low entrepreneurial and regulatory scores suggest that the state prefers to facilitate rather than lead AI development, focusing on creating a favorable environment for private sector

innovation. This approach can stimulate rapid innovation but might face challenges in addressing comprehensive safety and ethical standards.

State type characteristics of AI strategies

country	entrepreneurial_state	market_oriented_state	regulatory_state	self_regulation_promoting_state
Baden-Württemberg	0.71	0.50	0.73	0.41
Bayern	0.39	0.36	0.68	0.43
Hamburg	0.27	0.22	0.18	0.72
Hessen	0.86	0.74	0.97	0.10
Niedersachsen	0.79	0.54	0.39	0.44
Nordrhein-Westfalen	0.11	0.31	0.26	0.78
Schleswig-Holstein	0.15	0.29	0.12	0.86

Table 3. State type characteristics of AI strategies

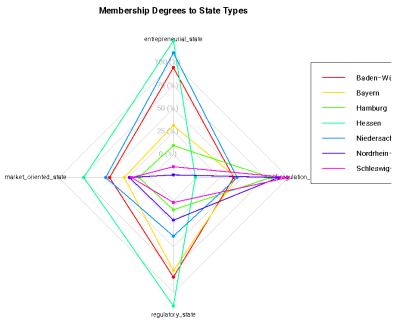

Figure 3. Membership Degree to State Types

4.3.1. Sensitivity Analysis

The results of the sensitivity analysis, illustrated in Figure 4., demonstrate the stability of the membership degrees for the various state types across different countries. The analysis included adjustments ranging from -0.2 to +0.2 of the standard deviation around the mean, encompassing a broader spectrum of possible threshold variations. The graphs show that, despite these substantial adjustments, the membership degrees for most state types remained relatively stable. For instance, countries like Schleswig-Holstein and Hessen exhibited minimal fluctuations in their membership scores, indicating a high degree of robustness in their classification. Even in cases where some fluctuations were observed, such as in Nordrhein-Westfalen and Hamburg, the overall consistency of the results suggests that the fuzzy set ideal type analysis is not unduly sensitive to changes in calibration thresholds. These findings confirm that the state type classifications are reliable and that the analysis method can be confidently used to draw meaningful conclusions about the policy instrument configurations in different countries. The robustness of the results underscores the validity of methodological approach and supports the reliability of the derived state types.

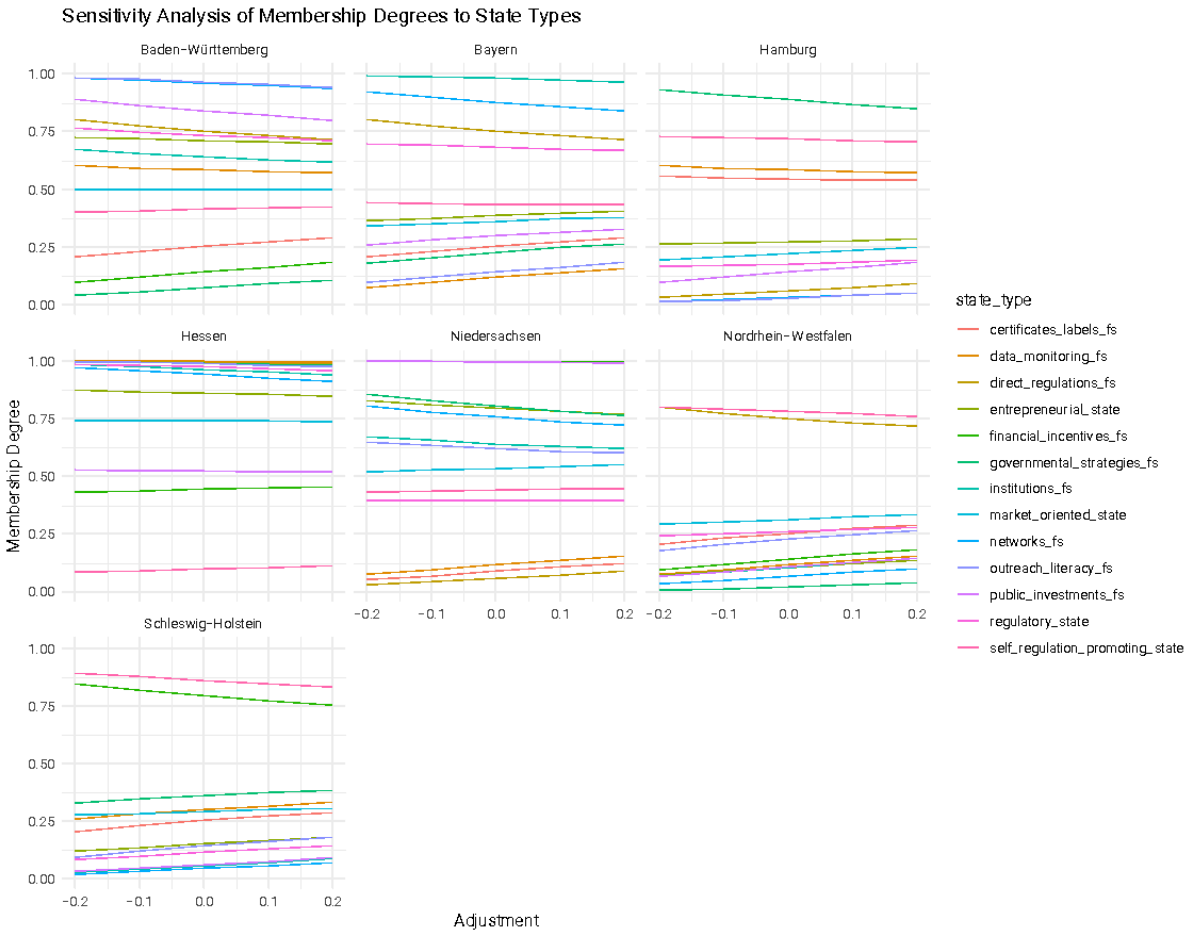

Figure 4. Sensitivity Analysis of Membership Degrees to State Types

5. Conclusion

5.1. Main Research Question

The primary research question, "How do the AI governance strategies of German federal states compare, and what does this reveal about the roles these states assume within the theoretical governance framework of AI?" has been addressed through a thorough examination of policy documents from seven German federal states. The findings indicate a significant variation in three main aspects across states, including activity levels, strategic focuses, and instrument designs, revealing diverse approaches to AI governance. The analysis highlights that states with more developed AI ecosystems tend to employ a broader range of instruments, emphasizing collaboration, public investment, and strategic planning. There can be justified assumptions about the roles the states assume within the AI governance framework, which include a significant variety across states and correlations between entrepreneurial and regulatory as well as market-oriented and self-regulating states.
These variations underscore the importance of subnational entities in shaping the AI governance landscape, reflecting the principles of AI federalism.

5.2. Contribution to the state of art

This research contributes to the existing body of knowledge by providing empirical insights into the decentralized policy-making processes within a federated system. By applying multi-level governance theories to the domain of AI, this study elucidates the roles of subnational entities in driving policy innovation and addressing regional needs.

Through the creation of the concept “AI-Federalism” Jobin et al. (2021) highlights the significance of subnational institutions in AI policy-making, arguing that subnational efforts offer unique insights that national and international frameworks might overlook. The findings align with this perspective, showing that German federal states, despite sharing cultural and institutional contexts, adopt diverse and sometimes competing strategies. The thesis especially highlights that while states commonly locate AI governance in the field of regional economic politics, their approaches in policy design significantly differ. The investigation of this diversity enhances our understanding of how AI policies are shaped by regional priorities and capabilities and might lead to better policy making by identifying best and worst practices. The subnational focus also emphasizes the role of German federal states as “policy design innovation labs”, suggesting that future research should further investigate the effectiveness of these subnational policies and their interplay with national strategies.

Concerning AI governance, this study enriches the understanding of assumed state roles in the field. Djeffal, Siewert, and Wurster (2022) discuss the distinction between states that actively govern AI through a combination of entrepreneurial and regulatory approaches and those that adopt a more passive, market-oriented stance. Our research confirms this dichotomy, with states like Hessen exemplifying an active, interventionist approach, while others like Schleswig-Holstein rely more on self-regulation. This supports the argument that the critical divide in AI governance is between active and passive states, rather than solely between regulatory and promotional strategies. This insight challenges the binary view often presented in public debates, highlighting the nuanced approaches governments can take in balancing innovation and regulation.

5.3. Limitations and future research directions

This study faced several limitations that should be addressed in future research. One major limitation is that not all states had dedicated AI strategies. Although the inclusion of digital plans, coalition agreements, and cabinet reports aimed to mitigate this issue, the dataset remained thin for some states such as Nordrhein-Westfalen and Hamburg. The analysis showed that states with an AI strategy are significantly more active, which raises the question about casualties. What roles play AI strategies in policy design? Are AI strategies obligatory for comprehensive governance frameworks? How could this thesis be justified? Future research should aim to replenish the dataset to address these limitations, ensuring a more robust analysis.

Additionally, time and resource constraints only allowed a limited case selection. While the case selection was justified through a intensity sample approach, expanding the analysis to include all 16 German federal states would provide a more complete picture of subnational AI governance and enhance the generalizability of the findings. This would also dive deeper into the interesting question of governing emerging technologies because although the activity level between investigated states still differs, all of them already had a form of base level including an AI policy agenda standing on its own and a certain institutionalization (Goldmann, 2021). So including the "underdevelopment" states could improve our understanding of developmental AI governance over time.

Taking this idea one step further, comparative studies analyzing subnational AI governance in other countries could reveal whether the observed patterns are specific to Germany or if they hold in other federal systems, contributing to a broader understanding of AI governance globally. This would also strengthen multi-level governance theory and its impact on emerging technologies across the globe.

Data accessibility issues posed challenges, as some policy instruments could not be clearly coded due to insufficient presentation. This included the intransparent allocation and use of funding resources as well as the unclear description of responsibility and accountability. Furthermore, certain causal relationships, such as the variability of networks and public investment codes, remained unclear, indicating areas where the analysis could be deepened. Explaining in detail why states use different instruments and what they expect from it, is of central importance to build theoretical frameworks that actually support good policy design. Future research would profit from expert interviews with policy makers that disclose in detail how certain instruments are to be implemented, by whom and to which purpose.

Adding to this idea, another limitation is described by the selected observation of the policy making circle. In this thesis only the policy formulation (and to a certain extent the policy implementation) part of the policy making circle was investigated. Policy makers and other actors involved in the process would significantly benefit from an analysis regarding the effectiveness of certain instrument types in AI governance.

Lastly, with a look at the European level, the EU AI Act introduces us to the first regulatory attempt of governing AI. Over years the European commision, parliament and council as well as other involved (profit and non-profit) stakeholders worked on this globally unique project. This will have extensive ripple effects on national states in the EU but also on federal states. As investigated in this thesis, German federal states employ very little to none direct regulations on AI development. This will change with the introduction of the EU AI Act, as national states need to implement regulatory requirements. As the EU allows a certain variability in this, to allow adoption to the national rule of law context, it will be interesting how states use their

room for maneuver. Especially in Germany history shows that federal states have their say in this. Future research should look closely at their role in introducing a great amount of direct regulations for the first time.

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7. Appendix

Figure 1. Governance dimensions of AI and resulting state types (Djeffal, Siewert, & Wurster, 2022)

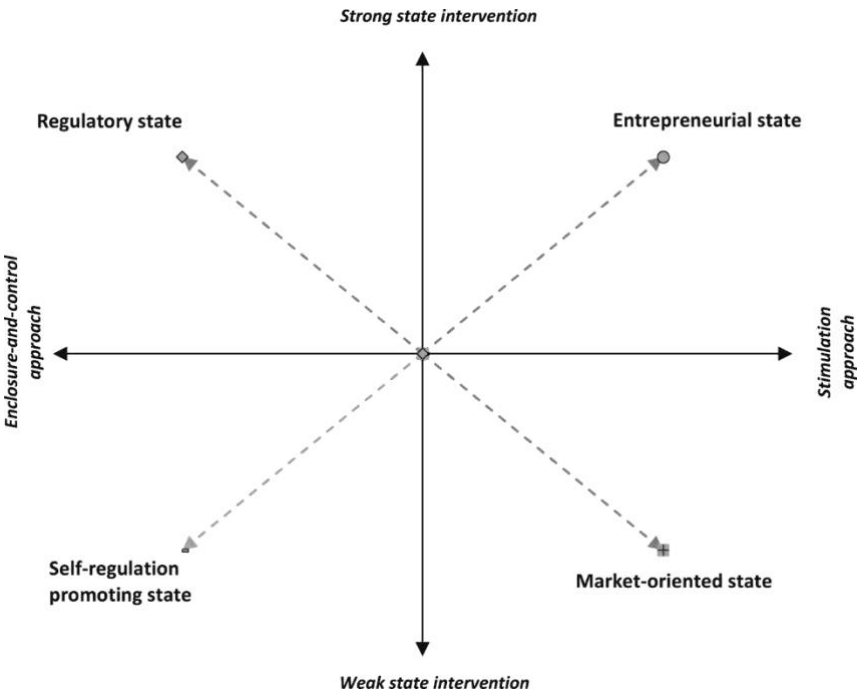

Figure 2. Results Coding

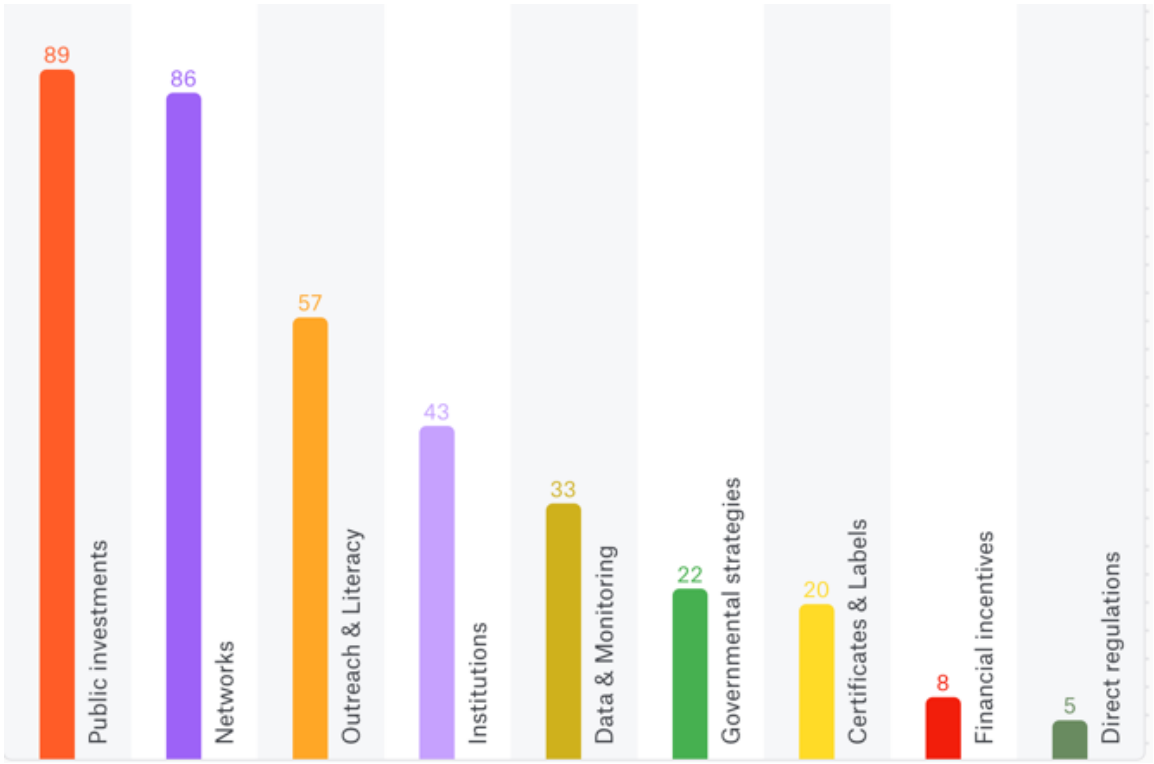

Figure 3. Membership Degree to State Types

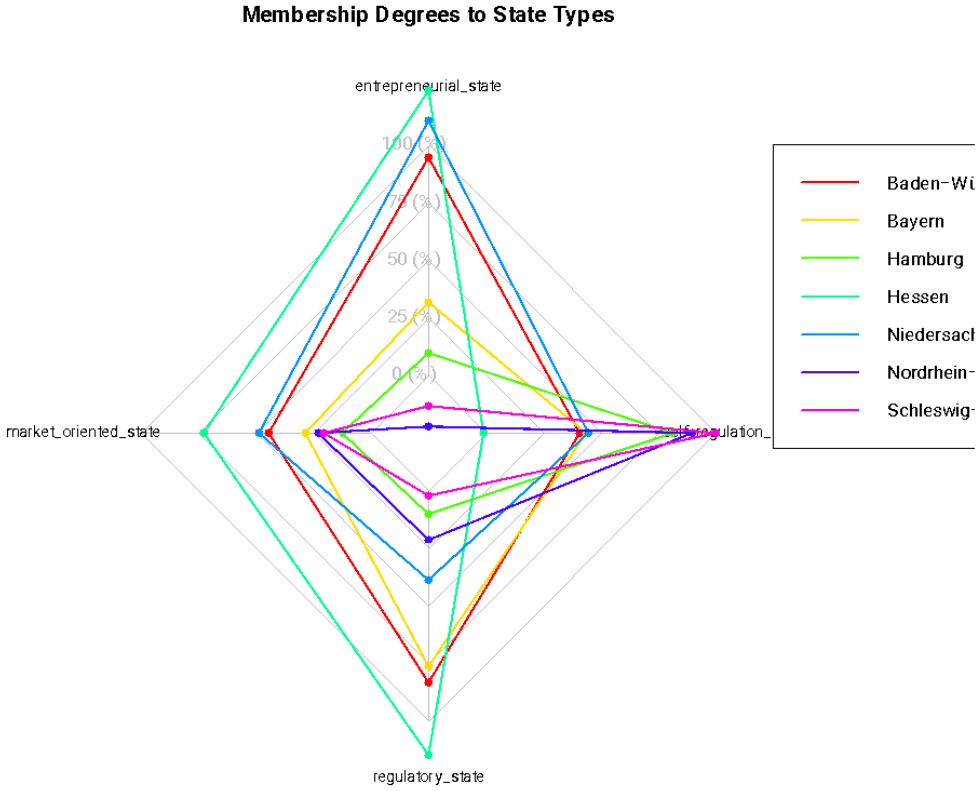

Figure 4. Sensitivity Analysis of Membership Degrees to State Types

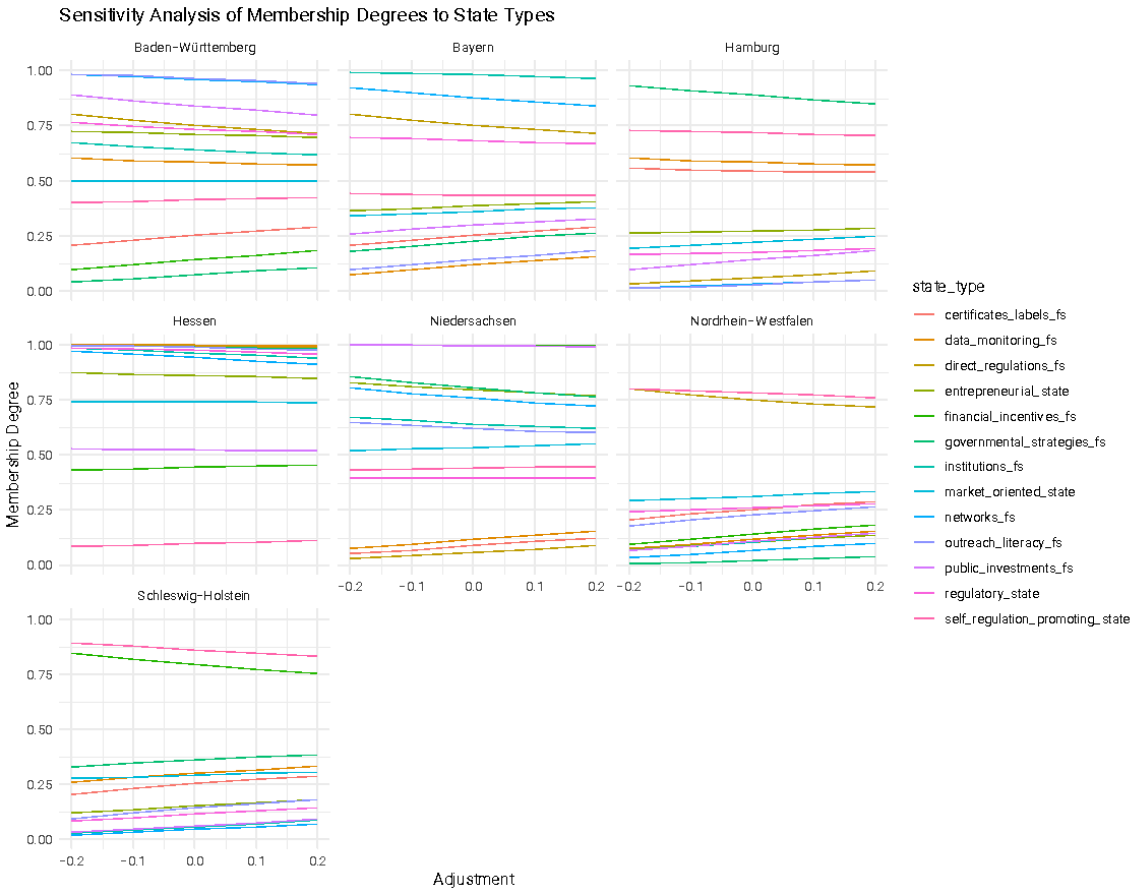

Table 1. Data Set

State	Coalition Agreement	Digital Plan	AI Strategy	Cabinet Reports
Nordrhein-Westfalen	X (2022)	X (2021)	/	/
Bayern	X (2023)	X (2023)	/	X (2018-2024)
Baden-Württemberg	X (2021)	X (2022)	X (2018)	X (2021-2023)
Niedersachsen	X (2022)	X (2018)	X (2022)	/
Hessen	X (2024)	X (2021)	X (2022)	/
Hamburg	X (2020)	X (2020)	/	/
Schleswig-Holstein	X (2022)	X (2024)	X (2022)	/

Table 2. Expected policy instrument mix of the four state types (Djeffal, Siewert, & Wurster, 2022)

Dimensions	Entrepreneurial state	Market-oriented state	Regulatory state	Self-regulation-promoting state
Authority				
Direct regulations	neutral	low	high	low
Governmental strategies	high	neutral	neutral	low
Finance				
Public investments	high	low	neutral	low
Financial incentives	neutral	high	neutral	neutral
Organization				
Institutions	neutral	neutral	high	low
Networks	high	neutral	low	high
Information				
Data & Monitoring	neutral	neutral	high	neutral
Certificates & Labels	neutral	high	neutral	high
Outreach & Literacy	high	neutral	neutral	neutral

Table 3. State type characteristics of AI strategies

State type characteristics of AI strategies

country	entrepreneurial_state	market_oriented_state	regulatory_state	self_regulation_promoting_state
Baden-Württemberg	0.71	0.50	0.73	0.41
Bayern	0.39	0.36	0.68	0.43
Hamburg	0.27	0.22	0.18	0.72
Hessen	0.86	0.74	0.97	0.10
Niedersachsen	0.79	0.54	0.39	0.44
Nordrhein-Westfalen	0.11	0.31	0.26	0.78
Schleswig-Holstein	0.15	0.29	0.12	0.86

Table 4: Description of policy instruments

Class of instruments	Type of instruments	Description
Authority	Direct regulations	Includes various types of direct regulation through legislation, binding agreements, and/or executive actions.
	Governmental strategies	Refers to all kinds of planning tools such as government white papers, policy guidelines, strategies, frameworks and roadmaps.
Finance	Public investments	Includes all kinds of instruments related to public investments, e.g. through budgetary accounting, the funding of programmes (e.g. R&D, education, procurement), or public expenditure for (technical and non-technical) infrastructure.
	Financial incentives	Encompasses incentive- and market-based instruments such as tax incentives and reductions, loans and grants for start-ups and businesses in AI, provision of venture capital for AI and creation of investment funds, or voucher systems.
Organization	Institutions	Covers instruments related to the creation of new bodies and entities tasked with AI-related policymaking or R&D, e.g., ethic councils. (non-)governmental commissions, expert bodies, or new research centres.
	Networks	Includes all kinds of activities concerning the creation of networks and platforms for exchange like public-private partnerships, dialogue platforms and discussion fora, participatory tools for stakeholders like hackathons and public consultations, or AI competition schemes, among others.
Information	Data & Monitoring	Comprises different tools which aim to collect, share and analysis data regarding trends in AI, as well as instruments that set out to monitor, review, and report on AI-related developments.
	Certificates & Labels	Entails instruments that pertain to voluntary standardization activities, the creation of certificates and auditing systems, or the publication of labels for AI-based technologies.
	Outreach & Literacy	Includes all instruments related to public outreach, increasing AI awareness and literacy, e.g. public relations campaigns, websites and platforms, AI literacy programmes.

Note: Djeffal, Siewert, & Wurster 2022, based on Howlett 2020; Hood and Margetts 2007.

Table 5: Codebook for the taxonomy of policy instruments

Code	Description and coding examples
Direct regulations	Includes various types of direct regulation through legislation, binding agreements, and/or executive actions. *Anchor example:* - "At the same time, the state government will strengthen existing digital experimentation clauses in the laws and promote the inclusion of new experimentation clauses in state laws. In this way, the law can be developed in a future-oriented manner." Nordrhein-Westfahlen, Digital Strategy2.0 2021, p. 100. - "In order to test automated administrative decisions, Section 35a of the State Administrative Procedure Act (LVwVfG) should be supplemented with an experimentation clause." Baden-Württemberg, Coalition Agreement 2021, p. 20.
Governmental strategies	Refers to all kinds of planning tools such as government white papers, policy guidelines, strategies, frameworks and roadmaps. *Anchor example:* - "We are also committed to ensuring that investigative authorities use new, innovative approaches, including examining the use of artificial intelligence (AI)." Hamburg, Coalition Agreement 2020, p. 178. - "With the " Human-centred AI for Lower Saxony " strategy, the state government of Lower Saxony is defining the framework conditions, identifying the need for action and deriving concrete goals and measures that will make Lower Saxony competitive in the field of artificial intelligence both nationally and internationally and further expand its own strengths." Niedersachsen, AI Strategy 2022, p. 9.
Public investments	Includes all kinds of instruments related to public investments, e.g. through budgetary accounting, the funding of programmes (e.g. R&D, education, procurement), or public expenditure for (technical and non-technical) infrastructure. *Anchor example:* - "From 2024, powerful AI clusters with state-of-the-art processors will be built at the Leibniz Supercomputing Centre in Garching (LRZ) and the Regional Computing Centre Erlangen (RRZE). The Free State of Bavaria is providing up to 55 million euros for this in the 2024/25 double budget as part of the High-Tech Agenda." Bayern, Cabinet Report 6.2.2024, p. 7. - "The federal-state initiative to promote artificial intelligence in higher education is funding projects at Goethe University Frankfurt am Main, the University of

Kassel, Frankfurt University of Applied Sciences and Offenbach University of Art and Design with 6.6 million euros." Hessen, AI Strategy 2022, p. 28.

Financial incentives

Encompasses incentive- and market-based instruments such as tax incentives and reductions, loans and grants for start-ups and businesses in AI, provision of venture capital for AI and creation of investment funds, or voucher systems.

Anchor example:

- "To this end, a €20 million "AI Turbo" funding programme will enable companies to initiate AI pilot projects and put their own business model and internal processes to the test in order to integrate AI applications in a targeted manner." Niedersachsen, AI Strategy 2022, p. 25.
- "Distr@l will publish a separate call for AI funding in the first quarter of 2022: Distr@l will specifically initiate the integration of AI into processes in SMEs." Hessen, AI Strategy 2022, p. 22.

Institutions

Covers instruments related to the creation of new bodies and entities tasked with AI-related policymaking or R&D, e.g., ethic councils. (non-)governmental commissions, expert bodies, or new research centres.

Anchor example:

- "The agency is to include an AI Council, which is to create an impact beyond the state's borders with internationally renowned AI ambassadors from science and industry. The Bavarian AI Council is to consist of around 15 renowned personalities from business and science, non-university research organisations and the start-up scene." Bayern, Cabinet Report 10.12.2019, p. 7.
- "In addition, regional AI centres of excellence are to be established in the Stuttgart, Karlsruhe and Neckar-Alb regions, as well as in Ulm, Ostalbkreis and Freiburg, and cooperation measures are to be implemented." Baden-Württemberg, Digital Strategy 2022, p. 31.