CEU Department of Public Policy
CENTRAL EUROPEAN UNIVERSITY

INFRASTRUCTURE INVESTMENT AS INDUSTRIAL POLICY: EVIDENCE FROM THE SOLIDARPAKT II IN EASTERN GERMANY

By
Evan Lee

Submitted to
Central European University
Department of Public Policy

In partial fulfillment for the degree of Master of Arts, Public Policy

Supervisor: **Martin Kahanec**

Vienna, Austria

2025

Copyright Notice

[1] Icon by Font Awesome.

Author's Declaration

I, the undersigned, Evan Lee, candidate for Master of Arts, Public Policy, declare herewith that the present thesis is exclusively my own work, based on my research.

All sources have been properly credited in the text, notes, and the bibliography. I declare that no unidentified and illegitimate use was made of the work of others, and no part of the thesis infringes on any person's or institution's copyright. Furthermore, I declare that no part of this thesis has been generated using artificial intelligence (ChatGPT).

I also declare that no part of the thesis has been submitted in this form as coursework for credits or to another institution of higher education for an academic degree.

Date:

Name:

Abstract

This thesis investigates the effectiveness of special-need federal budgetary transfers (Sonderbedarfs-Bundesergänzungszuweisungen - SoBEZ) in eastern Germany as a tool of industrial and regional policy. Using a novel district-level exposure index for unobserved federal equalization policy and a two-stage least squares (2SLS) instrumental variable strategy, the study estimates the empirical impact of infrastructure spending on productivity, employment, wages, and net migration at the district (NUTS 3) level. The analysis leverages state and municipal finance data, addressing endogeneity concerns through coarsened exact matching (CEM) methods. Findings reveal that targeted infrastructure investment yields measurable gains in manufacturing productivity and employment, particularly in urban areas with strong absorptive capacity. However, the effects are heterogeneous: there is little evidence for significant impacts on net migration or total compensation, and the benefits do not extend evenly to rural areas or other economic sectors. The study highlights methodological challenges inherent in evaluating large-scale regional policy interventions, including data gaps and overlapping policy interventions. Overall, the results support the view that while infrastructure investment can drive sector-specific development, its capacity to effect regional convergence is limited.

Keywords: Eastern Germany, Solidarpakt, 2SLS, Länderfinanzausgleich, SoBEZ, coarsened exact matching, industrial policy, regional policy, spatial equilibrium model, productivity, production elasticity.

Acknowledgements

Writing a thesis is never a simple task. A bit like villages and raising children, the work is much more collaborative than how it appears on the surface. Behind any prolonged work stands an army of compatriots, supporters, friends and family.

For that, my first thanks go out to my classmates in the Department of Public Policy over the past year. I have learned a great deal from everyone here, not only in public policy and economics, but also about the world writ large. This work would not be as nearly developed or thorough without them.

A salutation goes out to Martin Kahanec, who supervised this thesis. Professor Kahanec has been essential in correctly thinking through the instrumental variable strategy outlined here. For his support and supervisorship, I give my heartfelt thanks.

To all of the friends and family far away, I appreciate the understanding and the leeway you give me in my absence. By pursuing a master's degree here in Vienna, I have been able to develop my own abilities to an extent otherwise unimaginable. A special thanks goes to my mother, Jolene and my siblings, Andre, Lauren, Lucy, Oliver and Isaac. I am looking forward to spending part of the summer with you all along the Donau.

To those closer here in Germany and Austria, thank you for the constant friendship, compassion, and kindness that you show me. Being again stuck in trenches of thesis writing was long and arduous, but it was all the more worthwhile because of the amazing people in my life. A special thanks to Günter Holderried and Sylvia Ziesel for always being here for me whenever I have needed it.

And finally, thank you to Marlene for everything. This whole endeavor would be impossible without your support. I owe you the world.

Table of contents

Figures & Illustrations

Appendix:

Tables

Main Tables:

Appendix A: 2SLS Estimates

Appendix B: Data Collection

Introduction

More than three decades after reunification, eastern Germany is still behind. Between 1990 and 2025, hundreds of billions of euros have flowed into the five "new federal states", transforming roads, bridges, railways, schools, universities, harbors, airports, government buildings and city centers. The primary vehicle that funded this infrastructure from 2001 onwards was the *Sonderbedarfs-Bundesergänzungszuweisungen*, or SoBEZ transfers - "special budgetary allocations" created as a part of the twin "Solidarity Pacts" of 1994 and 2001. Over 23 years, the federal government transferred 251 billion euros to the eastern states and municipalities to tackle the legacies of the socialist command economy. Despite the federal government pouring massive sums into public investment, large gaps in employment, productivity, and wages persist between east and west. That raises a fundamental question for industrial and regional policies: can targeted public investment meaningfully alter a region's long-term economic trajectory?

The answer to this question matters. Place-based industrial policy is resurging across Europe and the world, from the EU's Cohesion Funds to Germany's current "*Gesamtdeutsches Fördersystem*". As interest in industrial policy in advanced economies grows, it is vital to apply empirical evidence within the right context. The lessons of German reunification and regional development policy offer insight into how sustained and concentrated public investment functions in an economically struggling area within industrial policy, regional policy, and convergence paradigms.

Furthermore, important empirical questions about the results of industrial policy persist. Do such policies increase productivity? Does a regional infrastructure development strategy reduce unemployment or economic stagnation, measured by negative population growth and increasing average ages? Most importantly, are there productivity gains to be made? The eastern German example provides evidence for these three questions. If such policies fail to raise productivity or only create temporary job gains, the economic and political rationale for regional redistribution may need to be reconsidered.

Through a two-stage least squares (2SLS) method, this work measures the effect of SoBEZ infrastructure spending on productivity, employment, wages and net migration in individual eastern *Landkreise* and *kreisfreie Städte* (alternatively "district"; administrative units below the German federal states at the NUTS 3 level). Before regression, each *Landkreis* receives a distribution (or exposure) to SoBEZ infrastructure funds spent by the federal state within a given year. In the first stage, this exposure value is used as an instrument for annual).total infrastructure expenditures by both state and local governments in each *Landkreis*. In the second stage, communal infrastructure expenditures are then regressed on local outcome variables, such as per-sector measures of productivity (gross value added, GDP per hour worked), unemployment (total unemployment, structural unemployment), and migration (net migration). The analysis is conducted on all units (excluding Berlin), between urban/rural classifications and on a subsample filtered through Coarsened Exact Matching.

The effects of regional infrastructure investment are generally positive, but heterogeneous across regions, sectors, and outcomes. While there is some evidence of modest productivity improvements, these are not universal or evenly distributed. Manufacturing and the public sector see the greatest benefits from sustained investment, whereas productivity effects in agriculture and other services remain limited. Employment sees no empirical effect outside of a weak one on urban manufacturing, while no statistically significant effect was found in net migration. Overall, the data confirms that public investment can help productivity, but the gains are uneven and sector specific.

And yet, measuring the causal effects of large-scale regional investment remains incredibly difficult. Programs like SoBEZ are neither randomized nor uniformly allocated: funding skews toward structurally weak areas and often responds to local lobbying, political interests, or federal quotas. (Juhász, Lane, and Rodrik 2024) In this specific case, economic distress and poor infrastructure conditions underwrote funding distribution, creating conditions of reverse causality in calculating naïve regression. Furthermore, the policy treats all directly geographically comparable units, creating a natural selection bias and problems in finding counterfactuals. The western German counterfactual is similarly beset by issues, since the factors affecting economic outcomes in eastern Germany are not broadly similar to those dominant in the west (i.e. persistent structural unemployment, dominant low value-added sectors, missing growth poles, etc). The result is a lack of control units.

To solve identification issues, this thesis introduces a novel synthetically calculated treatment index to assign SoBEZ funding at the district level. This combines with a instrumental variable and matching strategy to estimate the effect of local investment intensity on sectoral employment, productivity, total compensation and net migration between 2005 and 2021. The exposure index essentially estimates the policy effect through tax expenditure flows and domestic subsidy taxonomies: the effect of the policy through total local physical capital expenditures affecting outcome variables. (Criscuolo, Lalanne, and Díaz 2022; Evenett et al. 2024)

Two major limitations qualify the findings. First, the study cannot control for a major multi-year business subsidy program (*Gemeinschaftsaufgabe „Verbesserung der Regionalen Wirtschaftsstruktur* - GRW). All observational units received GRW funding during 2000-2021, which particularly affects productivity and unemployment. (Brachert et al. 2024; Alecke and Mitze 2023) Second, residual effects from Solidarpakt I (1995–2004) likely remain in the post-2005 outcome trends, even given a separate set of rules concerning capital expenditure requirements. (*Gesetz zur Umsetzung des Solidarpakts zwischen Bund und Ländern zur Förderung des Aufbaus Ost (Solidarpaktgesetz)*) Regrettably, GRW data is not publicly available due to privacy concerns (and was not accessible due to time constraints). CEM matching allows for some degree of individual identification, but it is difficult to narrowly identify to what degree each policy affects the sample without the GRW dataset.

Despite potential misidentification, the result confirms much of what is claimed about infrastructure externalities: namely the effect on employment and gains in per-sector productivity (specifically manufacturing). Infrastructure is a key input in the production function, enabling higher output, though subject to diminishing returns. (Glaeser and Poterba 2021) By extension, infrastructure is subject to saturation, implying marginally decreasing rates of return. Given Solidarpakt II's more restrictive disbursement rules, the policy criteria fulfills these assumptions.

Lastly, the empirical results must be understood within the narrow context of eastern and western Germany. German reunification involved a rich country absorbing a poorer one, integrating and exporting West Germany's governance system and institutional environment onto the former East Germany. Industrial policy itself is a broad moniker consisting of a great many things, but it certainly cannot encompass the effect of the unified German credit market, strong rates of human capital accumulation and the integration of a weak economy into a strong one. (Blum 2019) Thus, many of the conclusions here are not easily reproducible outside of this context; they are the likely effects of infrastructure spending as an input of the manufacturing sector's production function. (Hall and Ludwig 2006; Glaeser and Poterba 2021; Abiad, Furceri, and Topalova 2015)

Literature Review

As Paul Krugman famously remarked, “productivity isn’t everything, but in the long run, it’s almost everything.” Should we take this to be true, then much of the business of economics is really understanding productivity: what drives it, what limits it, and how it can be increased. This simple observation gives shape to the vast literature that spans growth theory, industrial policy, regional convergence, and the empirical study of place-based interventions.

Each strand of the policy and economic literature takes a different stance. Industrial policy makes the argument for empirically grounded interventions, while regional policy and convergence theory focus on spatial utility and structural factors. The eastern Germany-focused literature also anchors around a central question: how do macroeconomic interventions in the eastern German geography shape outcomes, such as productivity, innovation, employment, and by extension, the broader goal of East–West convergence?

Arguments for Industrial Policy

The impulse to subsidize, protect, and stimulate economic development comes naturally to policymakers. Usual justifications appeal to a range of desirable outcomes: higher productivity, job creation, or export growth and are frequently sought through economic, labor, or trade interventions. Justifications can be found just about everywhere, in climate transition, import substitution, export-led development, and the creation of “good jobs for instance. (Juhász, Lane, and Rodrik 2024) While the term "industrial policy" is often used broadly to describe a wide range of policy forms, the economics discipline typically defines it more narrowly. Under this definition, industrial policy refers to conditional and targeted interventions aimed at shaping economic incentives. They are also usually heavier-handed than standard government intervention, manifested through a greater level of market distortion and incentive realignment.

True to its name, industrial policy involves some combination of subsidies (classically to heavy industry, research and development, exports and emerging technologies), trade barriers (selective tariffs, local content requirements), public provision of inputs (education, land, occasionally capital), and public-private coordination (business roundtables, collective bargaining facilitation, public development banks, regional development authorities). Unsurprisingly, they are also highly subject to "state capacity", that is, the government's ability to mobilize resources and organize support. (Juhász, Lane, and Rodrik 2024)

Yet, under most standard definitions, infrastructure spending does not strictly qualify as industrial policy. Although infrastructure is a fundamental public input into production, decisions about its provision are often guided by political, spatial, or administrative priorities that extend well beyond the narrow logic of economic intervention. In most cases, infrastructure simply lacks the conditionality and targeted intent required to meet the standard criteria. However, certain forms of infrastructure spending, particularly those involving physical capital such as roads, railways, ports, and industrial zones, can resemble classic industrial policy in both design and effect. When such investments are strategically concentrated and aimed at improving economic performance in specific sectors or regions, they function as quasi-industrial interventions. (Abiad, Furceri, and Topalova 2015; Aiginger and Rodrik 2020) The key to differentiation lies within conditionality and intention: are policymakers targeting a tangible economic outcome (productivity, growth, job creation, etc) and are they affecting it through an identifiable policy design? The distinction matters: when a program deliberately channels investment into physical infrastructure as a productive input, its potential economic impact is basically an critical empirical question. (Becker, Egger, and Von Ehrlich 2012; Breidenbach, Mitze, and Schmidt 2016)

It is argued from here forth that Solidarpakt II infrastructure spending functioned basically as a *quasi*-industrial policy. This view is informed by empirical evaluations conducted in the early 2000s, which primarily criticized Solidarpakt I for allocating an excessive share of funds to general municipal budgets rather than targeted investment. (Ragnitz 2003) The Solidarpakt II program was conditional to a specific geographical region (eastern Germany) and targeted specific outcomes:

chiefly structural unemployment, negative net migration and most critically, "economic convergence" with western Germany. Thus, in its sustained and concentrated focus, the funding packages contain many elements of stereotypical industrial policy interventions.

On the other hand, there is also a counterargument to be made regarding employment and aggregate demand—namely, that infrastructure funding functions less as targeted industrial policy and more as a macroeconomic stimulus to local economies. From this perspective, the primary mechanism at work is not structural transformation or productivity enhancement, but rather the short- to medium-term boost in economic activity driven by increased spending. Infrastructure projects generate direct employment in construction and related sectors, induce demand in local goods and services markets, and can temporarily raise household incomes and consumption levels. (Criscuolo, Lalanne, and Díaz 2022; Abiad, Furceri, and Topalova 2015) In this sense, infrastructure funding acts as a Keynesian intervention, supporting aggregate demand during periods of economic slack.

Not that these arguments are mutually exclusive. In fact, the German example illustrates how both supply- and demand-side logics can operate simultaneously within the same policy framework. A perceived lack of investment was a central element in shaping the rationale for large-scale transfers to eastern Germany after reunification. The German government widely recognized that the collapse of the East German industrial base had left not only a productivity vacuum, but also a physical and institutional one. Roads, railways, utilities, schools, and administrative capacity all required extensive rebuilding to meet western standards. (Blum 2019) From that point, a role for supersized public capital investment naturally follows suit: including in stocks of public goods (including physical infrastructure).

Notably, this all goes without addressing the enduring ideological and theoretical resistance to industrial policy among many economists. The easy politics and attractiveness of big economic interventions has made them fodder for accusations of causing distortions in markets, encouraging rent seeking behavior and wasting public funds. Common concerns include high cost-per-job figures, susceptibility to political capture, and a lack of demonstrable impact on long-term productivity. These critiques are not purely rhetorical. For example, a 2025 study estimated the cost-per-job created by the GRW program, whose primary goal is employment generation at approximately $19,000. (Siegloch, Wehrhöfer, and Etzel 2025) That number is lower than similar interventions: a similar program in northern England spends about $30,842 per job (inflation adjusted). (Criscuolo et al. 2019)

Amid industrial policy's recent resurgence, the economic literature has shifted focus toward identifying the appropriate conditions and rationales for state intervention. This newer body of work seeks to bridge the divide between traditional market-based critiques and more politically grounded arguments by applying microeconomic frameworks to evaluate narrowly defined use cases. Rather than advocating broad intervention, these studies justify industrial policy in terms of specific market failures—such as externalities, coordination problems, or underprovision of public goods and inputs. (Juhász and Steinwender 2023; Juhász, Lane, and Rodrik 2024; Criscuolo et al. 2019) By grounding their arguments in established economic theory, this literature resituates industrial policy within a more orthodox framework – a far cry from the policy field's place two decades ago.

Policy solutions vary considerably depending on context (if only from a certain point of view). Pro-industrial policy about positive externalities, typically involve subsidies. Subsidization of basic research is a typical example, but they can also involve public inputs (in the case of both Solidarpakts). (Abiad, Furceri, and Topalova 2015) Here, the rationale lies in the creation of common-use infrastructure—roads, railways, industrial zones—that enable broader economic activity but is too large, expensive, or public in nature to be financed privately. In both cases, the social benefit exceeds the private incentive to invest, resulting in underprovision by the market.

Yet the positive spillovers (output elasticity), whether in innovation or job creation, are significant: estimated at 0.14 in cross literature meta-analysis. (Bom and Ligthart 2014)

Nevertheless, coordination failures are less applicable to eastern Germany during the time span. Coordination failures typically arise when multiple private actors would benefit from investing simultaneously (e.g., in skills, infrastructure, or complementary industries), but fail to act due to uncertainty about others' behavior. This rationale applies, for example, to the semiconductor supply chain in Saxony, Saxony-Anhalt, and Brandenburg, but it is markedly less important to grant infrastructure funding. While it lies beyond the scope of this study, developments such as the emergence of the *Silicon Saxony* innovation cluster and pre-2011 efforts to coordinate the nascent German solar industry may be seen as partial responses to potential coordination failures. (Bovenschulte, Parton, and Bernardt 2024) Substantial public investment in the Technical University of Dresden in Saxony is a close relative to both the coordination argument (through innovation cluster sponsorship) and the capital expenditure element elaborated on in this work.

Unsurprisingly, the public provision argument is key to any evaluation of infrastructural industrial policy. The main innovation in recent literature is the focus on temporality and place; production in practice is highly localized and subject to the nature of the activity at stake. Under such circumstances, the government must make a wide range of distributional decisions: If industries rely heavily on local labor markets, what kinds of skills and education must the state provide? If private capital markets fail to deliver sufficient liquidity or long-term investment, what forms of public financing or guarantees can fill the gap? And finally, if production involves the movement of physical goods—receiving inputs and delivering outputs, what forms of logistical and transport infrastructure must be built to enable that process? This is essentially at the heart of the question when situating Solidarpakt II within the industrial policy literature.

Arguments for Regional Policy

A close cousin of industrial policy interventions, regional policies are "spatially targeted" (geographical in scope – "place based"). They employ similar policy mechanisms targeting entities via subsidies (businesses, local governments) to boost some regional economic dimension. All or at least some of the usual suspects appear as outcome variables: productivity, job creation, growth, social welfare, average income. Because regional policy aims to boost lagging areas, the goals tend to cluster around economic convergence, rural development and revitalization of the places in question. Strategic industrial objectives are often present in both industrial and regional policy frameworks but have historically played a secondary role in the latter (although this is changing with the newest generation of regional policies). (Suedekum 2025)

Critiques of regional policy mirror those of industrial policy. The traditional economic perspective holds that regional policy interventions reduce overall social welfare by introducing inefficiencies relative to the non-intervention counterfactual. This critique draws on the Rosen-Roback spatial equilibrium framework, which models regions as economic "bundles" comprising amenities, wages, productivity, and costs—attributes shaped by the interaction of mobile agents and local constraints. (Roback 1982) In this model, labor is perfectly mobile, migrating to regions where individual utility is maximized, while housing supply is fixed in the short run and other inputs are variable. Meanwhile, the incidence of taxation required to fund regional interventions can reduce efficiency in the contributing regions. The interventions may be redistributively progressive, but the resulting welfare gains are completely offset by the loss of efficiency by supporting the lagging area. (Roback 1982; Kline and Moretti 2013)

Simply put, it is theoretically more efficient to subsidize individuals residing in economically underperforming regions than to subsidize the regions themselves. As Glaeser and Gottlieb (2008) famously put it: "Subsidize people, not places!"

Within the past decade, there has been something of a paradigm shift away from the traditional Roback spatial equilibrium framework, largely due to the unrealistic nature of its core assumptions. That does not imply that the model is invalid, but it contains several strong assumptions that are difficult to satisfy in reality.

Recent empirical evidence challenges the assumption of perfect labor mobility. For example, a 2019 study of the United Kingdom found that approximately 40 percent of the population continues to reside close to their place of birth well into adulthood, reflecting strong spatial "rootedness" and limited geographic mobility. (Clark and Lisowski 2019) Similar patterns have been observed in other advanced economies. In the United States, for instance, research has documented persistently high rates of individuals living in or near their hometowns, and a notable decline in interstate migration rates over recent decades. (Molloy, Smith, and Wozniak 2011) These findings suggest that migration decisions are shaped not only by economic incentives, but also by social ties, housing market frictions, cultural preferences, and other non-monetary factors.

Secondly, spatial constraints and broader utility considerations also limit the applicability of the Rosen-Roback model. For example, a recent estimate examining municipal financial transfers in Germany (*Kommunalfinanzausgleich* - approximately 60 billion euros annually) found that abolishing these transfers would lead to a 0.05% reduction in national welfare. (Suedekum 2025) While labor productivity was projected to increase by 5.8%, these gains would be offset by significant over-congestion in the recipient regions. The analysis further estimated that roughly 3.2 million people would relocate, mostly from eastern to western Germany. The effect would be dramatic: some eastern cities would lose around a quarter of their total population.

By comparison to industrial policy, the rationale for regional policy is more closely centered on the dynamics of agglomeration—specifically, the concentration and distribution of people and human capital across space. (Navaretti and Markovic 2021; Ehrlich and Overman 2020) Such rationales are more sensitive to context, because of the local nature of the problems they deal with (industrial policy is proactive on average, but regional policy is usually reactive). Within this framework, regional policies fall into four categories: policies that either encourage or maintain agglomeration, policies that avoid deglomeration and policies to connect areas. (Suedekum 2025) Each contains a number of remedies that are specific to the problems faced in the geographical space.

The first is typical to high density areas and is usually designed around urban-specific inputs. Often, this involves interventions around housing scarcity, physical congestion, wealth inequality and social inclusiveness. In the eastern German case, this includes business subsidies (GRW), but also capital expenditures, specifically on urban transit and physical infrastructure, also common to the next category.

The second group usually pertains to areas with historical legacies (often industrial). These are usually mid-sized urban units that have a difficult time attracting and maintaining investment and human capital (reflective of the Rosen-Roback mobility assumption). The goal is to prevent "erosion" of the area or region, manifested in negative net migration, a shrinking tax base, and deteriorating social structures. Policies focus on stabilization and revitalization (i.e., "urban renewal"), typically through public investment schemes, business investment programs, and transitional employment support amongst others.

The third and perhaps most prevalent category applies to rural and underdeveloped areas. While low-density areas often experience many of the same challenges as declining urban or industrial centers (low productivity and population loss), they characteristically lack concentrations of people and economic activity found in more established clusters. As a result, rural underdevelopment is commonly characterized by persistent economic stagnation, demographic decline, and limited access to services and opportunities. Public investment and spending, whether through direct transfers to local governments, infrastructure grants, or indirect channels such as public sector employment, constitute the core instruments of rural regional policy.

The fourth and final category operates differently, instead focusing on enhancing connectivity between regions. The premise is that greater connectivity provides linkages to areas with higher areas (sometimes urban areas) and that positive externalities in-turn boost local outcomes. For example, these can take the form of market access or suburbanization. In relative terms, successful connective policy can make treated units (by this type of regional policy) more attractive when compared to untreated areas, especially in a spatial equilibrium model. (Fajgelbaum and Gaubert 2019)

SoBEZ, both as a part of municipal capital expenditures (infrastructure) and through general transfers, spans all such categories. It most clearly falls under the fourth rationale (connectivity), but also across the remaining three. That is partly due to the geographical scope – the new federal states are composed of 108.179 square kilometers and seventeen district-free cities. In practice, the implementation of SoBEZ was determined at the level of individual districts, independent cities and state governments, reflecting significant local heterogeneity. For instance, major urban centers such as Leipzig and Dresden each have populations exceeding 500,000 (category one), while some rural districts are home to just over 60,000 residents (category three). Simultaneously, cities such as Halle (Saale) suffered from an unemployment rate reaching 21.4% in 2000 (category two). (Own calculations) Under the post-2001 SoBEZ rules, much of Solidarpakt II funding was allocated to infrastructure capital expenditure (category four). Owing to Germany's federal structure and the significant role of local governments in investment and service provision, SoBEZ exhibited a degree of contextual adaptability, allowing for it to address a diverse range of regional challenges typified in the regional policy literature through targeted outcomes.

German reunification came at a high cost, specifically to individual taxpayers in western Germany (the so-called *Solidaritätszuschlag* – or "Solidarity Tax"). Per spatial equilibrium and standard welfare economics, West-East transfers created high deadweight loss in the west, which tax redistribution then transferred to the less productive east. (Fuchs-Schündeln and Izem 2012) The implication follows that the Solidarity Pacts lowered net productivity and social welfare; this is empirically sound in the former, but debatable for the later.

However, high rates of post-secondary education in the east (in technical training and university graduates) created the case for underutilization, especially in the manufacturing sector. (Blum 2019) This rationale held that, with enough investment, the west German "hidden champions" model (extraordinarily successful small and medium sized enterprises) would at least be extendable to the east due to the availability of then-unemployed skilled labor. Ideally, this would result in the large-scale emergence of a robust, native east German SME sector, thereby catalyzing the "win-win" scenario embodied in the recent regional policy literature.

In sum, the contemporary literature on industrial and regional policy is moving past simple dichotomies of state versus market or people versus place. Instead, there is a growing appreciation for nuance and contextual rationales, as well as for the empirical realities that shape both market failures and the scope for state intervention. The German case illustrates how policy design must account for heterogeneity and a micro foundation at the temporal starting point; especially when empirically grounding an industrial policy. At the same time, enduring theoretical debates on efficiency, welfare trade-offs, and the risks of distortion or deadweight loss remain highly relevant for the critical assessment of large-scale interventions.

Between Two German States

German industrial and regional policy has a long tradition of state involvement. Beginning in the late 19th century, the state fostered cooperation between government and key sectors, laying the groundwork for robust scientific research and industrial infrastructure. After World War II, policy interventions diverged between East and West. In West Germany, the 1949 Basic Law enshrined the goal of "equivalent living standards" (*gleichwertige Lebensverhältnisse*) across regions. The mandate serves as the legal basis of the "*Gemeinschaftsaufgabe Verbesserung der regionalen Wirtschaftsstruktur"* (GRW), an ongoing program targeting regional disparities through investment and business subsidies. GRW became a cornerstone of West German regional policy and was expanded eastwards after 1990.

Occupied by the Soviet Union, East Germany (*Deutsches Demokratische Republik* or DDR) adopted a distinctly Stalinist development model characterized by central planning and state ownership. Growth was initially high. but collapsed comparatively to the west from the 1970s onward. While the planned economy was highly inefficient, it did facilitate substantial human capital formation, particularly in heavy industry. (Hall and Ludwig 2006) The DDR also made significant sectoral investments in semiconductors, plastics, and microelectronics, which emerged as rare bright spots within an otherwise increasingly stagnant economy.

By the late 1980s, a pronounced productivity gap had opened between the two states. In 1989, East German workers were producing only about 40 percent as much as their West German counterparts. (Ragnitz 2024) While West Germany decentralized and internationalized its medium sized enterprises during the 1970s, East Germany integrated its medium sized equivalents into vertically integrated socialist firms. With privatization and the collapse of the Soviet economic bloc, the markets in the east disappeared and non-production units within east German firms were liquidated ("investors looking for work benches"). (Blum 2019) This process hollowed out the most innovative portion of the human capital stock.

Arguments for Convergence

East-West German convergence initially got off to a good start. During the early 1990s, massive sums were poured into capital stocks (*Fonds Deutsche Einheit, Aufbau Ost Solidarpakt I*). By 2001, the capital intensity in the eastern German business sector (gross fixed capital stock per employed) had risen to approximately 85.5% of the western level, up from 50% in 1991. (Blum 2019) In manufacturing, the capital intensity was estimated to be just 8% below the western level. This rapid modernization was supported by substantial western subsidization, leading to a business capital stock that was both newer and more technologically advanced. Surveys indicated that the average

age of equipment in eastern enterprises had reached parity with that in the west, with only 6% of eastern firms considering their equipment obsolete, matching the 5% in western firms. (Ragnitz 2024)

Despite these advancements in physical capital, productivity levels in East Germany remained below those in the west. Labor productivity in the eastern manufacturing sector was about 65% of the western level in 1999, despite the high quality of human capital and massive east-west migration (an estimated one million people moved from East to West). (Ragnitz 2024) In analyzing why convergence stopped, some authors point to heterogeneity and firm size. Instead of replicating medium sized enterprises, East German firms remained too small: a consequence of the "tumbling over" effect stemming from privatization. Without their research segments and a strong entrepreneurial base, productivity growth collapsed and subsidization created so-called "zombie firms" (the beneficiaries of GRW). (Blum 2019) In this view, the factors often cited in the industrial policy literature—such as externalities, agglomeration effects, and sectoral competencies—operated in reverse. One commonality remains: subsidies create dependencies which ultimately backfire.

The question dominates much of the East German growth debate: why did such a modernized, well-equipped region not converge in productivity? Equally, which set of literature can best answer the question? There is likely truth in all three sets. Sectoral industrial policy leverages existing competencies, such as sector-specific human capital. Regional policy works through tailored inputs and spatial utility tradeoffs, where cumulative investment works by increasing positive spillovers - connective infrastructure chief amongst them. Lastly, convergence emphasizes innovation, firm/institutional conditions and creative destruction; essentially an argument about structural legacies and "growth tentpoles" (exemplified by Dresden, Jena, and Chemnitz).

Well thought-out interventions are well-defined and empirically grounded; they follow a traceable logic and target areas that suit the industrial policy use-case. As policymakers and scholars continue to grapple with the limitations of both traditional industrial and regional policy frameworks, recent research underscores the importance of evidence-based, adaptive approaches that respond to specific local conditions, harness underutilized potential, and foster sustainable, inclusive growth. The following analysis builds on this literature, examining the empirical impacts of place-based infrastructure investment in eastern Germany within this nuanced and evolving policy landscape.

Methodology

Evaluating the economic impact of large-scale regional investment programs presents significant methodological challenges. In the case of Solidarpakt II, the complexity arises from non-random policy allocation, overlapping interventions, and limited transparency at the subnational level. Simple comparisons or regressions risk being confounded by selection effects and omitted variables, as funds are often directed toward regions facing the greatest socioeconomic difficulties.

To address these issues, this study adopts a multi-pronged empirical approach combining a novel district-level SoBEZ exposure index, instrumental variable (IV) estimation, and matching techniques. The aim is to approximate the causal effect of infrastructure investment on key economic outcomes such as productivity, employment, and migration, while mitigating potential biases arising from endogeneity and data limitations.

The *Sonderbedarfs-Bundesergänzungszuweisungen*

The challenge in evaluating industrial and regional policy are typically ones of measurement. In transfer programs like the *Sonderbedarfs-Bundesergänzungszuweisungen* (SoBEZ), financial flows are subject to legal reporting standards and data availability. As a grant distributed to state governments, SoBEZ usage was released via yearly "*Aufbau Ost" Fortschrittsberichte* ("Eastern development progress reports" – or simply Aufbau Ost reporting). These documents provide a record of the aggregate allocations and utilization of SoBEZ funds at the state level. (Fortschrittsbericht "Aufbau Ost", 2005-2019)

Most variables included in the final dataset (dataset_v40.csv) originate from the *Statistisches Bundesamt* (Federal Statistical Office). The primary source is the *Volkswirtschaftliche Gesamtrechnungen der Länder* (VGRdL), which provides district-level accounts. These include figures on GDP per capita, per worker and per hour worked, and sectoral gross value added (GVA), employment, and compensation. The data includes measures of GDP per capita, GDP per worker, and GDP per hour worked, as well as detailed figures on sectoral gross value added (GVA), employment, and compensation. Additional demographic and labor statistics are available from the census, including total population, gender breakdowns, average age, structural unemployment, and migration flows (in-, out-, and net migration). Given the centrality of manufacturing to both the policy and the region, the dataset also includes manufacturing revenues (domestic and foreign), as well as the number of new manufacturing projects by district and year. The breadth of Landkreis-level sectoral data is particularly notable, allowing for disaggregated estimation of GVA, employment, and compensation across multiple sectors. They also allow for clean variable normalizations – sectoral employment and GVA ratios as well for measurements of heterogeneity between urban/rural districts and comparisons of different states. In total, final dataset contains 82 variables over 1672 observations (see Appendix B, Table XI & XII).

District-level capital expenditures data (*Sachinvestitionen – darunter Baumaßnahmen*) was available for all states, though the completeness varied. Figures for Mecklenburg-Vorpommern, Brandenburg, and Saxony were consistently available, with some gaps depending on the state (for example, Brandenburg's data for 2008). In contrast, the data for Thuringia and Saxony-Anhalt was much less complete; for instance, Thuringian data is only consistently available from 2011 to 2021. In Saxony-Anhalt, capital expenditure figures were inconsistently summed from individual municipalities, making them incomparable to equivalent statistics from other states for the period 2005–2008. While the underlying municipal figures are accurate, time constraints prevented aggregation into fully comparable district-level statistics (see Appendix B, Table XI, 7-10).

SoBEZ transfers are an entirely different animal. As special, federally funded instruments negotiated between the federal government and the new eastern states, they stand apart from the ongoing inter-state or intra-state municipal equalization systems. While municipal financial equalization is formula-based and determined by state law, SoBEZ funds were distributed according to political negotiation and specific policy objectives. Because unified and fully disaggregated *Aufbau Ost* reporting was not included under reporting requirements, there is no consistent dataset tracking SoBEZ transfers below the state level.

That leads to a fundamental assumption about allocation at the district level; tackled through a exposure index. The resulting disbursement is a formula-based distribution based on the conditions that influenced the policy rationale: inverse GDP per capita to capture economic weakness, unemployment totals as a mark of labor market distress, inverse net migration to capture population loss, and population density/urban-rural binaries to account for qualitative differences between urban and rural areas. The formula is expressed as:

$$\text{SoBEZ}_{it}^{\text{share}} = \frac{0.4\ \cdot \widetilde{U}_{i,t-1} + 0.3 \cdot \tilde{G}_{i,t-1}^{-1} + 0.15 \cdot \widetilde{M}_{i,t-1}^{-1} + 0.10 \cdot \text{PopDens}_{it} + 0.05 \cdot \text{Urban}_i}{\sum_{j \in S_t}(0.4 \cdot \widetilde{U}_{j,t-1} + 0.3 \cdot \tilde{G}_{j,t-1}^{-1} + 0.15 \cdot \widetilde{M}_{j,t-1}^{-1} + 0.10 \cdot \text{PopDens}_{jt} + 0.05 \cdot \text{Urban}_j)}$$

Where *i* is the district (Landkreis), *t* is the year, *S_t* is the set of all districts in the same state as *i* in year *t*, *Ũ_{i,t-1}* is normalized one-year lagged unemployment, *Ĝ_{i,t-1}^{-1}* is the inversely normalized one-year lagged GDP per capita, *Ṁ_{i,t-1}^{-1}* is the one-year lagged inversely normalized net migration rate, *PopDens_{it}* is normalized population density and *Urban_i* is a rural-urban binary, where 1 represents a district-free city and 0 represents a rural district.

By function, the index calculates a relative position for each year between 2005 and 2019. The weights within are designed to simulate reflect both the original policy rationale and inputs of policymakers: the normalized unemployment proportion is the largest weight at 40%, reflective of economic hardship and the stimulus function of government spending. The inverse of normalized GDP per capita (30%), and the inverse of normalized net migration (15%) captures different elements of the same dynamic, broadly through low productivity and the logic of spatial equilibrium (since SoBEZ transfers are equally regional policy). The remaining portion is divided between a higher weight given to population density (15%) and a segment preferable to administrative cities (5%) due to greater burden (also reflective of the regional policy literature).

While the weight choices are ultimately contestable, the overall structure of the index is anchored within the available data and the desired outcomes found within the policy background (see Appendix B, Figure XXIII).

The result is not precise but is designed to capture a likely yearly average of the spatial distribution of SoBEZ allocations across districts given the available data. It should be acknowledged that infrastructure spending is often subject to outside concerns. The distribution formula does not account for political influence (an argument present in both the industrial and regional policy literature), nor does it account for prior distributions which are likely to influence subsequent funding periods. Some concerns could, in principle, be addressed through GIS-based modeling, which might also partially account for federal funding omissions. Ultimately, the relevant raw data is dispersed among hundreds of local governments and is not readily accessible to researchers. While such granular data would clearly be superior to the hypothetical distributions proposed here, gathering it would be implausible given limited resources and time constraints.

The same holds for the spending decisions of state governments. The attitudes and postures of each state are highly variable and subject to individual conditionality. This is best exemplified by the range of ruling coalitions during the temporal scope. For example, from 2009 to 2014, Saxony (Sachsen) was governed by a center-right coalition (Christlich Demokratische Union and the Freie Demokratische Partei). By stark contrast, Thuringia was led by a left-leaning coalition during the late 2010s (Die Linke, Sozialdemokratische Partei Deutschland and Bündnis 90/Die Grünen). The politics of public debt, especially on the German center right, played a role after 2009.

This diversity makes it quite difficult to isolate the time-variant political economy factors affecting SoBEZ funding allocations and local capital investment decisions more generally. Given such grounds, it is recommendable that any future analysis includes a political-economic dimension to at least, attempt to control the role of politics. On the other hand, the non-contextual "clean" economic critique makes a related, but conceptually different point: some local governments may be better connected or positioned to secure funding for reasons unrelated to objective, empirical criteria. The logic of both arguments suggests an increased risk of bias in any analysis that does not account for such political factors.

As a result, one final simplification was made regarding state budgets. Each budget was apportioned using a formula intended to reflect each state's known public investment priorities. While this approach may introduce additional challenges related to the complexity of intergovernmental financial transfers, omitting state budgets altogether would significantly bias effect estimates upward—specifically, by overestimating municipal investment. Therefore, this abstraction was considered an acceptable trade-off, as the potential measurement error is preferable to the greater bias that would arise from not accounting for state-level infrastructure investment.

In the empirical model, a generalized allocation formula was used to replicate the distribution of state-level investment across districts. This works similarly to the exposure formula, but with much greater accuracy due to strict rules on state-municipal budgetary transfers. Broadly, they hang on population size, unemployment rates, migration trends, and in some cases, an adjustment for urban status or a flat "base" share for each district.

$$Score_i = \alpha \cdot Pop_i + \beta \cdot Unemp_i + \gamma \cdot Mig_i + \delta \cdot City_i + \epsilon \cdot Base_i$$

Where *Scorei* is the allocation score for district *I, Popi* is relative the district's population share, *Unempi* is the relative unemployment share, *Migi* is the net migration figure relative to the state total, *Cityi* is binary variable for urban status (1 = city, 0 = rural), *Basei* is an equal flat share (1/N) where *N* is the number of districts and *a,β,γ,δ,* ϵ are state dependent weights.

The underlying logic balances a standard per-capita distribution with varying measures of need and specific state priorities. For example, Brandenburg and Thuringia are known to have placed more weight on equalization, placing greater emphasis on flat baseline shares and avoiding explicit bonuses for city districts. In contrast, Saxony heavily prioritized population and invested heavily into its major cities, while Mecklenburg-Vorpommern and Saxony-Anhalt incorporated migration and city factors to address acute rural decline and urban–rural disparities. (Bullerjahn and Thöne 2020) The implied distributions are far from perfect, but they attempt to replicate the actual effect of state horizontal financial equalization mechanisms.

Measurement and distribution are further complicated by the Kreisgebietsreform (district boundary reforms) that occurred in three eastern federal states during the study period: Sachsen-Anhalt in 2007, Sachsen in 2008, and Mecklenburg-Vorpommern in 2011. Generally, each reform reduced the number of administrative units in response to declining population density. Some rural districts absorbed former district-free cities, for example, Greifswald in Mecklenburg-Vorpommern and Bautzen in Saxony. To maintain consistency over time, pre-reform data was redistributed onto post-reform boundaries using population proportions of the affected areas. Only eight districts required proportional data reallocation in total: six in Sachsen-Anhalt and two in Mecklenburg-Vorpommern (see Appendix B, Figures XIX & XXI). Most boundary changes consisted of straightforward amalgamations of smaller areas. While these reforms could theoretically affect both district and municipal administrative funding, only the latter is meaningful because of far greater investitive responsibility of cities and towns.

Regarding Solidarpakt II, the states had different degrees of allocative leeway between the two policy funding streams: *Korb I* and *Korb II*. Each "basket" followed distinct transfer rules. The first, Korb I (Basket I), consisted of legally fixed supplementary allocations aimed at capital expenditures and municipal finance. The second, Korb II (Basket II), fell under parliamentary grant funding, which provided state governments with greater flexibility in the use of funds. SoBEZ transfers explicitly fell under Basket II, with each federal state required to report aggregated funding decisions.

Furthermore, legislative changes toward the end of Solidarpakt I reinforced a needs-based allocation for Korb II. This introduces challenges for causal inference, as SoBEZ infrastructure funding was programmatically directed to areas with worse initial target outcomes. The pattern is evident when looking at municipal capital investment budgets, where high SoBEZ funding materializes through the capital expenditure subcategorization (*Sachinvestitionen – darunter Baumaßnahmen*). The result is a classic case of reverse causality: naïve regressions of SoBEZ funding amounts on outcomes yield negative point estimates.

As it follows, the primary strategy used was a two stage least squares regression. The first stage instrumentalizes SoBEZ spending onto combined per capita local public construction expenditure– a combination of municipal infrastructure investment (normally responsible for 70–80% of the district's total infrastructure expenditure share) and state investment (covering the remaining 20–30%) divided by total district population. The second stage then regresses the first stage onto various outcome variables targeted by the policy rationale (per sector productivity, unemployment and net migration.

Formulas

All IV estimates are based on two-stage least squares (2SLS) regressions.

General Formula:

$$\log(\text{Outcome}_{it} + 1) = \alpha + \beta \cdot \widehat{\text{Investment}}_{it-1} + \gamma \cdot X_{i,pre} + \varepsilon_{it}$$

Where lagged implied SoBEZ per capita is used as an instrument for lagged investment per capita, and $X_{i,pre}$ contains pre-treatment controls. For urban–rural analyses, the specification interacts instruments and exposures with the urban dummy.

Second Stage:

$$\log(\text{Y}_{it} + 1) = \alpha + \beta \cdot \text{InvPer}\widehat{\text{Cap}}_{it-1} + \gamma \cdot X_{i,pre} + \varepsilon_{it}$$

Where *Yit* is the economic outcome for district *i* in year *t* (e.g. GDP per hour worked, employment, sectoral GVA, net migration, total compensation, etc.), *InvPerCapit−1* s the fitted value of lagged infrastructure investment per capita from the first stage and *Xi,pre* is a vector of district-level pre-treatment controls (e.g., pre-2005 means of unemployment, GDP per capita, urban dummy, population density, etc.

First Stage:

$$\text{InvPerCap}_{it-1} = \pi_0 + \pi_1 \cdot \text{SoBezPerCap}_{it-1} + \delta \cdot X_{i,pre} + \eta_{it}$$

Where *InvPerCapit−1* is lagged infrastructure investment per capita, *SobezPerCapit−1* is lagged implied SoBEZ allocation per capita (the instrument) and *Xi,pre* and *ηit* are as above.

Urban-Rural:

Second Stage:

$$\log(\mathrm{Y}_{it}+1)=\alpha+\beta_1\cdot\widehat{\mathrm{InvUrban}}_{it-1}+\beta_2\cdot\widehat{\mathrm{InvRural}}_{it-1}+\gamma\cdot X_{i,pre}+\varepsilon_{it}$$

First Stage:

$$\mathrm{InvUrban}_{it-1}=\mathrm{InvPerCap}_{it-1}\cdot\mathrm{Urban}_i$$

$$\mathrm{InvRural}_{it-1}=\mathrm{InvPerCap}_{it-1}\cdot(1-\mathrm{Urban}_i)$$

$$\mathrm{InvUrban}_{it-1}=\pi_1\cdot\mathrm{SoBezUrban}_{it-1}+\delta\cdot X_{i,pre}+\eta_{it,1}$$

$$\mathrm{InvRural}_{it-1}=\pi_1\cdot\mathrm{SoBezRural}_{it-1}+\delta\cdot X_{i,pre}+\eta_{it,2}$$

Where Urban_i is a binary urban/rural indicator and all else is the same as above. Through interaction terms (e.g., sobez_urban, sobez_rural), a separate set of models allow estimation of heterogeneous effects by urban/rural typology. Besides the interaction term, they are identical in model specification and function identically as such.

In simplified terms, the effect of SoBEZ sends funding downwards onto the sum of all non-federal and non-EU infrastructure expenditures. The composite figure is the aggregated state, district and municipal infrastructure budget calculated per district per year. This result is then measured against district outcomes.

The primary prerequisites for the SoBEZ instrumental variable (IV) validity are twofold: first, SoBEZ transfers must be strongly correlated with total local infrastructure spending (instrument relevance); and second, SoBEZ should influence the outcome variable only through its effect on infrastructure investment, without being correlated with the error term or omitted variables (exclusion restriction). This is a deeply flawed and imperfect assumption, as one might guess; as there are many features that may impact local public infrastructure investment (as with politics geography, population, utilization rates, income, the federal government and countless other).

Again, the tradeoffs must be considered. The primary strength of the instrumental variable approach lies in its ability to address the central problem of reverse causality, which is deeply embedded in the policy design itself. The IV strategy cannot fully address all sources of endogeneity or omitted variable bias, but it also captures some aspect of real interaction between the targeted municipal financial transfers and the infrastructure spending they effect.

In an ideal situation, a policy-investment IV would meet two key conditions: first, it must be correlated with the endogenous regressor (instrument relevance, i.e., the first stage), and second, it must affect the outcome only through its impact on the endogenous regressor not directly (exogeneity, or the exclusion restriction). This is technically true as a matter of assumption, since the subvariable (annual state-level total infrastructure SoBEZ outlays reported by *Aufbau Ost* reporting) affects district infrastructure spending through earmarked grants. Infrastructure funding then affects productivity through various means (spillovers, production function, etc).

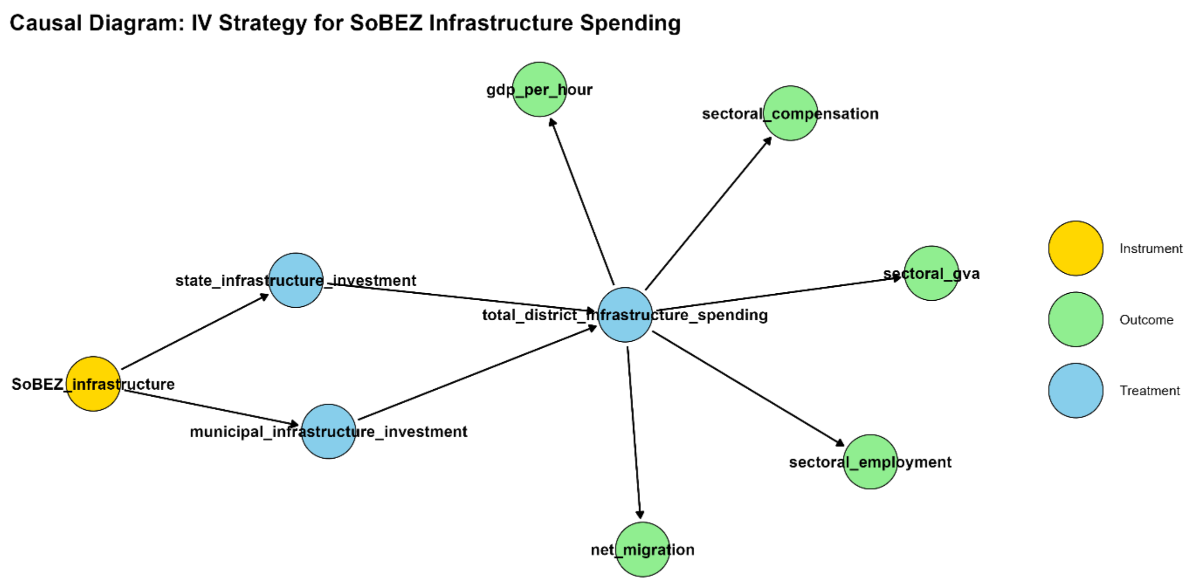

Fig 1: **Directed Acyclic Graph: IV Strategy for SoBEZ Infrastructure Spending**: Visual representation of the casual chain.

Non-compliance is also a distinct possibility: some districts may have misused or failed to spend SoBEZ funding (as with Solidarpakt I). If full compliance and the causal chain are assumed as correct, the primary issue then becomes other factors influencing the underlying distribution. In a theoretical sense, a perfect instrumental variable would be a factor that influences total district infrastructure investment but has no direct effect on the outcome variable other than through that impact. From this perspective, SoBEZ infrastructure funding comes close because it principally affects local infrastructure spending. If one was to remove the political argument (a very tall, if not impossible order), the result would be a simple reverse casual state: where SoBEZ infrastructure transfers are a direct function of need, size and other endogenous qualities (justifying the IV in the first place). Although not realistic, the SoBEZ exposure index works from this principle.

Political factors themselves can also work as IVs themselves. For instance, Giulietti et al. (2013) demonstrate that the number of parties in a governing coalition can be used as an instrument for welfare spending, since coalition politics affects the size of social transfers but (ideally) not directly the relevant outcome, such as migration or productivity. Yet, as their discussion of simultaneity bias and instrument exogeneity shows, political variables may themselves be endogenous if they respond to the same underlying economic shocks or spatial inequalities as the outcomes of interest. (Giulietti et al. 2013)

As shown here instrumental variables are picky things, why bother after all, if one can't find a suitable instrument? To that effect, a Differences-in-differences (DiD) style design was also conceptualized but was found unworkable given reserve casualty concerns. Under DiD, districts were categorized into high and low exposure groups based on whether their SoBEZ exposure index was above or below the median in each year. The split functions as a simple treatment-control distinction, allowing for quasi-experimental like testing. In practice, DiD estimates gave negative results despite strong historical evidence to the contrary, because higher infrastructure investment was correlated with economically weaker districts. Several DiD preconditions also fail upon a closer look. The absence of other treatments condition is violated given the previous Solidarity Pact I funding period (1994-2005) and other policies affecting infrastructure spending (GRW, EU Cohesion funding). As yet another blow, the pre-2005 trend was not consistently upheld, especially across federal states. For these reasons, DiD was not pursued.

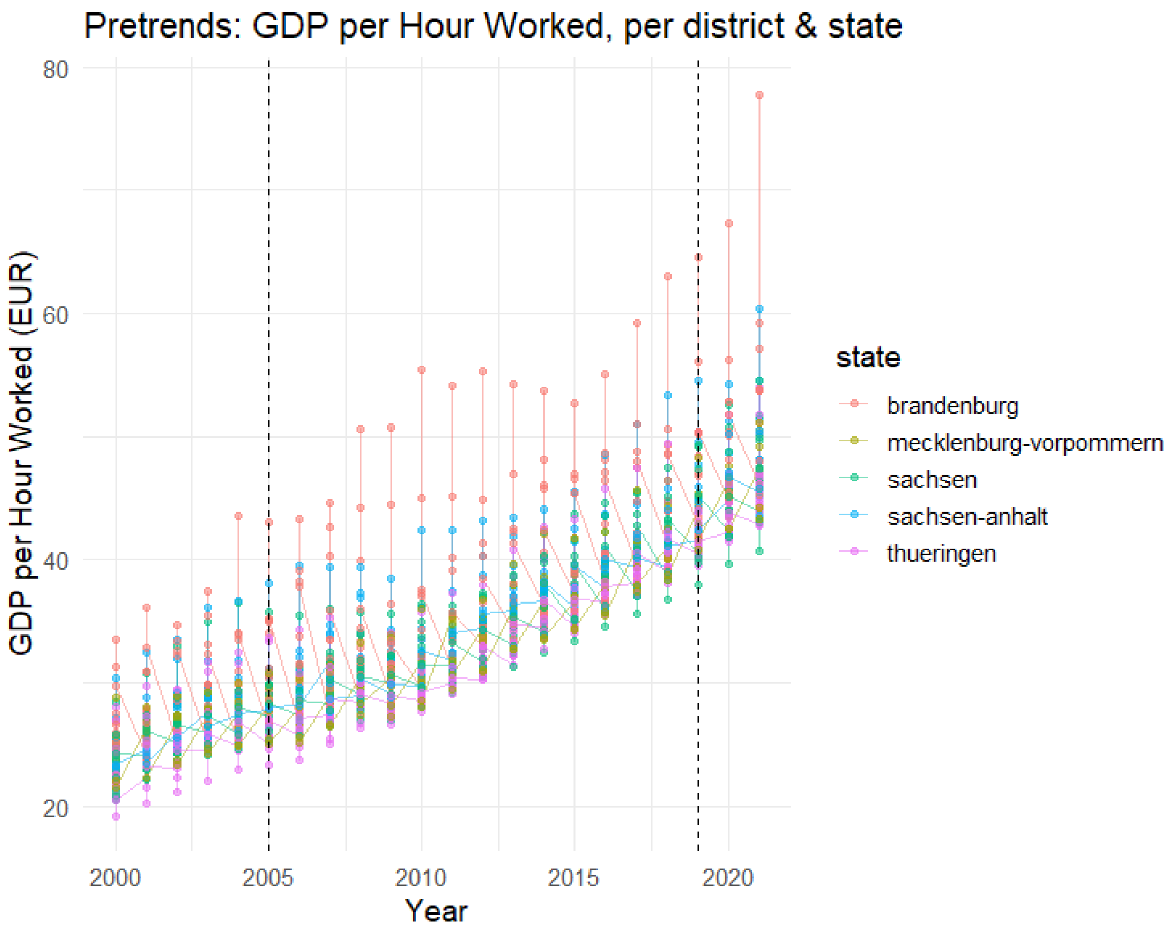

Fig 2*:* **Pretrends: GDP per Hour Worked, per district & state:** The Solidarpakt II policy years are indicated with the dashed line. The result indicates that it may be possible to justify a Difference-in-differences style design given higher GDP per hour worked after 2005, but reverse causality issues hinder estimation.

Coinhabitant policies are also a problem for the IV strategy. There also happens to be plenty of them, namely GRW business and infrastructure subsidies, EU-origin funding schemes, and federal infrastructure spending. Data availability is the major inhibitor in all three cases, with limited transparency on the precise allocation, timing, and intensity of these parallel interventions at the district level. Recipient-level GRW (Gemeinschaftsaufgabe "Verbesserung der regionalen Wirtschaftsstruktur") data does indeed exist at the Federal Office for Economic Affairs and Export Controls (BAFA) but was unobtainable within time constraints. EU funding, especially under ERDF and ESF frameworks, suffers from similar aggregation or lack of geographic disaggregation below the state or NUTS-2 level. Federal infrastructure spending, meanwhile, is channeled through the Federal Ministry for Transport (BMV). As ignoring other policies invites bias, causal methods are one answer.

Matching, and specifically Coarsened Exact Matching (CEM), offers a way to address concerns about omitted variable bias in this context. Since unobservable treatments—such as GRW and certain EU funding streams—were targeted according to similar policy criteria as SoBEZ, matching observations on key characteristics can help mitigate some of the resulting biases. This is particularly relevant for sectoral composition: for example, GRW disproportionately targeted districts with a strong manufacturing base by supporting both SMEs and major industrial employers in eastern Germany. By matching on proxies such as the share of manufacturing employment, the analysis can indirectly account for some of this exogenous variation. For example, Awan et al. (2019) propose a non-parametric matching framework for IV analysis that matches units on observed characteristics, thereby approximating randomized assignment and enhancing the credibility of causal estimates in observational studies. (Awan et al. 2019) A similar argument applies to EU funding, which, like SoBEZ, was frequently allocated based on GDP per capita.

Given the complexity of the causal inference strategy, the selection of regression outcome variables is comparatively straightforward. For each outcome variable, covariates were chosen based on likely omitted variable bias and theoretical relevance, as well as practical availability in the panel. In all main and robustness models, the covariates include pre-treatment district-level means for GDP per capita (gdp_pre), unemployment (unemp_pre), net migration (migration_pre), population density (pop_density_pre), and an urban–rural binary indicator (urban_pre). These account for baseline differences in economic structure, demographic pressure, and settlement type that may jointly affect both infrastructure allocation and post-treatment outcomes. For sectoral and compositional analyses, additional controls are included for baseline shares of employment in manufacturing, public services, construction, and agriculture, as well as pre-period sectoral employment counts, to mitigate bias from structural change (See Appendix B, Table 12).

In sum, the combination of incomplete administrative data, variation in state-level spending priorities, and the presence of overlapping policy instruments necessitates a careful and transparent approach to causal inference. The district-level SoBEZ exposure index and the allocation formulas adopted here reflect both data-driven and policy-informed assumptions. In the applied research design, instrumental variables and matching aim to mitigate endogeneity and omitted variable bias. Despite these efforts, significant limitations remain—notably the imperfect identification of funding streams and the continued influence of unobserved political and economic factors. These constraints underscore the importance of interpretive caution and highlight avenues for future research, particularly as more granular data becomes available or as new policy reforms reshape the landscape of German regional development.

Empirical Findings

This study set out to investigate the causal impact of infrastructure investment, proxied by a district-level exposure index to SoBEZ allocations, on a range of economic outcomes in eastern Germany over a 14-year period. The findings provide moderate evidence that increased infrastructure investment, as allocated through SoBEZ, contributed positively to sectoral gross value added (GVA), particularly in manufacturing, where the effect remained statistically significant even after matching (CEM matched: $p = 0.0289$). The same was true of manufacturing employment (CEM matched: $p = 0.0290$), but not for the sector's total compensation (CEM matched: $p = 0.4464$). Other observed sectors reported less consistent results, and no statistically significant effects were found for structural employment or net migration.

In terms of the SoBEZ instrumentation, the F-statistic (F-stat) was well above 10 for both matched and unmatched aggregate models (representative of strong IV relevance). When disaggregated into urban and rural districts, the rural F-stat commonly fell below 10, indicating weaker identification outside of cities. This may reflect problems with exposure variation (distributive assumptions) or limitations in the dataset itself. Given available evidence in the German regional policy literature, the answer is likely a mixture of both.

CEM matching produced a trimmed dataset of 968 observations with calipers set at 2.5. Weights ranged from 0.3636 for Landkreis Greiz to 2.181818 for Landkreis Spree-Neisse. Matched data generally provided estimates at the same statistical level as the unmatched data, only with smaller coefficients.

While all 2SLS estimates can be found in Appendix A, a moderate selection is presented here as critical findings. These mostly revolve around the manufacturing and similar industries (excluding construction).

In sum, the results suggest a measurable and policy-relevant effect of targeted infrastructure investment on manufacturing outcomes in eastern Germany (central to the industrial policy context). By contrast, challenges remain in reliably identifying causal effects in rural areas despite considerable expenditure. This would be solvable primarily through a stronger identification scheme (raw data).

Descriptive Statistics

To provide an overview of the dataset and contextualize the analysis, summary statistics are presented for the key variables included in the instrumental variable (IV) regressions. Table I reports the mean, standard deviation, minimum, and maximum and number of observations for measures such as per capita infrastructure investment, SoBEZ exposure coefficent, population per square kilometer, GDP per capita, unemployment, and net migration across all districts and years. Figures VI – X visualize average trends in both the urban, rural and total samples.

The distribution of these variables reflects substantial regional and temporal heterogeneity in both economic conditions and policy exposure. For example, infrastructure investment per capita fluctuates widely between districts and throughout the time period, mirroring the uneven allocation of federal and state resources. Unemployment rates and net migration also show variation, but also consistent trends between all samples.

Table I: Descriptive Statistics for Core Variables

Variable	Mean	Median	SD	Min	Max	N
GDP per capita	€23,159.73	€22,376.50	€6,636.88	€11,762.00	€48,457.00	1,650
GDP per hours worked	€34.42	€33.22	€7.79	€19.20	€77.82	1,518
Infrastructure SoBEZ Distribution	0.07	0.06	0.03	0.03	0.16	1,554
Total Population	171,925.63	155,198	94,774.16	34,835	597,493	1,650
Population per km²	284.23	116.64	400.78	35.58	2,006.36	1,628
Net Migration	49.68	-154.50	3,159.65	-13,874	37,620	1,650
Total district infrastructure spending per capita	€354.69	€341.6	€141.2	€32.4	€1,031.1	1,147
Total District Infrastructure SoBEZ (1000s of euros)	81,956.89	60,876.51	70,041.06	1,755.77	332,809.75	1,088
Total Unemployment	10,942.40	8,579.00	8,093.13	878.00	56,502.00	1,575

Descriptive Statistics for Core Variables: Key indicators display considerable variation across districts. In particular, the wide range between minimum and maximum values for total population, population density (population per km²), and total district infrastructure spending per capita illustrates rich geospatial diversity .

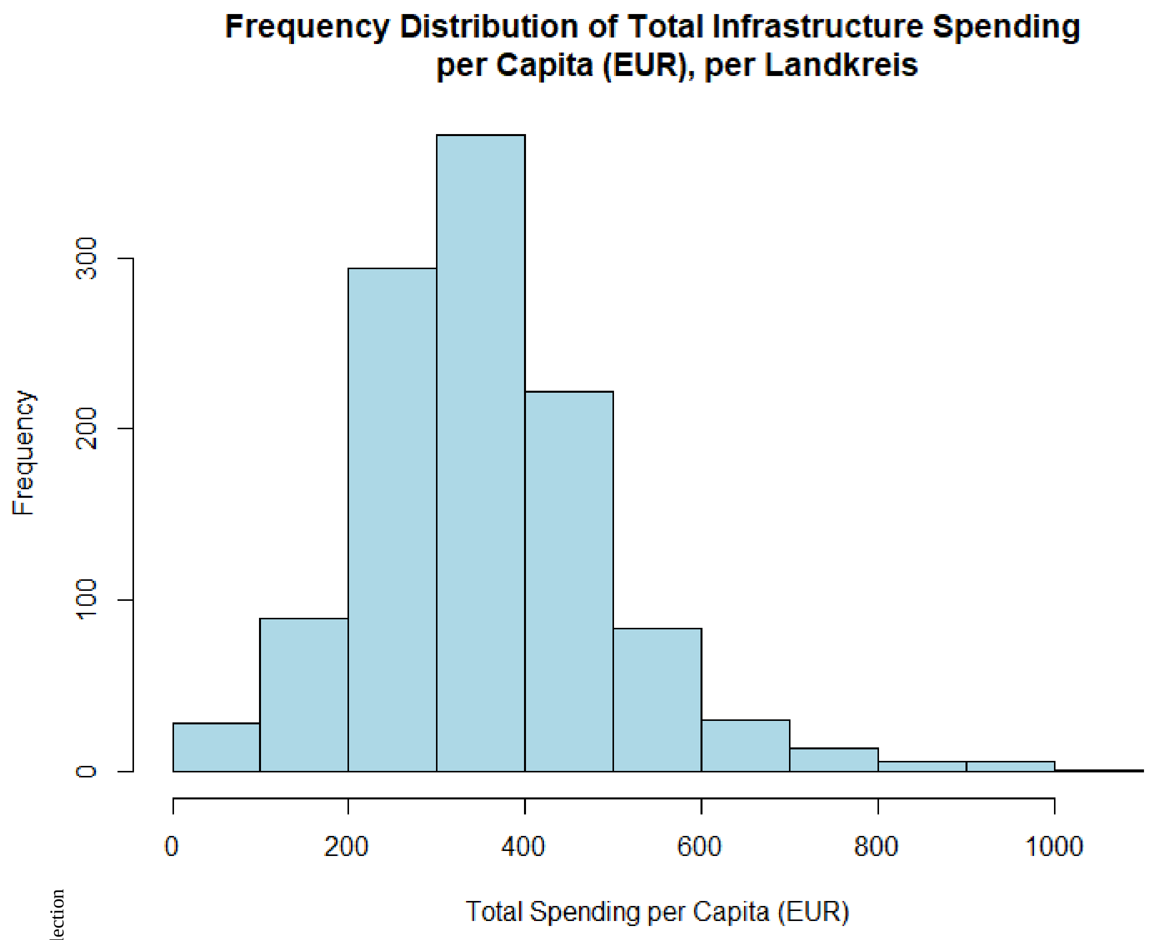

Fig 3: **Frequency Distribution of Total Infrastructure Spending per Capita:** Total local infrastructure spending is moderately left-skewed; on average, districts spend between €300 to €400 per inhabitant during the temporal scope. Bins are per €100.

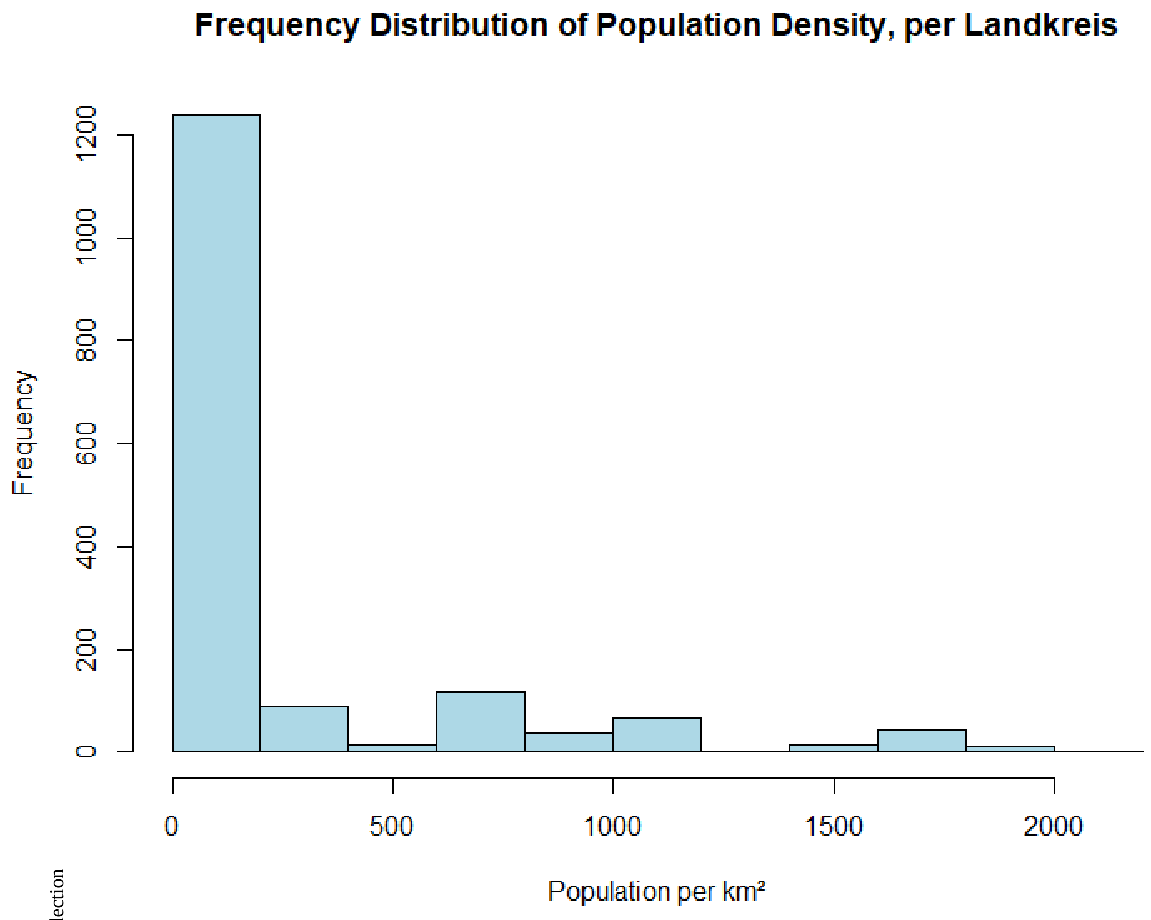

Fig 4: **Frequency Distribution of Population Density, per Landkreis** The overwhelming majority of the dataset consists of rural districts (denoted by the high left-side concentration of low-density observations). The right-side of the distribution shows frequency of dense urban areas such as Leipzig, Dresden and Chemnitz. Bins are per 200 persons.

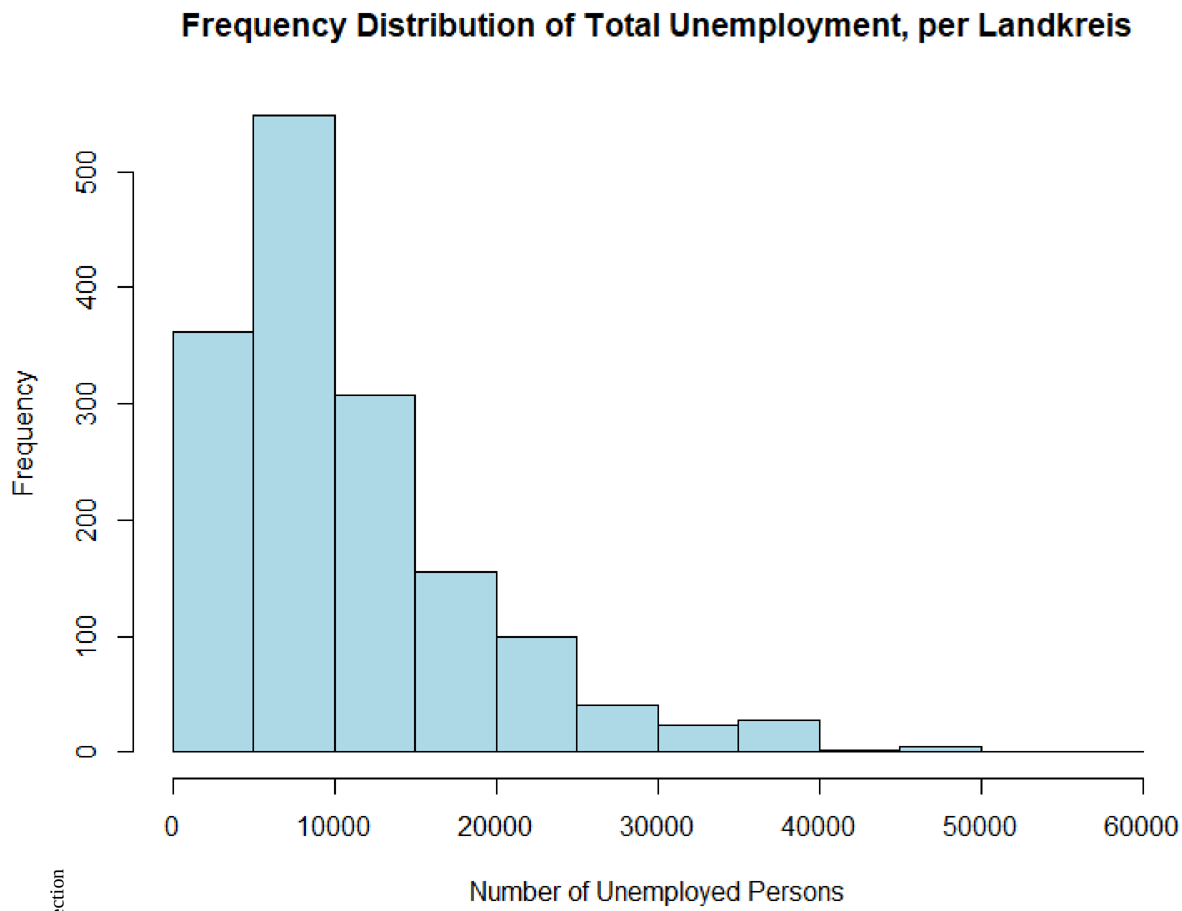

Fig 5: **Frequency Distribution of Total Unemployment, per Landkreis:** Total local unemployment is heavily left-skewed; with relatively fewer high unemployment districts. Bins are per 5000 persons.

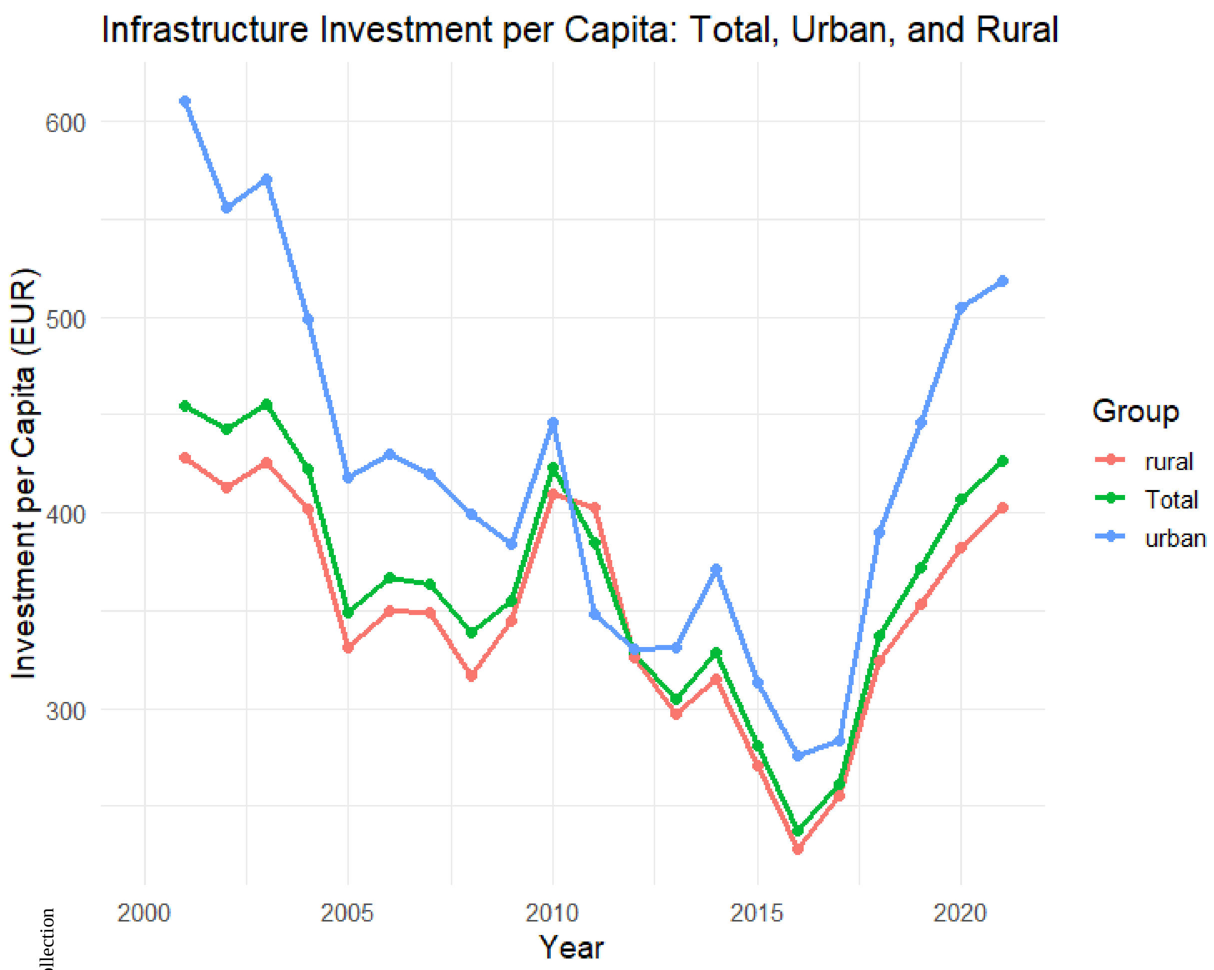

Fig 6: **Infrastructure Investment per Capita: Total, Urban, and Rural:** Aggregated per capita infrastructure investment plotted for total, urban, and rural districts. Initial investment levels decreased from the end of Solidarpakt I until the implementation of Solidarpakt II in 2005. Public investment fluctuate considerably, with a general decline in the mid-2010 (influenced by new debt rules – the so-called *Schuldenbemse*). Urban districts consistently invest more, especially at the beginning and end of the period owing to a stronger tax base and higher population density.

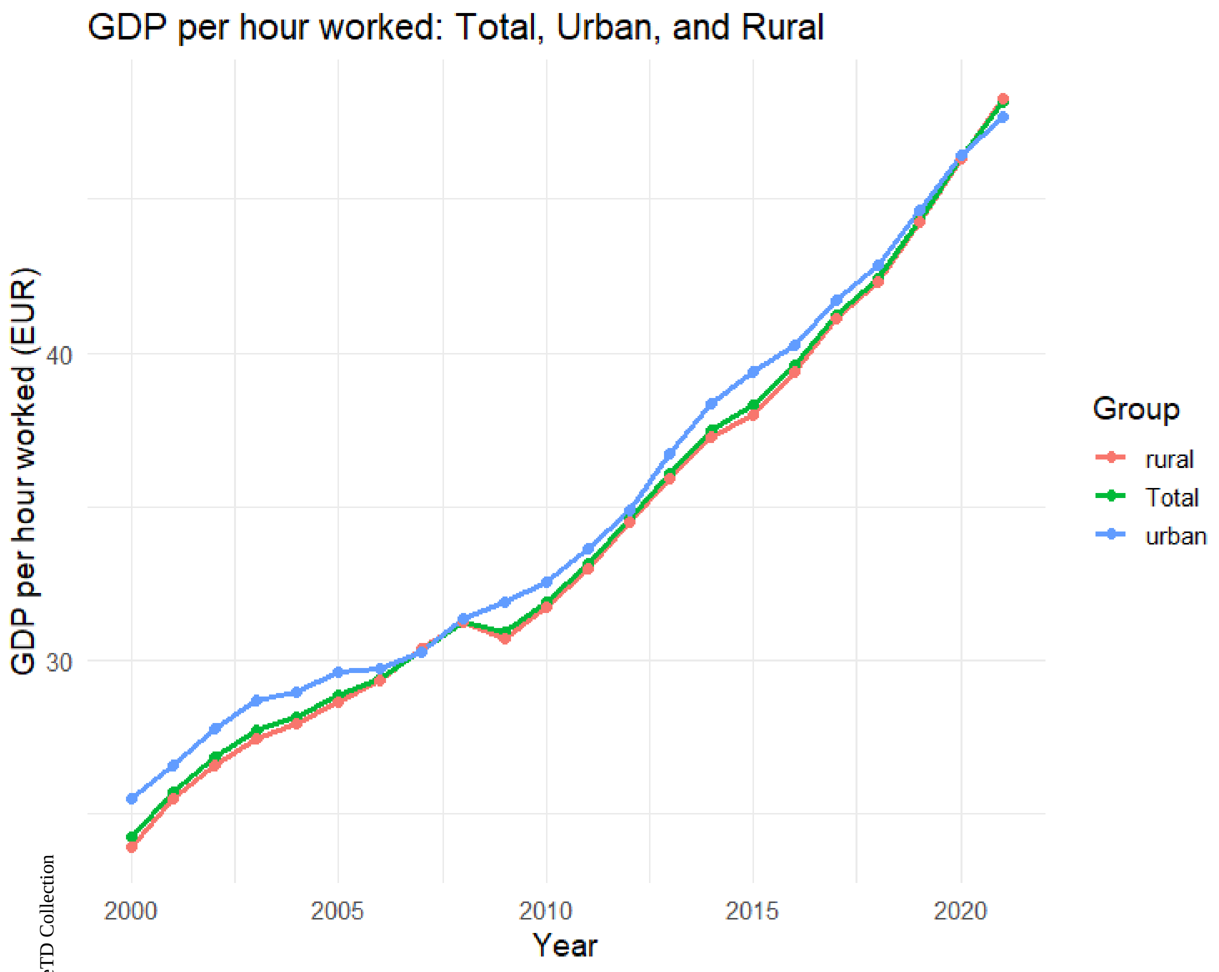

Fig 7: **GDP per hour worked: Total, Urban, and Rural:** Average rural, total, and urban GDP per hour worked in Euro amounts. All groups experience continuous growth in productivity, with only marginal differences between urban and rural areas by the end of the period.

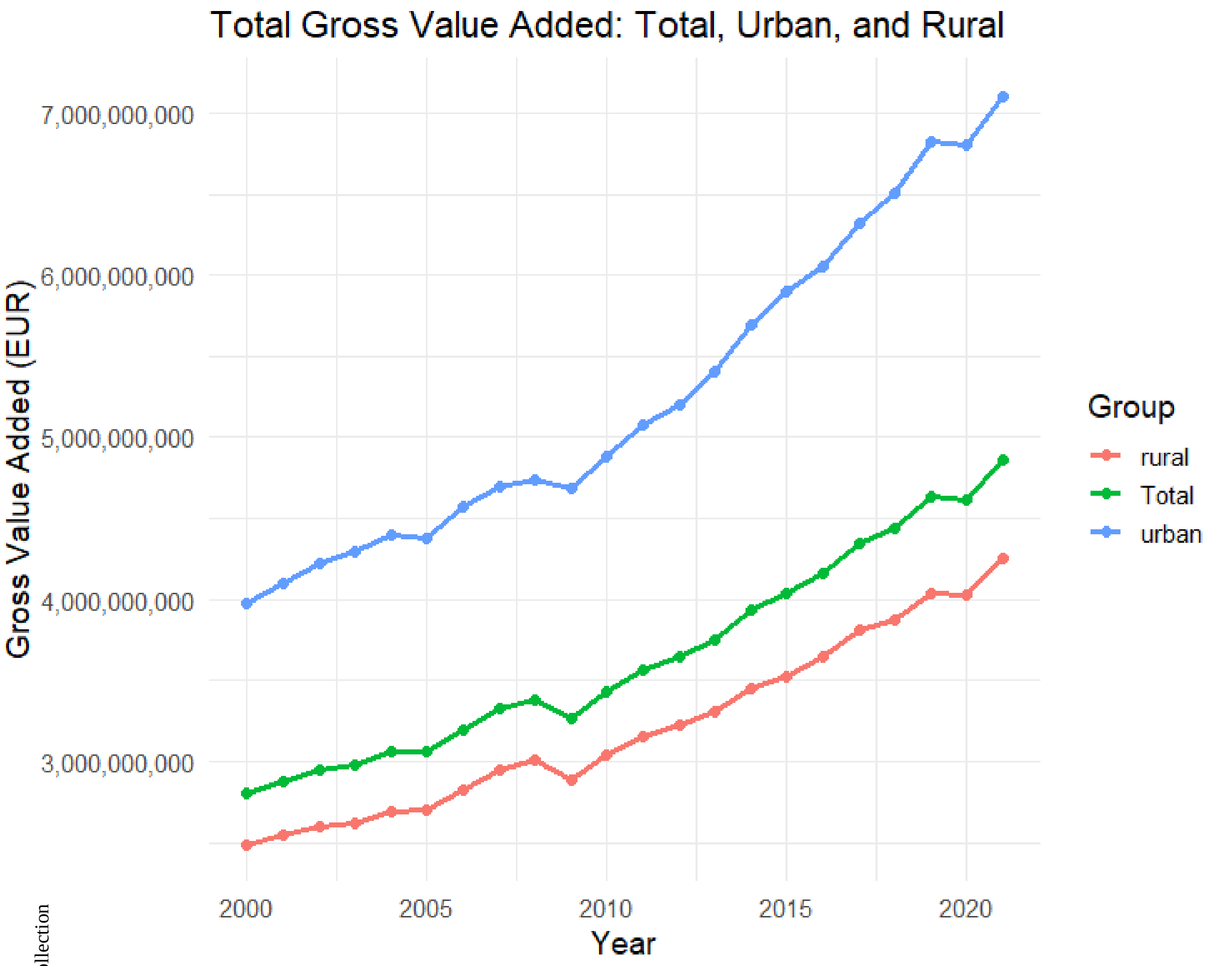

Fig 8: **Total Gross Value Added: Total, Urban, and Rural**: Gross added value measured per year. Cities hold a decisive edge within the dataset – this was by a factor of over 25% in 2000 and has only grown since. The statistic also betrays the stark economic differences between geographies: cities in Eastern Germany are doing quite well in productivity, while rural communities fall further and further behind.

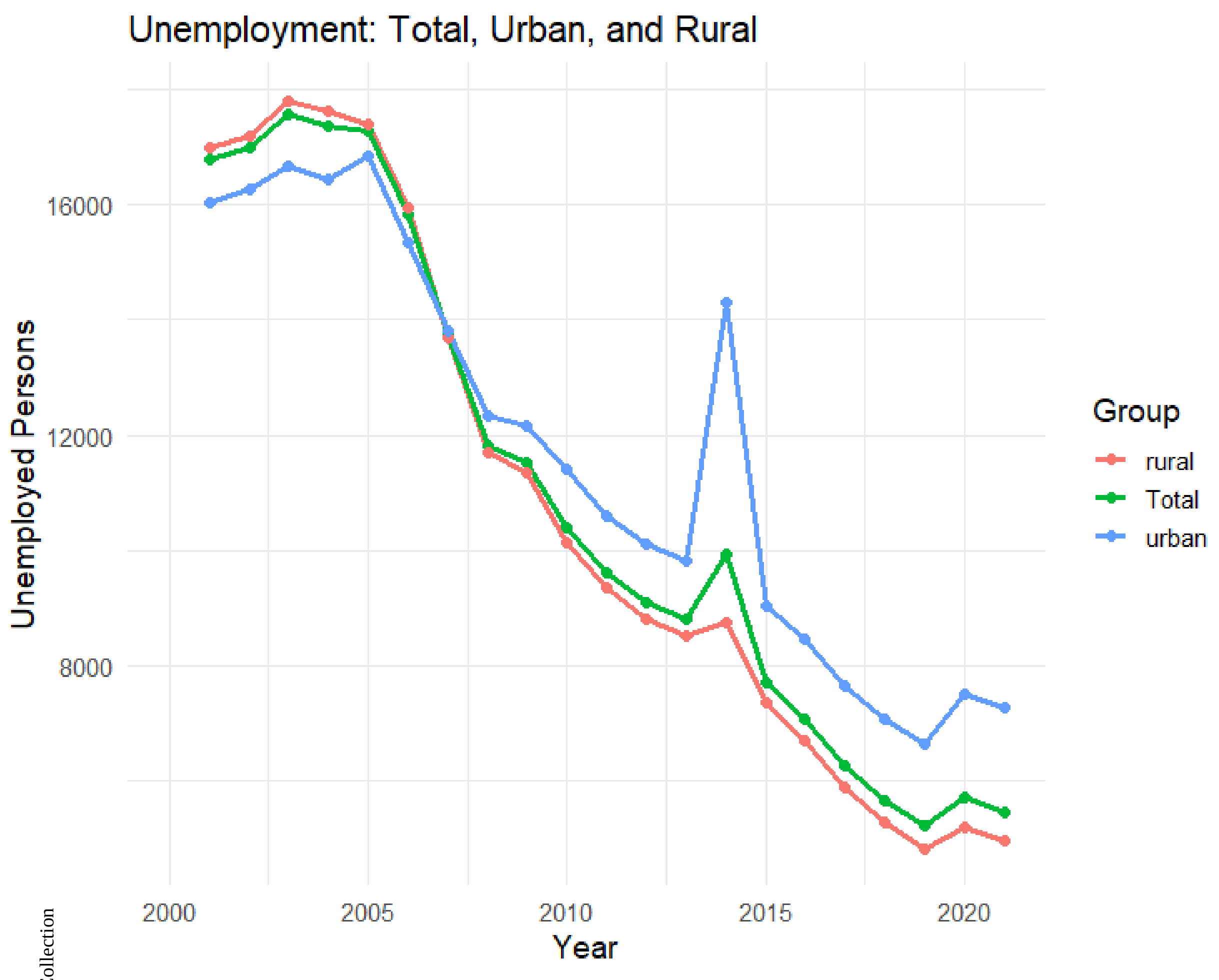

Fig 9: **Unemployment: Total, Urban, and Rural:** Aggregate unemployment steadily declined over the period, reflecting a gradual decline in lingering structural unemployment started from the 1990s onwards with a notable spike in 2014.

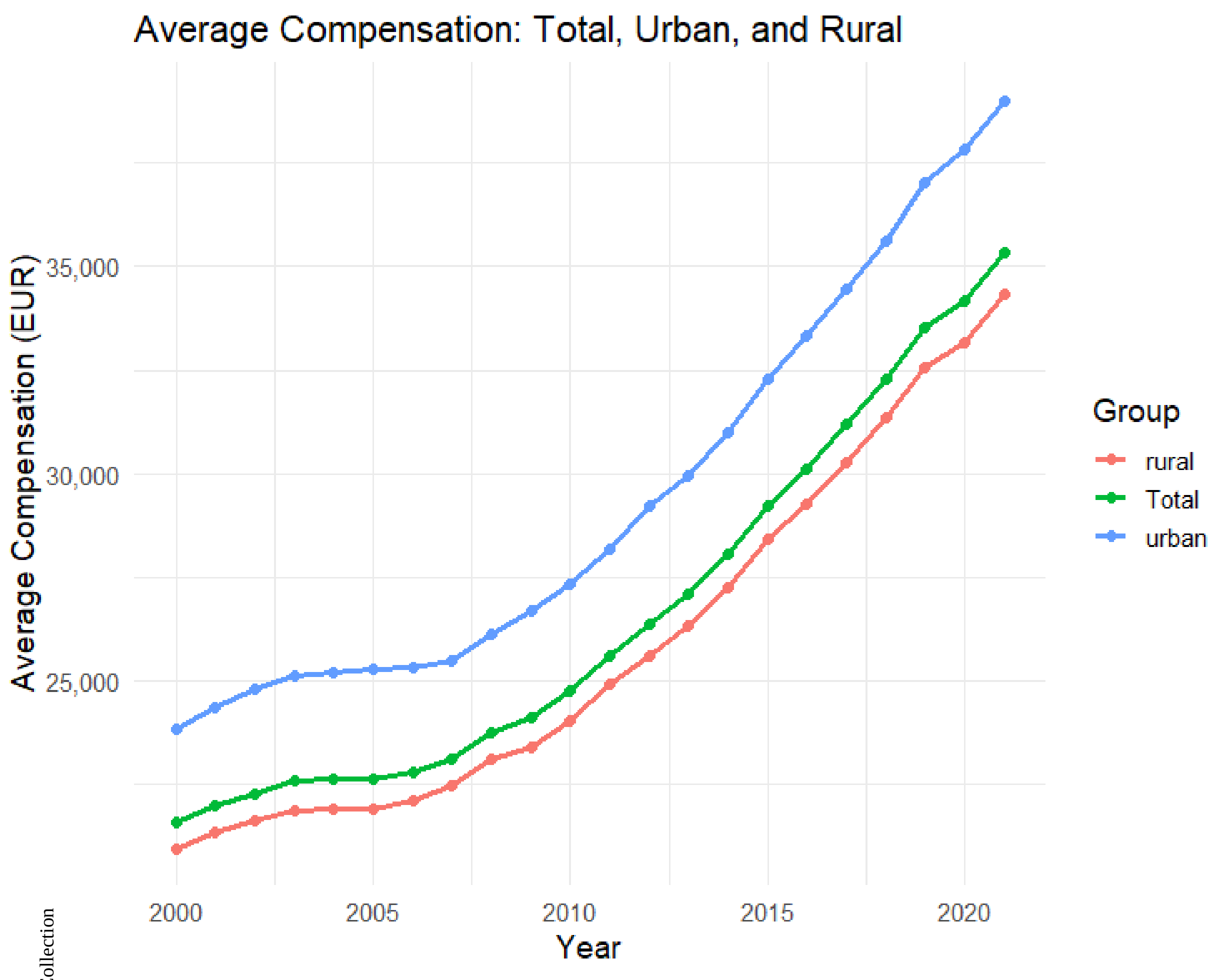

Fig 10: **Average Compensation: Total, Urban, and Rural**: Annualized and averaged employee compensation (i.e. average yearly wage) for all substrate. As one might expect, there is a serious wage premium to be had by urban workers. Wages grow steadily throughout the period, although values are not adjusted for inflation (€1 in 2000 = €1.39 in 2021).

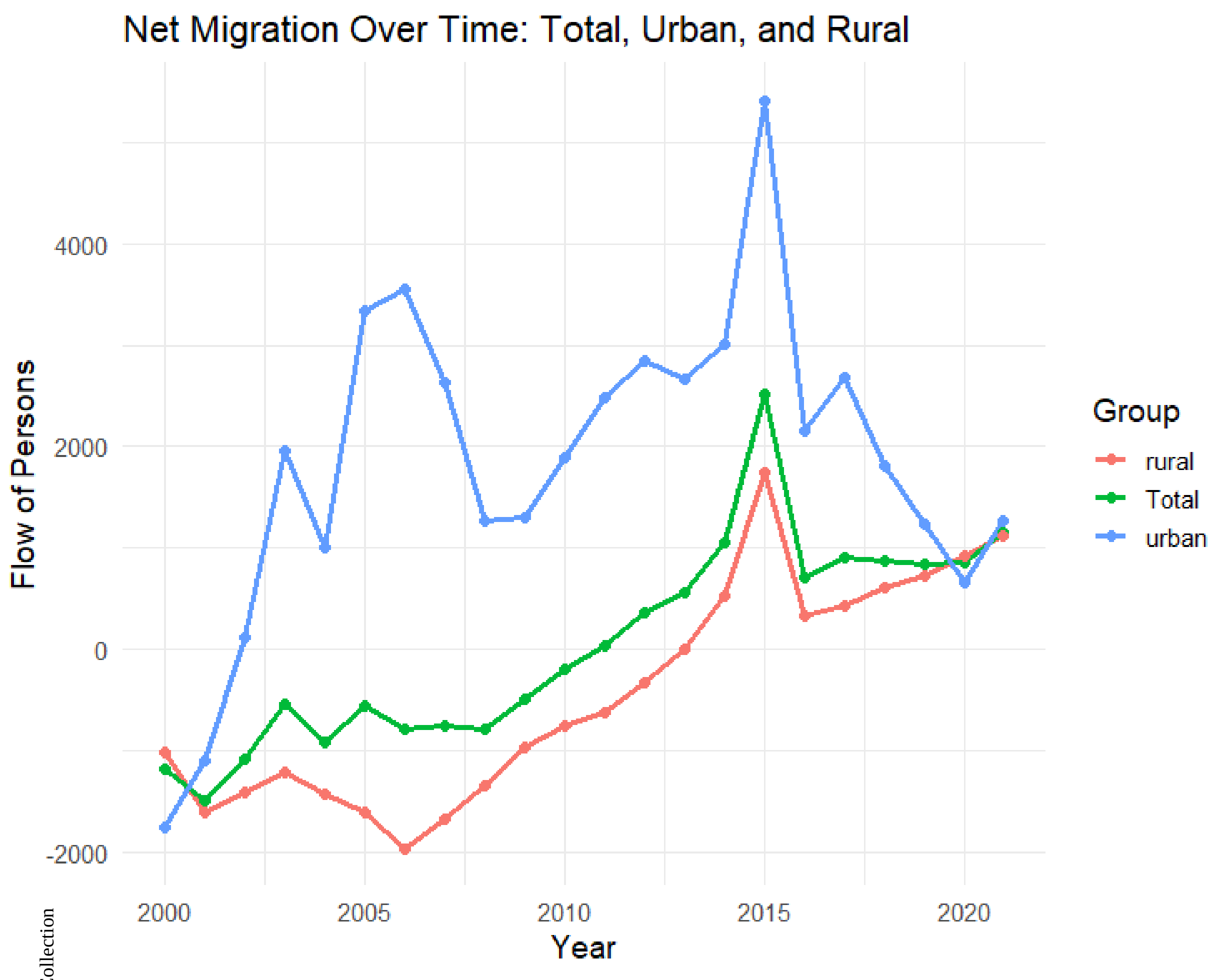

Fig 11: **Net Migration Over Time: Total, Urban, and Rural:** Net migration shown for total, urban, and rural districts. Urban districts experience larger swings in net migration, including during the early 2000s. By comparison, rural flight affected the east German countryside heavily in all years before 2015.

State-level Statistics:

Significant differences between the federal states also play a role. While matching helps to account for some of these disparities, there remain real, quantifiable variations. Mecklenburg-Vorpommern and Saxony-Anhalt experienced the highest rates of unemployment and out-migration, whereas Brandenburg and Saxony benefited from the highest GDP per capita and positive net migration. Brandenburg benefits from proximity to Berlin while Saxony contains large cities and the presence of high potential sectors (semiconductors and green energy). (own calculations)

For instance, the higher levels of capital spending observed in Mecklenburg-Vorpommern and Saxony-Anhalt are unlikely to be explained solely by greater per capita SoBEZ grants; rather, they may also reflect a response to sustained economic distress in these regions. This issue is further complicated by missing data, particularly in Thuringia (especially before 2010) and Saxony-Anhalt (before 2005). While reverse causality could potentially affect the overall findings, it does not account for the positive effects identified in the matched sectoral analyses.

Together, these figures underscore the heterogeneity of economic development across the eastern states, even under a common policy regime. Higher infrastructure investment does not automatically translate into stronger productivity or employment gains, especially where structural challenges and demographic pressures persist. The findings highlight the importance of context-sensitive policy design and the need to combine investment with targeted support for human capital, innovation, and sectoral diversification.

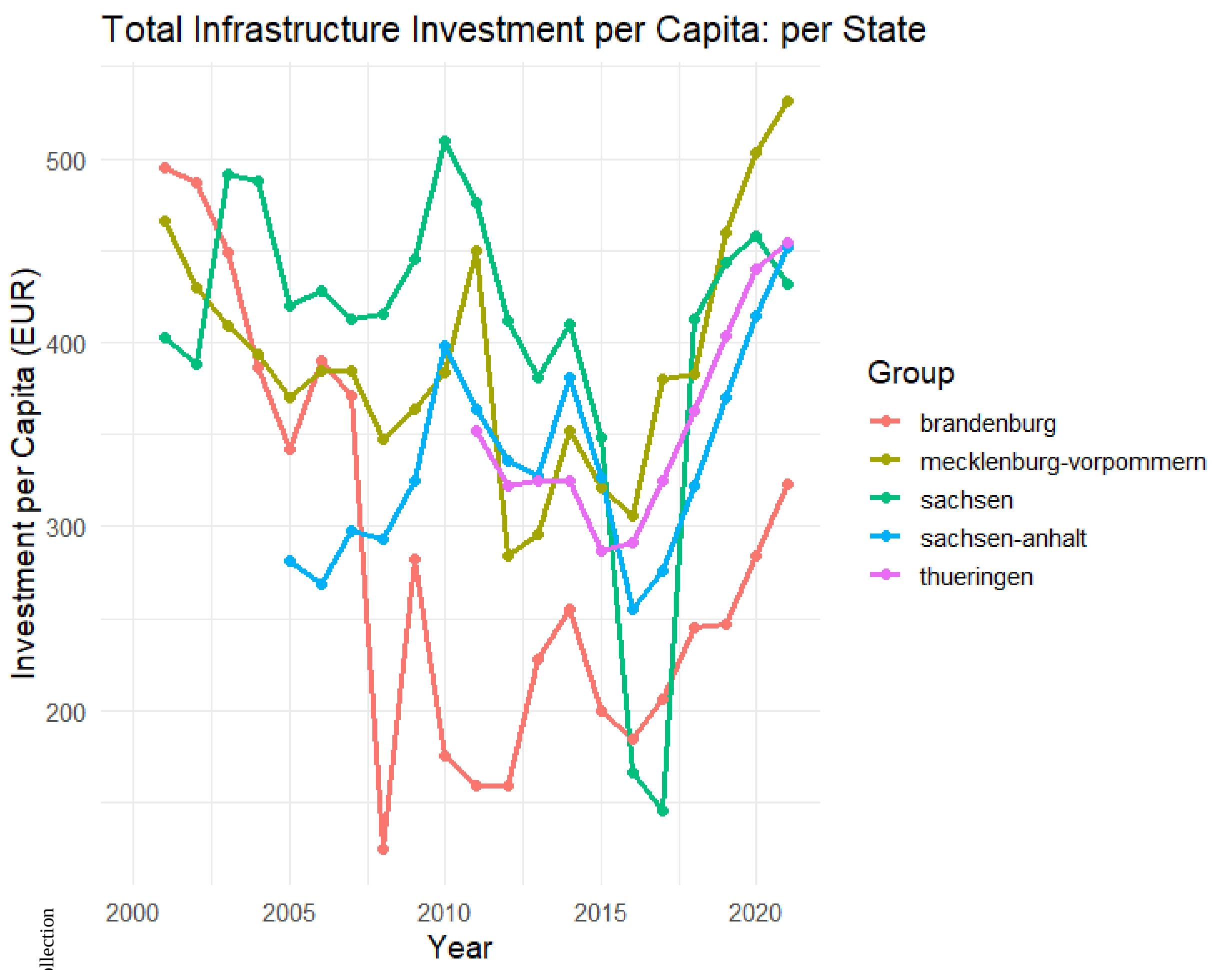

Fig 12: **Total Infrastructure Investment per Capita: per State:** This figure illustrates the pronounced variation in per capita infrastructure investment across the eastern German states over the study period. States such as Mecklenburg-Vorpommern and Saxony-Anhalt consistently display higher per capita investment, reflecting both higher SoBEZ allocations and greater economic need. Higher investment in both may reflect both greater need and more generous SoBEZ allocations, but persistent out-migration suggests limits to the effectiveness of such transfers alone

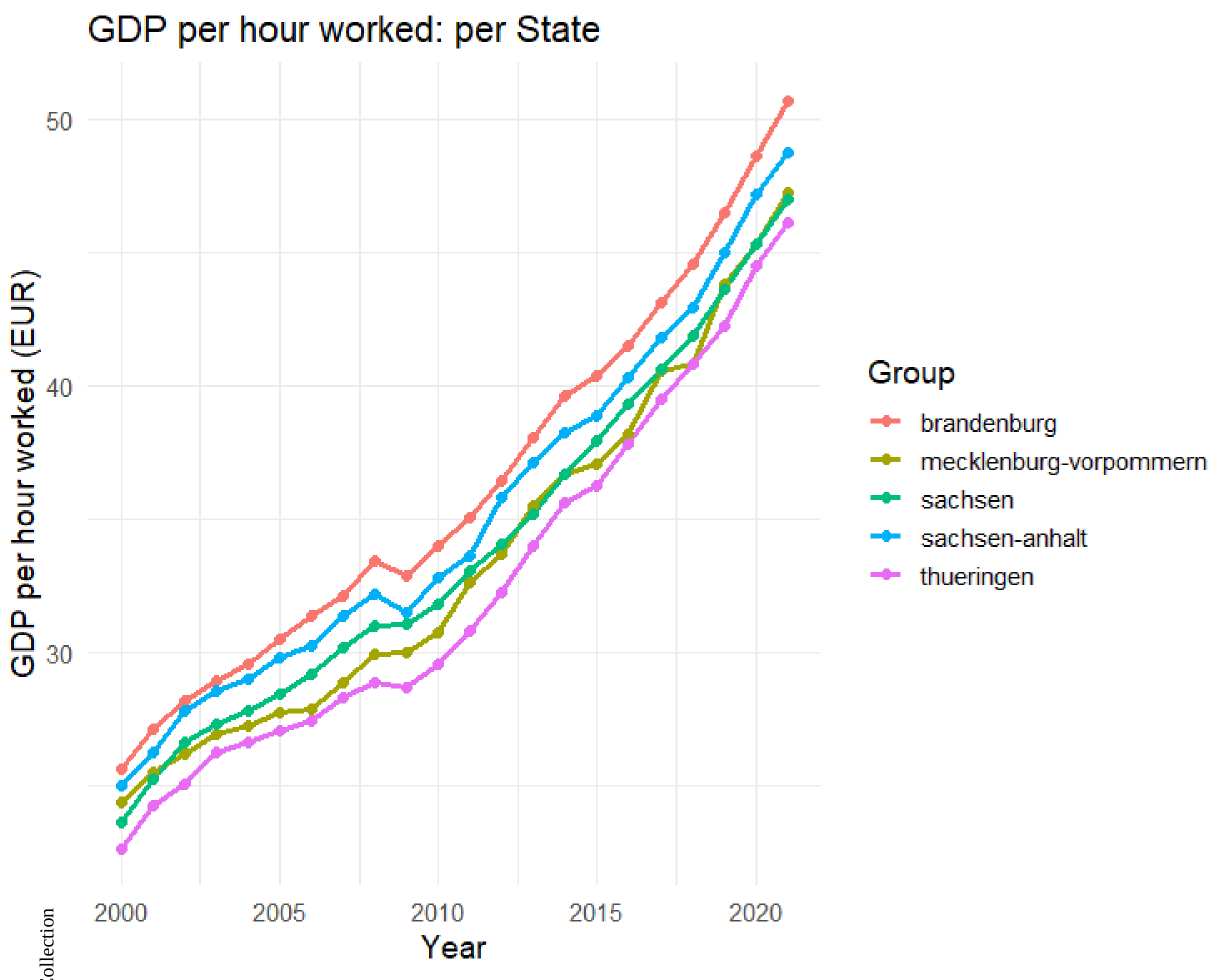

Fig 13: **GDP per hour worked per: per State:** Despite substantial public investment, notable differences in productivity persist at the state level. Saxony and Brandenburg generally exhibit higher GDP per hour worked, relative to the suburbanization of Berlin and more efficient utilization of public investment in Saxony (especially in "growth pole" high tech sectors). Mecklenburg-Vorpommern and Saxony-Anhalt continue to lag, but simultaneously keep the pace with the rest of eastern German

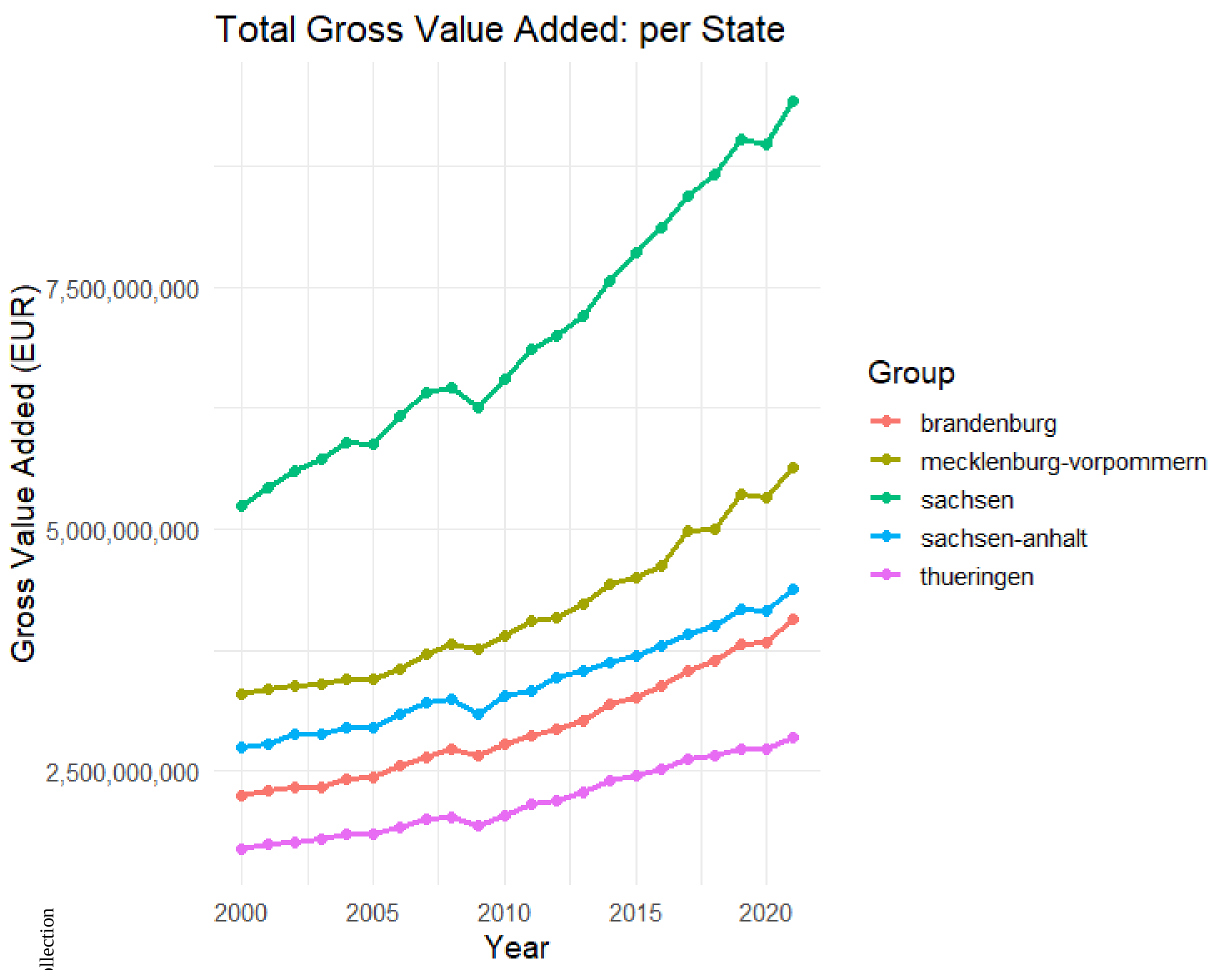

Fig 14: **Total Gross Value Added: per State:** Gross Value Added (GVA) varies considerably across states. The overall pattern reinforces the conclusion that infrastructure investment effects are uneven, with economic gains concentrated in states possessing greater absorptive capacity and diversified economies.

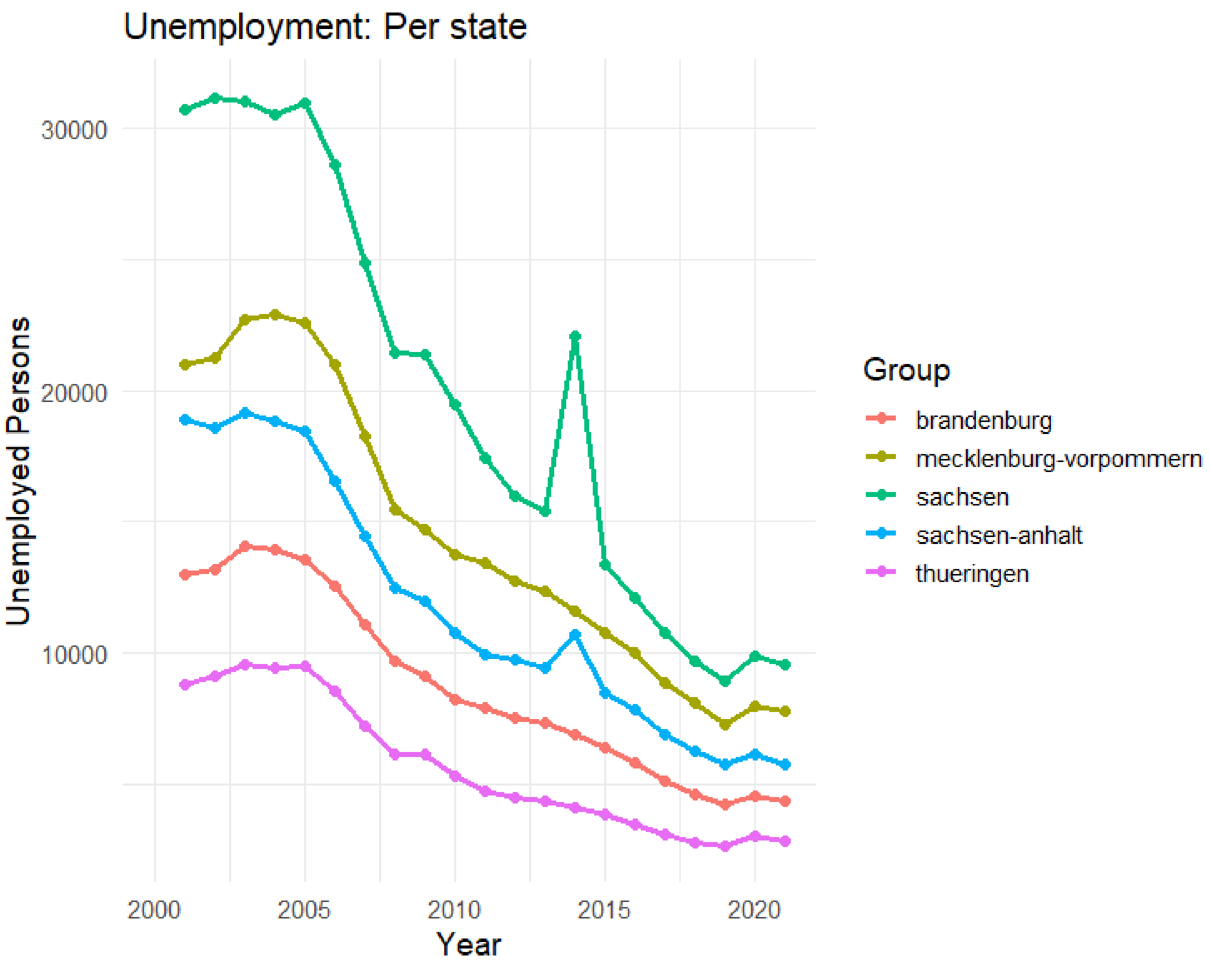

Fig 15: **Unemployment: Per state:** Unemployment trends also reveal marked differences. Mecklenburg-Vorpommern and Saxony-Anhalt have experienced persistently higher unemployment rates and slower labor market recovery, whereas Brandenburg and Saxony show more favorable outcomes. These differences correspond to broader demographic and economic trends, including migration patterns and sectoral shifts, and underscore the limitations of infrastructure investment as a tool for addressing deep-seated labor market challenges.

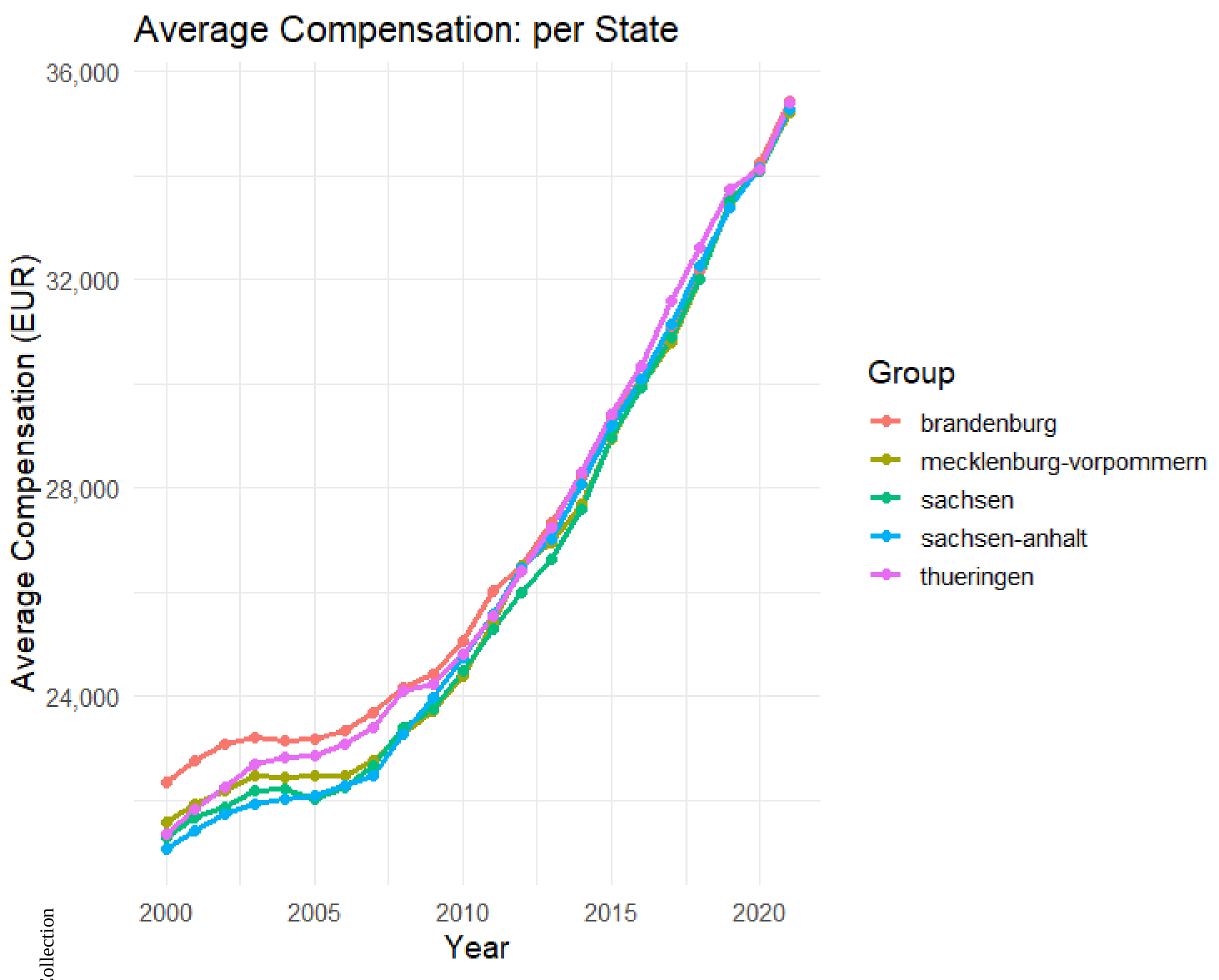

Fig 16: **Average Compensation: per State:** The rapid rise in incomes without a corresponding increase in productivity is often cited as a key reason why Eastern Germany continues to lag behind. Note the relatively similar levels of average compensation across states, while substantial differences persist in gross value added (GVA) and GDP per hour worked.

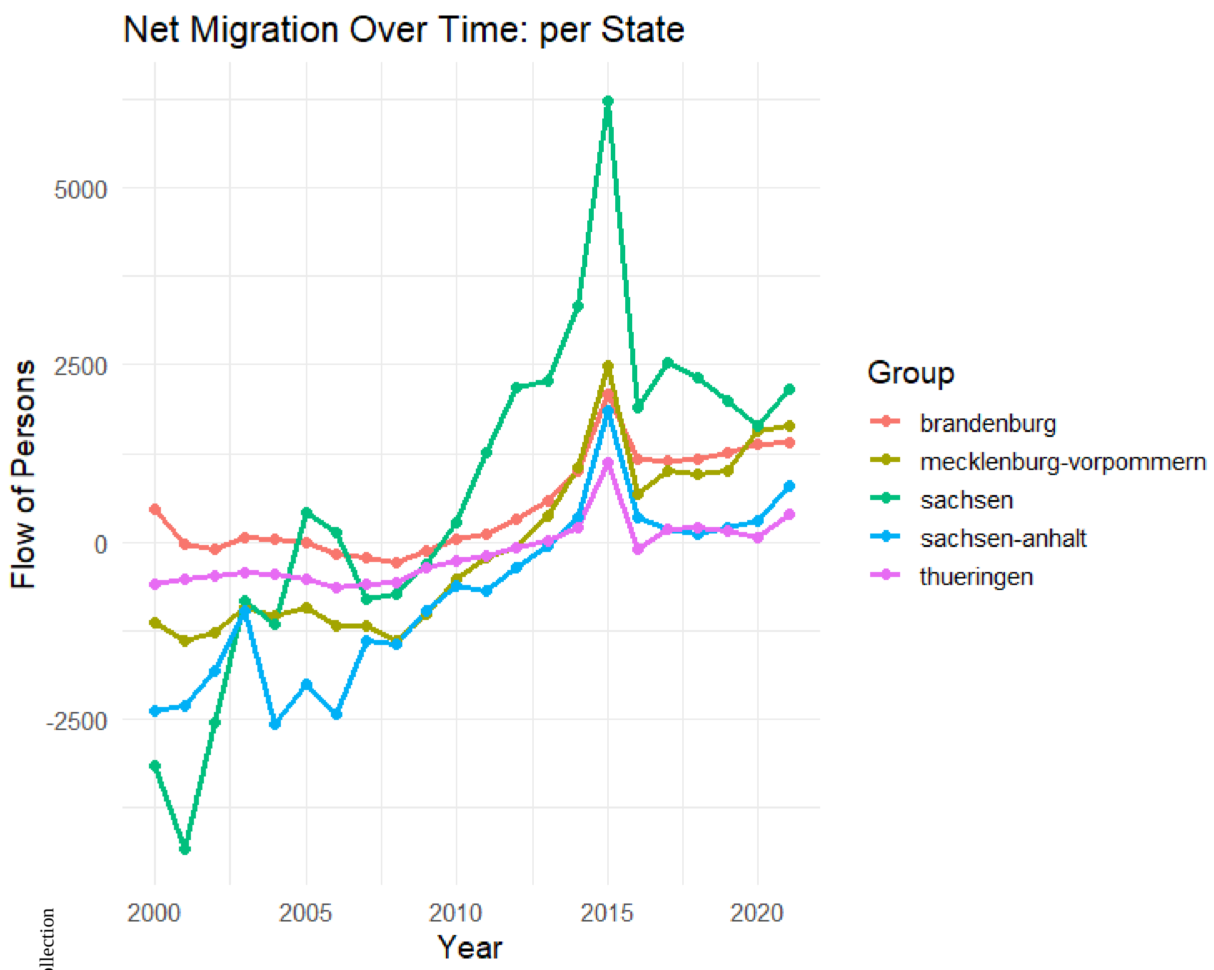

Fig 17: **Net Migration Over Time: per State:** Net population losses motivating boundary changes, increased municipal fiscal equalization, and greater spatial targeting are clearly reflected in net migration rates. Mecklenburg-Vorpommern and Saxony-Anhalt have experienced particularly severe outflows, whereas Saxony and Brandenburg have fared significantly better in recent yea

Econometrics:

GDP per Hour Worked: **(All model specifications)**

Table II: 2SLS Estimates for GDP per Hour Worked	IV GDP per Hour	IV GDP per Hour (Urban/Rural)	Matched IV GDP per Hour	Matched IV GDP per Hour (Urban/Rural)
(Intercept)	3.456	3.241	3.151	2.861
	(0.147)	(0.396)	(0.437)	(0.927)
Lagged Infra. Investment per Capita	0.806		1.356	
	(0.504)		(1.273)	
Pre-treatment Unemployment	-0.000	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Urban Dummy	0.007	0.297	0.329	0.847
	(0.109)	(0.397)	(0.335)	(1.191)
Pre-treatment Migration	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Pre-treatment Population Density	-0.000	0.000	-0.001	-0.001
	(0.000)	(0.000)	(0.001)	(0.001)
Urban interaction term		0.438		0.740
		(0.244)		(0.494)
Rural interaction term		1.485		2.263
		(1.275)		(2.798)
Num.Obs.	778	778	469	469
R2	-0.527	-0.959	-0.885	-1.466
R2 Adj.	-0.537	-0.974	-0.905	-1.498
AIC	-247.2	-51.1	-58.7	69.5
BIC	-219.2	-18.5	-33.8	98.5
RMSE	0.20	0.23	0.22	0.26
Std.Errors	by: landkreis	by: landkreis	by: landkreis	by: landkreis
F-statistic	39.5	114.4 (urban) 6.3758 (rural)	10.7	119.1 (urban) 2.96469 (rural)

p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

This table presents two-stage least squares (2SLS) estimates of the impact of lagged infrastructure investment per capita on GDP per hour worked, employing four alternative model specifications (n = 778, matched n = 469). The first two columns display results for the complete dataset, with column 2 incorporating an urban/rural interaction to capture potential heterogeneity in investment effects by settlement type. Columns 3 and 4 replicate these analyses for a subsample matched on key covariates to reduce selection bias. Across all models, standard errors are clustered at the district (Landkreis) level to account for within-unit correlation. Instrument strength is assessed using first-stage F-statistics, reported separately for urban and rural districts when interaction terms are included.

The results indicate that, in both unmatched and matched samples, there is no robust evidence of a significant effect of infrastructure investment on productivity as measured by GDP per hour worked. The relationship with SoBEZ exposure is positive, but it is not significant at any level, including in the matched sample. Instrument relevance is also a mixed bag; it demonstrates sufficient strength for the urban subgroup ($F > 10$), but the corresponding F-statistics for rural districts fall below conventional thresholds ($F < 10$). Overall, the estimates are reflective of the eastern German convergence slowdown of the mid-2000s and 2010s; if they do exist, they are heterogeneous and unevenly distributed.

Total Gross Value Added (GVA): **(Appendix A: Tables VII-X)**

Table III: 2SLS Estimates, Total Gross Value Added	Total GVA (Unmatched)	Urban/Rural (Unmatched)	Total (Matched)	Urban/Rural (Matched)
Lagged Infra. Inv./Capita	**-0.194910**		**2.124.**	
	(1.14422778)		(1.253)	
Infra. Inv./Capita (Urban)		**-0.880**		**0.646**
		(1.503)		(0.554)
Infra. Inv./Capita (Rural)		**1.337**		**4.740**
		(2.448)		(3.111)
Pre-treatment GDP	0.000080***	0.000***	0.000**	0.000***
	(0.00001342)	(0.000)	(0.000)	(0.000)
Pre-treatment Unemployment	0.000046***	0.000***	0.000***	0.000***
	(0.00000380)	(0.000)	(0.000)	(0.000)
Urban Dummy	-0.374502*	0.301	-0.625*	0.524
	(0.15975475)	(0.874)	(0.280)	(0.883)
Constant	12.951531***	12.355***	12.462***	11.201***
	(0.32277787)	(0.891)	(0.422)	(1.238)
Num.Obs.	832	832	478	478
R2		0.745	0.723	0.447
R2 Adj.	0.802276	0.743	0.721	0.441
AIC		337.4	264.6	541.9
BIC		365.8	285.4	566.9
RMSE	0.258292	0.29	0.32	0.42
Std.Errors	By: landkreis	by: landkreis	by: landkreis	by: landkreis
F-statistic	27.6	50.1 (urban) 4.29 (rural)	23.3	105.2 (urban) 2.62912 (rural)

. $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Broadly, the empirical results provide evidence that SoBEZ transfers have a measurable effect on gross value added (GVA) at the district level. In the matched dataset, significant or marginally significant impacts are observed for Total GVA, as well as in the manufacturing, construction, and public sector segments. These findings suggest that the policy did, in fact, move the needle on economic output—at least within these core areas.

When examining sectoral outcomes in more detail, the effect is most reliably identified for urban manufacturing GVA, where the coefficient on SoBEZ exposure achieves marginal statistical significance at the 10% confidence level (p = 0.0774). This pattern may be attributable to higher absorptive capacity, the presence of more robust supply chains, or positive spillover effects that are typically stronger in urban industrial centers. Such environments may be better positioned to capitalize on infrastructure investment, leading to the observed "virtuous cycle" effects.

The regression models included normalized GDP per capita and unemployment rates as controls, which serve as proxies for underlying economic weakness, as well as an urban indicator variable to capture spatial heterogeneity. The sectoral GVA regressions consistently yielded positive coefficients for SoBEZ transfers in the matched sample, with statistical significance at the conventional 5% level for manufacturing GVA (p = 0.0289), and positive, though less robust, effects in other sectors.

Taken together, these results are suggestive of a real and policy-relevant effect: SoBEZ funding appears to have most effectively boosted economic activity in the sectors and locations it aimed to target, especially in manufacturing-intensive urban districts. While effect sizes fall short of the strictest (1%) significance thresholds, the consistency of the findings across specifications lends credibility to the causal interpretation.

In terms of the SoBEZ instrumentation, the F-statistic (F-stat) was well above 10 for both matched and unmatched aggregate GVA models (representative of strong IV relevance). When disaggregated into urban and rural districts, the rural F-stat is below conventional relevance (F-stat: 2.62912).

Employment: **(Appendix A: Tables XI-XIV)**

Table IV: 2SLS Estimates, Manufacturing Employment	Total Manufacturing Emp.	Manufacturing Emp. (Urban/Rural)	Matched Manufacturing Emp.	Matched Manufacturing Emp. (Urban/Rural)
Lagged Infra. Inv./Capita	6.701*		9.138*	
	(3.130)		(4.068)	
Infra. Inv./Capita (Urban)		2.402		-0.067
		(2.835)		(1.345)
Infra. Inv./Capita (Rural)		18.570.		30.338.
		(9.995)		(16.036)
Pre-treatment GDP	0.000	0.000	0.000	0.000.
	(0.000)	(0.000)	(0.000)	(0.000)
Pre-treatment Migration	-0.000	-0.000	0.000	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Urban Dummy	-1.171**	3.723	-2.135*	5.782
	(0.412)	(3.090)	(0.976)	(4.008)
Constant	6.735***	2.439	6.056***	-3.621
	(1.333)	(3.535)	(1.549)	(6.428)
Num.Obs.	832	832	478	478
R2	-0.451	-4.311	-1.386	-13.447
R2 Adj.	-0.458	-4.343	-1.407	-13.600
AIC	2161.2	3242.9	1342.3	2158.2
BIC	2184.8	3271.2	1363.2	2183.2
RMSE	0.88	1.69	0.98	2.28
Std.Errors	by: landkreis	by: landkreis	by: landkreis	by: landkreis
F-Statistic	32.9	40.3 (urban) 3.86 (rural)	32.9	131.1 (urban) 2.477 (rural)

. p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

The picture illustrated by GVA repeats for employment (n = 832). The clearest evidence for an effect are stable, statistically significant positive coefficients in manufacturing employment, consistent in all four versions of the model (unmatched aggregate: p = 0.0356, unmatched rural: p = 0.0672, matched aggregate: p = 0.0298 and matched rural: 0.0652). For structural unemployment, the matched urban results displayed statistically significant reduction in the absolute number at the 0.10 level confidence level (p = 0.0888). IV relevance also mirrors the

GVA results, with an urban F-stat (F-stat = 131.1) clearing the standard threshold, while the rural IV struggled with identification (F-stat: 2.47).

Ultimately, the result provides another point for a positive effect of infrastructure investment. Across all model specifications—aggregate, urban/rural split, matched, and matched urban/rural—the estimated coefficients for lagged infrastructure investment per capita are consistently positive, with statistical significance at conventional levels in the main and matched models. Notably, the effect size is largest and most precisely estimated in urban districts, where the first-stage F-statistics confirm strong instrument relevance. In rural districts, by contrast, the instrument is weaker and estimates are less precise, leading to high standard errors and misidentification. Despite this, these findings underscore that targeted infrastructure investment contributed measurably to employment growth in the manufacturing sector, particularly where absorptive capacity was highest (cities). Importantly, the results remain robust when accounting for selection on observables via matching, reinforcing the credibility of the causal interpretation. Overall, the empirical evidence indicates that infrastructure-led policy interventions were most effective at stimulating manufacturing employment in urban contexts, while effects in rural districts remain inconclusive.

Compensation: **(Appendix A: Tables XV-XVIII)**

Table V: 2SLS Estimates, Total Manufacturing Compensation	Total Manufacturing Comp.	Manufacturing Comp. (Urban/Rural)	Matched Manufacturing Comp.	Matched Manufacturing Comp. (Urban/Rural)
Lagged Infra. Inv./Capita	-7.946		-2.417	
	(5.118)		(2.727)	
Infra. Inv./Capita (Urban)		0.182		9.707
		(2.943)		(9.167)
Infra. Inv./Capita (Rural)		-21.906.		-20.909
		(11.202)		(14.423)
Pre-treatment GDP	0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Total Population	0.000***	0.000***	0.000***	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Total Unemployment	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Urban Dummy	-0.646	-7.467*	-0.816	-9.517
	(0.749)	(3.238)	(1.082)	(5.974)
Constant	14.007***	19.446***	12.327***	21.470**
	(1.794)	(4.218)	(1.322)	(6.944)
Num.Obs.	832	832	478	478
R2	-0.015	-0.474	0.212	-0.119
R2 Adj.	-0.022	-0.485	0.203	-0.133
AIC	3803.4	4115.7	2130.6	2285.0
BIC	3831.8	4148.7	2155.6	2314.2
RMSE	2.36	2.85	2.22	2.60
Std.Errors	by: landkreis	by: landkreis	by: landkreis	by: landkreis
F-statistic	46.0	57.6 (urban) 8.12 (rural)	35.2	123.3 (urban) 4.358 (rural)
.	. p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001			

IV estimates suggest that infrastructure investment has a positive correlation on total compensation at the district level in cities (Estimate: 1.82), but no statistically significant effect in either urban or rural areas. In contrast, sector-specific analyses reveal some unexpected patterns: compensation in agriculture responds negatively to increased urban infrastructure investment (Estimate: -17.6, $p < 0.0001$), while no significant effects are detected in manufacturing or construction. This points towards weak controls/omitted variable bias or reverse causality concerns on the endogenous regressor: productivity increases would theoretically increase wages given enough time (best evidenced through moderately positive manufacturing coefficents).

Importantly, the relevance of the SoBEZ instrument only holds in the urban substrate, suggesting limited identification. However, the direction and magnitude of sectoral coefficients, especially the negative findings for agriculture and other non-urban sectors, indicate that the distributive impact of infrastructure investment on labor compensation is uneven.

Net Migration: **(Appendix A: Table XIX)**

Table VI: 2SLS Estimates, Net Migration	Net Migration	Net Migration (Urban/Rural)	Matched Net Migration	Matched Net Migration (Urban/Rural)
(Intercept)	-2916.88	-3258.300	1290.999	-3798.395
	(3567.018)	(8542.373)	(4430.827)	(14617.529)
fit_lagged_total_infrastructure_investment_per_capita	-4046.04		-5171.294	
	(9007.299)		(10998.535)	
gdp_pre	0.154	0.157	-0.275	-0.162
	(0.150)	(0.184)	(0.196)	(0.396)
unemp_pre	0.089	0.089	0.279	0.287
	(0.082)	(0.076)	(0.067)	(0.069)
urban_pre	1867.487	2253.994	9208.622	13844.421
	(2241.025)	(5643.705)	(3648.865)	(11704.600)
fit_inv_urban		-4438.543		-11134.549
		(7185.778)		(17346.259)
fit_inv_rural		-3168.752		5379.997
		(21759.876)		(29867.506)
Num.Obs.	832	832	478	478
R2	0.161	0.156	0.521	0.459
R2 Adj.	0.157	0.151	0.517	0.453
AIC	15789.8	15797.3	9116.2	9178.1
BIC	15813.4	15825.6	9137.1	9203.2
RMSE	3178.30	3188.87	3315.68	3530.05
Std.Errors	by: landkreis	by: landkreis	by: landkreis	by: landkreis
F-statistic	27.6	50.1 (urban) 4.29 (rural)	23.3	105.2 (urban) 2.6291 (rural)

p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

We use two-stage least squares (2SLS) to estimate the impact of lagged infrastructure investment per capita on net migration at the district level, instrumenting with lagged SoBEZ exposure. Across all model specifications—including both the full sample and urban/rural subsamples—we do not find any statistically significant effects of infrastructure investment on net migration. The point estimates are generally negative, but the confidence intervals are wide and the standard errors are large (e.g., full sample: Estimate = -4,046, SE = 9,007, p = 0.65; urban: -4,439, SE = 7,186, p = 0.54; rural: -3,169, SE = 21,760, p = 0.88). In the matched sample, the results are similar, with large standard errors and imprecise estimates.

The first-stage F-statistics confirm a strong instrument for urban investment but reveal weak identification for rural areas ($F = 4.3$), which contributes to the especially large standard errors in rural models. Taken together, these results indicate that there is no robust evidence for an effect of infrastructure investment on net migration at the district level, and that rural effects, in particular, should be interpreted with caution due to weak instruments and high estimation uncertainty.

Implications:

In essence, these findings reinforce the case for sector-specific industrial policy in regions with an established or latent manufacturing base. Evidence for spillover effects in other industries is more limited, though this warrants further, focused analysis. Evidently, it remains difficult to disentangle whether observed effects are primarily a result of (preexisting) human capital utilization (convergence theory) or increased connective efficiency (industrial/regional policy). Moreover, the potential deadweight losses resulting from spatial equilibrium adjustments are not directly quantified in this study—particularly given the lack of significant results outside the manufacturing sector. Nonetheless, such losses could be estimated in future work.

The lack of significant effects on total compensation and net migration—coupled with negative effects in agricultural compensation—underscores the heterogeneous and uneven distribution of policy impacts across sectors and regions. Data quality and measurement issues complicate the distinction between true null effects and potential estimation error. Importantly, robust first-stage results for urban areas contrast with persistent weak instrument challenges in rural districts, meaning that the empirical support for policy effectiveness is strongest for urban units and far less reliable for rural areas. Ultimately, the internal migration question requires more focused attention than can be afforded here.

Conclusion

This thesis has examined the causal effects of public infrastructure investment on economic outcomes in eastern Germany using a novel district-level SoBEZ exposure index and a matched instrumental variables (IV) approach. The results provide qualified support for the hypothesis that place-based infrastructure investment, particularly when concentrated in manufacturing-intensive urban areas, can generate sector-specific gains in productivity and employment. However, the effects remain heterogeneous and uneven, with rural districts showing persistently weak identification and little reliable evidence of broader spillover effects.

From a policy perspective, these findings reinforce the potential of targeted infrastructure investment as a form of industrial policy, but specifically when aligned with existing economic structures and latent sectoral capacities. Broadly, policymakers should be very careful not to overextrapolate; the observed productivity gains became non-significant outside of this context. Additionally, the lack of significant effects on net migration and total compensation underscores the limits of such strategies as universal tools for regional convergence. The differentiated impact across sectors and regions illustrates the inherent trade-offs in large-scale investment programs and signals the need for careful targeting and complementary policy support.

However, it is important to distinguish between different evaluative contexts. As a policy aimed at improving infrastructure quantity, holding other factors constant, Sobez likely succeeded. This is best supported by observed investment amounts (assuming bureaucratic efficiency). When focusing on the downstream effects of increased infrastructure spending, the policy also succeeded in a narrow sense, particularly in terms of manufacturing productivity and employment gains in urban areas. Whether such outcomes are efficient in the broader welfare sense, especially when accounting for potential marginal deadweight losses, remains an open question. Answering this would require a separate analysis of the *Solidaritätszuschlag's* incidence and welfare effects in western Germany.

Methodologically, this study highlights the persistent challenges of causal inference in regional policy evaluation, especially when administrative data is incomplete or aggregated and when parallel interventions cannot be fully controlled for. Matching played a central role in the identification strategy by enabling comparison between matched and unmatched samples. This approach was particularly important in the case of GRW, whose funding patterns likely overlapped with SoBEZ and targeted similar regions, thereby posing a major source of potential confounding.

Indeed, through the comparison of matched and unmatched samples the general empirical findings were stable. This consistency suggests that the estimated effects are not purely artifacts of model specification, although this is less true of rural district results. However, matching is also imperfect, as it cannot fully eliminate concerns about unobserved confounders or measurement error.

The empirical results confirm much of what is already established in the literature regarding infrastructure spending and productivity in eastern Germany. Much of the academic consensus has accepted that large transfer payments simply won't solve the problem; especially after the sobering experience of the early 2000s. (Ragnitz 2024; Blum 2019; Fuchs-Schündeln and Izem 2012) The disappointing per-sector results outside of the manufacturing can be reconciled within infrastructure production input model. (Bom and Ligthart 2014) By 2005, the production elasticity of infrastructure in eastern Germany appears to have reached saturation, as reflected in the economic slowdown of the late 1990s. Consequently, the vast sums invested in infrastructure were not economically transformative. This point should not be understated: capital infrastructure investments funded by Solidarpakt II totaled €117.097 billion across Korb I and Korb II (own calculations).

In essence, infrastructure related productivity gains are highly conditional: they are greatest in areas with absorptive capacity and go unrealized if there are sufficient stocks of capital. It doesn't mean that infrastructure policy is worthless either. While there are limits to the productive capacity of capital, persistent underfunding causes problems in the other direction – resulting in negative productivity and externalities. The policy implications are clear: ignore infrastructure at your own peril, but don't expect unconditional gains, especially without an understanding of preexisting capital stocks and local industry structures.

It also suggests that spatial policy must contend with deadweight losses and uneven migration responses that, while not quantified here, warrant deeper investigation. In the context of regional policy, this is especially relevant for the eastern German countryside, which lost about 13.3% of its total population. (own calculations) The implications are acute: as of 2022, Germany's national fertility rate remains below replacement level at 1.46. (Statistisches Bundesamt, 2022) It is therefore questionable whether infrastructure investment alone can address the underlying demographic and economic challenges. Nonetheless, the policy discourse often invokes some version of the case for improving public services, reflecting a broader argument for sustaining livability and institutional capacity in declining regions. Both Solidarpakt I & II explicitly included a public services rationale, especially in municipal finance transfers.

Ultimately, the Solidarpakt II case offers a rich, if imperfect, demonstration of how sustained regional infrastructure investment operates within advanced industrial economies. Particularly, the results hold well for export-oriented manufacturing economies through internationally competitive firms (in the German example, small and medium sized enterprises – SMEs). However, similar effects may be replicable in other contexts where physical infrastructure constitutes a central input in the local production function and where firms possess the capacity to absorb and leverage such investment.

Future research should deepen causal identification strategies, incorporate political economy dimensions, and investigate longer-term dynamic effects—particularly in rural regions and under varying institutional regimes. In the context of industrial policy, the political economy perspective is especially relevant, as such policies inherently revolve the state "picking winners and losers".

Principal factors such as sectoral lobbying and the political preferences of local decision-makers are very plausible but are unobserved in this study. The recent and often ferocious debate over the *Schuldenbremse* (debt brake) makes the point clearly: infrastructure policy decisions are shaped as much by political contestation as by need. A more comprehensive understanding of regional investment outcomes therefore requires a political-economy element.

By the end of 2019, Solidarpakt II and the associated SoBEZ transfers had run their course. The system was replaced by modifications to the *Länderfinanzausgleich* (state financial equalization). Instead of a direct replacement of SoBEZ as between the two Solidarpakts, the reformed system enabled targeted grants to structurally weak regions in both western and eastern Germany. Regional policy, long associated with the east, has come back westward.

To close, the end of Solidarpakt II and SoBEZ transfers marked a turning point in German regional policy. Continued industrial and regional policy in the form of GRW and the *Länderfinanzausgleich* reflects the continuing relevance and the evolving nature of efforts to balance economic disparities within the country, especially in infrastructure spending. Nevertheless, the legacy of reunification continues to shape German regional policy, even as the framework adapts to new challenges and disparities across the nation.

Bibliography

Abiad, Abdul, Davide Furceri, and Petia Topalova. 2015. "The Macroeconomic Effects of Public Investment: Evidence from Advanced Economies." IMF Working Papers 15/95. International Monetary Fund.

Aiginger, Karl, and Dani Rodrik. 2020. "Rebirth of Industrial Policy and an Agenda for the Twenty-First Century." *Journal of Industry, Competition and Trade* 20 (2): 189–207. https://doi.org/10.1007/s10842-019-00322-3.

Alecke, Björn, and Timo Mitze. 2023. "Institutional Reforms and the Employment Effects of Spatially Targeted Investment Grants: The Case of Germany's GRW," February.

Awan, M. Usaid, Yameng Liu, Marco Morucci, Sudeepa Roy, Cynthia Rudin, and Alexander Volfovsky. 2019. "Interpretable Almost-Matching-Exactly With Instrumental Variables." arXiv. https://doi.org/10.48550/arXiv.1906.11658.

Becker, Sascha O., Peter H. Egger, and Maximilian Von Ehrlich. 2012. "Too Much of a Good Thing? On the Growth Effects of the EU's Regional Policy." *European Economic Review* 56 (4): 648–68. https://doi.org/10.1016/j.euroecorev.2012.03.001.

Blum, Ulrich. 2019. "The Eastern German Growth Trap: Structural Limits to Convergence?" *Intereconomics* 54 (6): 359–68. https://doi.org/10.1007/s10272-019-0854-8.

Bom, Pedro R.D., and Jenny E. Ligthart. 2014. "What Have We Learned from Three Decades of Research on the Productivity of Public Capital?" *Journal of Economic Surveys* 28 (5): 889–916. https://doi.org/10.1111/joes.12037.

Bovenschulte, Marc, Frederik Parton, and Florian Bernardt. 2024. "Analyse Und Prognose Volkswirtschaftlicher Und Regionalökonomischer Wachstumseffekte Des Halbleiterökosystems in Sachsen." Berlin: Institut für Innovation und Technik (iit) in der VDI/VDE Innovation + Technik GmbH.

Brachert, Matthias, Eva Dettmann, Lutz Schneider, and Mirko Titze. 2024. "'Evaluation der Gemeinschaftsaufgabe "Verbesserung der regionalen Wirtschaftsstruktur" (GRW)' durch einzelbetriebliche Erfolgskontrolle: Evaluationsbericht." Impact Evaluation 3/2024. IWH Studies. Halle (Saale), Coburg: Halle Institute for Economic Research (IWH).

Breidenbach, Philipp, Timo Mitze, and Christoph M. Schmidt. 2016. "EU Structural Funds and Regional Income Convergence A Sobering Experience." *Ruhr Economic Papers*. https://doi.org/10.2139/ssrn.2758674.

Bullerjahn, Jens, and Michael Thöne. 2020. "Municipal Finances and Municipal Financial Equalisation in Germany." Hamburg: Deutsche Gesellschaft für Internationale Zusammenarbeit.

Clark, William A.V., and William Lisowski. 2019. "Extending the Human Capital Model of Migration: The Role of Risk, Place, and Social Capital in the Migration Decision." *Population, Space and Place* 25 (4). https://doi.org/10.1002/psp.2225.

Criscuolo, Chiara, Guy Lalanne, and Luis Díaz. 2022. "Quantifying Industrial Strategies (QuIS): Measuring Industrial Policy Expenditures." OECD Science, Technology and Industry Working Papers 2022/05. OCED. https://www.oecd.org/en/publications/quantifying-industrial-strategies-quis_ae351abf-en.html.

Criscuolo, Chiara, Ralf Martin, Henry G. Overman, and John Van Reenen. 2019. "Some Causal Effects of an Industrial Policy." *American Economic Review* 109 (1): 48–85. https://doi.org/10.1257/aer.20160034.

Ehrlich, Maximilian V., and Henry G. Overman. 2020. "Place-Based Policies and Spatial Disparities across European Cities." *Journal of Economic Perspectives* 34 (3): 128–49. https://doi.org/10.1257/jep.34.3.128.

Evenett, Simon, Adam Jakubik, Fernando Martín, and Michele Ruta. 2024. "The Return of Industrial Policy in Data." IMF Working Papers 24/1. Internation Monetary Fund.

Fajgelbaum, Pablo, and Cecile Gaubert. 2019. "Optimal Spatial Policies, Geography and Sorting." *National Bureau of Economic Research*, NBER Working Paper Series, , no. 24632 (November).
Fuchs-Schündeln, Nicola, and Rima Izem. 2012. "Explaining the Low Labor Productivity in East Germany – A Spatial Analysis." *Journal of Comparative Economics* 40 (1): 1–21. https://doi.org/10.1016/j.jce.2011.09.001.
Giulietti, Corrado, Martin Guzi, Martin Kahanec, and Klaus F Zimmermann. 2013. "Unemployment Benefits and Immigration: Evidence from the EU." *International Journal of Manpower* 34 (1): 24–38.
Glaeser, Edward L, and James M. Poterba. 2021. "The Macroeconomic Consequences of Infrastructure Investment." In *Economic Analysis and Infrastructure Investment*, 219–68. University of Chicago Press & National Bureau of Economic Research.
Hall, John B., and Udo Ludwig. 2006. "Economic Convergence across German Regions in Light of Empirical Findings." *Cambridge Journal of Economics* 30 (6): 941–53. https://doi.org/10.1093/cje/bel001.
Juhász, Réka, Nathan Lane, and Dani Rodrik. 2024. "The New Economics of Industrial Policy." *Annual Review of Economics* 16:213–42.
Juhász, Réka, and Claudia Steinwender. 2023. "Industrial Policy and the Great Divergence." *National Bureau of Economic Research*, no. 31736 (September).
Kline, Patrick, and Enrico Moretti. 2013. "People, Places and Public Policy: Some Simple Welfare Economics of Local Economic Development Programs." *National Bureau of Economic Research*, NBER Working Paper Series, , no. 19659 (November).
Molloy, Raven, Christopher L Smith, and Abigail Wozniak. 2011. "Internal Migration in the United States." *Journal of Economic Perspectives* 25 (3): 173–96. https://doi.org/10.1257/jep.25.3.173.
Navaretti, Giorgio Barba, and Borisav Markovic. 2021. "What Are We Building On? Place-Based Policies and the Foundations of Productivity in the Private Sector." In . OECD-EC High-Level Expert Workshop Series. OECD.
Ragnitz, Joachim. 2003. "Solidarpakt: Aufbaugerechte Verwendung der Mittel noch nicht gewährleistet." *Leibniz-Institut für Wirtschaftsforschung Halle (IWH)*, Wirtschaft im Wandel, 9 (16): 473–78.
———. 2024. "Der Produktivitätsrückstand Ostdeutschlands: Eine unendliche Geschichte." *ifo Dresden berichtet* 31 (1): 3–9.
Roback, Jennifer. 1982. "Wages, Rents, and the Quality of Life." *Journal of Political Economy* 90 (6): 1257–78. https://doi.org/10.1086/261120.
Siegloch, Sebastian, Nils Wehrhöfer, and Tobias Etzel. 2025. "Spillover, Efficiency, and Equity Effects of Regional Firm Subsidies." *American Economic Journal: Economic Policy* 17 (1): 144–80. https://doi.org/10.1257/pol.20220667.
"Statistisches Bundesamt." 2022. https://www.destatis.de/EN/Themes/Society-Environment/Population/Current-Population/_node.html.
Suedekum, Jens. 2025. "Place-Based Policies – How to Do Them and Why." *Global Challenges & Regional Science* 1 (March):100003. https://doi.org/10.1016/j.gcrs.2024.100003.

Appendix A: 2SLS Estimates

Gross-Value Added:

Table VII: 2SLS Estimates, GVA per Sector

Variable	Total Productivity	Manufacturing	Agriculture	Industry excl. Construction	Construction	Trade/Transport IT/Hospitality	Finance/Business Real Estate	Public Services
(Intercept)	12.95 (0.32) ***	9.59 (1.24) ***	10.25 (1.46) ***	10.36 (0.84) ***	10.18 (0.51) ***	11.09 (0.53) ***	11.97 (0.58) ***	11.93 (0.33) ***
fit_lagged_total_infrastructure_inv_pc	-0.19 (1.14)	7.20 (3.49) *	-0.95 (3.93)	4.38 (2.34) .	2.12 (1.62)	-1.72 (1.80)	-2.60 (1.98)	-0.18 (1.29)
gdp_pre	0.00008 (0.00001) ***	0.00006 (0.00004)	0.00003 (0.00006)	0.00008 (0.00003) **	0.00005 (0.00002) *	0.00010 (0.00002) ***	0.00008 (0.00002) ***	0.00006 (0.00002) ***
unemp_pre	0.00005 (0.00000) ***	0.00003 (0.00001) *	0.00004 (0.00002) *	0.00004 (0.00001) ***	0.00004 (0.00001) ***	0.00006 (0.00001) ***	0.00005 (0.00001) ***	0.00005 (0.00000) ***
urban_pre	-0.37 (0.16) *	-1.46 (0.45) **	-2.94 (0.67) ***	-1.26 (0.30) ***	-0.63 (0.19) **	-0.40 (0.24)	-0.06 (0.28)	0.21 (0.16)
F (1st Stage)	27.6	27.6	11.0	27.6	27.6	27.6	27.6	27.6
Obs.	832	832	802	832	832	832	832	832
Adj. R^2	0.80	-0.29	0.71	0.17	0.51	0.66	0.51	0.82
RMSE	0.26	0.92	0.68	0.64	0.44	0.41	0.45	0.26

Table VIII: GVA by Sector (Urban/Rural Effects)

Variable	Total GVA	Manufacturing	Agriculture	Industry excl. Construction	Construction	Trade/Transport IT/Hospitality	Finance/Business Real Estate	Public Services
(Intercept)	12.36 (0.89) ***	7.92 (2.33) **	8.13 (2.09) ***	8.51 (1.82) ***	8.42 (1.72) ***	11.98 (1.46) ***	12.73 (1.37) ***	10.73 (1.15) ***
fit_inv_urban	-0.88 (1.50)	5.28 (2.80) .	-6.25 (7.29)	2.26 (1.40)	0.09 (1.31)	-0.70 (1.36)	-1.73 (2.02)	-1.55 (1.83)
fit_inv_rural	1.34 (2.45)	11.49 (6.33) .	4.21 (5.67)	9.12 (5.18) .	6.64 (4.97)	-4.01 (4.13)	-4.55 (3.79)	2.89 (3.17)
gdp_pre	0.00009 (0.00001) ***	0.00007 (0.00004) .	0.00005 (0.00006)	0.00009 (0.00003) ***	0.00006 (0.00002) **	0.00009 (0.00002) ***	0.00007 (0.00003) **	0.00007 (0.00002) ***
unemp_pre	0.00005 (0.00000) ***	0.00004 (0.00001) **	0.00005 (0.00002) *	0.00004 (0.00001) ***	0.00005 (0.00001) ***	0.00005 (0.00001) ***	0.00005 (0.00001) ***	0.00005 (0.00001) ***
urban_pre	0.30 (0.87)	0.43 (1.86)	0.31 (2.35)	0.83 (1.57)	1.37 (1.53)	-1.40 (1.31)	-0.92 (1.32)	1.56 (1.05)
First Stage F (inv_urban)	50.1	50.1	22.1	50.1	50.1	50.1	50.1	50.1
First Stage F (inv_rural)	4.29	4.29	4.10	4.29	4.29	4.29	4.29	4.29
Observations	832	832	802	832	832	832	832	832
Adj. R^2	0.74	-0.98	0.49	-0.67	-0.24	0.51	0.33	0.63
RMSE	0.29	1.14	0.91	0.90	0.70	0.49	0.53	0.38

Table IX: GVA by Sector (CEM-weighted)

Variable	Total Productivity	Manufacturing	Agriculture	Industry excl. Construction	Construction	Trade/Transport IT/Hospitality	Finance/Business Real Estate	Public Services
(Intercept)	12.46 (0.42) ***	9.17 (1.16) ***	8.90 (1.85) ***	9.80 (0.70) ***	9.62 (0.82) ***	10.55 (0.62) ***	11.67 (0.36) ***	11.44 (0.67) ***
fit_lagged_total_infrastructure_inv_pc	**2.12 (1.25) .**	**7.83 (3.46) ***	5.18 (5.89)	3.62 (2.46)	**5.12 (2.53) ***	1.47 (2.18)	0.71 (1.42)	**3.69 (2.01) .**
gdp_pre	0.00006 (0.00002) **	0.00004 (0.00004)	0.00003 (0.00005)	0.00011 (0.00004) **	0.00002 (0.00003)	0.00007 (0.00003) .	0.00003 (0.00003)	0.00001 (0.00002)
unemp_pre	0.00005 (0.00000) ***	0.00006 (0.00001) ***	0.00001 (0.00003)	0.00006 (0.00001) ***	0.00005 (0.00001) ***	0.00006 (0.00000) ***	0.00006 (0.00000) ***	0.00004 (0.00001) ***
urban_pre	-0.63 (0.28) *	-2.22 (0.67) **	-3.33 (0.65) ***	-2.10 (0.44) ***	-1.13 (0.52) *	-0.58 (0.38)	0.10 (0.23)	0.08 (0.47)
F (1st Stage)	23.3	23.3	5.6	23.3	23.3	23.3	23.3	23.3
Obs.	478	478	463	478	478	478	478	478
Adj. R^2	0.72	-0.24	0.28	0.41	-0.06	0.75	0.80	0.46
RMSE	0.30	0.79	0.71	0.50	0.58	0.34	0.28	0.42

Table X: GVA by Sector (Urban/Rural Effects, CEM-weighted)

Variable	Total GVA	Manufacturing	Agriculture	Industry excl. Construction	Construction	Trade/Transport IT/Hospitality	Finance/Business Real Estate	Public Services
(Intercept)	11.20 (1.24) ***	3.67 (3.73)	8.09 (4.20) .	7.01 (2.25) **	6.38 (2.61) *	10.26 (2.34) ***	11.72 (1.39) ***	8.96 (2.17) ***
fit_inv_urban	0.65 (0.55)	1.39 (0.82)	1.30 (14.17)	0.36 (0.68)	1.33 (0.70) .	1.13 (0.94)	0.77 (0.49)	0.80 (0.70)
fit_inv_rural	4.74 (3.11)	19.22 (9.16) *	6.10 (8.02)	9.39 (5.91)	11.84 (6.62) .	2.07 (6.00)	0.61 (3.82)	8.82 (5.43)
gdp_pre	0.00009 (0.00002) ***	0.00016 (0.00008) *	0.00005 (0.00009)	0.00017 (0.00004) ***	0.00009 (0.00005) .	0.00007 (0.00004) .	0.00003 (0.00002)	0.00007 (0.00004)
unemp_pre	0.00005 (0.00000) ***	0.00007 (0.00001) ***	0.00003 (0.00006)	0.00006 (0.00001) ***	0.00006 (0.00001) ***	0.00007 (0.00000) ***	0.00006 (0.00000) ***	0.00005 (0.00000) ***
urban_pre	0.52 (0.88)	2.78 (2.39)	-1.89 (5.63)	0.43 (1.69)	1.82 (1.78)	-0.32 (1.68)	0.05 (1.11)	2.33 (1.47)
F (inv_urban)	105.2	105.2	0.91	105.2	105.2	105.2	105.2	105.2
F (inv_rural)	2.63	2.63	2.56	2.63	2.63	2.63	2.63	2.63
Obs.	478	478	463	478	478	478	478	478
Adj. R^2	0.44	-3.30	0.25	-0.50	-1.90	0.74	0.80	-0.51
RMSE	0.42	1.47	0.72	0.79	0.96	0.36	0.28	0.71

Employment:

Table XI: Employment by Sector

Variable	Total Employment	Manufacturing	Agriculture	Industry excl. Construction	Construction	Trade/Transport IT/Hospitality	Finance/Business Real Estate	Public Services	Structural Unemp.
(Intercept)	16.87 (0.81) ***	6.74 (1.33) ***	8.28 (2.14) ***	7.08 (1.14) ***	7.99 (0.89) ***	8.57 (0.85) ***	7.94 (0.92) ***	9.14 (0.87) ***	8.98 (1.76) ***
fit_lagged_total_infra_inv_pc	-0.39 (2.45)	6.70 (3.13) *	-7.86 (7.70)	5.13 (2.71) .	-0.80 (2.69)	-1.08 (2.56)	-1.92 (2.91)	-1.44 (2.70)	-7.29 (5.27)
gdp_pre	0.00008 (0.00003) *	0.00003 (0.00004)	0.00011 (0.00010)	0.00005 (0.00003)	0.00006 (0.00004)	0.00009 (0.00004) *	0.00010 (0.00004) *	0.00008 (0.00004) *	0.00007 (0.00008)
migration_pre	-0.00002 (0.00004)	-0.00002 (0.00004)	-0.00001 (0.00009)	-0.00003 (0.00003)	-0.00002 (0.00004)	-0.00001 (0.00004)	-0.00002 (0.00005)	-0.00003 (0.00004)	-0.00004 (0.00009)
urban_pre	-0.32 (0.39)	-1.17 (0.41) **	-3.50 (1.08) **	-1.10 (0.36) **	-0.78 (0.44) .	-0.41 (0.43)	0.08 (0.48)	0.02 (0.41)	-0.16 (0.82)
F (1st Stage)	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3
Obs.	832	832	832	832	832	832	832	832	832
Adj. R^2	0.13	-0.46	0.04	-0.24	-0.03	0.03	0.19	0.10	-1.04
RMSE	0.53	0.88	1.45	0.73	0.60	0.62	0.66	0.58	1.47

Table XII: Employment by Sector (Urban/Rural Effects)

Variable	Total Emp.	Manufacturing	Agriculture	Industry excl. Construction	Construction	Trade/Transport IT/Hospitality	Finance/Business Real Estate	Public Services	Structural Unemp.
(Intercept)	13.85 (3.25) ***	2.44 (3.54)	0.09 (8.99)	2.76 (3.44)	5.42 (3.44)	6.80 (3.03) *	5.64 (3.38) .	6.36 (3.38) .	8.54 (5.47)
fit_inv_urban	-3.42 (4.40)	2.40 (2.84)	-16.06 (17.09)	0.81 (2.79)	-3.38 (4.64)	-2.85 (3.94)	-4.22 (5.18)	-4.22 (4.81)	-7.73 (8.21)
fit_inv_rural	7.96 (8.69)	18.57 (10.00) .	14.77 (21.69)	17.05 (9.68) .	6.31 (9.23)	3.82 (8.31)	4.44 (8.91)	6.24 (8.90)	-6.09 (13.96)
gdp_pre	0.00010 (0.00006) .	0.00007 (0.00005)	0.00018 (0.00018)	0.00008 (0.00005)	0.00008 (0.00006)	0.00010 (0.00005) .	0.00012 (0.00006) .	0.00010 (0.00006)	0.00007 (0.00011)
migration_pre	-0.00001 (0.00006)	-0.00001 (0.00004)	0.00003 (0.00016)	-0.00001 (0.00005)	-0.00001 (0.00006)	-0.00000 (0.00006)	-0.00001 (0.00007)	-0.00001 (0.00006)	-0.00004 (0.00010)
urban_pre	3.12 (3.23)	3.72 (3.09)	5.84 (9.80)	3.82 (3.04)	2.15 (3.47)	1.61 (3.07)	2.70 (3.52)	3.19 (3.36)	0.34 (5.54)
F (inv_urban)	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
F (inv_rural)	3.86	3.86	3.86	3.86	3.86	3.86	3.86	3.86	3.86
Obs.	832	832	832	832	832	832	832	832	832
Adj. R^2	-1.82	-4.34	-1.39	-4.60	-1.34	-0.48	-0.33	-1.13	-1.00
RMSE	0.95	1.69	2.29	1.56	0.90	0.76	0.84	0.89	1.45

Table XIII: Employment by Sector (CEM-weighted)

Variable	Total Emp.	Manufacturing	Agriculture	Industry excl. Construction	Construction	Trade/Transport IT/Hospitality	Finance/Business Real Estate	Public Services	Structural Unemp.
(Intercept)	15.95 (0.94) ***	6.06 (1.55) ***	6.99 (0.91) ***	6.38 (1.34) ***	6.86 (0.94) ***	7.55 (1.03) ***	6.97 (0.93) ***	8.10 (0.82) ***	8.29 (1.28) ***
fit_lagged_total_infra_inv_pc	3.44 (2.61)	9.14 (4.07) *	-0.87 (2.57)	7.22 (3.53) *	2.78 (2.67)	2.84 (2.91)	2.94 (2.67)	2.93 (2.38)	1.31 (4.35)
gdp_pre	0.00006 (0.00004) .	0.00003 (0.00005)	0.00006 (0.00004)	0.00005 (0.00004)	0.00006 (0.00004)	0.00008 (0.00004) .	0.00007 (0.00004)	0.00005 (0.00003)	-0.00006 (0.00007)
migration_pre	0.00007 (0.00005)	0.00005 (0.00008)	0.00008 (0.00004) *	0.00005 (0.00007)	0.00008 (0.00005)	0.00008 (0.00005) .	0.00008 (0.00005)	0.00005 (0.00004)	0.00006 (0.00005)
urban_pre	-0.68 (0.55)	-2.13 (0.98) *	-3.02 (0.55) ***	-1.95 (0.85) *	-1.36 (0.53) *	-0.83 (0.60)	-0.16 (0.57)	-0.21 (0.48)	0.90 (0.72)
F (1st Stage)	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9
Obs.	478	478	478	478	478	478	478	478	478
Adj. R^2	0.14	-1.41	0.66	-0.99	0.04	0.26	0.48	0.32	0.01
RMSE	0.50	0.95	0.52	0.78	0.48	0.52	0.51	0.46	1.40

Table XIV: Employment by Sector (Urban/Rural Effects, CEM-weighted)

Variable	Total Emp.	Manufacturing	Agriculture	Industry excl. Construction	Construction	Trade/Transport IT/Hospitality	Finance/Business Real Estate	Public Services	Structural Unemp.
(Intercept)	11.43 (3.92) **	-3.62 (6.43)	3.57 (3.64)	-1.84 (5.41)	2.94 (3.93)	3.87 (4.33)	3.22 (3.89)	4.00 (3.57)	3.77 (6.56)
fit_inv_urban	-0.87 (0.82)	-0.07 (1.34)	-4.12 (1.43) **	-0.60 (1.20)	-0.95 (0.82)	-0.66 (0.93)	-0.63 (0.98)	-0.98 (0.66)	-2.99 (1.72) .
fit_inv_rural	13.35 (9.76)	30.34 (16.04) .	6.62 (8.76)	25.23 (13.51) .	11.39 (9.81)	10.90 (10.67)	11.14 (9.75)	11.92 (8.94)	11.22 (16.74)
gdp_pre	0.00016 (0.00007) *	0.00024 (0.00012) .	0.00013 (0.00007) .	0.00023 (0.00010) *	0.00015 (0.00007) *	0.00016 (0.00008) .	0.00015 (0.00007) *	0.00014 (0.00007) *	0.00004 (0.00011)
migration_pre	0.00010 (0.00003) **	0.00013 (0.00005) **	0.00010 (0.00002)***	0.00012 (0.00004) **	0.00011 (0.00003)***	0.00011 (0.00003) **	0.00011 (0.00003) **	0.00009 (0.00003)**	0.00010 (0.00004) *
urban_pre	3.02 (2.46)	5.78 (4.01)	-0.23 (2.23)	4.78 (3.40)	1.85 (2.49)	2.18 (2.69)	2.91 (2.51)	3.15 (2.27)	4.60 (4.47)
F (inv_urban)	131.1	131.1	131.1	131.1	131.1	131.1	131.1	131.1	131.1
F (inv_rural)	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48
Obs.	478	478	478	478	478	478	478	478	478
Adj. R^2	-3.00	-13.6	0.25	-11.2	-2.69	-1.39	-0.77	-2.07	-0.60
RMSE	1.07	2.33	0.76	1.94	0.94	0.94	0.93	0.97	1.78

Compensation:

Table XV: Total Compensation by Sector

Variable	Total Compensation	Manufacturing	Agriculture	Industry excl. Constr.	Construction	Trade/Transport IT/Hospitality	Finance/Business Real Estate	Public Services
(Intercept)	12.70 (0.32)***	14.01 (1.79)***	11.53 (2.20)***	14.37 (1.94)***	14.22 (2.20)***	14.94 (2.46)***	14.08 (2.41)***	16.05 (2.50)***
fit_lagged_total_infra	0.33 (0.78)	-7.95 (5.12)	-7.21 (4.81)	-9.68 (5.51).	-12.43 (6.14)*	-14.57 (6.85)*	-14.03 (6.81)*	-13.96 (6.97)*
gdp_pre	0.00005 (0.00001)***	0.00003 (0.00008)	-0.00000 (0.00009)	0.00006 (0.00008)	0.00004 (0.00009)	0.00008 (0.00010)	0.00009 (0.00009)	0.00006 (0.00010)
total_population	0.00001 (0.00000)***	0.00001 (0.00000)***	0.00001 (0.00000)**	0.00001 (0.00000)***	0.00001 (0.00000)***	0.00001 (0.00000)***	0.00001 (0.00000)***	0.00001 (0.00000)***
total_unemployment	-0.00002 (0.00001)***	-0.00019 (0.00003)***	0.00002 (0.00002)	-0.00018 (0.00003)***	-0.00014 (0.00003)***	-0.00014 (0.00004)***	-0.00014 (0.00004)***	-0.00015 (0.00004)***
urban_pre	-0.15 (0.15)	-0.65 (0.75)	-3.73 (1.28)**	-0.54 (0.80)	-0.18 (0.92)	0.20 (1.01)	0.75 (0.99)	0.72 (1.00)
F (1st Stage)	46.0	46.0	46.0	46.0	46.0	46.0	46.0	46.0
Obs.	832	832	832	832	832	832	832	832
Adj. R^2	0.86	-0.02	0.50	-0.10	-0.34	-0.38	-0.33	-0.29
RMSE	0.22	2.36	1.54	2.45	2.48	2.73	2.63	2.76

Table XVI: Total Compensation by Sector (Urban/Rural Effects)

Variable	Total Compensation	Manufacturing	Agriculture	Industry excl. Constr.	Construction	Trade/Transport IT/Hospitality	Finance/Business Real Estate	Public Services
(Intercept)	11.77 (0.61)***	19.45 (4.22)***	8.10 (2.89)**	19.45 (4.26)***	19.26 (4.13)***	21.40 (4.63)***	19.60 (4.54)***	21.30 (4.64)***
fit_inv_urban	-1.05 (1.45)	0.18 (2.94)	-12.33 (6.19)*	-2.09 (3.36)	-4.90 (4.55)	-4.92 (4.29)	-5.79 (4.96)	-6.11 (5.14)
fit_inv_rural	2.70 (1.48).	-21.91 (11.20).	1.60 (5.45)	-22.71 (11.27)*	-25.38 (10.69)*	-31.15 (12.23)*	-28.20 (11.96)*	-27.45 (12.27)*
gdp_pre	0.00006 (0.00001)***	-0.00001 (0.00008)	0.00002 (0.00009)	0.00002 (0.00008)	0.00000 (0.00009)	0.00003 (0.00010)	0.00004 (0.00009)	0.00001 (0.00009)
total_population	0.00001 (0.00000)***	0.00001 (0.00000)***	0.00001 (0.00000)***	0.00001 (0.00000)***	0.00001 (0.00000)**	0.00001 (0.00000)**	0.00001 (0.00000)**	0.00001 (0.00000)*
total_unemployment	-0.00003 (0.00001)***	-0.00016 (0.00003)***	-0.00000 (0.00002)	-0.00015 (0.00003)***	-0.00011 (0.00003)**	-0.00010 (0.00004)**	-0.00010 (0.00004)**	-0.00012 (0.00004)**
urban_pre	1.01 (0.63)	-7.47 (3.24)*	0.57 (2.27)	-6.90 (3.26)*	-6.51 (3.22)*	-7.90 (3.57)*	-6.17 (3.59).	-5.87 (3.68)
F (inv_urban)	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6
F (inv_rural)	8.13	8.13	8.13	8.13	8.13	8.13	8.13	8.13
Obs.	832	832	832	832	832	832	832	832
Adj. R^2	0.71	-0.48	0.50	-0.54	-0.91	-1.15	-0.96	-0.80
RMSE	0.32	2.85	1.55	2.90	2.96	3.41	3.19	3.26

Table XVII: Total Compensation by Sector (CEM-weighted)

Variable	Total Compensation	Manufacturing	Agriculture	Industry excl. Construction	Construction	Trade/Transport IT/Hospitality	Finance/Business Real Estate	Public Services
(Intercept)	12.20 (0.81)***	14.44 (2.61)***	11.54 (2.13)***	14.98 (2.64)***	14.50 (2.92)***	15.16 (2.59)***	14.66 (2.87)***	16.49 (2.89)***
fit_lagged_total_infra	1.287 (0.898)	1.759 (2.820)	-3.347 (2.722)	2.052 (2.754)	2.276 (2.984)	1.542 (2.785)	2.362 (2.954)	2.137 (2.916)
gdp_pre	0.000058 (0.000021)**	0.000022 (0.000050)	-0.000012 (0.000057)	0.000031 (0.000051)	0.000022 (0.000056)	0.000036 (0.000049)	0.000039 (0.000055)	0.000041 (0.000055)
total_population	0.0000061 (0.0000006)***	0.000011 (0.0000021)***	0.0000074 (0.0000021)**	0.000011 (0.0000022)***	0.000010 (0.0000024)***	0.000011 (0.0000023)***	0.000010 (0.0000026)***	0.0000096 (0.0000025)***
total_unemployment	-0.000032 (0.0000097)**	-0.000151 (0.000045)**	-0.000022 (0.000019)	-0.000159 (0.000048)**	-0.000123 (0.000050)*	-0.000123 (0.000049)*	-0.000131 (0.000053)*	-0.000130 (0.000051)*
urban_pre	0.623 (0.625)	-1.223 (1.946)	0.051 (1.503)	-1.064 (2.018)	-0.782 (2.205)	-0.666 (2.007)	-0.737 (2.273)	-0.724 (2.228)
F (1st stage)	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9
Observations	478	478	478	478	478	478	478	478
Adj. R^2	0.70	-0.13	0.63	-0.28	-0.52	-0.78	-0.78	-0.50
RMSE	0.32	2.63	1.18	2.83	2.82	3.31	3.19	3.16

Table XVIII: Total Compensation by Sector (Urban/Rural Effects, CEM-weighted)

Variable	Total Compensation	Manufacturing	Agriculture	Industry excl. Constr.	Construction	Trade/Transport IT/Hospitality	Finance/Business Real Estate	Public Services
(Intercept)	11.49 (0.94)***	21.47 (6.94)**	6.24 (5.49)	22.89 (7.42)**	23.25 (7.03)**	26.64 (8.31)**	25.66 (8.30)**	26.46 (7.93)**
fit_inv_urban	0.20 (0.61)	9.71 (9.17)	-22.54 (5.33)***	9.00 (9.31)	8.40 (8.54)	9.99 (9.90)	10.06 (9.83)	9.75 (9.95)
fit_inv_rural	3.58 (2.24)	-20.91 (14.42)	3.58 (10.63)	-25.18 (15.66)	-28.07 (14.96).	-34.84 (17.93).	-33.42 (17.94).	-31.03 (17.09).
gdp_pre	0.000065 (0.000023)**	-0.00016 (0.00018)	0.000089 (0.00015)	-0.00016 (0.00019)	-0.00019 (0.00018)	-0.00023 (0.00021)	-0.00024 (0.00021)	-0.00023 (0.00019)
total_population	0.0000060 (0.0000007)***	0.000011 (0.0000030)**	0.000011 (0.0000020)***	0.0000094 (0.0000032)**	0.0000081 (0.0000031)*	0.0000091 (0.0000034)**	0.0000088 (0.0000034)*	0.0000076 (0.0000035)*
total_unemployment	-0.000032 (0.000010)**	-0.00022 (0.00005)***	0.000012 (0.000019)	-0.00021 (0.00006)***	-0.00018 (0.00006)**	-0.00019 (0.00006)**	-0.00019 (0.00006)**	-0.00020 (0.00006)**
urban_pre	0.66 (0.72)	-9.52 (5.97)	4.43 (4.08)	-10.33 (6.31)	-10.54 (5.96).	-12.17 (7.11).	-11.02 (7.06)	-10.41 (6.94)
F (inv_urban)	123.3	123.3	123.3	123.3	123.3	123.3	123.3	123.3
F (inv_rural)	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36
Obs.	478	478	478	478	478	478	478	478
Adj. R^2	0.70	-0.13	0.63	-0.28	-0.52	-0.78	-0.78	-0.50
RMSE	0.32	2.63	1.18	2.83	2.82	3.31	3.19	3.16

Table XIX: Net Migration (All models & Samples)

Variable	Non-matched Aggregate	Non-matched Urban	Non-matched Rural	Matched Aggregate	Matched Urban	Matched Rural
(Intercept)	-2916.88 (3567.02)	-3258.30 (8542.37)	-	1291.00 (4430.83)	-3798.40 (14617.53)	-
fit_lagged_total_infrastructure_investment_per_capita	-4046.04 (9007.30)	-4438.54 (7185.78)	-3168.75 (21759.88)	-5171.29 (10998.54)	-11134.55 (17346.26)	5379.99 (29867.51)
gdp_pre	0.15 (0.15)	0.16 (0.18)	-	-0.27 (0.20)	-0.16 (0.40)	-
unemp_pre	0.09 (0.08)	0.09 (0.08)	-	0.28 (0.07)***	0.29 (0.07)***	-
urban_pre	1867.49 (2241.03)	2253.99 (5643.71)	-	9208.62 (3648.86)*	13844.42 (11704.60)	-
F (1st stage)	27.6	50.1 (urban), 4.3 (rural)		23.3	105.2 (urban), 2.63 (rural)	
Observations	832	832		478	478	
Adj. R^2	0.16	0.15		0.52	0.45	
RMSE	3,178.3	3,188.9		3,138.5	3,333.9	

Appendix B: Data Collection

Table XX: Data collection

Nr. / Data Source / File Name	Description / Main Variables	Coverage (Years)	Spatial Level	Access	Notes
1. dataset_v40.csv	Main analytical dataset: exposure index, infrastructure spending, employment, productivity, migration, sectoral variables	2000–2021	Landkreis (NUTS 3)	Internal	Merged/cleaned using Python. R Studio was used for data analysis.
2. Statistisches Bundesamt (Destatis), Regionaldatenbank, Volkswirtschaftlichen Gesamtrechnungen	Population, employment, GDP, sectoral GVA, migration, employment by sector, average age, manufacturing specific variables	2000–2021	Landkreis (NUTS 3)	Public	Source for core demographic and economic variables
3. Bundesagentur für Arbeit (BA)	Unemployment rate	2001–2021	Landkreis (NUTS 3)	Public	Year 2000 missing
4. BBSR Raumabgrenzungen / Urban-Rural Typology	Urban/rural classification, region type	2000–2021	Landkreis (NUTS 3)	Public	Used for heterogeneity analysis (urban/rural)
5. Sonderbedarfs-Bundesergänzungszuweisungen (SoBEZ)	Annual district-level allocation estimates (exposure index, €), imputed by formula	2005–2021	Landkreis (NUTS 3)	Constructed	Method: exposure index construction (see Methodology)
6. Finanzministerium Mecklenburg-Vorpommern	State, communal and municipal finances	2000–2021	Bundesland (NUTS 2)	Public	Data available for all years
7. Staatsministerium der Finanzen Sachsen	State, communal and municipal finances	2000 - 2021	Bundesland (NUTS 2)	Public	Disaggregated and aggregated SoBEZ infrastructure amounts listed yearly

Nr. / Data Source / File Name	Description / Main Variables	Coverage (Years)	Spatial Level	Access	Notes
8. Ministerium der Finanzen Sachsen-Anhalt	State, communal and municipal finances	2000-2021	Bundesland (NUTS 2)	Public	Signficant gaps in data (2000-2004, 2009-2015) SoBEZ available from 2006 -2021
9. Finanzminsterium Thüringen	State, communal and municipal finances	2005 - 2021	Bundesland (NUTS 2)	Public	Pre-2011 disaggregated local finance data systemically unavailable
10. Ministerium der Finanzen des Landes Brandenburg	State, communal and municipal finances	2005 – 2021	Bundesland (NUTS 2)	Public	Year 2008 missing
11. Own calculations	Exposure index (0–1), lagged values, binary indicators,	2005–2021	Landkreis (NUTS 3)	Constructed	Calculated using R data mutations

Table XXI: Variable explanations

Variable	Type / Scale / Quantity	Coverage (Years)	Spatial Level	Explanation
year	Discrete (integer)	2000–2021	Landkreis (NUTS 3)	Year of observation
landkreis	Categorical (76 units)	2000–2021	Landkreis (NUTS 3)	District name or code (Landkreis/kreisfreie Stadt)
state	Categorical (6 Bundesländer)	2000–2021	Bundesland (NUTS 2)	Federal state
nuts3	Categorical	2000–2021	Landkreis (NUTS 3)	NUTS-3 code for district
communal_investment	1000s of Euros, continuous	2000–2021	Landkreis (NUTS 3)	Municipal infrastructure investment
state_investment	1000s of Euros, continuous	2000–2021	Bundesland (NUTS 2)	State-level infrastructure investment

Variable	Type / Scale / Quantity	Coverage (Years)	Spatial Level	Explanation
sobez_exposure	0–1, continuous index	2005–2021	Landkreis (NUTS 3)	District-level SoBEZ exposure index (see Methodology)
merger_mv	Binary (0/1)	2000–2021	Mecklenburg-Vorpommern	Indicates boundary reform in MV (unused)
adjustment_factor	Continuous	2000–2021	National	Inflation adjustment, 1.0 = 2021
communal_investment_real	1000s of Euros, continuous	2000–2021	Landkreis (NUTS 3)	Inflation-adjusted municipal investment
gdp_per_capita	Euros, continuous	2000–2021	Landkreis (NUTS 3)	District GDP per inhabitant
gdp_per_worker	Euros, continuous	2000–2021	Landkreis (NUTS 3)	GDP per employed person
gdp_per_hour_worked	Euros, continuous	2000–2021	Landkreis (NUTS 3)	GDP per hour worked
total_solidarpakt_infra	Euros, continuous	2000–2021	Bundesland (NUTS 2)	Total Solidarpakt infrastructure funds (state-level, Aufbau Ost reporting, distribution is self calculated)
dissected_solidarpakt_infra	Euros, continuous	2000–2021	Bundesland (NUTS 2)	Aggregated Solidarpakt amounts transferred from the federal states to municipalities. Not reported consistently enough for analysis.
total_population	Persons, continuous	2000–2021	Landkreis (NUTS 3)	Total resident population
male_population	Persons, continuous	2000–2021	Landkreis (NUTS 3)	Male population
female_population	Persons, continuous	2000–2021	Landkreis (NUTS 3)	Female population

Variable	Type / Scale / Quantity	Coverage (Years)	Spatial Level	Explanation
total_average_age	Years, continuous	2000–2021	Landkreis (NUTS 3)	Average age of total population
male_average_age	Years, continuous	2000–2021	Landkreis (NUTS 3)	Average age, males
female_average_age	Years, continuous	2000–2021	Landkreis (NUTS 3)	Average age, females
sq_km	km², continuous	2000–2021	Landkreis (NUTS 3)	Area of district
pop_sq_km	Persons/km², continuous	2000–2021	Landkreis (NUTS 3)	Population density
urban_rural	Binary (1=urban, 0=rural)	2000–2021	Landkreis (NUTS 3)	Urban/rural typology (BBSR)
merger	Binary (0/1)	2000–2021	Landkreis (NUTS 3)	Boundary reform (various states, rarely used)
urban_merger	Binary (0/1)	2000–2021	Landkreis (NUTS 3)	Urban/rural boundary change
coast	Binary (1=coastal, 0=not)	2000–2021	Landkreis (NUTS 3)	District borders Baltic Sea
total_unemployment	Persons, continuous	2001–2021	Landkreis (NUTS 3)	Registered unemployed (all)
foreign_unemployment	1000s of Persons, continuous	2001–2021	Landkreis (NUTS 3)	Unemployed foreign nationals
disabled_unemployment	1000s of Persons, continuous	2001–2021	Landkreis (NUTS 3)	Unemployed with disabilities

Variable	Type / Scale / Quantity	Coverage (Years)	Spatial Level	Explanation
teen_unemployment	1000s of Persons, continuous	2001–2021	Landkreis (NUTS 3)	Unemployed, age 15–19
youth_unemployment	1000s of Persons, continuous	2001–2021	Landkreis (NUTS 3)	Unemployed, age 20–24
elderly_unemployment	1000s of Persons, continuous	2001–2021	Landkreis (NUTS 3)	Unemployed, age 55–65
long_term_unemployment	1000s of Persons, continuous	2001–2021	Landkreis (NUTS 3)	Unemployed >12 months
in_migration	Persons, continuous	2000–2021	Landkreis (NUTS 3)	Incoming residents
out_migration	Persons, continuous	2000–2021	Landkreis (NUTS 3)	Departing residents
net_migration	Persons, continuous	2000–2021	Landkreis (NUTS 3)	Net migration (in - out)
manufacturing_total_revenue	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Manufacturing sector revenue (unused)
manufacturing_foreign_revenue	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Manufacturing export revenue (unused)
with_wz2008	Binary (0/1)	2000–2021	Landkreis (NUTS 3)	Uses WZ2008 classification (flag)
manufacturing_projects	Integer (count)	2000–2021	Landkreis (NUTS 3)	Number of manufacturing projects (unused)
manufacturing_employment	Persons, continuous	2000–2021	Landkreis (NUTS 3)	Manufacturing employment (unused)

Variable	Type / Scale / Quantity	Coverage (Years)	Spatial Level	Explanation
manufacturing_investment_thousand_euros	1000s of Euros, continuous	2000–2021	Landkreis (NUTS 3)	Manufacturing sector investment (unsued)
total_productivity_at_production_prices_current	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Gross value added: total
gva_agriculture_forestry_fishing	Euros, continuous	2000–2021	Landkreis (NUTS 3)	GVA: agriculture/forestry/fishing
gva_industry_excl_construction	Euros, continuous	2000–2021	Landkreis (NUTS 3)	GVA: industry excl. construction
gva_manufacturing	Euros, continuous	2000–2021	Landkreis (NUTS 3)	GVA: manufacturing
gva_construction	Euros, continuous	2000–2021	Landkreis (NUTS 3)	GVA: construction
gva_trade_transport_it_hospitality	Euros, continuous	2000–2021	Landkreis (NUTS 3)	GVA: trade/transport/IT/hospitality
gva_finance_business_real_estate	Euros, continuous	2000–2021	Landkreis (NUTS 3)	GVA: finance/business/real estate
gva_public_services_health_education	Euros, continuous	2000–2021	Landkreis (NUTS 3)	GVA: public services/health/education
total_comp	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Total compensation (wages & salaries)
comp_agriculture_forestry_fishing	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Compensation: agriculture/forestry/fishing
comp_industry_excl_construction	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Compensation: industry excl. construction

Variable	Type / Scale / Quantity	Coverage (Years)	Spatial Level	Explanation
comp_manufacturing	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Compensation: manufacturing
comp_construction	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Compensation: construction
comp_trade_transport_it_hospitality	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Compensation: trade/transport/IT/hospitality
comp_finance_business_real_estate	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Compensation: finance/business/real estate
comp_public_services_health_education	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Compensation: public services/health/education
net_capital_investment	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Net capital investment
inv_agriculture_forestry_fishing	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Investment: agriculture/forestry/fishing
inv_industry_excl_construction	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Investment: industry excl. construction
inv_manufacturing	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Investment: manufacturing
inv_construction	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Investment: construction
inv_trade_transport_it_hospitality	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Investment: trade/transport/IT/hospitality
inv_finance_business_real_estate	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Investment: finance/business/real estate

Variable	Type / Scale / Quantity	Coverage (Years)	Spatial Level	Explanation
inv_public_services_health_education	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Investment: public services/health/education
efre_total	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Total EU structural funds (unused)
efre_infra	Euros, continuous	2000–2021	Landkreis (NUTS 3)	EU infrastructure funds (unused)
grw_economic_infra	Euros, continuous	2000–2021	Landkreis (NUTS 3)	GRW economic infrastructure (unused)
grw_urban_infra	Euros, continuous	2000–2021	Landkreis (NUTS 3)	GRW urban infrastructure (unused)
grw_eu_co_financed	Euros, continuous	2000–2021	Landkreis (NUTS 3)	GRW EU co-financed projects (unused)
grw_total_economic	Euros, continuous	2000–2021	Landkreis (NUTS 3)	Total GRW subsidies (where available)
total_employed	Persons, continuous	2000–2021	Landkreis (NUTS 3)	Total employed persons
emp_agriculture_forestry_fishing	Persons, continuous	2000–2021	Landkreis (NUTS 3)	Employed in agriculture/forestry/fishing
emp_industry_excl_construction	Persons, continuous	2000–2021	Landkreis (NUTS 3)	Employed in industry excl. construction
emp_manufacturing	Persons, continuous	2000–2021	Landkreis (NUTS 3)	Employed in manufacturing
emp_construction	Persons, continuous	2000–2021	Landkreis (NUTS 3)	Employed in construction

Variable	**Type / Scale / Quantity**	**Coverage (Years)**	**Spatial Level**	**Explanation**
emp_trade_transport_it_hospitality	Persons, continuous	2000–2021	Landkreis (NUTS 3)	Employed in trade/transport/IT/hospitality
emp_finance_business_real_estate	Persons, continuous	2000–2021	Landkreis (NUTS 3)	Employed in finance/business/real estate
emp_public_services_health_education	Persons, continuous	2000–2021	Landkreis (NUTS 3)	Employed in public services/health/education
urban_rural_binary	Binary (1=urban, 0=rural)	2000–2021	Landkreis (NUTS 3)	Alternative urban/rural binary

Fig 18: **2011 Redistricting in Mecklenburg-Vorpommern:** Redistricted areas colored by same color shade, old districts outlined in smaller text and by boundaries. (Source: Maximilian Dörrbecker – Wikimedia Commons)

Fig 19: **2008 Redistricting in Saxony:** Large text represents now-abolished state administrative sub-units. (Source: NordNordWest – Wikimedia Commons)

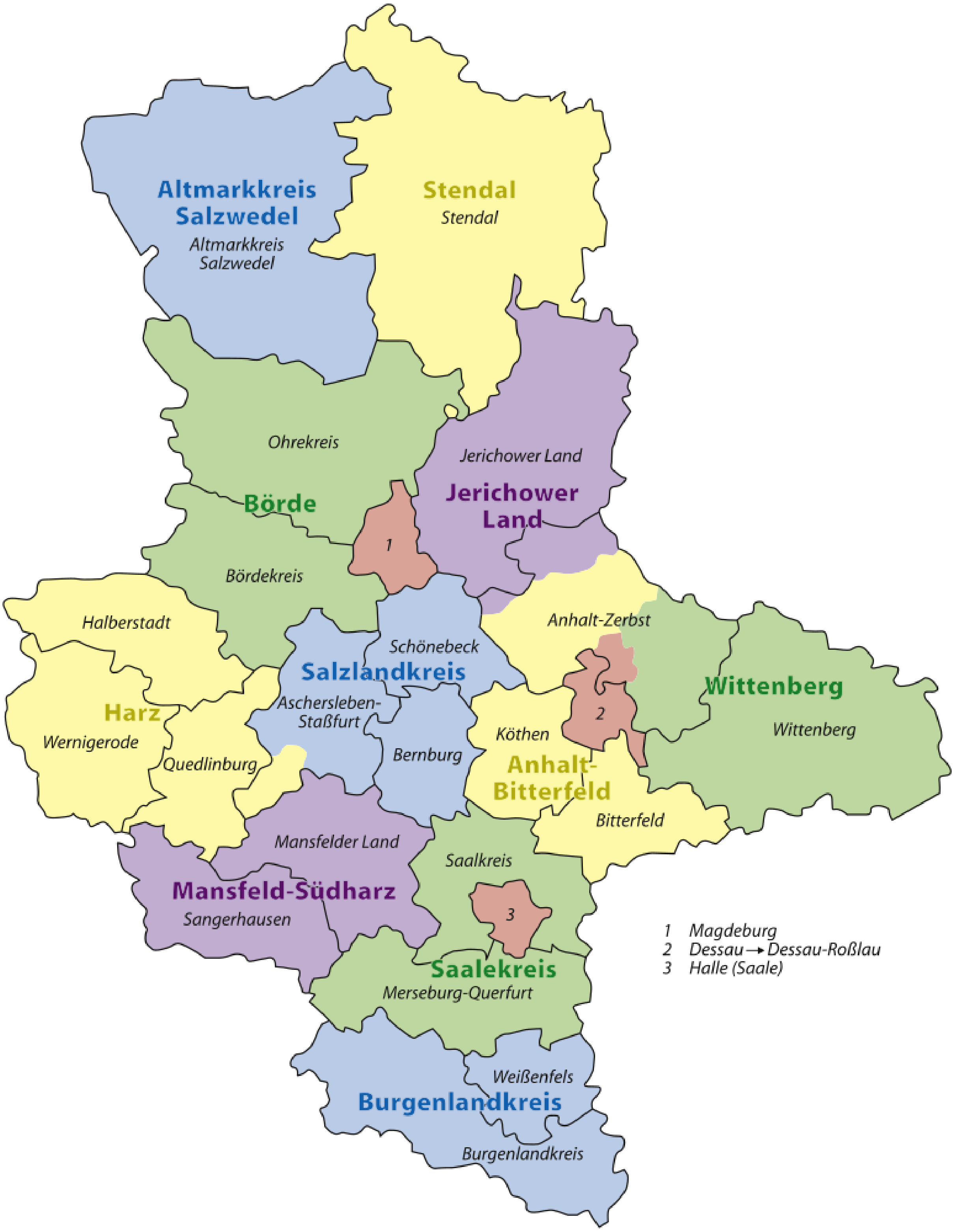

Fig 20: **2007 Redistricting in Saxony-Anhalt:** Redistricted areas colored by same color shade, old districts outlined in smaller text and by boundaries. (Source: NordNordWest – Wikimedia Commons)

Fig 21**: State Budget Distributions:**

Brandenburg:

$$\text{Score}_i = 0.50 \cdot \text{Pop}_i + 0.30 \cdot \text{Unemp}_i + 0.20 \cdot \text{Base}_i$$

where *score* is the distributive coefficient, *pop* is population, *unemp* is unemployment and *base* is a base score. Here, unemployment works as proxy for tax revenue (local economic conditions).

Mecklenburg-Vorpommern:

$$\text{Score}_i = 0.30 \cdot \text{Pop}_i + 0.40 \cdot \text{Unemp}_i + 0.10 \cdot \text{City}_i + 0.20 \cdot \text{Mig}_i$$

where *score* is the distributive coefficient, *pop* is population, *unemp* is unemployment and *mig* is net migration. Designed to mimic equalization to distressed communities (high out migration).

Saxony:

$$\text{Score}_i = 0.60 \cdot \text{Pop}_i + 0.15 \cdot \text{Unemp}_i + 0.25 \cdot \text{City}_i$$

where *score* is the distributive coefficient, *pop* is population, *unemp* is unemployment and *city* is a base score. Specific urban investitive priority.

Saxony-Anhalt:

$$\text{Score}_i = 0.50 \cdot \text{Pop}_i + 0.20 \cdot \text{Unemp}_i + 0.20 \cdot \text{City}_i + 0.10 \cdot \text{Mig}_i$$

where *score* is the distributive coefficient, *pop* is population, *unemp* is unemployment and *mig* is net migration. Designed to mimic equalization to distressed communities (high out migration as in Mecklenburg-Vorpommern).

Thuringia:

$$\text{Score}_i = 0.55 \cdot \text{Pop}_i + 0.25 \cdot \text{Unemp}_i + 0.20 \cdot \text{Base}_i$$

where *score* is the distributive coefficient, *pop* is population, *unemp* is unemployment and *base* is a base score. Closest to an unweighted scheme.