Where Regional Policy Gets Stuck: Local Implementation-Capacity Frictions and Territorial Governance in Baden-Württemberg

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Abstract

Regional science and regional policy increasingly ask why formally similar places differ in their ability to absorb programmes, permits, infrastructure plans, and fiscal commitments. This paper develops a reproducible county-year diagnostic of local implementation-capacity frictions for Baden-Württemberg's 44 counties and urban counties, 2007–2024. The live hierarchical State Capacity Friction Index (H-SCFI-Live) summarizes administrative, infrastructure, and fiscal frictions on a fixed calibration scale; transformation pressure is estimated separately for policy prioritization. The index combines official regional, fiscal, labor-market, construction, accessibility, census, and traffic indicators with a public-source audit of direct administrative validation targets. Measured frictions are spatially patterned, not reducible to urbanity or industrial exposure, and associated most consistently with subsequent construction outcomes. Because the association weakens after excluding the broader construction domain, the evidence is best read as construction-domain predictive validity rather than broad administrative-performance validation. The contribution is a transparent regional-policy measurement framework for identifying where planning-capacity support, infrastructure-delivery analysis, and better administrative data collection should be prioritized.

Keywords: regional science; regional policy; implementation capacity; state capacity; composite indicators; Baden-Württemberg

JEL Codes: H70, H77, R11, R50, O18

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1 Introduction

Regional policy is ultimately implemented by local and territorial institutions. Programmes for housing, infrastructure renewal, digitalization, climate and energy transition, and industrial adjustment can be designed nationally or at state level, but they become effective only when local governments, lower administrative authorities, utilities, planning bodies, and intermunicipal actors convert mandates and funding into permits, procurement, construction, and service delivery. This implementation layer is a regional-science problem as much as a governance problem: development constraints are not only differences in endowments or market potential, but also differences in the capacity to mobilize local assets, coordinate public action, and connect spatial strategies to deliverable projects (Healey, 1998; Albrechts et al., 2003; Barca, 2009; Barca et al., 2012; Pike et al., 2017). For regional policy and planning practice, the question is therefore not only which territories lag behind, but where spatial-development policy is most likely to get stuck.

This question is acute in Baden-Württemberg. The state is wealthy, administratively capable, fiscally sophisticated, and deeply industrial, which makes it a demanding case for measuring implementation frictions rather than an obvious low-capacity case. Since 2022, however, German municipalities have faced a historically large investment backlog, with national evidence pointing to weak planning capacity, staff shortages, complex documentation requirements, and slow approval procedures as well as financing constraints (KfW Research, 2025; OECD, 2025). In Baden-Württemberg, permitted dwellings fell again in 2024, while the municipal fiscal position deteriorated sharply: in 37 of 44 counties, aggregate municipal payments exceeded receipts in 2024 (Statistisches Landesamt Baden-Wuerttemberg, 2025b,a). At the same time, the statewide rollout of the digital building-application system, ViBa BW, creates new implementation demands for lower building authorities (Ministerium fuer Landesentwicklung und Wohnen Baden-Wuerttemberg, 2024). A common shock therefore meets uneven local implementation conditions.

Recent evidence on work-permit decisions points to the same territorial-governance problem from a different administrative margin. Using BA decision data for 2018–2024, Schneider and Wohlfart (2026) document substantial county-level variation in rejection rates for third-country labour-market access, including within Baden-Württemberg, and argue that these differences are only partly explained by local labour-market conditions. This study is not a validation of the SCFI, but it is directly relevant because it shows that formally rule-bound administrative decisions can vary strongly across local territories.

Mainstream regional science and European planning research offer the conceptual starting point but not yet the empirical object needed here. The literature on place-based development, territorial cohesion, and territorial inequality emphasizes that policies must be adapted to local conditions rather than applied as uniform templates (Davoudi, 2005; Barca et al., 2012; Todtling and Trippl, 2005; Iammarino et al., 2019; Rodriguez-Pose, 2018). Strategic spatial-planning work highlights the institutional work required to translate spatial visions into coordinated action (Healey, 2004;

Albrechts, 2004). Work on institutions and quality of government shows that subnational institutional quality matters for regional development and for the returns to public investment (Rodriguez-Pose, 2013; Rodriguez-Pose and Garcilazo, 2015; Charron et al., 2014, 2019; Mendez and Bachtler, 2024). Research on regional resilience stresses that local economies differ in their ability to absorb and adjust to shocks (Martin, 2012). What is still missing is a reproducible regional-science measurement device that follows counties over time and separates capacity bottlenecks from transformation pressure. Direct administrative outcomes such as permit-processing durations, grant drawdown, staffing vacancies, budget-supervision records, and project delays are not available as reproducible public county-year series for Baden-Württemberg.

This paper asks where regional policy in Baden-Württemberg is most likely to encounter local implementation-capacity frictions, how those frictions overlap with transformation pressure, and what this implies for place-sensitive territorial governance, planning capacity, and infrastructure delivery. To answer that question, it develops a State Capacity Friction Index (SCFI) for the state's 44 counties and urban counties. The term friction is deliberate. The index does not measure state capacity as a constitutional stock, does not rank the competence of local governments, and does not observe administrative performance directly. It measures public-data conditions under which local implementation constraints are more likely to bind for investment, infrastructure, housing, and adjustment. The headline live series, H-SCFI-Live, summarizes administrative, infrastructure, and fiscal frictions; transformation pressure is estimated separately because exposure to industrial or demographic change can raise demand for policy capacity without being a capacity failure.

The paper makes three contributions to regional studies and regional science. First, it translates state-capacity concepts into a county-year regional-policy diagnostic for high-income federations, where the relevant policy problem is not state absence but uneven local ability to implement complex public tasks. Second, it provides an auditable public-data implementation: official regional statistics, fiscal records, labor-market data, construction outcomes, accessibility indicators, digital-permitting pages, grant-program pages, energy and broadband records, public-service data, and administrative-validation targets are classified by their evidentiary role. Third, it separates policy screening from index publication mechanics. The live H-SCFI uses one-sided filtered estimates that can be archived by release vintage, while full-sample smoothed estimates and static principal component analysis (PCA) benchmarks are treated as research diagnostics (Stock and Watson, 2002; Doz et al., 2012; OECD and European Commission Joint Research Centre, 2008).

Empirically, measured frictions are spatially patterned but not reducible to a simple map of urbanity, fiscal weakness, or industrial exposure. Counties with the highest H-SCFI-Live scores are not always the places with the highest reform leverage once transformation pressure and site potential are considered. This distinction matters for policy: some territories call for closer administrative diagnosis, planning-capacity support, and infrastructure-delivery assistance, while others combine manageable capacity conditions with high transformation exposure and may be better suited for rapid programme deployment. Fixed-effects diagnostics show that H-SCFI-Live is most strongly

related to subsequent construction outcomes; the association survives excluding the exact completion outcome from the index but weakens after excluding the broader construction domain. The evidence is therefore construction-domain predictive validity, not broad administrative-capacity validation or causal proof of administrative delay. The practical contribution is a transparent regional-policy screen for locating where implementation support and direct administrative data collection should be prioritized.

The remainder of the paper is structured as follows. The next section develops the conceptual framework. The data section describes the county-year panel and source audit. The measurement-strategy section explains the publication constraint, the headline H-SCFI-Live, and the benchmark indices. The results, validation, and robustness sections report the spatial patterns, policy typologies, diagnostics, and sensitivity checks. The final sections discuss limitations and conclude with implications for regional policy design.

2 Conceptual Framework

The framework starts from a simple implementation chain. Regional-policy mandates, grants, planning reforms, and infrastructure programmes create opportunities for territorial development, but outcomes depend on whether local institutions can coordinate actors, finance complementary investment, process applications, procure projects, and maintain infrastructure. Strategic spatial planning is explicitly concerned with this translation from spatial visions to institutional action, and collaborative planning research treats local institutional capacity as a condition for durable place-making (Healey, 1998; Albrechts et al., 2003; Albrechts, 2004). Place-based policy therefore requires information not only on need and potential, but also on the institutional conditions under which policy can be absorbed locally (Barca et al., 2012; Rodriguez-Pose, 2013; Crescenzi and Giua, 2020). This is the territorial-governance object measured here.

The state-capacity literature provides the broader institutional logic: taxation, public-good provision, and development depend on organizational capacity and credible public institutions (Acemoglu et al., 2005; Besley and Persson, 2010; Dincecco, 2017). Measurement work also shows that state capacity is multidimensional and that fiscal, administrative, legal, and territorial dimensions should not be collapsed without specifying the construct (Cingolani, 2013; Hanson and Sigman, 2021). At the subnational level in a high-capacity federation, the relevant mechanisms are operational rather than constitutional: planning capacity, fiscal buffers, infrastructure maintenance, permitting processes, intermunicipal coordination, and the ability to absorb grants or implement reforms.

The SCFI measures frictions in that operational sense. A high score means that observable conditions are consistent with binding public-sector bottlenecks; it is not a normative ranking of local governments. A high-friction county may be competently governed but face unusually difficult fiscal, infrastructural, or demographic constraints, while a low-friction county may operate under more favorable conditions. This interpretation is consistent with fiscal-health research, which treats

local fiscal condition as multidimensional and warns against collapsing distinct time horizons and mechanisms into a single unqualified measure (Hendrick, 2004; Jimenez, 2009).

The framework distinguishes four channels. Administrative capacity frictions capture whether the local public sector has scale and demographic conditions compatible with complex tasks. Investment and infrastructure frictions capture weak construction, public-capital renewal, land, digital-infrastructure, or accessibility conditions that matter for planning and infrastructure delivery. Fiscal constraints capture limited own-source resources or high debt burdens. Transformation pressure captures exposure to structural change and regional labor-market adjustment. The headline index averages the first three channels because they describe bottlenecks in public implementation capacity. Transformation pressure is kept separate because industrial exposure, demographic pressure, or transition need can increase demand for capacity without being a capacity failure itself.

This separation generates a policy typology. Counties with high frictions and high transformation pressure are candidates for intensive implementation support because development pressure and bottlenecks coincide. Counties with high frictions but lower transformation pressure require closer diagnosis of fiscal, administrative, or infrastructure constraints before new programmes are layered on top. Counties with low frictions and high transformation pressure may be able to absorb transformation programmes quickly. Counties with low scores on both dimensions are not priority cases for capacity intervention, although they may still need ordinary investment or service policy. The reform-leverage screen in the results operationalizes this typology by combining capacity bottlenecks, separately estimated transformation pressure, and site potential.

The empirical design follows four expectations. First, higher implementation-capacity frictions should be associated with weaker subsequent project realization on margins where local public action matters, even though the relationship is not causal without an exogenous capacity shock. Second, these associations should be stronger for implementation-sensitive outcomes than for broad economic outcomes such as employment growth, which also reflects sectoral demand and macroeconomic conditions. Third, transformation pressure should identify where capacity constraints are especially policy-relevant, but it should not by itself define a high-friction county. Fourth, an index intended for repeated public release should limit artificial historical revision; otherwise a county's reported past capacity changes merely because later observations have been added to the estimation sample. The design follows composite-indicator guidance that emphasizes transparent indicator selection, direction coding, normalization, weighting, and sensitivity analysis (OECD and European Commission Joint Research Centre, 2008; Afonso et al., 2005).

3 Data

The unit of observation is the county-year. The sample covers Baden-Württemberg's 44 counties and urban counties from 2007 to 2024. The panel combines official administrative, fiscal, construction, labor-market, accessibility, census, and traffic sources that are relevant to regional planning, housing

implementation, infrastructure delivery, and local fiscal room. Table 2 summarizes coverage; Appendix Table 25 documents the broader candidate data dictionary.

The paper uses the following abbreviations consistently after first mention. Baden-Württemberg is abbreviated as BW in source labels. The Statistisches Landesamt Baden-Württemberg is abbreviated as StaLa BW, the Federal Employment Agency (Bundesagentur fuer Arbeit) as BA, and the German industry classification (Wirtschaftszweig) as WZ. GENESIS denotes the Gemeinsames Neues Statistisches Informations-System database interface used by official German statistical offices. BBSR denotes the Federal Institute for Research on Building, Urban Affairs and Spatial Development, INKAR denotes its Indikatoren und Karten zur Raum- und Stadtentwicklung database, BASt denotes the Federal Highway Research Institute, and BMDV denotes the Federal Ministry for Digital and Transport. NKHR denotes the Neues Kommunales Haushalts- und Rechnungswesen municipal accounting framework, ViBa BW denotes the Virtuelles Bauamt Baden-Württemberg, MaStR denotes the Marktstammdatenregister of the Federal Network Agency (Bundesnetzagentur, BNetzA), FAG denotes the Finanzausgleichsgesetz, MLW denotes Baden-Württemberg's Ministry for Regional Development and Housing, RP denotes the regional Regierungspraesidien, and ERDF denotes the European Regional Development Fund.

The source audit is a main data product. Table 1 summarizes the audit footprint, while Appendix Tables 25, 26, 27, and 28 retain the detailed machine-readable classification. The audit separates five evidentiary categories: headline index inputs, robustness and control variables, reported diagnostics, located or raw-cached series that are not used in the current analysis, and direct administrative validation targets that would require non-public data access.

Table 1: Public-Source Audit Footprint

The table summarizes the machine-readable source audit behind the SCFI database. Series counts refer to raw candidate indicators or diagnostic targets tracked in the catalog and audit files, not to raw observations. The 13 headline inputs are raw headline indicators; Table 22 reports model-input series after processing and splits. The classification separates variables used in the index from robustness inputs, reported diagnostics, documented exclusions, and direct administrative validation targets for which no reproducible public county-year panel was identified.

Audit component	Series	Sources	Evidence role
Headline H-SCFI panel/index inputs	13	2	Headline index construction
Extension, robustness, control, and transformation inputs	41	9	Robustness, controls, and exposure measurement
Reported validation, audit, and scope diagnostics	44	12	Reported diagnostics and public-source audit context
Checked candidate series not used in the current analysis	13	9	Documented exclusions or not analysis-ready
Direct administrative validation targets requiring non-public data	4	2	Data-request targets; absent as reproducible public county-year panels

The estimation panel contains 792 county-year observations. Regionalstatistik/GENESIS provides population, construction, land-market, tax, debt, commuter, and historical municipal-finance indicators. Federal Employment Agency series add employment and labor-market measures. INKAR contributes accessibility, service-access, housing, and broadband indicators; Zensus 2022 adds structural housing and education variables; and BASt traffic archives provide road-traffic diagnostics assigned to county polygons.

Several sources have important coverage limits. Historical cash-statistics variables are available for

Table 2: Data Coverage

Usable rows count non-missing county-year observations in the processed panel. Municipality, municipal-association, and station-level sources are aggregated to the county-year level before index construction.

Source	Spatial level	Years	Usable rows
Regionalstatistik population	County	2007-2024	792
Regionalstatistik building completions	County	2007-2024	792
Regionalstatistik construction and land-market details	County	2007-2024	792
Regionalstatistik commuter jobs	Municipality or municipal association aggregated to county	2021-2024	176
Regionalstatistik historical municipal cash statistics	County	2007-2014	336
BA employment time series	County	2007-2024	792
BA labor-market time series	County	2007-2024	792
Regionalstatistik real tax	County	2007-2024	792
Regionalstatistik debt	County	2019-2024	259
INKAR accessibility and infrastructure indicators	County	2017-2023	220
Deutschlandatlas latest cross-section	County	2024-2024	44
Zensus 2022 regional tables	County	2022-2022	44
BASt traffic intensity	Station-year assigned to county polygons	2007-2023	602
BASt station-presence proxy	Station metadata assigned to county polygons	2007-2023	748

2007–2014 and are useful for historical capacity conditions, but they are not treated as evidence about current municipal fiscal conditions. Fiscal debt variables are available from 2019 under the current definition; earlier 2010–2018 debt data are parsed separately and used diagnostically because of a statistical break. INKAR, Zensus, and BASt variables are often short panels, cross-sections, or diagnostic context rather than headline time-series inputs. The design therefore distinguishes headline indicators from robustness, controls, validation targets, and documented exclusions.

The current analysis also reports the IW Gemeindecheck Daseinsvorsorge as a cross-sectional external benchmark (Diermeier et al., 2026).[1] The downloadable workbook contains 10,817 German municipalities, including 1,102 municipalities in BW. It reports national municipality ranks and rating classes for overall Daseinsvorsorge and five service-provision domains: education, health, mobility, digitalization, and leisure. The parser transforms each rank to a 0–100 service-deficit score, where higher values indicate worse national rank, and aggregates the BW municipalities to 44 counties as unweighted municipality means because the workbook does not provide population weights. These variables enter only the adjacent-diagnostics table. They are not H-SCFI-Live inputs because they are a recent cross-section, are institutional rather than official administrative data, and measure service availability and accessibility rather than processing times, grant drawdown, staffing bottlenecks, or project delays.

The public-data panel should be read as a reproducible lower-bound implementation of the framework. With one newly integrated exception, the source audit below shows that several direct administrative outcomes, including permit-processing durations, grant drawdown, staffing vacancies, budget-supervision records, and project-delay data, are not available as reproducible public county-year series in the harvested sources. The exception is the BA annual public table on approvals and rejections for third-country labour-market access, which is parsed for BW counties for 2018–2024 and reported as a validation diagnostic (Bundesagentur fuer Arbeit, Statistik, 2026). It is not a headline index input because it reflects a specific labour-market admission procedure and combines BA decision rules with employer demand, job characteristics, wage and legal-basis requirements, and the territorial location of the employer. Existing datasets from the closest literature are useful benchmarks but do not solve the broader validation problem. Hanson and Sigman's state-capacity data are national rather than subnational. The European Quality of Government Index is public and repeated over time, but for Germany it is reported at a broad regional level, so Baden-Württemberg supplies one regional observation per wave rather than county-year variation. The Minas Gerais municipal State Capacity Index has public replication data, but it tests portability of the measurement idea in Brazil rather than external validity for German counties. European Regional Development Fund (ERDF) absorption and compliance data used in Cohesion Policy research are closer to grant-administration outcomes, but they are programme-period regional measures, not Landkreis-level BW drawdown or project-delay records. The index therefore uses only variables that add valid public evidence about implementation-capacity frictions rather than

[1] The accompanying raw workbook is linked from the IW study page.

increasing the variable count with unaudited or unavailable outcomes.

4 Measurement Strategy

4.1 Publication Constraint

The measurement problem follows from the policy use case. A one-off research index can be re-estimated whenever data are added. A published territorial-governance diagnostic cannot silently revise a county's past score merely because later observations, indicators, or calibration moments become available. Historical values should change only under an explicit data correction or a new methodology version. This is why the paper separates a live publication product from research and robustness benchmarks.

Table 3 summarizes the naming convention, and Table 4 states the corresponding release rule. The headline public product is H-SCFI-Live, a one-sided filtered county capacity-friction state. H-SCFI-Research is the corresponding full-sample smoothed research series. Static cross-sectional and pooled-PCA specifications are retained as benchmarks to show how rankings depend on index design; they are not presented as alternative policy truths.

Table 3: SCFI Publication and Benchmark Specifications

H-SCFI denotes the hierarchical State Capacity Friction Index used as the paper's planning and regional-policy diagnostic. HDFM denotes the hierarchical dynamic factor model used to estimate it; DFM denotes the lower-dimensional dynamic factor model benchmark; PCA denotes principal component analysis. H-SCFI-Live is the headline public index and averages only administrative, investment and infrastructure, and fiscal capacity-friction states. Transformation pressure is estimated separately. H-SCFI-Research, SCFI-CS, G-SCFI, and dynamic factor model specifications are benchmark or research designs. When the capacity DFM has the same rank ordering as H-SCFI-Live, it is interpreted as an implementation-equivalence check, not as independent validation.

Short name	Label	Revision behavior	Primary use
H-SCFI-Live	Hierarchical dynamic SCFI Live	No historical revision within a methodology version	Headline public index and county ranking
H-SCFI-Research	Hierarchical dynamic SCFI Research	May revise history	Academic diagnostics and backcasts
SCFI-CS	Cross-sectional SCFI	Recomputed for each cross-section	County ranking within a release
G-SCFI	Global PCA SCFI	Recomputed for each release	Latent-factor robustness benchmark
SCFI-DFM-Live	Capacity-only dynamic factor model Live	No historical revision within a methodology version	Dimensional dynamic factor model benchmark
SCFI-DFM-Research	Capacity-only dynamic factor model Research	May revise history	Academic analysis and diagnostics

Table 4: Release Protocol for a Live SCFI Diagnostic

The publication protocol separates ordinary annual updates from methodology-version changes. Live values should not be silently revised when new data arrive.

Item	Rule	Rationale
Official live index	Publish one-sided filtered H-SCFI-Live estimates only	Prevents silent historical revisions on the public website
Research index	Publish smoothed H-SCFI-Research estimates separately	Uses full sample information for academic analysis
Static benchmark	Publish SCFI-PCA and G-SCFI with each release	Maintains transparent comparison to PCA-based factor methods
Versioning	Assign a methodology version to every public release	Makes model changes auditable
Vintage archive	Store every released dataset and score file by release date	Allows users to reproduce any historical website value
Re-estimation trigger	Create a new major version when loadings or validation diagnostics materially drift	Allows adaptation without rewriting history

4.2 Headline Index

All candidate variables are direction-coded so that higher values indicate more friction and then mapped to the relevant conceptual dimension. The headline index is a hierarchical dynamic factor model (HDFM): multiple noisy public indicators are treated as imperfect signals of persistent county-level latent states (Stock and Watson, 2002; Doz et al., 2012). The model estimates administrative capacity (A), investment and infrastructure (I), fiscal constraints (F), and transformation pressure (T) as separate states. The headline capacity-friction score averages only the three capacity bottleneck dimensions:

$$H\text{-}SCFI_{it}^{Live} = \frac{1}{3}\left(D_{it}^{A,Live} + D_{it}^{I,Live} + D_{it}^{F,Live}\right). \tag{1}$$

Transformation pressure $D_{it}^{T,Live}$ is estimated, reported, and used in the reform-leverage score, but it is excluded from the headline H-SCFI. High transformation pressure can make capacity constraints more policy-relevant; by itself, it does not mechanically make a county a high-friction county.

The live series is the one-sided filtered estimate based on information available at the release date. When data for a later year arrive, previously published live values remain archived within the same methodology version. Full-sample smoothed estimates are reported separately as H-SCFI-Research because they use later information and may revise history. Approximate uncertainty intervals are reported from the state covariance matrix after transformation to the 0–100 scale. The state-space model is estimated with `KFAS` (Helske, 2017). Appendix Section A gives the replication equations and benchmark construction.

4.3 Benchmarks and Interpretation

The benchmark indices serve two purposes. First, they make the ranking sensitivity visible: cross-sectional PCA, percentile aggregation, pooled global PCA, and equal-weighted dynamic factors can identify similar broad patterns while moving individual counties. Second, they prevent the paper from treating a single statistical specification as if it were the policy object. The relevant policy claim is robust only if the spatial interpretation does not depend entirely on one modelling choice.

The empirical interpretation is therefore deliberately conservative. H-SCFI-Live is a screening measure for implementation-capacity frictions. The reform-leverage score combines H-SCFI bottlenecks with separately estimated transformation pressure and site potential to identify where capacity reforms may have high policy returns. Validation tests ask whether high measured frictions are followed by weaker implementation-sensitive outcomes within counties over time, not whether the index causally estimates administrative performance.

5 Results

The results are organized around the regional-policy and planning question rather than around the index machinery. They support three claims. First, observable implementation-capacity frictions are spatially patterned but do not reduce to a simple map of industrial exposure or urbanity. Second, the counties with the highest capacity frictions are not necessarily the same counties where transformation pressure and site potential make capacity reform most urgent. Third, measurement design matters enough that the index should be used as a screening and prioritization tool, not as a league table.

The 2024 H-SCFI ranking is diagnostic rather than normative. It identifies counties where observable friction indicators are jointly high relative to the fixed calibration scale and where closer institutional diagnosis may be warranted. The top of the distribution includes mixed rural-industrial and suburban counties rather than only large cities, which is consistent with the argument that implementation bottlenecks are territorial-governance conditions rather than a simple urban-rural gradient.

Table 5 reports the highest H-SCFI-Live scores for 2024. Benchmark rankings are generated for replication but kept out of the main results because the central empirical object is the live hierarchical index.

The headline index measures friction, not policy returns. For policy prioritization, the more relevant object is a reform-leverage screen: a county has high leverage when high transformation pressure coincides with binding public-sector bottlenecks and substantial site potential. Table 6 reports this screen to show where capacity reforms may be most policy-relevant, without treating the leverage score as part of the headline SCFI.

Let $P_{it} = D_{it}^{T,Live}$ denote transformation pressure, let $B_{it} = \frac{1}{3}(D_{it}^{A,Live} + D_{it}^{I,Live} + D_{it}^{F,Live})$ denote

Table 5: Highest H-SCFI-Live Scores, 2024

Counties are ordered by the selected score in 2024. The headline ranking uses H-SCFI-Live; other ranking tables are capacity-only benchmark outputs. Transformation pressure is reported separately.

Rank	Region ID	Region	Score
1	08117	Göppingen, Landkreis	71.95158
2	08315	Breisgau-Hochschwarzwald, Landkreis	71.69895
3	08336	Lörrach, Landkreis	65.37817
4	08235	Calw, Landkreis	65.29802
5	08215	Karlsruhe, Landkreis	62.59963
6	08236	Enzkreis, Landkreis	61.87596
7	08316	Emmendingen, Landkreis	61.41046
8	08135	Heidenheim, Landkreis	61.06875
9	08226	Rhein-Neckar-Kreis, Landkreis	59.69394
10	08216	Rastatt, Landkreis	59.55771

the average capacity bottleneck, and let $S_{it} = \frac{1}{3}(p_{it}^{emp} + p_{it}^{comm} + p_{it}^{tax})$ denote site potential, where the three p terms are the 0–100 county percentile scores for employment density, commuter intensity, and fiscal capacity. The reported reform-leverage score is:

$$L_{it} = 100 \left(\frac{P_{it}}{100}\right) \left(\frac{B_{it}}{100}\right) \left(\frac{S_{it}}{100}\right). \tag{2}$$

This is the equal-elasticity multiplicative case of $L_{it}(w) = 100(P_{it}/100)^{w_P}(B_{it}/100)^{w_B}(S_{it}/100)^{w_S}$ with $w_P = w_B = w_S = 1$. Alternative weights are policy choices rather than estimated parameters. In the current 2024 data, a simple additive equal-weight stress test retains only three of the ten multiplicative top-ten counties, so Table 6 should be read as a conjunction screen and not as a precise welfare ranking. It is not used to validate the index.

The contrast between Table 5 and Table 6 is the central policy result. High-friction counties such as Goeppingen, Breisgau-Hochschwarzwald, Loerrach, Calw, and Karlsruhe county are priority cases for diagnosing implementation bottlenecks in planning, permitting, fiscal room, and infrastructure delivery. High reform-leverage places such as Stuttgart, Boeblingen, Karlsruhe city, Ostalbkreis, and Hohenlohekreis are different: they combine transformation pressure, bottlenecks, and site potential in ways that make capacity reforms especially consequential for regional adjustment. This distinction is the practical value of keeping transformation pressure outside the headline index. It separates where capacity conditions look weak from where capacity interventions are likely to matter most for regional-policy delivery.

Table 6: Highest Reform-Leverage Scores, 2024

Reform leverage equals 100 times the product of transformation pressure, average capacity bottleneck, and site potential after each component is scaled to 0–1. Site potential averages employment-density, commuter-intensity, and fiscal-capacity percentiles. It is a prioritization screen, not a welfare ranking.

Rank	Region ID	Region	Reform Leverage	Pressure	Bottleneck	Potential
1	08111	Stuttgart, Stadtkreis	26.82	89.49	32.50	92.25
2	08115	Böblingen, Landkreis	21.04	65.69	35.62	89.92
3	08212	Karlsruhe, Stadtkreis	14.87	63.23	35.69	65.89
4	08136	Ostalbkreis, Landkreis	9.69	43.72	38.63	57.36
5	08126	Hohenlohekreis, Landkreis	7.94	44.35	24.56	72.87
6	08116	Esslingen, Landkreis	7.82	18.83	52.03	79.84
7	08415	Reutlingen, Landkreis	7.59	37.61	56.62	35.66
8	08221	Heidelberg, Stadtkreis	6.91	45.42	20.02	75.97
9	08222	Mannheim, Stadtkreis	6.49	61.16	15.22	69.77
10	08327	Tuttlingen, Landkreis	6.22	28.53	33.47	65.12

The resulting typology is place-sensitive. High-friction/high-pressure territories require integrated capacity and transformation support, including planning staff, permitting support, and grant-management assistance. High-friction/lower-pressure territories call for targeted administrative, fiscal, or infrastructure-capacity diagnosis before new programmes are added. Lower-friction/high-pressure territories are candidates for faster deployment of transformation programmes because local absorption conditions appear less binding. Lower-friction/lower-pressure territories remain relevant for ordinary investment policy but are not the first cases for capacity-oriented intervention.

5.1 Discussion in the Regional-Planning Literature

The results contribute first to the place-based policy debate. Place-based development research argues that policy effectiveness depends on territorially specific constraints rather than on uniform sectoral or regional templates (Barca et al., 2012; Todtling and Trippl, 2005; Iammarino et al., 2019). The H-SCFI results identify implementation capacity as one such constraint inside a prosperous high-capacity region. Capacity frictions vary across counties and are not reducible to urbanity, industrial exposure, or a generic lagging-region category. The empirical implication is that even in Baden-Württemberg, a place-based strategy needs to distinguish need, exposure, site potential, and local absorption conditions. A county can be highly exposed to transformation without being the most capacity-constrained, and a high-friction county can require administrative diagnosis even

when it is not the central transformation site.

The results also sharpen the territorial-governance and strategic spatial-planning literatures. Strategic planning emphasizes the institutional work required to translate spatial visions into coordinated delivery (Healey, 1998, 2004; Albrechts et al., 2003; Albrechts, 2004). The distinction between the H-SCFI ranking and the reform-leverage screen gives that claim an empirical operationalization: planning and regional-policy problems are not only questions of where development should occur, but also of where administrative, fiscal, and infrastructure bottlenecks may prevent agreed strategies from being implemented. The typology therefore supports a delivery-oriented reading of territorial governance. Different places need different combinations of planning staff, shared administrative capacity, grant-management assistance, and infrastructure lifecycle support.

Finally, the findings complement the regional quality-of-government literature. Existing work shows that institutional quality matters for regional development and Cohesion Policy performance (Charron et al., 2014, 2019; Rodriguez-Pose and Garcilazo, 2015; Mendez and Bachtler, 2024). This paper does not replace those broader measures; it moves the empirical focus to a narrower county-year implementation margin where direct administrative records are mostly absent from public data. The construction-domain validation is therefore best read as evidence that public-data capacity frictions capture part of the local delivery environment, not as proof that the index measures administrative performance directly. The absence of direct public administrative outcome series is itself part of the result: territorial governance cannot be evaluated well if permit duration, grant drawdown, project delay, staffing, and budget-supervision data remain unavailable at the local level.

The static indices can also be summarized for Baden-Württemberg as a whole, but these statistics must be interpreted carefully. Because the PCA and percentile benchmarks are normalized within each year across counties, the unweighted county average is mechanically centered near 50. The dynamic H-SCFI aggregate is not mechanically centered and is therefore the only implemented series with a meaningful statewide level interpretation. Even so, it is not reported as definitive evidence that state capacity has improved or deteriorated over time. Variable coverage changes materially across years, and a fixed-calibration state-space model can still mix substantive changes with measurement-regime changes.

For that reason, the main empirical objects are the latest-release county distribution, dimension decomposition, and live-publication protocol. Table 7 reports the latest Baden-Württemberg aggregate values as descriptive diagnostics, and Table 8 clarifies that the headline score averages only the three capacity-friction dimensions. Strong trend claims would require a coverage-stable release design and vintage-specific uncertainty reporting.

Figure 1 plots the aggregate H-SCFI-Live path as a diagnostic series, not as stand-alone evidence of statewide administrative improvement or deterioration.

Figure 2 decomposes annual aggregate movements by dimension, which is useful for diagnosing where measured changes enter the state-space index even when the aggregate path itself is not

Table 7: Baden-Wuerttemberg Aggregate SCFI, Latest Year

The headline measure is the population-weighted H-SCFI-Live on the fixed calibration scale. All SCFI aggregates in this table are capacity-only and exclude transformation pressure, which is reported separately as an exposure diagnostic. Static PCA, global PCA, percentile, and dynamic factor model aggregates are benchmarks and are not interpreted as state-level time-series levels.

Measure	Value	Interpretation
Population-weighted H-SCFI-Live	42.84	Headline live index on fixed calibration scale
Population-weighted H-SCFI-Research	43.03	Full-sample smoothed headline index
Population-weighted PCA SCFI	50.13	Resident exposure to high-friction counties
Population-weighted global PCA SCFI	46.41	Pooled global principal-component common friction factor
Population-weighted capacity-only dynamic factor model Live	42.84	Equal-weighted capacity-dimension dynamic-factor benchmark
Unweighted PCA SCFI	50.00	County-average relative friction
Unweighted global PCA SCFI	50.00	County-average common factor
Cross-county SCFI standard deviation	20.55	Spatial dispersion
Cross-county global SCFI standard deviation	29.87	Global-factor spatial dispersion

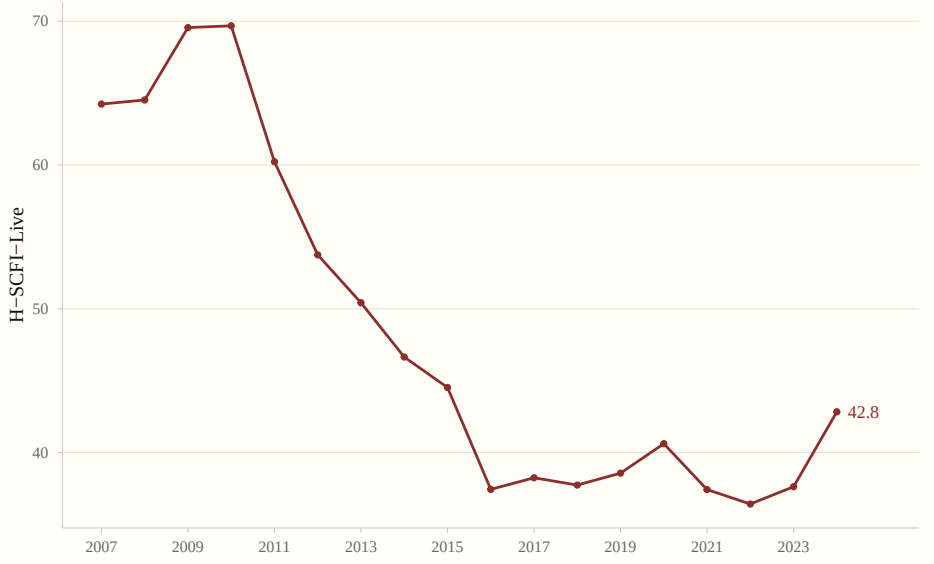
Table 8: H-SCFI Headline Dimension Weights

The headline H-SCFI score is a capacity-friction index and averages administrative, investment and infrastructure, and fiscal dimension states. Transformation pressure is reported separately and enters the reform-leverage screen.

Dimension	Weight	Share
Administrative capacity	0.333	0.333
Investment and infrastructure	0.333	0.333
Fiscal constraint	0.333	0.333

Figure 1: Baden-Württemberg Aggregate H-SCFI-Live over Time

The series is the population-weighted county aggregate of H-SCFI-Live on the fixed calibration scale. It is shown as a diagnostic series. The level path should not be read as evidence of a large improvement in municipal fiscal or administrative conditions because the underlying indicator coverage changes across the sample.



interpreted causally.

Figure 3 shows that the spatial patterns are broadly coherent, so the territorial interpretation does not hinge on a single map. At the same time, the county that visibly changes color across the panels is Baden-Baden rather than Karlsruhe. This is not a plotting artifact: in the latest year Baden-Baden scores 7.8 on H-SCFI-Live, compared with 69.8 on the dimension-PCA benchmark and 75.3 on the percentile benchmark. Dimension-PCA and the percentile index are cross-sectional release measures, so they rank counties relative to other Baden-Württemberg counties in the same year. H-SCFI-Live is a filtered state estimate on a fixed calibration scale, so it also carries forward earlier administrative-finance information rather than relying only on the current-year cross-section. The Baden-Baden color change is therefore a ranking-sensitivity diagnostic, and Table 21 reports it as the largest method-driven rank shift. For policy use, counties with large rank shifts should be treated as cases for additional diagnosis rather than as precise rank positions.

Figure 4 reports the cross-county distribution of latest-year H-SCFI-Live scores, showing the dispersion behind the map rather than only the spatial pattern.

6 Validation

The validation evidence is organized around three questions rather than around source availability alone. First, do measured frictions predict subsequent official outcomes in the reproducible county-year panel? Second, is any predictive signal mechanical, because the validation outcome or its policy

Figure 2: Diagnostic Attribution of Annual Changes in H-SCFI-Live

Bars decompose annual changes in the population-weighted H-SCFI-Live aggregate into dimension-level contributions. The decomposition is diagnostic because changing data availability and fixed-calibration state updates can generate apparent aggregate movement that is not a substantive change in local capacity.

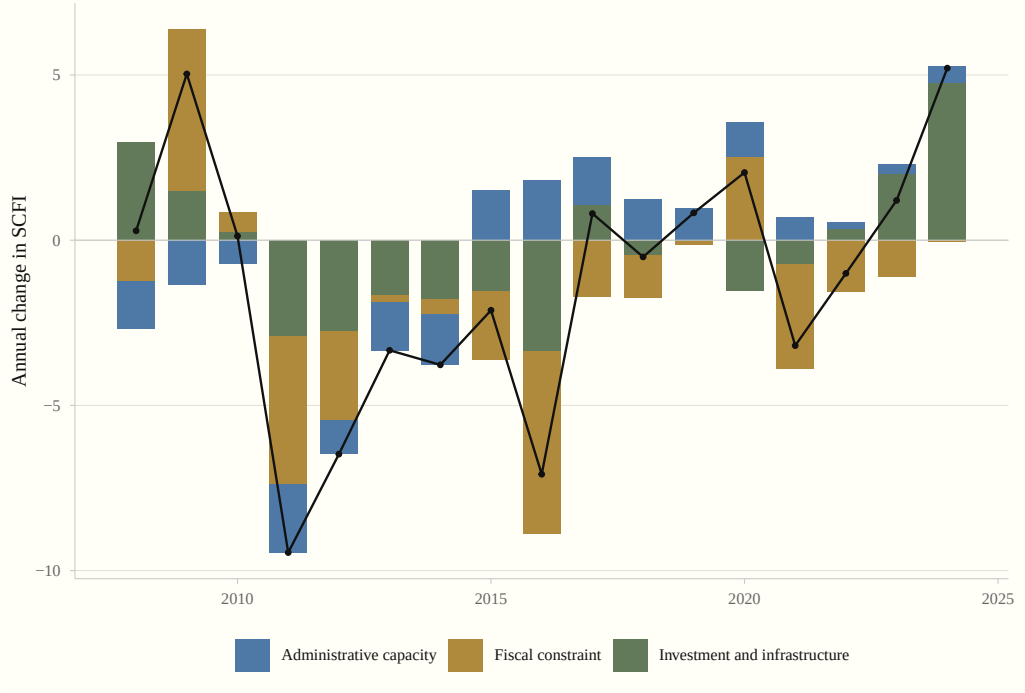


Figure 3: Spatial Patterns across Comparable SCFI Specifications

H-SCFI-Live is the headline filtered state on the fixed calibration scale. Dimension-PCA and percentile maps are cross-sectional benchmark scores for the same year. All panels use the same 0–100 color scale; higher values indicate more friction.

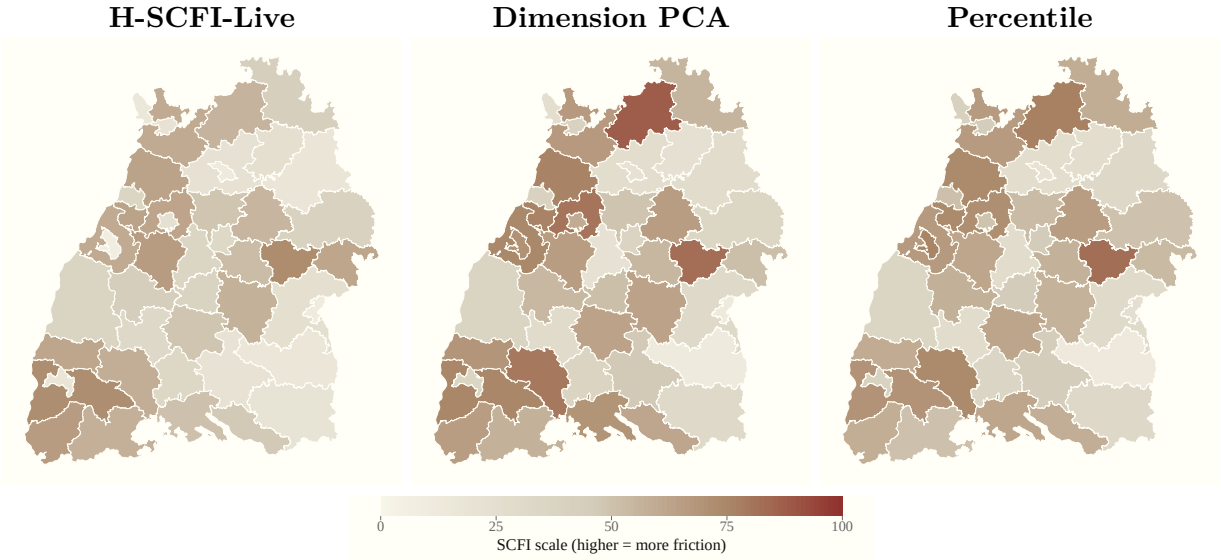
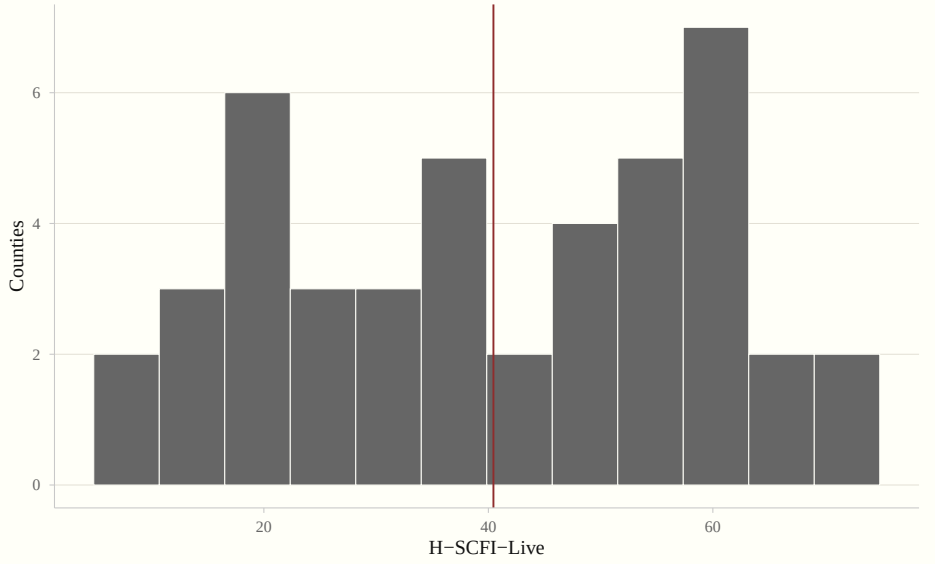


Figure 4: Distribution of H-SCFI-Live in the Latest Available Year

The figure reports the cross-county distribution of the H-SCFI-Live headline score in the latest available year.



domain is already part of the index? Third, do newly harvested administrative and adjacent public sources provide independent validation, or should they be treated as source-audit and monitoring diagnostics? Table 9 maps each table to one of these roles. This distinction is important because direct administrative records on permitting duration, grant drawdown, budget supervision, staffing bottlenecks, and project delays would provide the closest validation margin, but the harvested public sources do not provide reproducible county-year panels for those outcomes.

6.1 Panel Outcome Validation

Within the current county-year panel, the two official outcome diagnostics are subsequent employment growth and subsequent building completions per capita. Employment growth is a broad regional outcome and should be only weakly related to implementation capacity after county and year effects. Building completions are closer to the implementation margin, but they are not a pure administrative-performance measure because they also reflect private demand, financing conditions, land availability, and construction capacity.

The main empirical specification is:

$$y_{i,t+1} = \alpha_i + \lambda_t + \beta SCFI_{it} + X'_{it}\Gamma + \varepsilon_{it}, \tag{3}$$

where $y_{i,t+1}$ is an outcome such as employment growth or building completions per capita; α_i are county fixed effects; λ_t are year fixed effects; and X_{it} contains controls such as population, demographic structure, industry mix, and fiscal capacity. The models are not causal. They ask

Table 9: Validation Evidence Map

The table separates empirical validation from source-audit and monitoring diagnostics. Only Panel A tests predictive validity in the reproducible county-year panel. Panels B and C document administrative source discovery, adjacent public-data checks, and search-salience diagnostics; they are informative about scope and data availability but are not treated as confirmatory validation evidence.

Evidence block	Main inputs	What it tests	Interpretation rule
Panel A. Reproducible county-year outcome validation			
Table 10	H-SCFI-Live; employment growth; building completions	Whether high measured frictions predict subsequent implementation-sensitive outcomes within counties	Main predictive-validity check; construction-domain evidence, weak broad-employment evidence
Table 11	H-SCFI variants excluding completions or the construction domain	Whether the construction association is mechanical	Exact-outcome exclusion is reassuring; full-domain exclusion defines the scope condition
Table 12	Alternative index constructions	Whether another aggregation rule validates better	Robustness check; no alternative resolves the limited direct-validation margin
Table 13	FE, county-trend, and first-difference variants	Whether panel associations are driven by time-dependent moments	Temporal audit; strongest construction claims remain level/trend evidence, not annual-change evidence
Panel B. Administrative source audit			
Table 14	NKHR budget and annual-account public-document traces	Whether public municipal-accounting documents proxy administrative performance	Audit-stage evidence; selected public-document traces are not clean outcomes
Table 15	ViBa/digital building-application pages	Whether rollout dates can define an administrative digitization shock	Sampling-frame audit; not a regression input in the current version
Table 16	BA work permits, grants, MaStR, BA industries, water, broadband, hospitals, NKHR traces	Which harvested public sources can be linked to H-SCFI	Source-audit diagnostics; informative but not additional headline validation
Panel C. Adjacent scope and salience diagnostics			
Table 17	Infrastructure, transformation, hospital, water, and IW service-provision diagnostics	Whether adjacent policy margins co-move with H-SCFI	Scope check; mixed signs imply no index-input upgrade
Table 18	Google Trends administrative-search baskets	Whether administrative concern is visible in search salience	Exploratory monitor; not county-level administrative validation

whether high measured frictions are followed by weaker local adjustment margins within counties over time.

The interpretation rule is deliberately conservative. Table 10 reports the baseline fixed-effects associations. Table 11 then tests whether the construction result survives removing the exact validation outcome or the broader construction domain from the index. Persistence after excluding the exact outcome supports non-mechanical predictive validity; disappearance after excluding the full construction domain means that the current public-data validation does not establish a general administrative-capacity mechanism. Table 12 asks whether alternative index constructions solve the same validation problem. Public-management research similarly treats organizational performance as multidimensional and shaped by strategy, capacity, and operating environment rather than by a single observed outcome (Andrews et al., 2006).

Table 10: Panel Outcome Validation with Fixed Effects

Models regress one-year-ahead outcomes on H-SCFI-Live with county and year fixed effects. Controls are log population, average age, manufacturing employment share, and the Federal Employment Agency unemployment-rate proxy. Standard errors are clustered by county.

Specification	Coefficient	Standard error	p-value	N
Employment growth t+1				
County and year fixed effects	-0.0045	0.0051	0.384	748
County and year fixed effects + controls	-0.0142	0.0078	0.073	572
Building completions per capita t+1				
County and year fixed effects	-0.0391	0.0039	<0.001	748
County and year fixed effects + controls	-0.0417	0.0054	<0.001	572

Table 11: Mechanical-Overlap Checks: Outcome and Construction-Domain Exclusions

The first two rows re-estimate H-SCFI after excluding building completions, the validation outcome, from the catalog. The remaining rows exclude the broader construction domain: building permits, building completions, and municipal construction investment. Models use county and year fixed effects. Controls match Table 10. Standard errors are clustered by county.

Outcome	Specification	Coefficient	Standard error	p-value	N
H-SCFI without completions					
Building completions per capita t+1	County and year fixed effects	-0.0364	0.0037	<0.001	748
Building completions per capita t+1	County and year fixed effects + controls	-0.0362	0.0047	<0.001	572
H-SCFI without construction domain					
Building completions per capita t+1	County and year fixed effects	-0.0040	0.0055	0.475	748
Building completions per capita t+1	County and year fixed effects + controls	-0.0033	0.0075	0.663	572
Employment growth t+1	County and year fixed effects + controls	-0.0074	0.0080	0.358	572

A remaining concern is temporal dependence. County and year fixed effects remove time-invariant county differences and common statewide shocks, so the usual pooled level-regression stationarity problem is less severe here than in an unstructured time-series regression. They do not, however, remove county-specific trends or guarantee that annual changes in the index predict annual changes in outcomes. Table 13 summarizes the key temporal audit: county-specific linear trends and first

Table 12: Index-Construction Benchmarks for Panel Outcome Validation

Each row re-estimates the controlled county and year fixed-effects validation model after standardizing the index variant to mean zero and unit variance. Controls are log population, average age, manufacturing employment share, and the Federal Employment Agency unemployment-rate proxy. Standard errors are clustered by county. The capacity DFM benchmark is omitted because it is implementation-equivalent to H-SCFI-Live in the current run and is reported in Table 19.

Index variant	Building completions pc t+1			Employment growth t+1			N
	Coef.	SE	p-value	Coef.	SE	p-value	
H-SCFI-Live	-0.865	0.112	<0.001	-0.295	0.161	0.073	572
Dimension PCA	-0.466	0.118	<0.001	-0.193	0.121	0.119	572
Percentile	-0.314	0.085	<0.001	-0.095	0.091	0.302	572
Global PCA	-0.056	0.106	0.599	-0.142	0.115	0.224	572
Expanded H-SCFI	-0.378	0.188	0.050	-0.067	0.175	0.701	572

differences are added to the main panel associations, while the full row-level audit is retained in the replication files. The table is a diagnostic stress test rather than the preferred estimator, because first differences discard the persistent capacity conditions that the index is designed to summarize.

Table 13: Temporal-Dependence Audit: Summary of Panel Association Results

Cells in the first four rows report coefficients with p-values in parentheses from controlled models. The baseline column reproduces the county and year fixed-effects design. The county-trend column adds county-specific linear time trends. The first-difference column tests annual changes. The last two rows summarize the full row-level audit retained in the machine-readable CSV. Correlation-only, latest-year, map, ranking, and source-availability results are not panel regressions and are classified separately in the scope audit.

Evidence item	Baseline FE	County-trend FE	First diff.	Reading
Employment growth, H-SCFI-Live	-0.014 (0.073)	-0.019 (0.027)	-0.045 (0.007)	Weak baseline, but negative after trends and differencing
Building completions, H-SCFI-Live	-0.042 (<0.001)	-0.026 (0.006)	0.021 (0.022)	Persistent level/trend signal; annual-change test reverses
Completions, exact outcome excluded	-0.036 (<0.001)	-0.029 (<0.001)	-0.023 (0.007)	Most reassuring construction-domain check
Completions, construction domain excluded	-0.003 (0.663)	0.003 (0.734)	-0.000 (0.982)	No evidence outside the construction domain
Index benchmarks, full audit	10 rows	9/10 same sign	4/5 construction rows reverse	No benchmark removes the validation scope condition
Harvested FE diagnostics, full audit	9 rows	0/9 precise	2/9 precise	Audit-stage evidence; no confirmatory direct outcome

The fixed-effects evidence is informative but narrow. The employment-growth association is weak in the baseline but remains negative in the temporal audit, so it is not an obvious spurious positive validation result. The construction result is more specific. The building-completions association remains negative after adding county-specific trends, and the outcome-excluded H-SCFI remains negative even in first differences. At the same time, the headline H-SCFI first-difference specification

changes sign for building completions, and the full construction-domain exclusion remains weak. The safest reading is therefore that H-SCFI contains construction-domain predictive information in persistent county-year levels, not that annual changes in the headline index mechanically forecast annual changes in completions. The benchmark audit leads to the same conclusion from a different angle: changing the aggregation rule to dimension PCA, percentile ranks, global PCA, or the expanded-coverage H-SCFI does not produce a clearly better external validation pattern. The limitation is therefore not primarily a failed choice of weighting algorithm; it is the lack of direct public county-year administrative outcomes. Business registrations are deliberately excluded as a headline validation outcome because they combine start-ups, relocations, legal reorganizations, and local demand conditions.

6.2 Administrative Source Audit

Administrative outcomes are closer to the intended validation margin than broad economic outcomes: permit-processing durations, budget-approval constraints, grant absorption, staffing bottlenecks, project delays, and program-level funding drawdown speak directly to implementation bottlenecks. This is why Cohesion Policy research can study administrative performance with compliance, absorption, spending timeliness, and achievement measures (Mendez and Bachtler, 2024). The newly parsed BA work-permit rejection rate follows the administrative-discretion logic emphasized by Schneider and Wohlfart (2026), but it remains a procedure-specific diagnostic rather than a general local-capacity outcome. It is therefore reported in the harvested-source audit rather than as a separate headline validation table.

The Kreditanstalt fuer Wiederaufbau (KfW) Kommunalpanel and OECD Germany survey evidence document that German municipalities face investment backlogs, weak planning capacity, staffing limits, complex procedures, and grant-management burdens (KfW Research, 2025; OECD, 2025); however, their public headline series are not county-year administrative outcomes for the BW panel. The source audit therefore checks official NKHR and double-entry municipal accounting (Doppik) budget and annual-account documents as another reproducible open-source administrative validation source identified in the harvest.

Table 14: Administrative Source Audit: NKHR Public-Document Traces

The table reports descriptive correlations between H-SCFI-Live and scraped official NKHR budget or annual-account timing indicators, plus the annual-account document-availability flag. The expected sign is defined relative to H-SCFI, where higher values denote more friction; – denotes an ambiguous indicator for which no signed validation claim is made. Assessments distinguish 1

Indicator	Expected sign	Observations	Counties	Years	Pearson r (p)	Spearman ρ (p)	Assessment
Budget adoption delay	+	15	10	2020–2024	0.103 (0.715)	0.237 (0.396)	Expected sign; n.s.; sparse
Supervisory approval delay	+	12	7	2021–2024	-0.165 (0.609)	-0.139 (0.667)	Opposite sign; n.s.; sparse
Budget publication delay	–	14	7	2015–2024	-0.785 (<0.001)	-0.628 (0.016)	Association at 1%; no sign claim
Annual-account preparation delay	+	11	3	2015–2024	0.548 (0.081)	0.477 (0.138)	Consistent at 10%; sparse
Annual-account establishment delay	+	8	5	2019–2024	–	–	No variation
Annual-account publication delay	–	1	1	2024–2024	–	–	Too sparse
Annual-account backlog	+	8	5	2019–2024	–	–	No variation
Recent annual account observed	–	77	20	2012–2024	0.012 (0.919)	0.021 (0.856)	No signed claim; n.s.

The NKHR audit does not provide strong positive validation evidence. Several indicators have too few observations or no usable variation. Some better-populated public-document indicators are also opposite-signed, but those series mix administrative timing with publication practice, document retention, and source discoverability. They are therefore treated as audit diagnostics rather than clean signed performance outcomes. The result is not evidence that H-SCFI is reverse-coded; it is evidence that reproducible public-document traces are too selected and indirect to validate the administrative-capacity dimension on their own.

The audit also scrapes official state and local pages on ViBa BW and digital building-application rollouts. These dates are closer to an administrative digitization shock than the economic outcome diagnostics, but the current public pages cover only selected authorities and the extracted dates require manual source verification. Table 15 therefore reports them as a rollout audit and sampling-frame diagnostic, not as a regression input.

Table 15: Administrative Source Audit: ViBa/Digital Building-Application Rollout

The table reports dates extracted from official state, county, and city web pages on ViBa BW or digital building applications. It is a source audit and rollout chronology, not a causal treatment design: coverage is selective, dates are pattern-extracted from public web pages, and each date should be manually verified before event-study use.

Authority	Region	First digital	ViBa start	Mandatory from	Status
Land Baden-Wuerttemberg	Statewide	2023-11-01	2022-11-01	2025-01-01	Pilot or beta context
Land Baden-Wuerttemberg	Statewide	2023-11-01	2025-01-01	2025-01-01	Mandatory or exclusive
Landeshauptstadt Stuttgart	08111	2022-01-01	2026-06-01	2022-01-01	Announced rollout date
Landkreis Esslingen	08116	2024-03-01	2024-03-01	–	Active or referenced
Rems-Murr-Kreis	08119	2025-01-01	2025-01-01	2025-01-01	Mandatory or exclusive
Stadt Baden-Baden	08211	2022-01-01	2024-07-01	2022-01-01	Mandatory or exclusive

Table 16 gives the consolidated source-audit view. When a harvested source has enough county-year variation, the table reports a standardized county and year fixed-effects association; for one-year or too-sparse sources, it reports a cross-county correlation. The FE-capable diagnostics are included in the temporal-dependence audit in Table 13. They include BA work-permit rejection rates, MaStR renewable-energy measures, BA industry transformation shares, and StaLa BW annual water and wastewater bills. Grant approvals, Gigabit-Grundbuch broadband coverage, hospital capacity, and selected NKHR document traces are reported as correlations or audit associations because the public data are cross-sectional, selected, or too sparse for a credible fixed-effects design. The BA work-permit row is informative but not confirmatory: the association has the expected positive sign in levels, but it is small relative to its uncertainty, not statistically distinguishable from zero, and not stable in first differences.

6.3 Adjacent Diagnostics and Search Salience

The newly parsed MaStR, Gigabit-Grundbuch/Breitbandatlas, Bundes-Klinik-Atlas, StaLa BW water-price, and IW Gemeindecheck sources are reported as non-index diagnostics. The energy

Table 16: Source-Audit Associations from Harvested Public Sources

The table summarizes additional checks using already parsed or audited public sources. When a diagnostic has enough county-year variation, the estimate is a standardized coefficient from a regression of the diagnostic variable on H-SCFI-Live with county and year fixed effects and county-clustered standard errors. Otherwise, the estimate is the Pearson correlation with H-SCFI-Live. Expected signs are relative to H-SCFI, where higher values denote more friction; – denotes no signed validation claim. Assessments distinguish 1

Diagnostic	Method	Sign	Estimate	SE	p-value	N	Years	Assessment
MaStR								
Renewable capacity per capita	County and year FE	-	-0.309	0.139	0.032	792	2007–2024	Consistent at 5%
Registered renewable units without commissioning date	County and year FE	+	-0.033	0.059	0.582	792	2007–2024	Opposite sign; n.s.
BA Branchen im Fokus								
Machinery employment share	County and year FE	–	-0.032	0.026	0.223	220	2020–2024	No signed claim; n.s.
Automotive employment share	County and year FE	–	-0.068	0.035	0.058	155	2020–2024	Association at 10%; no sign claim
Automotive plus machinery employment share	County and year FE	–	-0.104	0.041	0.016	155	2020–2024	Association at 5%; no sign claim
BA work permits								
Work-permit rejection rate	County and year FE	+	0.127	0.205	0.539	308	2018–2024	Expected sign; n.s.
StaLa BW water prices								
Water/wastewater annual bill per resident	County and year FE	–	-0.017	0.068	0.803	176	2021–2024	No signed claim; n.s.
Drinking-water annual bill per resident	County and year FE	–	0.045	0.128	0.724	176	2021–2024	No signed claim; n.s.
Wastewater annual bill per resident	County and year FE	–	-0.067	0.096	0.489	176	2021–2024	No signed claim; n.s.
RP/MLW grant pages								
Grant approval amount per resident	Pearson correlation	–	0.039	–	0.804	43	2023	No signed claim; n.s.
Grant project count	Pearson correlation	–	0.284	–	0.065	43	2023	Association at 10%; no sign claim
Gigabit-Grundbuch								
Fiber availability for households	Pearson correlation	-	0.024	–	0.879	44	source 2025; H-SCFI 2024	Opposite sign; n.s.
5G mobile coverage by area	Pearson correlation	-	-0.414	–	0.005	44	source 2025; H-SCFI 2024	Consistent at 1%
Bundes-Klinik-Atlas								
Hospital beds per 1,000 residents	Pearson correlation	–	-0.512	–	<0.001	44	source 2024; H-SCFI 2024	Association at 1%; no sign claim
NKHR public documents								
NKHR document count	Pearson correlation	–	0.116	–	0.316	77	2012–2024	No signed claim; n.s.

and broadband measures are useful scope checks because they measure transformation and digital-infrastructure margins adjacent to local implementation capacity. The hospital, water, and IW variables add public-service context: public-provider hospital beds and sites, hospital capacity, water and wastewater fees, model annual bills, and service-provision rank scores all describe territorial service conditions, but they also reflect planning geography, specialization, cost recovery, topography, asset condition, tariff design, settlement structure, and accessibility rather than administrative processing performance. They are therefore not used to construct H-SCFI. The StaLa BW annual water-bill series can be matched to same-year H-SCFI for 2021–2024; the individual 2025 fee components and the 2026 IW county aggregates remain latest-source diagnostics against the latest available H-SCFI vintage.

The diagnostic correlations are mixed rather than confirmatory. Renewable capacity and 5G coverage move in the expected direction, fixed-broadband measures are weak or imprecise, and the MaStR queue proxy is significantly opposite-signed. Hospital, water, and IW diagnostics are reported without a signed validation claim because their expected relationship to capacity frictions is theoretically ambiguous. The IW benchmark is partly aligned with H-SCFI on some service dimensions: the education service-deficit rank is positively associated with H-SCFI ($r = 0.407$, $p = 0.006$), while health and leisure are weaker 10 percent associations and the overall, mobility, digitalization, and bad-or-very-bad rating-share measures are not statistically distinguishable from zero. The interpretation is therefore narrow: H-SCFI is somewhat colocated with selected service-provision deficits, but the IW rows do not validate administrative capacity or justify adding Daseinsvorsorge ranks to the index.

A final demand-side diagnostic uses Google Trends search-volume indices (SVI) for administrative-search baskets. This exercise is deliberately separate from the official public-source panel: it does not measure administrative performance, it is not available at county scale, and it is not an input to H-SCFI. Its purpose is narrower. If administrative frictions become salient to households, firms, or advisers, information-seeking around deadlines, inaction, objections, legal escalation, and construction permitting may rise relative to the national benchmark. The Google Trends series are therefore treated as a behavioral monitoring diagnostic for Baden-Württemberg relative to Germany, not as validation of county rankings.

The search diagnostic follows the same reproducibility rule as the source audit. Search terms are downloaded in overlapping windows, each window is cached with a manifest, and adjacent windows are chained through their overlap before annual basket aggregation. Because Google Trends normalizes each request, the preferred statistic standardizes each term across the requested regions and years and then reports Baden-Württemberg minus Germany. Table 18 reports both quantitative evaluation metrics and data-quality diagnostics; Figure 5 plots the relative annual basket scores. Low-volume windows and mean-ratio fallbacks are reported explicitly. Because both aggregate H-SCFI and search salience can be persistent time series, the table does not regress Google Trends levels on H-SCFI levels. The H-SCFI comparison is reported only in first differences. The diagnostic

Table 17: Adjacent Infrastructure, Transformation, and Public-Service Diagnostics

The table reports descriptive correlations between H-SCFI-Live and newly parsed official or institutional MaStR, Gigabit-Grundbuch/Breitbandatlas, Bundes-Klinik-Atlas, StaLa BW water-price, and IW Gemeindecheck variables. IW service-deficit scores transform national municipality ranks to a 0–100 scale, where higher values indicate worse service-provision rank, and aggregate them to counties as unweighted municipality means. Parentheses report two-sided correlation-test p-values. Expected signs are relative to H-SCFI, where higher values denote more friction; – denotes an ambiguous indicator for which no signed validation claim is made. Assessments distinguish 1

Indicator	Source/alignment	Sign	N	Counties	Years	Pearson r (p)	Spearman ρ (p)	Assessment
Renewable generation capacity per capita	MaStR; same-year H-SCFI	-	792	44	2007–2024	-0.115 (0.001)	-0.063 (0.077)	Consistent at 1%
Registered units without commissioning date	MaStR; same-year H-SCFI	+	792	44	2007–2024	-0.200 (<0.001)	-0.322 (<0.001)	Opposite-signed at 1%
Fiber availability for households	Gigabit-Grundbuch; 2025 source vs latest H-SCFI	-	44	44	source 2025; H-SCFI 2024	0.024 (0.879)	0.062 (0.691)	Opposite sign; n.s.
Gigabit availability for households	Gigabit-Grundbuch; 2025 source vs latest H-SCFI	-	44	44	source 2025; H-SCFI 2024	-0.126 (0.415)	-0.191 (0.214)	Expected sign; n.s.
5G mobile coverage by area	Gigabit-Grundbuch; 2025 source vs latest H-SCFI	-	44	44	source 2025; H-SCFI 2024	-0.414 (0.005)	-0.417 (0.005)	Consistent at 1%
Hospital beds per 1,000 residents	Bundes-Klinik-Atlas; 2024 source vs same-year H-SCFI	–	44	44	2024–2024	-0.512 (<0.001)	-0.370 (0.013)	Association at 1%; no sign claim
Public-provider hospital beds per 1,000 residents	Bundes-Klinik-Atlas; 2024 source vs same-year H-SCFI	–	44	44	2024–2024	-0.365 (0.015)	-0.257 (0.092)	Association at 5%; no sign claim
Public-provider hospital bed share	Bundes-Klinik-Atlas; 2024 source vs same-year H-SCFI	–	44	44	2024–2024	0.257 (0.092)	0.202 (0.189)	Association at 10%; no sign claim
Public-provider hospital site share	Bundes-Klinik-Atlas; 2024 source vs same-year H-SCFI	–	44	44	2024–2024	0.243 (0.112)	0.211 (0.168)	No signed claim; n.s.
Annual water/wastewater bill per resident	StaLa BW Wasserpreise; same-year H-SCFI	–	176	44	2021–2024	-0.079 (0.297)	-0.047 (0.534)	No signed claim; n.s.
Annual drinking-water bill per resident	StaLa BW Wasserpreise; same-year H-SCFI	–	176	44	2021–2024	-0.016 (0.833)	-0.020 (0.795)	No signed claim; n.s.
Annual wastewater bill per resident	StaLa BW Wasserpreise; same-year H-SCFI	–	176	44	2021–2024	-0.112 (0.140)	-0.085 (0.260)	No signed claim; n.s.
Drinking-water fee per cubic meter	StaLa BW Wasserpreise; 2025 source vs latest H-SCFI	–	44	44	source 2025; H-SCFI 2024	0.079 (0.612)	0.083 (0.590)	No signed claim; n.s.
Wastewater fee per cubic meter	StaLa BW Wasserpreise; 2025 source vs latest H-SCFI	–	44	44	source 2025; H-SCFI 2024	-0.041 (0.791)	0.032 (0.837)	No signed claim; n.s.
Stormwater fee per square meter	StaLa BW Wasserpreise; 2025 source vs latest H-SCFI	–	44	44	source 2025; H-SCFI 2024	-0.301 (0.047)	-0.218 (0.155)	Association at 5%; no sign claim
Drinking-water basic fee	StaLa BW Wasserpreise; 2025 source vs latest H-SCFI	–	44	44	source 2025; H-SCFI 2024	-0.324 (0.032)	-0.280 (0.065)	Association at 5%; no sign claim
IW overall service-deficit rank	IW Gemeindecheck; 2026 source vs latest H-SCFI	–	44	44	source 2026; H-SCFI 2024	0.207 (0.177)	0.194 (0.206)	No signed claim; n.s.
IW education service-deficit rank	IW Gemeindecheck; 2026 source vs latest H-SCFI	–	44	44	source 2026; H-SCFI 2024	0.407 (0.006)	0.310 (0.041)	Association at 1%; no sign claim
IW health service-deficit rank	IW Gemeindecheck; 2026 source vs latest H-SCFI	–	44	44	source 2026; H-SCFI 2024	0.277 (0.069)	0.188 (0.222)	Association at 10%; no sign claim
IW mobility service-deficit rank	IW Gemeindecheck; 2026 source vs latest H-SCFI	–	44	44	source 2026; H-SCFI 2024	0.116 (0.454)	0.117 (0.450)	No signed claim; n.s.
IW digitalization service-deficit rank	IW Gemeindecheck; 2026 source vs latest H-SCFI	–	44	44	source 2026; H-SCFI 2024	0.100 (0.518)	0.092 (0.551)	No signed claim; n.s.
IW leisure service-deficit rank	IW Gemeindecheck; 2026 source vs latest H-SCFI	–	44	44	source 2026; H-SCFI 2024	0.268 (0.079)	0.229 (0.134)	Association at 10%; no sign claim
IW bad/very-bad municipality share	IW Gemeindecheck; 2026 source vs latest H-SCFI	–	44	44	source 2026; H-SCFI 2024	0.029 (0.852)	0.093 (0.547)	No signed claim; n.s.

is useful for monitoring whether administrative-search pressure becomes more visible, but it remains weaker than direct administrative outcome data.

A further measurement caveat is specific to the final years of the series. The public release of ChatGPT in late 2022 (OpenAI, 2022) and Google's subsequent integration of generative AI into Search through AI Overviews (Google, 2024) changed the information channel that Google Trends is meant to proxy. Users may substitute conversational AI prompts for keyword searches, and search interfaces may answer some administrative questions without generating the same downstream search behavior. Post-2022 movements in Google Trends can therefore reflect channel substitution or search-interface redesign rather than changes in underlying administrative concern. For this reason, Table 18 reports the 2022–2024 change separately, and the diagnostic is interpreted only as an exploratory salience measure.

Table 18: Search-Salience Diagnostic: Google Trends Administrative Baskets

The table reports a demand-side Google Trends diagnostic that is not used in H-SCFI construction. Terms are downloaded as overlapping windows for Baden-Wuerttemberg (DE-BW) and Germany (DE), chained to a common scale, standardized within search term across regions and years, and aggregated into baskets. The BW–DE columns report Baden-Wuerttemberg's term-standardized search pressure relative to the national benchmark. Trend/yr is a descriptive linear slope of the annual BW–DE basket score on calendar year; it is not interpreted as a stationarity-based validation test. To avoid spurious level-on-level inference, the H-SCFI column reports the Pearson correlation between annual changes in the BW–DE basket score and annual changes in the population-weighted Baden-Wuerttemberg H-SCFI time series. The 2022–24 column isolates the period after the public release of ChatGPT and the subsequent diffusion of generative search interfaces; it is descriptive and not interpreted as a causal AI effect. Parentheses report exploratory two-sided p-values only for the first-difference correlations. Failed/scale reports low-volume no-data windows and sparse-overlap mean-ratio scaling fallbacks.

Basket	Mean BW–DE	2024 BW–DE	2011–24 Δ	2022–24 Δ	Trend/yr	ΔH-SCFI corr. (p)	Failed/scale
Procedural uncertainty	-0.89	-1.08	-0.26	0.43	-0.045	0.039 (0.900)	0/8
Administrative delay and conflict	-0.01	-0.19	0.15	-0.16	-0.008	-0.420 (0.153)	1/14
Legal escalation	-0.64	-2.83	-2.76	-2.49	-0.109	-0.492 (0.087)	3/5
Construction permitting	-0.48	-0.92	-0.04	-0.60	0.029	-0.153 (0.617)	1/5

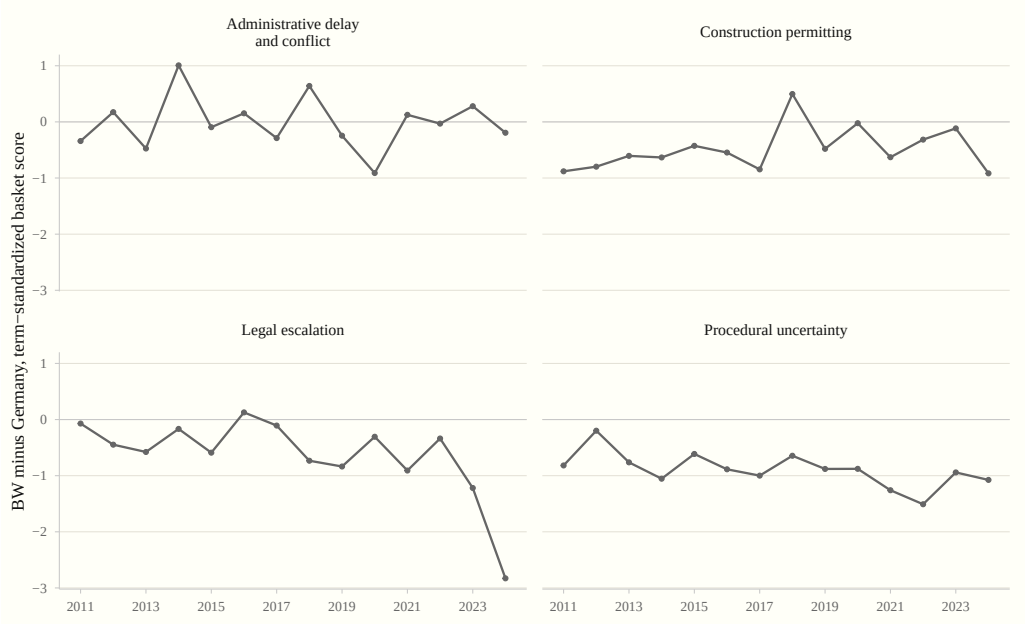
The trend-per-year column gives the main descriptive reading of the plot. Since the dependent variable is the Baden-Württemberg minus Germany basket score, a positive trend would indicate that administrative-search pressure is rising in Baden-Württemberg relative to the national benchmark. The table shows no such pattern. Administrative-delay/conflict has a near-zero trend (-0.008), and construction permitting is positive but small (0.029). Procedural uncertainty and legal escalation move in the opposite direction, becoming more negative over time (slope $= -0.045$; slope $= -0.109$). All four baskets also have negative average BW–Germany scores. The trend evidence therefore weakens, rather than strengthens, the interpretation that Google searches reveal rising Baden-Württemberg-specific administrative pressure.

The post-2022 window is also mixed, which is important given the changing search environment. Procedural uncertainty rises by 0.43 standardized basket units between 2022 and 2024, while administrative delay/conflict, legal escalation, and construction permitting fall by 0.16, 2.49, and 0.60 units. The first-difference correlations with changes in the population-weighted H-SCFI are weak

or opposite-signed: procedural uncertainty is essentially zero ($r = 0.039$, $p = 0.900$), administrative delay/conflict is negative and imprecise ($r = -0.420$, $p = 0.153$), legal escalation is negative at the 10 percent level ($r = -0.492$, $p = 0.087$), and construction permitting is negative and imprecise ($r = -0.153$, $p = 0.617$). We therefore interpret Google Trends as a weak salience monitor rather than a validation margin. It shows that administrative-search behavior can be documented reproducibly, but it does not corroborate a broad capacity-friction interpretation of the county index.

Figure 5: Google Trends Administrative-Search Pressure in Baden-Württemberg Relative to Germany

The figure reports annual Google Trends basket scores for Baden-Württemberg relative to Germany. Each basket averages term-standardized, chained search-volume indices; positive values indicate higher Baden-Württemberg search pressure than the national benchmark for the same basket and year. The diagnostic is not an H-SCFI input and does not validate county rankings.



7 Robustness

Robustness is assessed in four steps. First, H-SCFI-Live is compared with the static dimension-PCA index, the percentile index, the pooled global-PCA benchmark, and the equal-weighted dynamic factor model. These are benchmark designs, not alternative headline definitions: all reported SCFI benchmarks use the same capacity-only construct, while transformation pressure is compared separately as an exposure dimension. Capacity DFM rows are retained as implementation-equivalence checks; when they are identical to H-SCFI-Live, they do not provide independent robustness evidence. Table 19 reports the resulting rank concordance and shows that the non-equivalent benchmark indices are related but not rank-equivalent. The comparisons provide a ranking-sensitivity diagnostic: counties with large rank shifts are those whose measured friction

depends most strongly on modelling choices. Second, pseudo-vintages quantify historical revision under re-estimation. Third, an expanded-coverage specification incorporates additional indicators where their direction is conceptually defensible. Fourth, a constant-coverage H-SCFI checks whether the aggregate dynamic is mainly an artifact of adding variables over time.

The live-publication claim is checked with pseudo-vintages. Table 20 compares index values from truncated release vintages with the full 2024 run for the same historical county-years. Re-estimated methods revise history because loadings, calibration, and smoothed state estimates change when later observations are added. The archived H-SCFI-Live row is zero by construction: it reflects the publication protocol under which previously released one-sided live values are stored rather than silently overwritten.

The different index constructions are not rank-equivalent. Table 21 reports the counties with the largest rank movements relative to H-SCFI-Live. These movements are substantively informative because they identify counties whose measured friction depends on whether the index emphasizes a live state estimate, transparent within-year ranks, a pooled static factor, or an equal-weighted dimensional state-space estimate.

Figure 6 shows how county scores from the alternative specifications compare with H-SCFI-Live in the latest available year. Aggregate time-series plots for the benchmark indices are generated for replication, but they are not treated as results because changing data coverage and within-year standardization make level comparisons over time difficult to interpret.

The expanded-coverage specification is deliberately inclusive but not mechanically superior. It adds information on accessibility, broadband, public-service access, labor-market slack, historical personnel and investment expenditure, and land-use structure. It follows the headline H-SCFI rule and therefore remains capacity-only: transformation pressure is estimated separately and does not enter the expanded headline score. Some series are short, static, or historically bounded. Table 22 therefore asks whether adding them materially changes the headline index rather than treating them as a preferred replacement, and Figure 7 shows the corresponding aggregate path and latest-year spatial pattern.

The constant-coverage check re-estimates the H-SCFI with the same seven indicators available for all counties from 2011 to 2024. It is intentionally narrower than the headline index because it excludes later debt and fiscal-balance variables, newly harvested INKAR variables, and historical municipal-finance series concentrated in early years. Figure 8 shows that the aggregate path is broadly similar under full available coverage and constant coverage, reducing the concern that the diagnostic time path is driven only by expanding indicator availability.

Table 23 lists the highest constant-coverage county scores, providing a county-level check on whether the narrowed long-panel specification identifies broadly similar high-friction places.

The state-space model also provides filtered-state uncertainty. Table 24 reports the latest-year counties with the widest approximate H-SCFI-Live intervals. These intervals capture Kalman-filter

Table 19: Rank Concordance across Index Specifications

The table reports rank correlations for 2024 county scores. All reported SCFI specifications are capacity-only. Values below one indicate that the benchmark specification changes county ordering relative to other capacity-index designs. Capacity DFM rows are retained as implementation-equivalence checks; when they equal H-SCFI-Live, they are not independent robustness evidence.

Compared index	Spearman	Kendall	N
Reference: H-SCFI-Live			
H-SCFI-Research	0.999	0.985	44
Dimension PCA	0.779	0.624	44
Percentile	0.750	0.594	44
Global PCA	0.692	0.510	44
Capacity DFM Live	1.000	1.000	44
Capacity DFM Research	0.999	0.985	44
Expanded H-SCFI-Live	0.753	0.622	44
Reference: H-SCFI-Research			
Dimension PCA	0.782	0.628	44
Percentile	0.752	0.596	44
Global PCA	0.699	0.520	44
Capacity DFM Live	0.999	0.985	44
Capacity DFM Research	1.000	1.000	44
Expanded H-SCFI-Live	0.753	0.624	44
Reference: Dimension PCA			
Percentile	0.963	0.847	44
Global PCA	0.864	0.667	44
Capacity DFM Live	0.779	0.624	44
Capacity DFM Research	0.782	0.628	44
Expanded H-SCFI-Live	0.852	0.660	44
Reference: Percentile			
Global PCA	0.775	0.564	44
Capacity DFM Live	0.750	0.594	44
Capacity DFM Research	0.752	0.596	44
Expanded H-SCFI-Live	0.845	0.655	44
Reference: Global PCA			
Capacity DFM Live	0.692	0.510	44
Capacity DFM Research	0.699	0.520	44
Expanded H-SCFI-Live	0.739	0.529	44
Reference: Capacity DFM Live			
Capacity DFM Research	0.999	0.985	44
Expanded H-SCFI-Live	0.753	0.622	44
Reference: Capacity DFM Research			
Expanded H-SCFI-Live	0.753	0.624	44

Table 20: Pseudo-Vintage Revision Diagnostics

Rows average pseudo-vintage comparisons over release years 2020–2023. Re-estimated specifications compare values from a truncated vintage against the 2024 full-sample run for the same county-years. The archived H-SCFI-Live row is zero by the publication rule: published live vintages are stored rather than silently overwritten.

Specification	Mean absolute revision	95th percentile	Maximum	N
Archived H-SCFI-Live publication rule	0.000	0.000	0.000	682
Dimension PCA	0.297	1.405	3.488	682
Global PCA	3.060	11.192	22.093	682
Re-estimated H-SCFI-Live	3.801	13.667	28.170	682
H-SCFI-Research	4.059	13.766	27.540	682

Table 21: Largest Ranking Differences across Index Specifications

Ranks are compared against H-SCFI-Live, the headline live index. All reported SCFI benchmark ranks are capacity-only; transformation pressure is reported separately. Larger shifts identify counties whose position is sensitive to the measurement design.

Region	H-SCFI-Live	Dimension PCA	Percentile	Global PCA	Dynamic factor model Live	Max shift
Baden-Baden, Stadtkreis	44	8	3	8	44	41
Sigmaringen, Landkreis	35	26	29	16	35	19
Böblingen, Landkreis	27	42	39	43	27	16
Heidenheim, Landkreis	8	24	21	18	8	16
Stuttgart, Stadtkreis	29	30	28	44	29	15
Rhein-Neckar-Kreis, Landkreis	9	11	9	24	9	15
Pforzheim, Stadtkreis	33	18	26	19	33	15
Ostalbkreis, Landkreis	23	33	25	37	23	14
Neckar-Odenwald-Kreis, Landkreis	14	1	2	1	14	13
Lörrach, Landkreis	3	13	16	5	3	13

Table 22: Expanded-Coverage Robustness Check

The expanded-coverage specification adds newly parsed demographic, residential and non-residential construction, land-market, labor-market, accessibility, service-access, broadband, historical municipal-finance, and BASt station-presence indicators where their direction is conceptually defensible. It follows the headline capacity-only rule, so transformation pressure remains outside the expanded H-SCFI score. Variable counts here are model-input series after processing and splits; Table 1 counts raw headline indicators. It is a robustness check, not the headline release index.

Specification	Model-input series	Mean	Dispersion	Spearman with headline
Headline H-SCFI-Live	17	40.55	18.88	1.000
Expanded-coverage H-SCFI-Live	44	49.88	11.12	0.753

Figure 6: County-Level Comparison of Implemented Index Variants

Each panel compares 2024 county scores from a benchmark specification with H-SCFI-Live. The diagonal line marks equality with the headline index.

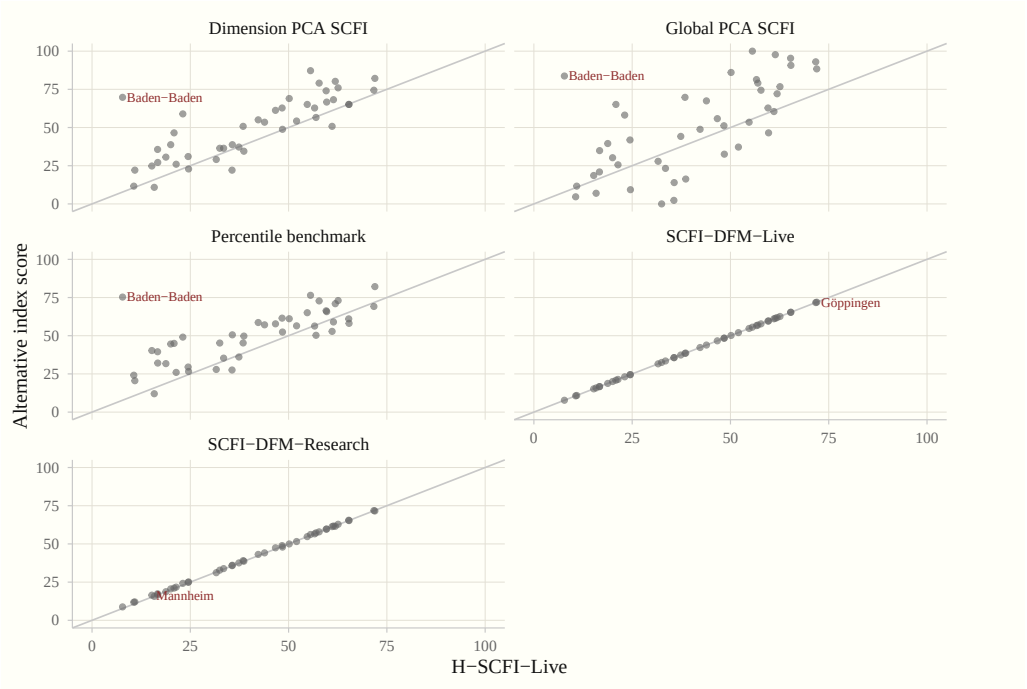


Figure 7: Expanded-Coverage H-SCFI Robustness Diagnostics

The left panel compares the population-weighted headline H-SCFI-Live path with the expanded-coverage H-SCFI-Live path. The right panel maps the latest expanded-coverage county scores. The expanded specification is a robustness check, not the release index.

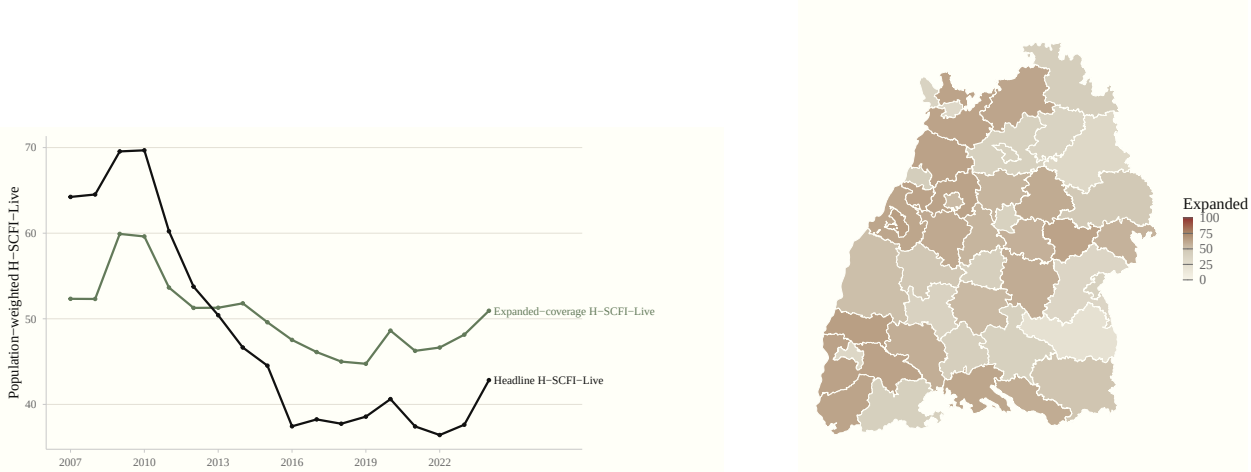


Figure 8: Coverage Robustness of the Aggregate H-SCFI

The constant-coverage benchmark re-estimates H-SCFI for 2011–2024 using the same seven indicators in every county-year. Similar aggregate paths under the full available indicator set and the constant-coverage set suggest that the diagnostic aggregate dynamic is not primarily caused by the later addition of debt, fiscal-balance, or other newly available variables. The benchmark is narrower than the headline index and is therefore used only as a robustness check.

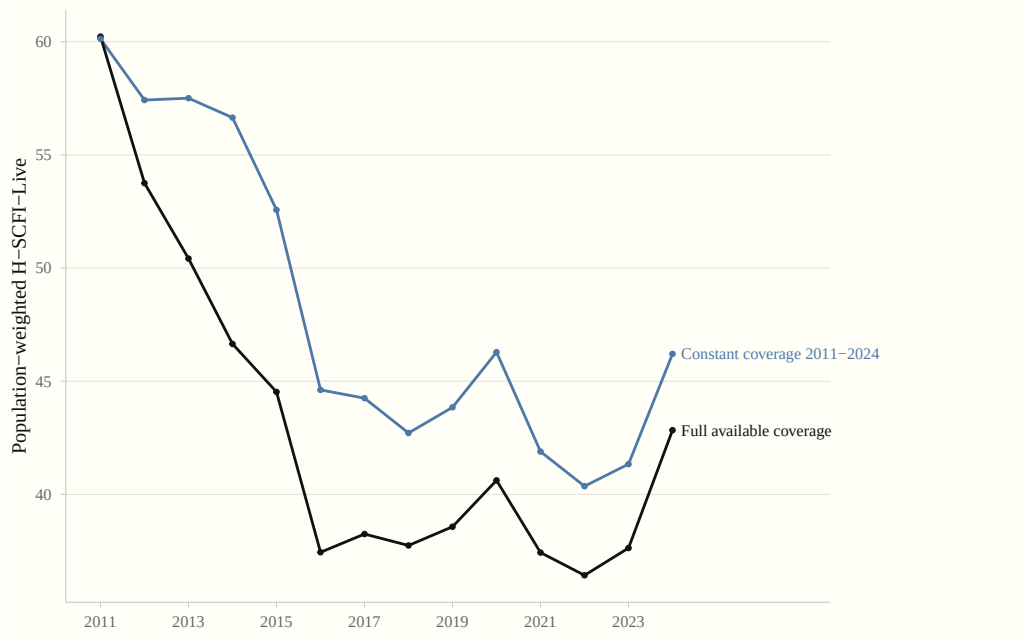


Table 23: Highest Constant-Coverage H-SCFI Scores, 2024

The constant-coverage benchmark uses the same seven indicators for all counties from 2011 to 2024: average age, manufacturing employment share, business-tax dependence, building permits, building completions, tax capacity, and business-tax revenue. It excludes debt and fiscal-balance variables because they are unavailable over the full window.

Rank	Region ID	Region	Score
1	08117	Göppingen, Landkreis	77.66
2	08315	Breisgau-Hochschwarzwald, Landkreis	77.56
3	08236	Enzkreis, Landkreis	70.04
4	08336	Lörrach, Landkreis	69.56
5	08215	Karlsruhe, Landkreis	65.22
6	08216	Rastatt, Landkreis	61.52
7	08226	Rhein-Neckar-Kreis, Landkreis	61.13
8	08337	Waldshut, Landkreis	60.92
9	08316	Emmendingen, Landkreis	59.88
10	08335	Konstanz, Landkreis	59.84

state uncertainty after the 0–100 calibration transform. They do not include uncertainty about indicator selection, direction coding, factor structure, or the decision to average the three capacity dimensions, so close ranks should still be interpreted cautiously.

Table 24: Largest H-SCFI-Live State Uncertainty, 2024

Intervals are approximate 95 percent state-space intervals transformed to the 0–100 H-SCFI scale with the delta method. They capture filtered-state uncertainty, not uncertainty about indicator selection or factor structure.

Rank	Region	Score	Lower	Upper
42	Heilbronn, Stadtkreis	10.89	0.00	28.42
39	Freiburg im Breisgau, Stadtkreis	16.68	1.93	31.42
36	Heidelberg, Stadtkreis	20.02	6.00	34.04
41	Mannheim, Stadtkreis	15.22	2.55	27.89
4	Calw, Landkreis	65.30	52.88	77.72
43	Ulm, Stadtkreis	10.63	0.00	22.99
20	Bodenseekreis, Landkreis	46.66	35.25	58.08
44	Baden-Baden, Stadtkreis	7.76	0.00	19.12
17	Konstanz, Landkreis	50.16	39.06	61.27
28	Tuttlingen, Landkreis	33.47	22.76	44.19

8 Limitations

The SCFI is a public-data screening measure of observable capacity-friction conditions, not a direct measure of administrative performance. The decisive empirical limitation is demand-versus-capacity confounding. Low construction activity may reflect weak private demand, financing conditions, land scarcity, or sectoral investment cycles rather than local implementation barriers. Fiscal indicators may capture prosperity, past investment choices, or tax-base structure as well as binding fiscal capacity. The outcome-excluded validation reduces the most mechanical concern, but it does not eliminate these alternative interpretations. The domain-excluded check is especially important because it shows that administrative and fiscal proxies alone are not enough to explain subsequent construction outcomes.

The validation evidence should therefore be read as a hierarchy rather than as a single confirmation test. The fixed-effects diagnostics provide construction-domain predictive validity, not broad administrative-capacity validation. The BA work-permit series supplies a direct but narrow administrative-decision diagnostic; the NKHR, grant, ViBa, hospital, water, broadband, and MaStR exercises document audit-stage source discovery and scope checks. Apart from the BA procedure-specific series, the audited public sources do not contain reproducible county-year series for direct administrative outcomes such as permit-processing durations, budget-approval constraints, grant absorption, staffing bottlenecks, or project delays, so those outcomes are treated as documented exclusions rather than empirical validation results.

Other limitations are standard for subnational composite measurement. County-level aggregation masks municipal heterogeneity within counties. Settlement-structure variables such as population scale, density, and employment centrality are excluded from the headline index and used only as controls or potential measures. PCA loadings are sample- and variable-dependent, which is why PCA is treated as a benchmark rather than a structural model. The dynamic-factor index depends on assumptions about persistence, measurement error, and factor structure. Finally, the architecture is more portable than the specific Baden-Württemberg implementation: other states or countries could use the same vintage-stable publication design, but their indicator set, administrative validation margins, and interpretation of fiscal or construction signals would need to be rebuilt locally. The IW Gemeindecheck discussed above illustrates this point: it improves cross-sectional benchmarking of service provision after county aggregation, but it should not be read as direct administrative-performance validation. For regional policy practice, this means the SCFI should not be used as a league table or a substitute for administrative records. Its appropriate use is to screen where closer institutional diagnosis, intermunicipal support, targeted implementation assistance, or improved administrative data collection may be most valuable.

9 Conclusion

This paper develops a regional-science measurement framework for local implementation-capacity frictions in regional policy. In a high-capacity federation, the central question is not whether public authority exists, but where local institutions face conditions that make implementation difficult. The Baden-Württemberg application shows that administrative, fiscal, and infrastructure indicators can be organized into a reproducible county-year capacity-friction screen, while transformation pressure should be kept separate as an exposure dimension for policy prioritization. This distinction matters because the places with the highest observed bottlenecks are not always the places where bottlenecks and transformation pressure jointly make reform most urgent.

The contribution is therefore substantive as well as methodological. For regional studies, the paper identifies local implementation capacity as a territorial condition that can vary within an otherwise prosperous region and therefore needs to be diagnosed alongside need and potential (Barca et al., 2012; Iammarino et al., 2019). For regional policy and strategic spatial planning, the results show why delivery capacity has to be treated as part of policy design rather than as a downstream administrative detail (Healey, 2004; Albrechts et al., 2003). For regional institutional-quality research, the paper complements broad quality-of-government measures by offering a reproducible county-year screen for operational bottlenecks, while remaining explicit that direct administrative-performance data would be needed for stronger validation (Charron et al., 2019; Mendez and Bachtler, 2024).

The policy implication is concrete. H-SCFI-Live should be used as an early-warning and triage device for territorial governance, not as a funding formula or a league table. High-friction counties warrant closer diagnosis of administrative workload, fiscal room, infrastructure condition, planning

capacity, and housing-delivery pipelines. High-friction/high-pressure counties are candidates for integrated implementation support, including shared-service capacity, faster permitting support, grant-management assistance, and infrastructure lifecycle planning. Lower-friction/high-pressure counties may be better positioned for rapid transformation programmes. Across all groups, the public-source audit shows that direct administrative data on permit durations, grant drawdown, project delays, staffing bottlenecks, and budget supervision would substantially improve validation and should become part of the regional-policy data infrastructure.

The methodological implication serves that policy purpose. Static PCA is useful for cross-sectional diagnosis, but repeated publication requires a design that distinguishes real-time filtered estimates from smoothed research estimates. The hierarchical dynamic-factor SCFI provides such a structure and preserves dimension-level decomposition. The current evidence supports the index as a transparent screening framework and shows construction-domain predictive validity. It does not establish a causal effect of administrative capacity, and it does not replace administrative records. Its contribution is to make territorial implementation frictions visible enough that regional policy can investigate and address them directly.

Declaration of Generative AI Use

During preparation of this manuscript, OpenAI Codex (GPT-5, OpenAI; accessed May 2026) was used for language editing, proofreading, consistency checks, LaTeX and R code assistance, and tailoring the manuscript to the journal's regional planning and policy audience. The tool was used to improve clarity, terminology, table wording, and reproducible manuscript compilation. It was not used as an author, and all substantive claims, data choices, empirical results, citations, and final text were designed, created, reviewed and approved by the author. The author takes full responsibility for the content of the manuscript.

Competing Interests

The author declares no competing interests.

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A Index Construction Details

Let i index counties, t years, d dimensions, and k variables. Each raw variable x_{kit} is assigned a direction so that higher transformed values indicate higher friction:

$$\tilde{x}_{kit} = \begin{cases} x_{kit}, & \text{if higher values imply higher friction,} \\ -x_{kit}, & \text{if higher values imply lower friction.} \end{cases} \tag{4}$$

Direction-coded variables are standardized within year:

$$z_{kit} = \frac{\tilde{x}_{kit} - \bar{x}_{kt}}{\sigma_{kt}}. \tag{5}$$

The static dimension benchmark extracts the first principal component within each dimension $d \in \{A, T, I, F\}$:

$$PC_{it}^{d} = \sum_{k \in d} \omega_k^d z_{kit}. \tag{6}$$

After theory-based direction coding, component loadings are restricted to be nonnegative. The component is converted to a within-year percentile score, $S_{it}^{d} = 100 \times P_t(PC_{it}^{d})$. The percentile benchmark replaces the first principal component with a transparent rank average:

$$S_{it}^{d,P} = \frac{1}{K_d} \sum_{k \in d} 100 \times P_t(z_{kit}). \tag{7}$$

The aggregate static capacity benchmark is:

$$SCFI_{it} = \frac{1}{3} \left(S_{it}^{A} + S_{it}^{I} + S_{it}^{F} \right). \tag{8}$$

The pooled global-PCA robustness benchmark is:

$$SCFI_{it}^{G} = 100 \times P_t \left(\sum_k \omega_k^G z_{kit} \right), \tag{9}$$

where ω_k^G are loadings from a single PCA over the standardized, direction-coded capacity-friction indicators. Missing values are imputed by variable means for PCA estimation after within-year standardization, preventing a single missing indicator from dropping an entire county-year.

For the HDFM, the standardized, direction-coded indicator z_{kit} belonging to dimension $d(k)$ is a noisy signal of the corresponding latent dimension:

$$z_{kit} = \alpha_k + \lambda_k D_{it}^{d(k)} + \varepsilon_{kit}, \qquad \varepsilon_{kit} \sim N(0, r_k). \tag{10}$$

Each latent dimension evolves as:

$$D_{it}^{d} = \rho_d D_{i,t-1}^{d} + \eta_{it}^{d}, \qquad \eta_{it}^{d} \sim N(0, q_d). \tag{11}$$

The standardized capacity dimension states, $d \in \{A, I, F\}$, are also used as noisy measurements of a pooled global state G_{it}:

$$D_{it}^{z,d} = \gamma_d G_{it} + \nu_{it}^{d}, \qquad G_{it} = \rho_G G_{i,t-1} + \omega_{it}. \tag{12}$$

The filtered estimate is $E(G_{it} \mid \mathcal{D}_t)$, where $\mathcal{D}_t$ is the information available at release date t. The smoothed estimate is $E(G_{it} \mid \mathcal{D}_T)$ for $T \geq t$. In ordinary annual releases, loadings, state parameters, indicator directions, and 0–100 calibration constants remain fixed within the active methodology version; a changed indicator set or factor structure requires a new methodology version and a preserved archive of earlier live releases.

B Candidate Data Sources

Appendix Tables 25 and 26 distinguish series used in the reproducible panel or explicitly reported validation diagnostics from series that were located, raw-cached, parsed only as audit context, or excluded because no reproducible public county-year series was found. Table 27 summarizes the acquisition status only for remaining candidate series that are not already reported in Table 25, while Table 28 separates direct administrative-validation targets from broader context variables. The BA public ae-aezu work-permit tables are parsed for 2018–2024 and reported as a direct but procedure-specific administrative-decision diagnostic, motivated by the regional decision heterogeneity documented in Schneider and Wohlfart (2026). The BA "Branchen im Fokus" dashboard is integrated for WZ 28 (machinery) and WZ 29 (motor vehicles and parts) as transformation-exposure diagnostics for 2020–2024. The WZ 29 series is subject to BA statistical-confidentiality suppression in some county-years, including some highly concentrated automotive counties, so it is reported as a robustness and description variable rather than a headline index input. The MaStR full export, Gigabit-Grundbuch/Breitbandatlas sources, Bundes-Klinik-Atlas export, StaLa BW water-price tables, and IW Gemeindecheck workbook are parsed and reported as non-index diagnostic correlations, but they remain outside the headline index because they are adjacent infrastructure, transformation, or public-service cost/accessibility measures, not direct administrative-performance outcomes.

The public grant-source audit starts from the RP Staedtebaufoerderung funding page and official MLW/RP-linked program material. Table 29 reports the key distinction for the paper: approval-only lists are retained as public context (`grant_approval_pc`, `grant_project_count`), while `grant_drawdown_rate` and `project_delay_events` are documented as unavailable in the harvested public sources because no explicit payment, drawdown, deadline, or delay status was recovered.

Table 25: Time Series Used in the Current Analysis

The table reports time series that enter the current SCFI panel, headline index, robustness checks, controls, reported diagnostics, or explicitly labelled validation audit tables. Panel A lists headline H-SCFI index inputs only. Panel B lists extension, control, transformation-exposure, and robustness inputs that are not part of the headline index. Panel C lists reported diagnostics and validation/audit context. Dimension codes are A = administrative capacity, I = investment/infrastructure, F = fiscal constraints, T = transformation pressure, and S = site potential; I also covers infrastructure-only diagnostics. Candidate series that are not used are reported separately in Table 26. Source details are retained in the companion CSV and source-audit appendix; in brief, headline inputs come from StaLa BW/GENESIS and Regionalstatistik, extensions and controls from official BA, BBSR/INKAR, Deutschlandatlas, Zensus, BASt, KBA, and Statistik BW sources, and diagnostics from official NKHR, ViBa BW, BA, MaStR/BNetzA, Gigabit-Grundbuch, Bundes-Klinik-Atlas, StaLa BW water-price, and RP/MLW grant sources. Direction codes are + = higher raw value denotes higher friction/exposure, - = higher raw value denotes lower friction/exposure, – = ambiguous or no signed claim, and n/a = not direction-coded. Role codes are H = headline H-SCFI input, E = expanded/robustness input, C = control or site-potential covariate, T = transformation-pressure exposure, V = validation/audit diagnostic, D = descriptive diagnostic/context, and X = catalog extension candidate not used in the headline index.

Indicator	Dim.	Dir.	Role	Years
Panel A. Headline H-SCFI index inputs				
Administrative expenditure per capita	A	-	H	2007–2014
Administrative expenditure share of total expenditure	A	+	H	2007–2014
Average population age	A	+	H	2011–2024
Personnel expenditure per capita	A	-	H	2007–2014
Business tax revenue per capita	F	-	H	2007–2024
Debt per capita	F	+	H	2019–2024
Dependence on intergovernmental transfers	F	+	H	2007–2014
Financing balance per capita	F	-	H	2018–2024
Investment ratio	F	-	H	2007–2014
Tax capacity per capita	F	-	H	2007–2024
Building completions per capita	I	-	H	2007–2024
Building permits per capita	I	-	H	2007–2024
Municipal construction expenditure per capita	I	-	H	2007–2014
Panel B. Extensions, controls, and robustness inputs				
Accessibility of physicians or hospitals	A	-	C	2015–2024
General practitioners per resident	A	-	C	2024–2024
School leavers without degree share	A	+	C	2024–2024
School or childcare accessibility	A	+	C	2023–2023
Unemployment rate	A	+	C	2007–2024
Old-age dependency ratio	A	+	E	2011–2024
Population aged 65 and older	A	+	E	2007–2024
Investment grants per capita	F	–	C	2007–2014
Private overindebtedness share	F	+	C	2024–2024
Municipal cash credits per capita	F	+	X	2024–2024
Tax revenue per capita	F	-	X	2007–2023
Commuting balance per employed resident	I	–	C	2007–2023
Housing cost or price pressure	I	+	C	2010–2024
Housing vacancy rate	I	–	C	2022–2022
Settlement and transport area share	I	+	C	2021–2021
Capital expenditure per capita	I	-	X	2007–2014
Housing construction intensity	I	-	X	2007–2023
Maintenance or material expenditure per capita	I	-	X	2007–2014
Households with broadband availability at 100 Mbit/s	I	-	C	2017–2023

Indicator	Dim.	Dir.	Role	Years
Public transport accessibility	I	-	C	2020–2022
Share of buildings built before 1979	I	+	C	2022–2022
Travel time to motorway access	I	+	C	2024–2024
Travel time to upper-order centre	I	+	C	2021–2021
Absence of BASt traffic-counting station in county	I	+	E	2007–2023
BASt traffic-counting stations per 1000 square kilometers	I	-	E	2007–2023
Building-land sales area per 1000 residents	I	-	E	2007–2024
Building-land sales cases per capita	I	-	E	2007–2024
Non-residential building completions per capita	I	-	E	2007–2024
Non-residential building permits per capita	I	-	E	2007–2024
Residential building completions per capita	I	-	E	2007–2024
Residential building permits per capita	I	-	E	2007–2024
Employment density	S	-	C	2008–2023
Population with tertiary education share	S	-	C	2022–2022
Automotive and suppliers employment share	T	+	T	2020–2024
Dependence on business tax revenue	T	+	T	2007–2024
Five-year employment growth	T	-	T	2012–2024
Machinery employment share	T	+	T	2020–2024
Manufacturing employment share	T	+	T	2008–2024
Registered vacancies relative to employment	T	+	T	2007–2024
Electric vehicle share in vehicle stock	T	-	C	2024–2024
Share of buildings heated with fossil energy	T	+	C	2022–2022
Panel C. Reported diagnostics and validation/audit context				
Annual-account backlog in years implied by establishment date	A	+	V	2019–2024
Days after fiscal-year start until budget public notice or publication	A	–	V	2015–2024
Days after fiscal-year start until county budget adoption	A	+	V	2020–2024
Days after fiscal-year start until supervisory budget approval or confirmation	A	+	V	2021–2024
Days after one-year statutory deadline until annual account establishment	A	+	V	2019–2024
Days after one-year statutory deadline until annual account public notice or publication	A	–	V	2024–2024
Days after six-month statutory deadline until annual account preparation	A	+	V	2015–2024
Indicator that a recent annual account was publicly identified for the county-year	A	–	V	2012–2024
Mandatory digital building-application date	A	-	V	2022–2025
ViBa BW or digital building-application start date	A	-	V	2022–2026
ViBa BW pilot or silent-go-live rollout	A	-	V	2022–2026
Work-permit rejection rate for third-country nationals	A	+	V	2018–2024
Legacy municipal debt per capita, 2010–2018	F	+	D	2010–2018
Urban-development funding approvals per capita	I	–	V	2023–2023
Average daily traffic load	I	+	D	2007–2023
Business deregistrations per capita	I	+	D	2007–2024
Business registrations per capita	I	-	D	2007–2024
Commuter intensity	I	+	D	2021–2024
Drinking-water annual basic fee	I	–	D	source 2025; H-SCFI 2024
Drinking-water fee per cubic meter	I	–	D	source 2025; H-SCFI 2024
Fictive annual drinking-water bill per resident	I	–	D	2021–2024
Fictive annual wastewater bill per resident	I	–	D	2021–2024
Fictive annual water and wastewater bill per resident	I	–	D	2021–2024
Gemeindecheck digitalization service-deficit rank score	I	–	D	source 2026; H-SCFI 2024
Gemeindecheck education service-deficit rank score	I	–	D	source 2026; H-SCFI 2024

Indicator	Dim.	Dir.	Role	Years
Gemeindecheck health service-deficit rank score	I	–	D	source 2026; H-SCFI 2024
Gemeindecheck leisure service-deficit rank score	I	–	D	source 2026; H-SCFI 2024
Gemeindecheck mobility service-deficit rank score	I	–	D	source 2026; H-SCFI 2024
Gemeindecheck overall service-deficit rank score	I	–	D	source 2026; H-SCFI 2024
Heavy-goods vehicle share	I	+	D	2007–2023
Hospital beds per 1,000 residents	I	–	D	source 2024; H-SCFI 2024
New installations awaiting commissioning	I	+	D	2007–2024
Public-provider hospital beds per 1,000 residents	I	–	D	source 2024; H-SCFI 2024
Share of hospital beds in public-provider facilities	I	–	D	source 2024; H-SCFI 2024
Share of hospital sites under public providers	I	–	D	source 2024; H-SCFI 2024
Share of municipalities rated bad or very bad in IW Gemeindecheck	I	–	D	source 2026; H-SCFI 2024
Stormwater fee per square meter	I	–	D	source 2025; H-SCFI 2024
Wastewater fee per cubic meter	I	–	D	source 2025; H-SCFI 2024
5G mobile coverage by area or households	I	-	D	source 2025; H-SCFI 2024
Fiber availability for households	I	-	D	source 2025; H-SCFI 2024
Gigabit availability for households	I	-	D	source 2025; H-SCFI 2024
Public grant approval amount per capita	I	–	V	2023–2023
Public grant approval project count	I	–	V	2023–2026
Renewable generation capacity per capita	T	-	D	2007–2024

The table lists candidate series that do not enter the current SCFI panel, headline index, robustness checks, controls, reported diagnostics, or validation audit tables. A raw-cached status means source files or manifests exist locally; it does not imply use in the analysis. A parsed status means a reproducible artifact exists but is not reported as an empirical diagnostic unless it appears in Table 25. The source-audit classification distinguishes parsed public-data artifacts from unavailable public county-year series. The companion machine-readable table retains the full catalog notes.

Table 26: Candidate Time Series Not Used in the Current Analysis

Indicator	Dimension	Role	Status	Source-audit class	Reason not used
Projected population change	Administrative capacity	Control	Located; not in analysis	Manual official-table parser not integrated	An official source was located, but no stable reproducible analysis series is available in the current pipeline.

Indicator	Dimension	Role	Status	Source-audit class	Reason not used
Approved grants drawn down by deadline	Administrative capacity	Validation	Not observed in public data	Not reproducible from public sources	Official public grant pages were scraped. Approval-only rows are reported as context, but no harvested public source reports the payment, deadline, extension, cancellation, or delayed-completion status needed for direct drawdown or delay outcomes.
Median administrative permitting duration	Administrative capacity	Validation	Not observed in public data	Not reproducible from public sources	No reproducible public county-year administrative outcome was identified in the audited official sources.
State-funded infrastructure project delay events	Administrative capacity	Validation	Not observed in public data	Not reproducible from public sources	Official public grant pages were scraped. Approval-only rows are reported as context, but no harvested public source reports the payment, deadline, extension, cancellation, or delayed-completion status needed for direct drawdown or delay outcomes.
Fiscal equalization grants per capita	Fiscal constraint	Headline	Raw cached; not used	Public parser not integrated or reported only as context	Official fiscal or grant material was cached locally, but no reproducible county-year analysis series was parsed.
Budget approval constraints or supervisory conditions	Fiscal constraint	Validation	Not observed in public data	Not reproducible from public sources	No reproducible public county-year administrative outcome was identified in the audited official sources.
Households with fiber availability	Infrastructure	Potential	Located; not in analysis	Superseded by parsed Gigabit-Grundbuch diagnostic	The Deutschlandatlas/INKAR fiber candidate is not used because the direct Gigabit-Grundbuch household-fiber county cross-section is parsed and reported instead.
Commercial or industrial land growth	Investment and infrastructure	Headline	No usable panel values	Implemented; no usable source values	The yearly official land-use downloader/parser is implemented, but the current panel has no usable multi-year growth values unless those yearly files are present.
Apprenticeship vacancies or establishment counts	Site potential	Potential	Not reproducible	Not reproducible statewide from public sources	No statewide machine-readable reproducible panel was identified.
Patent applications per employee	Site potential	Potential	Located; not in analysis	Documented; not analysis-ready	An official source was located, but no stable reproducible analysis series is available in the current pipeline.
Commercial vehicles per employee or resident	Transformation pressure	Control	Not observed in public data	Manual official-table parser not integrated	No reproducible public county-year panel was identified in the audited official sources.

Indicator	Dimension	Role	Status	Source-audit class	Reason not used
Older worker share in industrial sectors	Transformation pressure	Exposure	Raw cached; not used	BA dashboard extractor does not produce series	The official BA dashboard source is verified, but this item is not produced by the current dashboard extractor.
Short-time work by industry and county	Transformation pressure	Exposure	Raw cached; not used	Separate BA statistic not integrated	Short-time work is a separate BA statistic; it is not produced by the Branchen im Fokus WZ employment extractor integrated here.

Table 27: Source Harvest Status for Candidate Series Not Reported in Table 25

The table summarizes only harvested, located, or requested candidate series that are not reported in Table 25. Series already listed as headline index inputs, extensions, controls, robustness inputs, diagnostics, or validation/audit context are omitted here to avoid duplicating Table 25. Raw-cached rows mean official source material was retrieved and documented, but no reported analysis series is produced. Request package indicates that a reproducible public county-year series was not identified and a data request or restricted access would be needed.

Source	Workstream	Status	Variables	Example variables	Raw manifest	Request package
Land Baden-Wuerttemberg	Admin validation	Not observed in public data	2	Approved grants drawn down by deadline; State-funded infrastructure project delay events	Yes	Yes
Land Baden-Wuerttemberg	Admin validation	Not observed in public data	1	Median administrative permitting duration	Yes	Yes
StaLa BW / Finanzministerium BW	Admin validation	Not observed in public data	1	Budget approval constraints or supervisory conditions	Yes	Yes
Bundesagentur fuer Arbeit	BA industry	Raw cached; not used	2	Older worker share in industrial sectors; Short-time work by industry and county	Yes	No
BBSR INKAR	Existing sources	Located; not in analysis	1	Projected population change	No	No
Deutschlandatlas	Existing sources	Located; not in analysis	1	Households with fiber availability	No	No
DPMA / PATSTAT	Existing sources	Located; not in analysis	1	Patent applications per employee	No	No
IHK / Handwerkskammern	Existing sources	Not reproducible	1	Apprenticeship vacancies or establishment counts	No	No
Kraftfahrt-Bundesamt	Existing sources	Not observed in public data	1	Commercial vehicles per employee or resident	No	No
Regionalstatistik / GENESIS	Existing sources	Implemented; no usable reported series	1	Commercial or industrial land growth	No	No
StaLa BW / Finanzministerium BW	Fiscal/grants	Raw cached; not used	1	Fiscal equalization grants per capita	Yes	No

Table 28: Supplementary Administrative Validation Source Audit

The table documents direct administrative validation outcomes that were audited but not used as empirical evidence because no reproducible public county-year panel was available. These items are reported as source-audit exclusions, not as validation findings.

Target outcome	Authority/source	Open-data audit result	Status	Exclusion class
Budget approval constraints or supervisory conditions	StaLa BW / Finanzministerium BW	No reproducible public county-year panel identified in the audited official sources.	Not observed in public data	No reproducible public county-year panel
Approved grants drawn down by deadline	Land Baden-Wuerttemberg	No reproducible public county-year panel identified in the audited official sources.	Not observed in public data	No reproducible public county-year panel
Median administrative permitting duration	Land Baden-Wuerttemberg	No reproducible public county-year panel identified in the audited official sources.	Not observed in public data	No reproducible public county-year panel
State-funded infrastructure project delay events	Land Baden-Wuerttemberg	No reproducible public county-year panel identified in the audited official sources.	Not observed in public data	No reproducible public county-year panel

Table 29: Public Grant-Program Validation Scrape

The grant scrape starts from official RP and MLW public program pages. Approval-only lists are retained as public validation context and county-year aggregates, but they do not populate drawdown or project-delay outcomes unless the source explicitly reports payment, drawdown, deadline, extension, cancellation, or delay status.

Evidence type	Obs.	Years	Counties	Status	Interpretation
Parsed public grant approval records	935	2023–2026	43	Recovered	Approval/context only; unresolved rows are retained with geocode flags.
County-geocoded approval records	906	2023–2026	43	Recovered	Approval/context rows eligible for county-year aggregation.
County-year approval aggregates	122	2023–2026	43	Recovered	County-year aggregation for validation context outside the index.
Drawdown-rate observations	0	–	0	Not recovered from public scrape	Populated only from explicit payment/drawdown or deadline-completion status.
Project-delay observations	0	–	0	Not recovered from public scrape	Populated only from explicit delay, extension, cancellation, deadline-miss, or delayed-completion status.

C Replication Details

The empirical outputs are reproduced from the repository root with:

```
Rscript 02_code/R/download/parse_regionalstatistik_core.R
Rscript 02_code/R/download/parse_regionalstatistik_extended_csv.R
Rscript 02_code/R/download/download_inkar_indicators.R
Rscript 02_code/R/download/parse_ba_labor_market_timeseries.R
Rscript 02_code/R/download/parse_zensus2022.R
Rscript 02_code/R/download/import_bast_hourly_archives.R
Rscript 02_code/R/download/download_google_trends_admin_search.R
Rscript 02_code/R/download/parse_google_trends_admin_search.R
Rscript 02_code/R/build_county_panel.R
Rscript 02_code/R/run_pipeline.R
Rscript 02_code/R/run_expanded_coverage_pipeline.R
Rscript 02_code/R/run_constant_coverage_pipeline.R
Rscript 02_code/R/paper_constant_coverage_outputs.R
Rscript 02_code/R/paper_outputs.R
```

For a bounded local reproduction after raw and intermediate inputs exist, the repository also provides:

```
make test
make assets
make all
make panel
make index
make expanded
make constant-coverage
make paper
```

Published live-score vintages are archived with:

```
Rscript 02_code/R/archive_vintage.R --release-id=YYYY-MM-DD \
  --methodology-version=methodology-v1
```

GENESIS downloads require local credentials in an ignored `.env` file. The Regionalstatistik commuter table is retrieved through background jobs and then fetched through stored result names. INKAR downloads use the `inkaR` package; the repository script applies a local certificate-chain workaround because the execution environment does not validate the INKAR certificate chain. The county map uses `01_data/external/geodata/bw_admin_boundaries.geojson`; the script filters `admin_level == 6` and joins on the five-digit county key. Google Trends diagnostics require `gtrendsR` and internet access. The workflow caches raw search windows and writes a manifest so that the parsed diagnostic can be reproduced from archived raw windows without repeated Google requests. The IW Gemeindecheck diagnostic is reproduced with `Rscript`

`02_code/R/download/download_iw_gemeindecheck.R`; it caches the raw workbook, writes a manifest, and aggregates BW municipality ranks to county-level service-deficit diagnostics.

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