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# Southern Germany's Innovation Clusters: Regional Growth Coalitions in the Knowledge Economy

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## Abstract

This paper examines Germany's distinctive path toward the knowledge economy, emphasizing the role of regional innovation dynamics and governance, with a focus on Southern Germany's high-innovation clusters. Unlike other advanced economies that pivoted toward high-tech services, Germany has prioritized digital advancements within its manufacturing base, creating a model driven by smart manufacturing and Industry 4.0. We argue that regional growth coalitions, formed by firms, social partners, and local governments, foster institutional configurations supporting knowledge-based and innovation-focused competition. This regionalized governance has enabled Southern Germany to capitalize on Germany's innovation agenda, a success that other regions have struggled to replicate. By analysing multi-scalar dynamics—interactions across regional, national, and EU levels—our study expands evolutionary economic geography (EEG) and political economy literature, challenging traditional, nation-centric frameworks. Our findings highlight that cohesive regional governance can enhance national and supranational innovation strategies, underscoring the importance of regional institutions in advancing and sustaining knowledge economy innovation.

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## 1. Introduction

In recent decades, advanced industrialized countries have undergone a substantial shift toward the knowledge economy. This new economic paradigm emphasizes the importance of non-Fordist technical capabilities, intellectual creativity, and innovation as primary drivers of economic development. Contrary to predictions of a more “flattened” world with uniform economic opportunities, this shift has instead produced a “spikier” world with concentrated regional growth (Storper 1997, 2018). As a result, some areas have thrived and experienced notable growth, whereas others have stagnated or declined.

A significant body of research has focused on the spatial economic disparities in the United States, where differences between highly innovative tech sectors in urban coastal areas and deindustrialized midwestern regions have been associated with growing political polarization and social inequality (Soskice 2022). However, the European transition toward the knowledge economy has followed different trajectories, largely shaped by distinctive regional and institutional contexts. With few exceptions (Hassel & Palier 2021; Thelen 2019; Diessner et al. 2022), the literature has not sufficiently explored these distinct pathways or considered the spatial dynamics and role of innovation in shaping the transition in the EU.

Germany presents a unique case: unlike other European economies that have diversified into high-tech and service sectors, Germany has doubled down on high-end manufacturing through initiatives like Industry 4.0, which emphasizes digitalization within traditional sectors. Germany’s innovation capabilities are widely recognized. In 2020, Germany ranked sixth in gross expenditure on R&D (GERD) as a percentage of GDP (3.14% of GDP, amounting to USD 110 billion) (OECD 2022). Additionally, Germany accounted for 30% of all Patent Cooperation Treaty (PCT) applications in Europe and held a substantial global share in high-value patents. However, despite these strengths, the German innovation system is often critiqued for its relative lack of advancements in digital services and artificial intelligence. Manufacturing-focused innovation has created dependencies on external providers of essential digital services, such as cloud computing, particularly from US tech firms, which could potentially restrict Germany’s digital sovereignty (Trampusch 2024; Lechowski & Krzywdzinski 2022).

This paper addresses a critical gap in the literature by examining the regional dynamics and institutional factors that have shaped Germany's transition to the knowledge economy, with a focus on the Southern German Länder of Baden-Württemberg and Bavaria. These regions have emerged as centres of productivity and R&D in high-end manufacturing, with notable clusters in advanced manufacturing. The 2023 European Innovation Scoreboard (EIS, 2024) classifies six German regions as Innovation Leaders, five of which are in Southern Germany<sup>2</sup>. The metropolitan areas of Stuttgart and Munich are among the most prominent innovation clusters in Southern Germany, driving productivity and technological advancements (EPO, 2020). These two clusters have consistently outpaced other regions in terms of economic and productivity growth, aligning with global innovation leaders like Boston and San Francisco. These spatial patterns, however, cannot be fully explained through a national framework alone. Our central questions, therefore, are: What factors have enabled Southern German regions to capitalize on smart manufacturing, and what challenges might this focus present in the evolving digital economy?

We argue that Southern Germany's success in the knowledge economy stems from regional growth coalitions, which include firms, social partners, and regional governments, and foster institutional configurations aligned with smart manufacturing. These regional coalitions, in coordination with federal policies, have supported Southern Germany's transition to innovation-driven industry clusters. Both regions have benefited from strong Large Research-Oriented Companies (LROCs), which have enabled them to address the challenges of digitalization and software integration effectively. Additionally, cooperative labour relations, strong educational institutions, and industry-focused policies have been foundational to these regions' sustained growth and adaptation.

Our analysis also posits that innovation is deeply embedded within a broader macroeconomic and regulatory context that shapes firms' strategies. In Germany, the Eurozone's fiscal and monetary policies constrain investment behaviours, while low levels of financialization limit high-risk investments. As a result, German firms typically rely on self-funded innovation, often focusing on established high-end manufacturing sectors. Within this macroeconomic framework, LROCs have pursued regional innovation strategies in collaboration with regional

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<sup>2</sup> Bavaria: Oberbayern and Mittelfranken. Baden-Württemberg: Stuttgart, Karlsruhe, and Tübingen. North-Rhine Westphalia: Cologne.

policymakers and social partners, leading to concentrated knowledge-based industry clusters in Southern Germany while limiting the development of similar sectors in other regions.

Regional diversity has always been a feature of Germany's political economy, but the transition to the knowledge economy has accentuated and intensified these differences. The paper examines how new political-economic foundations support regional innovation clusters. We argue that regional institutional arrangements, supported by growth coalitions that include political actors at both regional and federal levels, LROCs, works councils, and unions, have enabled the emergence of smart manufacturing clusters. This cohesive innovation ecosystem has thrived where regional initiatives align with regional strengths, while regions with less cohesive growth coalitions have struggled to capitalize on these changes.

Our approach builds on the work by Rodríguez-Pose and co-authors that underscores the critical role of well-developed institutional frameworks in fostering resilient, innovation-driven economies (e.g. Rodríguez-Pose 2013; Rodríguez-Pose & Crescenzi 2008). It extends existing scholarship by addressing the role of regional institutions and multi-scalar dynamics in shaping economic outcomes, an area that remains underexplored in evolutionary economic geography (EEG). As Essletzbichler et al. (2023) and others (MacKinnon et al. 2009; Dawley 2014) suggest, the dominant EEG focus on micro- and meso-level interactions has often neglected macro-level factors, such as the interplay between subnational and national policy contexts and actors. By incorporating these multi-scalar dynamics, our study highlights the importance of regional and national institutions as interdependent forces that shape spatial economic outcomes.

Our study also advances the emerging literature on the spatial effects of the knowledge economy in Germany (e.g., Thelen 2019; Diessner et al. 2022) by demonstrating how regional governance and innovation clusters shape economic trajectories. We show that the decline of national-level coordination and the rise of decentralized, regionally-focused institutions have enabled regions like Baden-Württemberg and Bavaria to succeed in the knowledge economy. This underscores that cohesive innovation—driven by regional policies tailored to smart manufacturing—can promote both economic success and social cohesion, as seen in Southern Germany.

Furthermore, our study highlights the importance of considering subnational dynamics within political economy research. While much of the existing literature (e.g., Hassel & Palier 2021; Baccaro et al. 2022) has traditionally focused on the nation-state, we demonstrate that regional institutional configurations are crucial for understanding divergent economic paths within a country. Our analysis challenges the nation-centric perspective, underscoring that regional dynamics and inter-scalar interactions are essential to understanding the complex evolution of the knowledge economy.

This paper is structured as follows. First, we provide a conceptual framework for understanding regional dynamics within the knowledge economy, focusing on how firms and institutions co-evolve to foster innovation-driven competition. Next, we examine Southern Germany's success in smart manufacturing, identifying key factors—including regional growth coalitions and supportive institutional arrangements—that have positioned regions like Baden-Württemberg and Bavaria as leaders in high-tech manufacturing. We then examine Germany's shift from centralization to regionalization, highlighting how Southern Germany successfully transformed its regional institutions to strengthen and sustain its innovation clusters through targeted adaptations in education, industrial relations, and regional investment strategies. Finally, we reflect on the significance of multi-scalar dynamics in shaping southern Germany's innovative strength and underscoring the pivotal role of regional governance and growth coalitions in navigating Germany's economic transformation.

## **2. Conceptualizing Regional Dynamics in the Knowledge Economy: Firms, Institutions, and Competitive Adaptation**

We propose a conceptual framework that combines the factors driving the transition towards the knowledge economy based on firms' strategies towards innovation and the institutional environment shaping these strategies. Our approach builds on foundational ideas in economic geography, which aims to explain the role that space and location play in economic development, and how the economic landscape evolves over time as well as recent comparative political economy addressing underlying actor constellations that drive institutional change. By integrating insights from EEG, we address how shifts in spatial development patterns are influenced by changes in institutional configurations that enable development and innovation activities. We respond to the critique by Essletzbichler et al. (2023), who highlight that EEG

has a tendency to overlook links between subnational and national policy contexts and actors. This critique echoes earlier observations by Dawley (2014), who emphasize the need to incorporate macro-level influences to understand regional economic evolution fully. Our framework, therefore, integrates these multi-scalar dynamics, positioning regional and national institutions as interdependent elements that shape economic landscapes.

Our framework comes in three parts: first the reorganization of firms in the context of knowledge-based competition, second the analysis of institutions and policies that shape path dependent development and third the factors that drive institutional change and economic specialization. These components explain the ability of firms to adapt to a new business environment which we call knowledge-based competition.

The transformation from traditional Fordist to knowledge-based business models has reshaped the business landscape of global manufacturing. The drive toward continuous innovation, product development, and efficiency has led to a new mode of competition that increasingly relies on advanced knowledge and innovation capacity rather than mass production capabilities alone. This has led firms to continuously innovate, reduce cooperations and instead uphold secrecy to avoid risk of imitation.

This shift toward "knowledge-based competition" represents a fundamental departure from previous business models focused predominantly on hardware and traditional industrial processes. To remain competitive, firms must constantly innovate and refine their products in an environment where secrecy, intellectual property protection, and rapid iteration are key to success (Krzywdzinski 2019).

One critical consequence of this transition is the rise of 'coopetition'—firms simultaneously cooperate on certain pre-competitive aspects of R&D while fiercely competing in the market once new technologies are established. The benefits of collaboration are decreasing with rising intensity and can even have negative returns on product innovation, showing an inverted U-shape curve in terms of benefits (Hottenrott & Lopes-Bento, 2016). In addition, the threshold or turning point is much lower for larger firms with higher collaboration complexities (Crescenzi et al. 2022).



Furthermore, the rise of "servitisation"—the blending of manufacturing with services—has become a key competitive strategy for many firms. The combination of traditional products with service offerings, such as software updates, maintenance, and predictive analytics, is a key component of the knowledge-based competition (Neely 2014). Firms are increasingly using long-term contracts and service-oriented business models to lock in customers, extending their competitive advantage beyond the initial sale.

The increasing emphasis on R&D activities, as well as the development and delivery of new services require a reconfiguration of a firm's workforce and governance practices. High-skilled employees proficient in software development, data analysts, as well as sales and marketing are increasingly in demand to sustain a competitive position in the market, while automation and digitization will transform previous jobs or make them redundant (Frey & Osborne 2017; Kurer & Galego 2019; Battisti et al. 2023; Krzywdzinski 2021; Herrigel 2015).

As a result, the need for guaranteeing a skilled workforce has become even more crucial for firms. While the increasing need for graduates is undermining the associational influence (Diessner et al. 2022), the new competitive environment has meant that works councils are aiming for guarantees of continuous learning and upskilling. In addition, graduates feel that they have more freedom and flexibility in terms of their career opportunities, increasing the pressure on firms to offer them an environment to stay. A cooperative highly skilled workforce is paramount for firms to achieve their goals. The way firms structure employee representation and cooperation is very flexible however and does not necessarily require a formal works council.

At the level of institutions and path dependence, we refer back to basic elements of comparative capitalism research (or Varieties of Capitalism or VoC) (Hall & Soskice 2001). VoC has proposed that the interplay of relationships governing labour relations, skills provision and corporate finance creates the conditions under which firms develop their strategies. In coordinated market economies, these relationships are controlled by largely centralized organizations in the forms of banks, trade unions and employers' associations and public policy. We use the basic insights of VoC to focus on these three sets of relationships to analyse the institutional changes within a coordinated market economy.

A substantial body of research underscores the critical role that institutions play in shaping regional economic outcomes. Studies by Rodríguez-Pose and collaborators (Rodríguez-Pose 2013; Rodríguez-Pose & Crescenzi 2008; Rodríguez-Pose & Ezcurra 2010; Rodríguez-Pose & Garcilazo 2015) highlight that both the quality and alignment of institutional structures are essential for fostering innovation, reducing regional disparities, and maximizing the returns on public investment. Hulke and Diez (2022) further show that regional development outcomes are often shaped by complex governance interactions and institutional layering. This layered governance framework is similarly crucial for fostering resilience and innovation within Southern Germany's high-tech clusters.

Our framework extends VoC and economic geography insights by emphasizing mutual influence: not only do institutions shape firms' strategies, but firms' evolving market adaptations also drive institutional adjustments. In other words, our perspective diverges from traditional institutionalist literature that emphasizes the primacy of institutions. Instead, we argue, following Herrigel (2010), that companies are the active agents of change, adapting internally while simultaneously exerting pressure on institutions to align with their evolving needs. In other words, while companies are restrained by existing institutions as they evolve internally, they also start to exert pressure externally to drive incremental institutional adaptations, fostering regional institutional configurations tailored to support competitive innovation.

The success of both large and smaller companies in transitioning to the knowledge economy is deeply influenced by their regional environments, which are shaped by policies and other institutions. While firms are adapting to the new competitive innovation reality, they exert pressures on and remain constrained by the environments and institutions they are embedded in. We assume and show path dependence does not preclude institutional change but that over time institutions adapt to the pressures by firms that upgrade their business models. This includes a stronger regionalization of institutional configurations.

Building on recent advances in comparative political economy (Baccaro et al. 2022, Hassel & Palier 2021) we acknowledge that key institutions shaping firms' behaviour are located at the federal level and constrain regionalization. These include most forms of taxation, the legal system and corporate governance systems. Importantly, fiscal and monetary policies are generally also out of reach for regions.

Aggregate demand at the regional level remains a semi-determinant of growth and employment within regions and industry clusters. For regions within the Eurozone, key macroeconomic policies, such as monetary policy, are set by the ECB in nominal terms, while the nominal exchange rate is given by the Euro in relation to other currencies, limiting regional influence over these rates.

However, regional competitiveness (real effective exchange rate) is also influenced by factors like unit labour costs and pricing strategies. Here, unions play a key role. Notably the regional sections of trade unions in coordinated wage bargaining systems will carefully consider the implications of wage agreements with this in mind.

Similarly, fiscal policy is shaped by national constraints. While individual Länder are required to maintain balanced budgets, restrictive federal fiscal policy limits regional fiscal flexibility, constraining the use of fiscal tools at the state level. Thus, the growth of private sector aggregate demand in regions depends significantly on domestic aggregate demand growth, on demand growth in its major export markets, and on net FDI and net foreign income flows. Most important for aggregate demand in regions is the growth of demand for their exports, along with net profits from these markets.

While regionalization is therefore limited, it is also supported by federal actors. At the federal level, there remains a vested interest in successful regional development, often leading to national support for region-specific specializations. Such specialization strategies enhance overall competitiveness while fostering unique regional innovation hubs that align with broader national economic objectives.

Finally, we argue that regional growth coalitions consisting of firms, social partners and regional governments jointly work on changing the institutional setting in order to support firms to protect their competitive advantage. The emerging literature on growth coalitions (Baccaro et al. 2022, Di Carlo et al. 2025) builds on the notion that cross-class coalitions form in coordinated economies that aim to protect and promote industries (Swenson 1991, Thelen 2019). These growth coalitions are often connected to particular sectors. They form networks and initiatives in which both business and trade unions jointly with government agencies engage in knowledge dissemination but also the promotion of best practices. Regional growth

coalitions contribute to regional differentiation of economic institutions and to the evolution of innovation clusters in some regions and not in others.

In conclusion, regional institutional differentiation based on regional growth coalitions has been instrumental in supporting the emergence of innovation clusters in the context of coordinated market economies. These clusters, embedded in supportive regional frameworks, have become drivers of the knowledge-based business models.

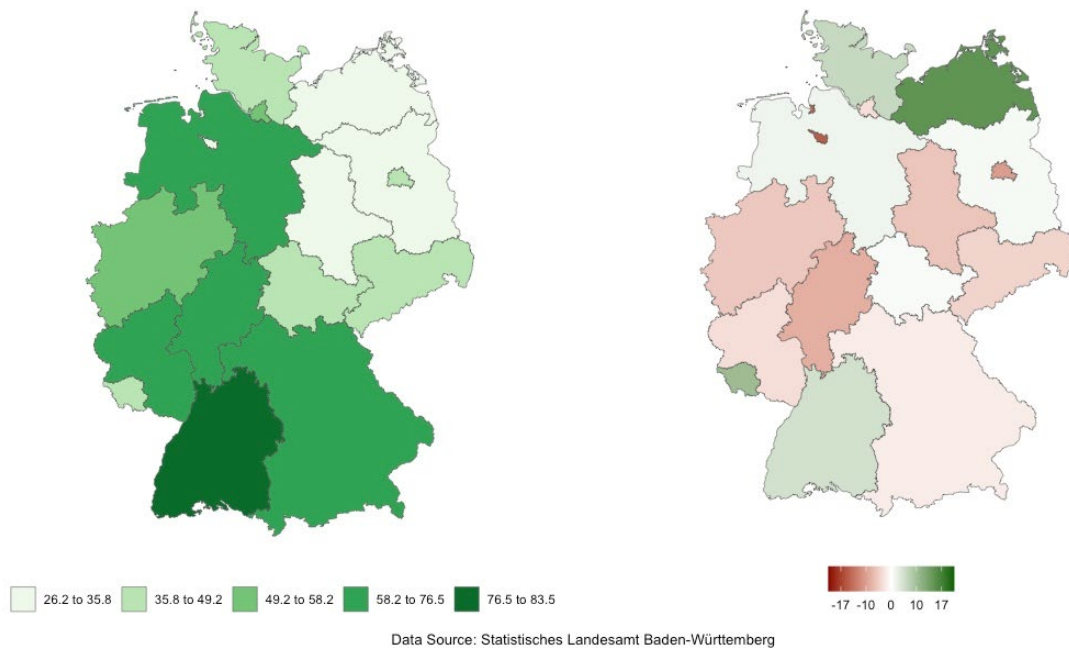
### **3. Smart Manufacturing as a Regional Innovation Strategy in Southern Germany**

Baden-Württemberg and Bavaria have emerged as the leading regions of innovation as a result of the transition towards the knowledge economy between 2000 and 2020 in Germany. The transition to knowledge-based competition has become especially evident in the automotive sector. Leading firms like BMW, Mercedes-Benz, and Audi have rapidly integrated emerging technologies—such as electric mobility, autonomous driving, and advanced software—into their production processes to maintain a competitive edge in the knowledge economy (Schwarz-Kocher et al. 2019). This transformation has been facilitated by regional growth coalitions in Baden-Württemberg and Bavaria, where collaboration among firms, local governments, and educational institutions has enabled the development of a highly skilled workforce tailored to the demands of smart manufacturing.

Businesses, particularly large research-oriented companies, highlight the importance of strategic company decisions in the new economic environment. Successful firms also seem to be spatially concentrated which is fuelling increasing regional divergence resulting from the transition to the knowledge economy. From 1999-2019, BW's business share of R&D spending intensity increased from 78.7% to 83.5%. Bavaria and Lower Saxony's shares remained relatively constant, while NRW's business share decreased from 63.9% to 58.2%.

Business Share of R&D Spending Intensity (%)  
by Land 2019

Change in Business Share of R&D Spending Intensity (%)  
by Land 1999-2019



*Figure 1, Business share of R&D spending intensity by Bundesland 2019 (left). Change in Business share of R&D spending intensity by Bundesland 1990-2019. Data source: Statistisches Landesamt Baden-Württemberg*

High R&D costs and diminishing returns due to increasing technological complexity and shorter product cycles make SMEs less likely to invest in R&D. However, SMEs in BW employ the highest number of R&D personnel in Germany, with 19.4% of R&D personnel in SMEs, showing a focus on knowledge-intensive activities. Moreover, the total number of employed R&D personnel in SMEs in BW grew by roughly 19% in the time period 2017-19, showing that SMEs in BW are increasingly focusing on knowledge intensive activities as well (Einwiller 2022).

The metropolitan areas of Stuttgart and Munich stand out as epicentres for these developments, where dense networks of firms and institutions drive innovation in advanced manufacturing, with both regions recognized by the European Patent Office (2020) and European Regional Innovation Scoreboard (2024) as leading clusters.

Patent activity by company size shows that a few knowledge-intensive firms dominate patent registrations. Companies or institutions with more than 100 new patents a year accounted for 49.3% of total new patents in 2021, up from 31.6% in 2000. The top 50 companies with the most patents in BW in 2018 made up 47.7% of new patents in BW, compared to 36.7% in 2006

and 14.9% of all new German patents in 2018 compared to 10.1% in 2006. The top five companies in NRW accounted for 22.6% of patents in 2018, compared to 10.4% in 2006, and 3.3% of all German patents in 2018 compared to 1.8% in 2006.

Southern Germany, particularly BW and BY, dominates the top 50 list of companies, making up almost half (20% BW and 28% BY) of all companies. However, NRW still has a comparable number of companies, but with fewer patents (2% of the German total in 2006 and 3.6% in 2018) compared to southern companies, which increased their share from 25.3% (11.4% BW) in 2006 to 33.6% (17.1% BW) in 2018.

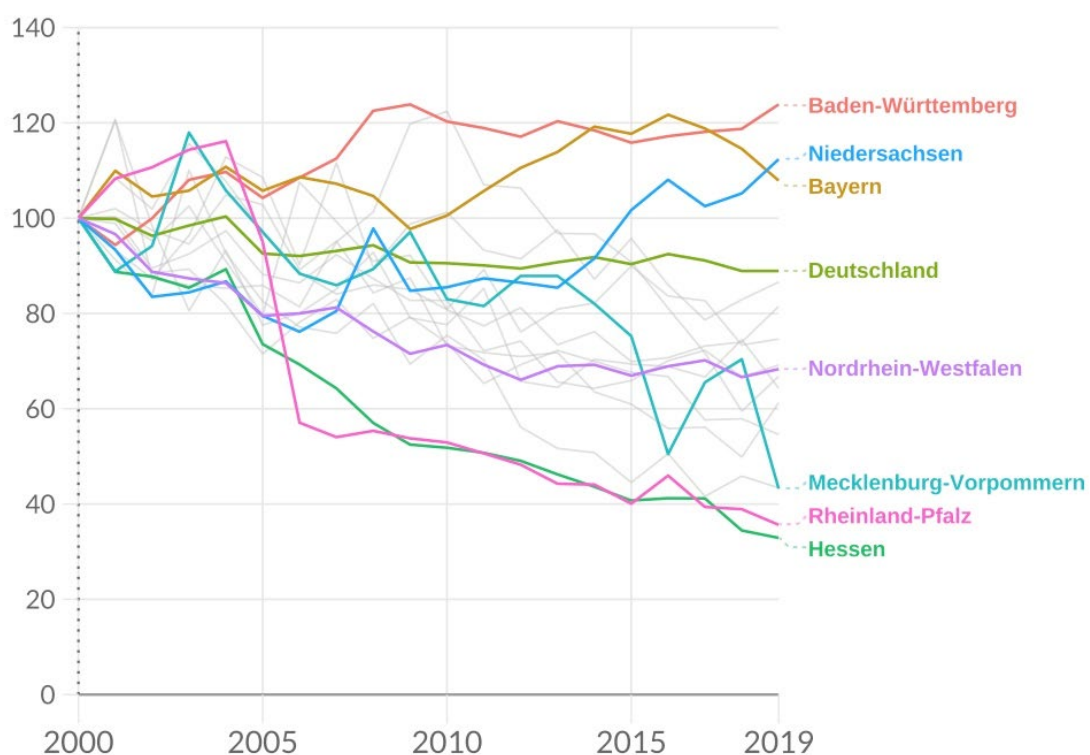


Figure 2, Number of patent registrations by Bundesland indexed (2000=100), German Average and selected Länder highlighted, own calculations. Data source: DPMA

The shift toward knowledge-based competition has affected inter-firm collaboration within the region. In Southern Germany, where proprietary knowledge has become a central competitive asset, companies are increasingly limiting cooperation to reduce the risk of imitation. For example, Mercedes-Benz and BMW briefly collaborated on autonomous driving research but dissolved the partnership after only a year, as the need to protect proprietary innovations became more pressing (Bouncken et al. 2015). As noted by Veer, Lorenz, and Blind (2016),

firms engaged in R&D cooperation with competitors face the constant risk of imitation, which has become a central strategic concern in the knowledge economy. In other words, firms will seek to hold cooperation to a necessary minimum in order to reap potential benefits without exposing themselves to higher risk of sharing potentially competitively advantageous information with other actors (Crescenzi et al. 2022). The increasing wariness of larger firms to share their knowledge and increase restrictions to access for others including suppliers is causing tensions in the previous collaborative relationships. This is also forcing suppliers to re-orient themselves entirely towards new sectors (see for example EBM Papst in Buchenau 2022).

Unsurprisingly, not all firms are managing to adjust to the new realities of competition as a result of the described changes and given the incentive structure of the existing macroeconomic framework. Some decided to focus on a more short-term price cutting strategy to remain competitive, which is increasingly challenging to maintain (Krzywdzinski 2019). Other companies did not read the signs of where markets were going and missed to invest in product developments to future proof themselves and are now struggling to keep up.

Unions and associations which traditionally played an integral part in coordinating innovation activities between companies within the same sector have experienced changes due to the reduced incentives to engage in inter-firm cooperation. Innovation-oriented companies are now not just less likely to be organised in associations, but also increasingly disincentivised to share information with each other as competition is increasingly knowledge and innovation driven. The result is the emergence of a more decentralised industrial relations model. As a result, regional coalitions are now crucial for fostering innovation ecosystems where knowledge transfer can still occur in a controlled and locally focused manner, even as firms become more protective of proprietary innovations.

Similarly, knowledge-based competition is contributing to the erosion of the 'Deutschland AG'—the tightly knit network of firms, banks, and directors that once characterized German corporate governance—reflecting the increasing autonomy of individual firms (Ringe 2015). Companies are opening up to a more international and diverse investor base in order to finance their strategic plans.

While the agency of firms—particularly their strategic decisions and investment in innovation—plays a critical role in determining success in the knowledge economy, other

factors at the regional, federal and supranational level significantly shape the context in which these firms operate. For large research-oriented companies (LROCs) like those in Southern Germany, the alignment between regional governments, firms, and other stakeholders has been instrumental in providing the necessary support for innovation. The macroeconomic environment and federal and EU fiscal and monetary policy responses still influence companies' innovation strategies. Growth coalitions in regions like Baden-Württemberg and Bavaria have enabled these firms to access tailored training programs, infrastructure support, coordinated R&D initiatives, as well as successful supra-regional lobbying efforts allowing them to maintain a competitive edge in smart manufacturing. This highlights that while firm strategies are crucial, they often thrive best when complemented by a supportive regional environment.

The macroeconomic framework in which German firms operate plays a pivotal role in shaping their innovation strategies in response to changing competitive pressures. The Eurozone's fiscal and monetary policies impose significant constraints on member states, limiting their ability to pursue expansionary fiscal policies that could stimulate aggregate demand. Germany itself has been a strong proponent of this macroeconomic and fiscal approach since the 2000s and heightened by the European sovereign debt crisis. For German firms, being embedded in this framework has led them to pursue a relatively conservative approach to investment and innovation, with a focus on self-financing and the avoidance of risky ventures.

Financialization in Germany has remained relatively low compared to other major economies like the United States or the United Kingdom. This is particularly evident in the limited role of venture capital and high-risk investments in the German economy (Lechowski & Krzywdzinski 2022).

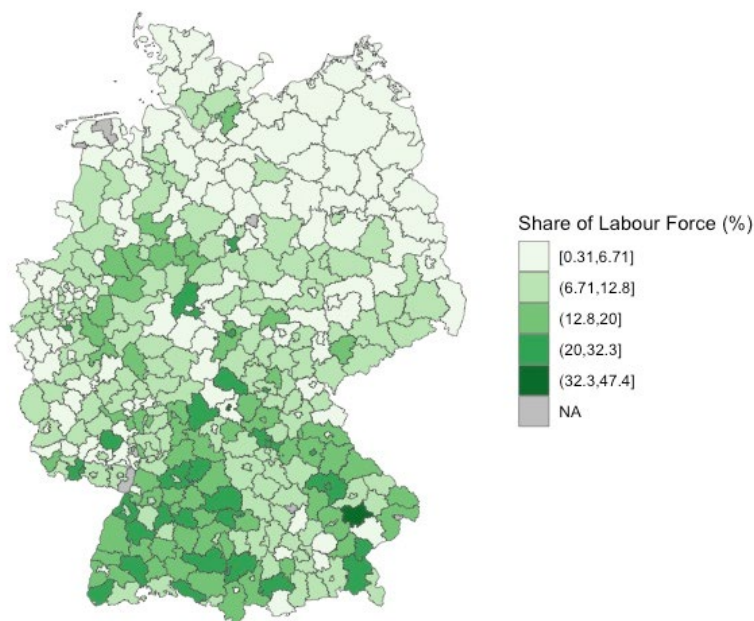
As a result, German firms have been disincentivised to pursue radically new innovation strategies or explore new sectors. This has contributed to the heavy concentration of innovation in established manufacturing sectors, such as automotive and machinery, while stifling the growth of new, high-tech, or service-based industries. In addition, the federal government is further incentivising innovation in established manufacturing through different funding schemes. Most notably science and research funding has become an important alternative to traditional sectoral subsidies. The federal government is key for these new alternative support subsidies (74% of Science and research funding is direct expenditure by the federal level,



whereas subsidies are only 33% federal). Its core programme, the federal High-Tech strategy shows classical selective vertical industrial policy elements supporting key technologies and sectors. 12 billion Euro from 2006 until 2009 supported 17 high-tech sectors (including Aerospace, Energy technologies, ICT, health and med-tech, nanotech, material science, microsystem and optical technologies).

One major consequence of the macroeconomic framework and policy decisions is that Southern Germany with its advanced industrial and manufacturing base (see figure 3 with share of the labour force employed in knowledge-intensive industries<sup>3</sup>) has not been as adversely affected by these constraints and managed to maintain a relatively high level of innovation activity. In addition, both Baden-Württemberg and Bavaria have benefited from strategic federal support and regional governance structures that prioritize smart manufacturing and Industry 4.0 initiatives, allowing firms to adapt to the challenges posed by the macro-regulatory environment of the Eurozone.

Share of Labour Force in Knowledge Intensive Industries  
by District in 2019



Data Source: INKAR

<sup>3</sup> Knowledge intensive industries are classified according to the 2008 revised classification of economic sectors (Klasifikation der Wirtschaftszweige [WZ]) and include WZ 20-21 and 26-30. 20 – chemical; 21 – pharmaceuticals; 26 – electrical and optical; 27 – electric equipment; 28 - mechanical engineering; 29 – automobiles and parts; 30 – other automobile. The share of the labour force in knowledge intensive industries is calculated based on employees subject to social security contributions in knowledge intensive industries divided by all employees subject to social security contributions multiplied by 100.

*Figure 3, Share of Labour Force in Knowledge Intensive Industries by administrative district 2019. Data source: INKAR*

Federal programs such as the High-Tech Strategy have provided substantial funding for research and development, particularly in sectors like smart manufacturing. This federal support complements the efforts of regional coalitions by enabling access to larger pools of resources, which would be difficult to mobilize at the regional level alone. In Baden-Württemberg and Bavaria, federal R&D subsidies have allowed local governments to align their strategies with national priorities, such as Industry 4.0, thereby reinforcing regional strengths in advanced manufacturing. This alignment between federal and regional policies ensures that national resources are effectively leveraged to sustain regional innovation clusters.

Yet, the effectiveness of regional adaptation to macroeconomic constraints is closely tied to their regional institutions and growth coalitions. Southern German regions, supported by cohesive growth coalitions, have successfully leveraged federal and EU funding to bolster regional innovation. These coalitions have ensured that investment strategies align with local industry strengths, such as smart manufacturing and Industry 4.0. They have also enabled a collaborative approach to navigating the constraints of the Eurozone's fiscal framework, which prioritizes stability over aggressive public investment. Meanwhile, in regions like NRW, the lack of a united coalition has resulted in less effective use of available funds, as divergent interests among regional stakeholders have made it difficult to agree on long-term investment strategies. As a result, the conversion of pre-existing institutions towards a more regional arrangement was more successful in Southern Germany enabling these regions to effectively aid their businesses in remaining innovative and competitive.

In the next section we will explore the decentralisation of key institutions in the German system and exemplify how this decentralisation was effectively exploited by Southern Germany to incentivise and support its innovation clusters in the areas of education and training, industrial relations and cooperation, as well as targeted investments and lobbying efforts.

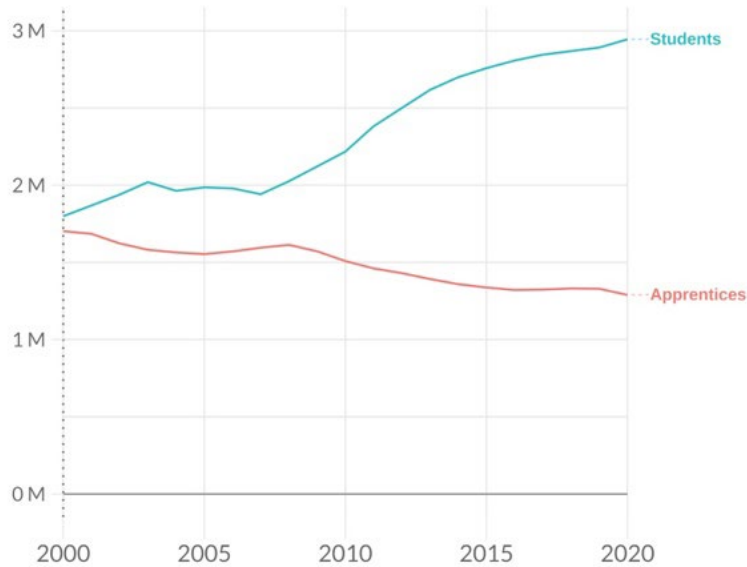
#### **4. From Centralization to Regionalization: Institutional Adaptation in Germany**

The new competition dynamics of the knowledge economy, and the accompanying macroeconomic decisions taken by the EU and Germany have led to changes in firms' behaviours and needs, and increased pressures on changing aspects of the old institutional setting in Germany. The shifts underscore a significant transformation in Germany's economic landscape, where regional dynamics increasingly shape the competitive strategies of firms. As the knowledge economy evolves, regional institutions are becoming the key arenas where economic success is determined, setting the stage for further regional differentiation in Germany's economic trajectory. In the following section, we will explore how these institutional changes unfolded in the areas of education and training, labour relations, and corporate finance. The result is a more regionally diversified political economic system, characterised in the decline in traditional inter-firm cooperation and the rise of more flexible, decentralized arrangements. We will show how Southern Germany managed to convert its regional institutions to focus on the needs of their innovation clusters, while other regions were not as successful in their conversion efforts inhibiting the emergence of other successful innovation clusters.

#### *4.1 Aligning Education with Industry: The Role of Dual Universities in Southern Germany's Knowledge Economy*

As Germany transitioned into the knowledge economy, the traditional vocational training regime, which long underpinned the country's industrial success, was challenged by the rapid expansion of tertiary education. This shift is not uniform across the country, leading to significant regional differences in educational approaches and outcomes. In particular, the rise of universities of applied sciences (UAS) and dual universities reflects a regionalized response to the evolving demands of firms, increasingly influencing the landscape of higher education.

Thelen (2004; 2014; 2019) argues that regardless of major external shocks core ideas around the German vocational training regime have survived throughout the 20th century. Entering the 21<sup>st</sup> century, Germany experienced a massive expansion of tertiary education challenging vocational training and its ideas. While apprenticeships have historically been the backbone of Germany's vocational training system, their numbers have been declining in recent decades. As a result, the apprenticeship model is losing ground to tertiary education, which is increasingly tailored to meet the needs of the knowledge economy.



*Figure 4, Number of Students and Apprentices 2000-2020. Source: BMBF*

As Germany transitions to a knowledge economy, regional variations in educational strategies have become pivotal. Southern Germany, led by Baden-Württemberg, has taken an innovative approach to educational reforms by creating a pipeline of industry-ready talent through dual university programs and universities of applied sciences (UAS). Unlike the national apprenticeship model, which traditionally supported Germany's manufacturing base, these programs are tailored for the knowledge economy's needs, particularly in high-tech manufacturing.

The German tertiary expansion is evolving quite differently compared to other countries (with some exceptions such as Austria or Switzerland). Namely, a large part of the expansion is driven by increasing numbers of young people enrolling at universities of applied science (UAS) or dual universities instead of traditional universities. Some authors (e.g. Durazzi & Benassi 2018; Graf 2018; Thelen 2019) have pointed out that specific forms of university education in Germany are following the previous vocational approach, in particular the dual studies programmes. These programmes are essentially offering the same structure as dual apprenticeships do, with the difference in theoretical courses being offered by universities or equivalent higher education institutions, as well as leading to an accredited bachelor's degree (post-graduate dual programmes also exist but remain relatively rare). Thus, making this a case for what is called institutional layering (Streek & Thelen 2005). What is noteworthy about these programmes is the increasing influence firms receive in shaping the theoretical training

students receive compared to the apprenticeship system (Durazzi & Benassi 2018; Graf 2018). Firms, particularly large ones, are increasingly shaping the curricula of UAS and dual university programs to align with their specific needs, bypassing traditional union and association influences. This firm-driven approach to education is fostering a close alignment between regional economic needs and educational offerings, further decentralizing the German education system.

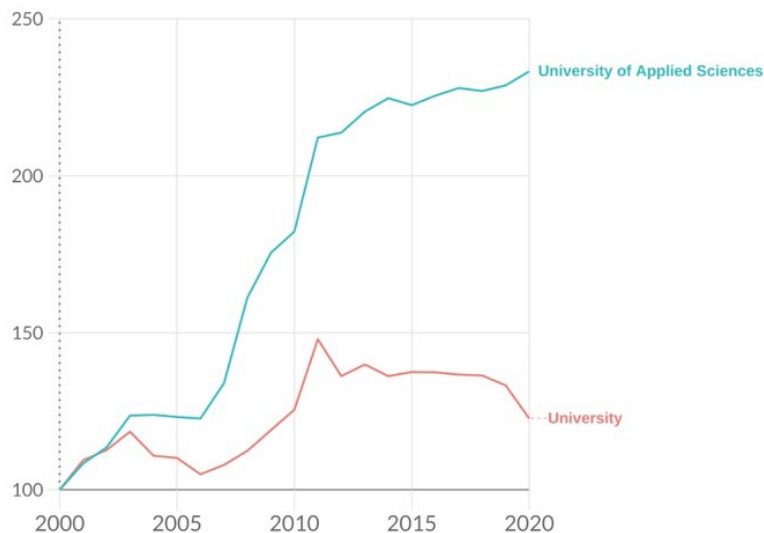


Figure 5, Relative Intake of 1<sup>st</sup> Year Students by University Type indexed (2000 = 100) 2000-2020, own calculations. Data source: BMBF

The rise of universities of applied sciences (UAS) and dual universities illustrates a regionally driven response to the knowledge economy. Baden-Württemberg’s creation of the dual university model exemplifies how regional educational institutions align with industry requirements, bridging theoretical knowledge with practical skill, creating an education-to-employment pipeline tailored for knowledge-based competition<sup>4</sup>. Education remains one of the last legislative domains firmly controlled by the Länder, leading to significant variation in how different regions approach higher education. The federalism reforms of 2006 further empowered the Länder, resulting in diverse educational landscapes across the country. For instance, the data presented in Figure 6 highlights the increasing divergence: while all Bundesländer have seen growth in UAS enrolments, the rate of increase and the emphasis on dual programs vary widely, contributing to the growing economic divergence between regions.

<sup>4</sup> In some Länder, dual study programmes are only offered by UAS, whereas in e.g. BW or Saxony only one dual university with several campuses exists (e.g. DHBW).

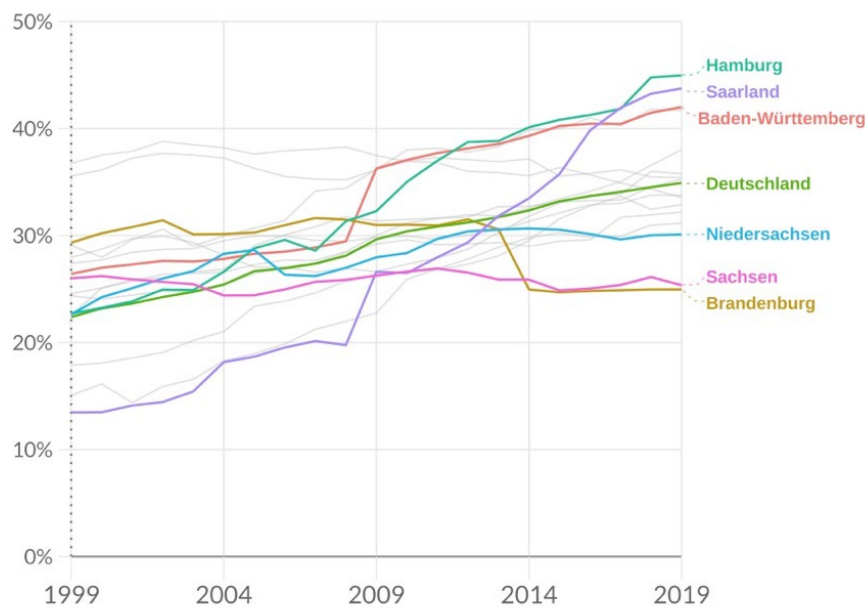


Figure 6, Share of number of University of Applied Science students by Bundesland 1999-2019, German Average and selected Länder highlighted, own calculations. Data source: BMBF

Baden-Württemberg's success in transitioning to the knowledge economy is exemplified by its proactive approach in developing the dual university system, an initiative driven largely by the region's corporate giants like Daimler. The creation of the 'Stuttgart Model' and its subsequent expansion into the dual university system showcases how regional firms actively shaped educational infrastructure to meet their evolving needs.

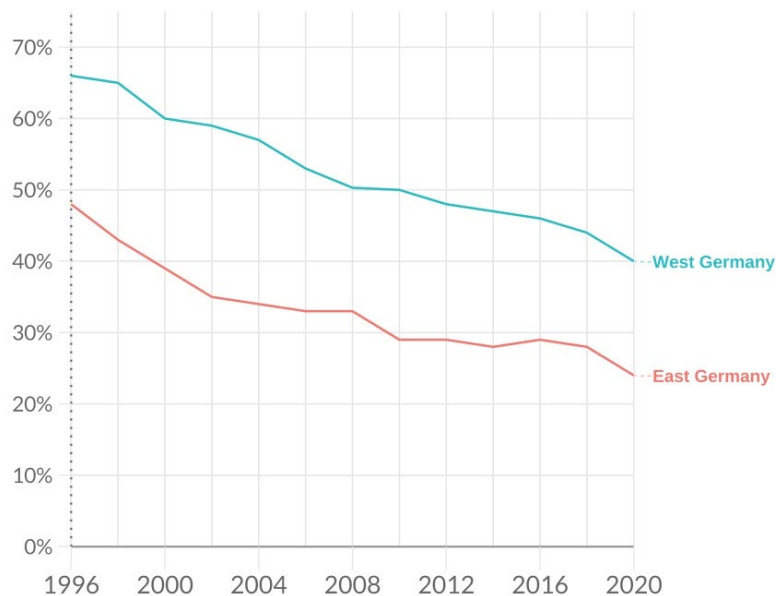
In 1971, Daimler proposed combining apprenticeship with higher education courses, leading to the creation of the 'Stuttgart Model' in collaboration with Bosch, Standard Elektrik Lorenz AG, and the Industrial Chamber Mittlerer Neckar. This initiative, formalized in 1982 with the Berufsakademie Gesetz (BA law), expanded rapidly due to high demand. By 2019, BW hosted 36,212 dual students, representing 33.4% of Germany's total (BiBB 2020).

After this new higher education type had been legally established in the state, BW started pursuing a wider recognition of the model across Germany. BW's lobbying efforts resulted in some other Länder adopting similar models, and with the Bologna reform, Berufsakademie (BA) degrees became equivalent to university degrees. BW's dual university strategy, driven largely by its corporate landscape, has significantly benefited SMEs, especially in non-urban areas. In addition, over time the role of the Dual University has now become especially critical for family companies in non-urban areas (Demary et al. 2020: 64; Schenkenhofer & Wilhelm

2020). These companies – mostly SMEs – are as a result benefitting from the large research-oriented companies’ and state cooperation into the scheme. This is likely contributing to the higher research orientation of SMEs in BW compared to other Länder.

#### 4.2 Evolving Industrial Relations: The Shift from National Coordination to Regional Flexibility

Over the past decades, Germany's traditional social partnership model has evolved, weakening the traditional roles of unions and business associations (Hassel 1999). While collective agreements and unions still influence labour relations, union density hit a new low of 14% in 2021 (Greef 2022).



*Figure 7, Share of employees in private sector firms with collective agreement, 1996-2020. Note: Private sector excludes agriculture and non-profit organisations. Data Source: IAB, [http://doku.iab.de/arbeitsmarktdaten/Daten\\_zur\\_Tarifbindung.xlsx](http://doku.iab.de/arbeitsmarktdaten/Daten_zur_Tarifbindung.xlsx)*

German industrial relations have traditionally relied on two pillars: collective agreements for wage coordination and firm-level co-determination (Betriebsrat) for managing working conditions and supervising management. Over the past decades, participation in both has declined, particularly in small and medium-sized enterprises (SMEs). While collective agreement coverage in West Germany fell from 65% in 1998 to 40% in 2021, large firms in core industries continue to maintain high levels of works council participation (Ellguth & Kohaut 2022). Meanwhile, business associations have responded to declining membership by increasing the flexibility of tariff regulations, allowing firms to join without adhering to collective agreements, further decentralizing labour relations. Membership in business

associations has also declined, particularly among SMEs. Associations have responded by increasing flexibility and decentralization of tariff regulations and allowing membership without requiring adherence to collective agreements. This strategy has increased membership without tariff obligations from 1,432 in 2005 to 3,591 in 2017, while membership with tariff obligations decreased. The overarching decline in collective bargaining and co-determination participation is evident, except in large firms in core industries. However, the number of businesses with works councils has stabilized and may be increasing (Ellguth & Kohaut 2019).

With the decline of sectoral bargaining, works councils have become increasingly crucial in representing workers at the firm level. The 2021 Betriebsrätemodernisierungsgesetz aimed to facilitate the creation of works councils in smaller companies and enhance their influence, particularly in areas like training and technological adaptation. This law reflects a broader trend toward decentralized worker representation, as the traditional link between unions and works councils weakens. The changing demographics of the workforce, with a growing proportion of white-collar employees, further erodes union influence. Highly skilled employees and graduates are less likely to join unions, viewing works councils more as a channel for information rather than confrontation (Artus et al. 2019; Funder 2018; Hocke 2012: 273-4). As a result, unions like IG Metall are shifting their focus to supporting works councils through education and information-sharing, though their influence is waning, particularly among younger and more highly skilled employees (Haipeter 2020).

The decline in union influence and the rise of decentralized labour relations, particularly through works councils, underscore a significant shift in Germany's industrial relations landscape. This shift is part of a broader trend toward decentralization and regional differentiation in the knowledge economy, as traditional forms of coordination and cooperation among German economic actors disintegrate.

Baden-Württemberg is also pro-actively shaping the regional industrial relations. For example, in 2017 the state government launched the Strategiedialog Automobilwirtschaft (strategic dialogue for the automotive sector) bringing together the major actors from the industry including suppliers, as well as unions and employer associations to coordinate a common response to the challenges such as e-mobility facing its core industrial sector. The role of the state is not limited to providing a platform for more coordination but also engaging as a lobbyist at the federal and EU-level via a federal campaign for concerted action for mobility, as well as



using the state representation in Brussels to engage with the European Commission and EU lawmakers to represent its economic interests.

#### 4.3 The End of the Deutschland AG: Corporate Finance Changes and regional industrial policies

The traditional German system of cross-shareholding, dominated by powerful blockholders such as banks, insurance companies, and industrial firms, is unravelling under the pressures of globalization and heightened international competition (Höpner & Krempel 2004; Ringe 2015). In addition, the 2001 corporate taxation reform, played a pivotal role in promoting ownership diversification and internationalization. This system, once a cornerstone of Germany's coordinated market economy, is being replaced by a more dispersed ownership structure, increasingly influenced by foreign institutional investors. The shift away from domestic blockholders to international shareholders, particularly in DAX companies, reflects a broader trend towards market liberalization and reduced coordination at the national level (Kalemli-Özcan et al. 2013).

However, one fundamental feature of the corporate financing model has remained stable, namely new block-shareholders continue to support firm's and their strategies with patient capital. Yet, the growing influence of international investors, especially the 'Big Three'—Blackrock, Vanguard, and State Street—marks a significant departure from the traditional German model. These institutional investors are less concerned with the long-term, coordinated strategies that once defined German corporate governance and are instead focused on maximizing shareholder value. This shift is reducing the influence of traditional stakeholders, such as unions and business associations, and is further decentralizing corporate decision-making.

Germany's approach to regional economic adaptation contrasts sharply with that of other European countries like the Netherlands and Sweden. While Germany has emphasized maintaining its strengths in high-end manufacturing through regionally-focused growth coalitions, the Netherlands and Sweden have pursued more aggressive financialization and embraced higher levels of venture capital investment. These countries have leveraged financial markets to support high-risk ventures in digital services and AI, which has resulted in a more diversified economic base. This comparison underscores how Germany's lower levels of financialization, combined with its focus on smart manufacturing, have shaped a different

regional innovation landscape—one where stability and incremental innovation are prioritized over the rapid shifts seen in more financially liberalized economies.

The growing autonomy of political actors from traditional associations since the 1990s has facilitated a shift in German policy-making (Weßels 2014). Federal policy changes, such as the 2001 corporate taxation reform, played a pivotal role in dismantling the Deutschland AG and promoting ownership diversification and internationalization. These reforms, while significant at the federal level, were supported by diverse Länder governments, reflecting the diminishing influence of national unions and the increasing importance of regional policy-making in shaping economic outcomes (Schroeder & Greef 2020).

Despite broad consensus among political actors on the need to reform aspects of the German institutional model, national-level agreement on the specifics has been elusive. This deadlock, driven by party differences and competing regional interests, has resulted in an increase of policy initiatives at the Länder level (Herrigel 2010). As a consequence, industrial policy differences across the German Länder have become more pronounced over the past decades, contributing to the growing regional differentiation in Germany's political economy (Lemb 2017). Ortiz (2013) supports this view by comparing the innovation systems of Baden-Württemberg and the Metropolitan Region Hannover Braunschweig Göttingen Wolfsburg in Lower Saxony.

Baden-Württemberg is playing an active role in promoting smart manufacturing but also branching into other sectors and fields. Instead of trying to create new winners, Baden-Württemberg's major efforts in its industrial policy is based on a co-funding strategy. Two recent examples are the state involvement in the creation of 'Cyber Valley' and the 'Innovation Park Artificial Intelligence' (IPAI).

In 2016 the so called 'Cyber Valley' was founded to create a start-up ecosystem to anchor and retain leading AI researchers and talent in the region. The Cyber Valley was founded by the state of Baden-Württemberg together with company partners Amazon, Mercedes-Benz, Porsche, BMW, ZF Friedrichshafen, IAV GmbH (part of VW), as well as the universities of Stuttgart and Tübingen, and the Max-Planck institute for intelligent systems. Industry, government, and private foundations provide the financial resources for the initiative which includes, among other things, a newly built AI Campus at Tübingen University, endowed professorships, university programs, one hundred PhD positions a year and commercialisation

support. The total amount of funding is difficult to ascertain but the regional government alone contributed €140 million between 2017 and 2020, a private foundation committed to contribute €100 million between 2020 and 2030 and industry funds professorships at the Universities of Stuttgart and Tübingen (Landesregierung Baden-Württemberg 2020). There is not only substantial financial endorsement of the Cyber Valley, but also high-level political support. In 2020, Chancellor Angela Merkel and Vice-President of the European Commission Margarethe Vestager visited Cyber-Valley and demonstrated their support epitomized by an AI strategy of the German federal government (The AI strategy of the German federal government is backed by an additional €2 billion) and the European Union’s ambition to create European AI build on European values respectively (Landesregierung Baden-Württemberg 2020).

The IPAI is located in Heilbronn and forms strong links with the adjacent Bildungscampus (‘Educationcampus’) an innovation ecosystem supported and driven by the founder of Lidl’s Schwarz Foundation. Funding for the development IPAI was based on a state-led competition for 50 million Euro in 2020. The joint bid by the city of Heilbronn together with the Schwarz Group and the Dieter Schwarz Foundation won this competition. The foundation had already made major investments in the area around the city of Heilbronn and attracted a campus from the two leading start-up universities of continental Europe, Technical University Munich (TUM) and ETH Zurich to its ecosystem. The campus attracted different institutions onto its premises including the DHBW’s center for advanced studies, two Fraunhofer institute branches as well as an Ecole42. While Cyber Valley is focusing on working with startups to bring outstanding fundamental research to market quickly, the IPAI is supposed to help businesses quickly integrate the products of this research into their value-creation chains.

## **5. Regional Growth Coalitions: Building Resilience and Competitive Advantage in the Knowledge Economy**

The case of Southern Germany highlights the critical role that regional growth coalitions play in adapting to the demands of the knowledge economy. These coalitions—comprising firms, educational institutions, local governments, and labour organizations—serve as pivotal structures that align regional strengths with the broader competitive dynamics of the knowledge economy. In regions like Baden-Württemberg, growth coalitions have been instrumental in fostering smart manufacturing and supporting firms in navigating the technological and structural shifts required by knowledge-based competition. This section reflects on how these

coalitions have managed to create an enabling environment for innovation, specifically by adapting educational systems, labour relations, and corporate finance frameworks to regional economic needs.

One of the most significant contributions of regional growth coalitions has been their ability to tailor educational programs to meet the skill demands of local industries. The establishment and expansion of universities of applied sciences (UAS) and dual university programs, particularly in Baden-Württemberg, illustrate how growth coalitions have effectively aligned regional educational institutions with industry-specific needs. By collaborating with corporate leaders like Daimler and Bosch, these coalitions have crafted specialized curricula and practical training programs that produce a highly skilled workforce prepared for roles in digitalized manufacturing. This tight integration between education and industry has been a cornerstone of Southern Germany's success, ensuring a steady pipeline of talent that is both regionally grounded and industry-relevant.

In addition to education, regional growth coalitions have played a central role in adapting labour relations to support knowledge-based competition. As Germany's traditional model of centralized labour relations has decentralized, works councils in Southern Germany have become essential in representing employees within individual firms. With these more decentralised structures, the regional growth coalition in Baden-Württemberg managed to establish new regional platforms for collaboration and coordination such as Strategic Dialogue for the Automotive Sector in which all relevant stakeholders cooperate to arrive jointly at potential solutions. This collaborative approach has created a model where labour relations are flexible and closely aligned with the specific needs of regional industries, a contrast to the traditional, nation-wide bargaining structures that have declined in recent decades.

Corporate finance is another area where regional growth coalitions in Southern Germany have made a notable impact. Faced with limited access to high-risk capital due to Germany's relatively low levels of financialization, these coalitions have proactively fostered an environment that combines stability with targeted opportunities for risk capital. Initiatives such as Cyber Valley and IPAI exemplify this approach: they create specialized ecosystems designed to attract venture capital aligned with the needs and interests of the region's core industries. By pooling resources from large, research-oriented firms and coordinating with regional

governments, these coalitions have built innovation clusters that appeal to both local and international investors interested in technology-driven, sustainable growth.

This strategic approach enables Southern German firms to pursue ambitious innovations in smart manufacturing and AI without the pressures of rapid turnover investments that characterize more financialized economies. Instead of relying solely on external venture capital, growth coalitions balance regional and federal resources to support initiatives that draw in risk capital while remaining closely connected to the long-term goals of Southern Germany's manufacturing sector. This combination of patient capital and selectively applied venture investment allows for continuous, incremental progress in the knowledge economy, positioning the region as both an industry leader and an emerging hub for technology-focused finance.

Furthermore, regional growth coalitions have effectively bridged multi-scalar dynamics, linking regional priorities with federal and EU support structures. Federal programs, such as Germany's High-Tech Strategy, provide critical resources for innovation, yet it is the regional coalitions that ensure these resources are effectively applied within the specific context of Southern Germany's manufacturing sectors. This strategic alignment between regional and federal levels underscores the unique capacity of growth coalitions to navigate and leverage Germany's decentralized political-economic system. By acting as a conduit between local industries and national policy frameworks, these coalitions have amplified the impact of federal support, reinforcing Southern Germany's role as a leading innovation cluster within the Eurozone.

In summary, regional growth coalitions in Southern Germany illustrate a powerful model of adaptive regionalism, where local stakeholders work in tandem to create an ecosystem tailored for the demands of knowledge-based competition. Through strategic coordination across education, labour relations, and finance, these coalitions have fostered an environment in which firms can thrive despite the structural constraints imposed by the Eurozone. The success of Southern Germany's growth coalitions underscores the importance of regionally cohesive governance structures in driving innovation and highlights the potential for other regions to adopt similar coalition-based approaches to build resilience and competitiveness in the knowledge economy.

## 6. Conclusion

The shift to a knowledge economy in Germany has redefined the interplay between firms, regional governments, and other stakeholders, transforming the economic landscape with a renewed focus on fostering innovation. A core finding of this paper is that regional growth coalitions—when cohesive and well-coordinated—play a pivotal role in adapting institutions to actively support regional innovation ecosystems. In Southern Germany, the alignment among large research-driven companies, regional governments, works councils, and unions has fostered an environment that not only attracts but sustains targeted investments in education, research, and digital infrastructure, thereby maintaining the region’s competitive edge in high-innovation, knowledge-based industries.

The development of regionalized education initiatives, such as dual universities, illustrates how Southern Germany’s growth coalitions have proactively aligned educational institutions with industry needs, producing a skilled workforce tailored to the demands of smart manufacturing and technological innovation. This close alignment between education and industry is foundational to the region’s success, underscoring the critical role of adaptive workforce strategies in advancing the knowledge economy.

Furthermore, as knowledge-based competition increasingly drives firms toward proprietary innovation, traditional industrial collaboration patterns have evolved. Regional coalitions in Baden-Württemberg, for instance, have adapted by bridging coordination gaps through initiatives like the Strategic Dialogue for the Automotive Sector, fostering cross-sector collaboration that synchronizes workforce training, technology integration, and regional innovation priorities. This coordinated approach not only enables firms to innovate effectively but also ensures that the regional workforce remains adaptable to rapidly changing industry needs. By replacing previous federal coordination with a responsive, localized model, Baden-Württemberg’s coalitions have strengthened the region’s competitive advantage in the knowledge economy.

While financialization has introduced changes in corporate governance, Germany’s relatively conservative financial approach has kept firms focused on established manufacturing sectors. Southern Germany’s growth coalitions have strategically counterbalanced this by creating

innovation-focused ecosystems, such as Cyber Valley and IPAI, which attract venture capital aligned with local industrial needs. These initiatives promote sustainable, incremental innovation, allowing firms to pursue ambitious goals within a stable, innovation-friendly ecosystem.

This decentralized economic governance has contributed to growing regional divergence, with innovation-centric regions like Baden-Württemberg thriving due to cohesive growth coalitions, while others, such as North Rhine-Westphalia, face structural adaptation challenges. Nonetheless, federal and EU policies continue to provide support, balancing regional autonomy with national and supranational innovation strategies. These multi-scalar interactions are crucial in sustaining Germany's manufacturing-led, export-oriented focus within the Eurozone's fiscal landscape.

This study underscores the need for political economy research to pay greater attention to subnational dynamics. Traditional, nation-centric frameworks often overlook the innovative potential of regional coalitions that drive distinct trajectories within a single national context. The German experience demonstrates that regional arrangements, especially robust growth coalitions, are critical in shaping national economic outcomes in a knowledge economy.

However, an exclusive focus on high-end manufacturing and reliance on growth coalitions present potential vulnerabilities. Southern Germany's emphasis on manufacturing may limit its ability to capitalize on rapidly evolving sectors such as digital services and AI, where German firms currently lag behind global leaders. Additionally, the region's reliance on export markets could pose risks if global demand shifts.

In conclusion, Germany's transition to the knowledge economy highlights the transformative role of cohesive, innovation-oriented regional growth coalitions. These coalitions enable regions to harmonize educational policies, innovation strategies, and industrial relations to meet evolving industry needs, bolstering regional adaptability and resilience. Regions with strong, well-aligned coalitions have successfully navigated digitalization and economic transformation, while those without struggle to keep pace, illustrating the critical impact of regional coordination in shaping Germany's broader trajectory in the knowledge economy.

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