Re-employment, Earnings Scarring and the Public Cost of AI Displacement

Technical supplement: Industry-weighted national transitions and the German worker-history framework

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Abstract

This supplement documents a monthly industry model linking expanding AI adoption to unemployment and fiscal costs in Germany over 2026-2035. Observed counts represent 34.84 million insured employees; establishment adoption informs a calibrated workplace-exposure allocation. A starting conversion fitted to German employers' three-year net employment expectation yields a conditional EUR 5.75 billion cumulative unemployment cost under explicit diffusion and re-employment assumptions. A separate worker-history model follows benefit eligibility and earnings scarring under fixed 2025 rules. Equations, source definitions and validation checks reproduce the national and worker accounts while preserving their distinct populations, price years and fiscal scope.

Keywords: AI and employment; unemployment insurance; tax-benefit microsimulation; fiscal accounting; Germany

1 Introduction

AI adoption can affect public finances through job separation, unemployment and subsequent earnings recovery. This paper connects observed German industry employment and workplace adoption to monthly job transitions over 2026-2035. A complementary worker-history model follows benefit eligibility and earnings under fixed 2025 rules. The national experiment and the synthetic mechanism model share a ten-year observation period while retaining distinct populations and fiscal accounts.

The national calculation represents 34,840,671 insured employees directly in fourteen industry cells. Its starting calibration matches German employers' expected three-year net employment change under an explicit fixed-labour-supply closure. Annual fiscal costs evolve with adoption, capability and re-employment. The worker-history model separately traces the nonlinear taxes, benefit entitlements and earnings paths that a representative microdata extension would need.

A separate one-year comparison applies seven countries' insurance rules to a standard worker. It isolates institutional differences but does not supply complete disposable income or extend the German cohort results to other populations.

1.1 National population, adoption and transitions

BA's August 2026 monthly report, table 2.2, supplies June 2025 social-insurance employment stocks by industry. Fourteen mapped groups contain 34,840,671 employees, or 99.87% of the 34,885,488 national insured stock. The model excludes 42,496 private-household employees and 2,321 with no industry classification. Civil servants, self-employed people and exclusively marginal jobs are outside this insured population. Public administration and extraterritorial organisations are pooled in BA's O/U cell; public-administration adoption is a proxy for this combined group. Personal services maps to R/S.

Friedrich and Kagerl (2026), IAB-Kurzbericht 8/2026 and figure A4, report 2025 industry shares of establishments using generative AI. Their national employee anchor is nearly 40% of insured workers employed in AI-using establishments. This does not imply that all these employees use AI personally. Sector employee workplace shares are not observed, so a common log-odds intercept adjusts the establishment shares until their employment-weighted mean equals 0.40. Preserving the cross-industry log-odds differences is an analyst allocation assumption.

$$a_s = \text{logistic}(\text{logit}(e_s) + b), \qquad \frac{\sum_s N_s a_s}{\sum_s N_s} = 0.40 \tag{1}$$

N_s is the observed industry employee count; e_s is establishment adoption; a_s is the allocated employee workplace-exposure proxy. The fitted intercept is stored with the public inputs.

The reference freezes the 2025 workplace allocation and capability index. The shock closes 10.56% of each industry's remaining adoption gap annually: 1 - sqrt((1 - 0.24)/(1 - 0.05)), using the approximate rise in establishment adoption from 5% in 2023 to 24% in 2025. Extending establishment diffusion to future employee workplace exposure is an assumption. The common gap-closure rate means initially low-adoption industries catch up faster in percentage points. Industry cost rankings therefore reflect that diffusion rule and employment size; they are not rankings of technical task vulnerability. The sector technical exposure index is uniformly one because a defensible occupation-to-industry crosswalk is unavailable.

$$A_s(t) = 1 - (1 - a_s)(1 - r)^t, \qquad C(t) = (1 + g)^t \tag{2}$$

t is years since the start of 2026; r is annual adoption-gap closure and g is capability-index growth. The default shock sets g = 0.05; the reference sets r = g = 0.

Capability is an intensity index starting at one, not a fraction of workers or tasks automated. A 5% annual increase is a declared assumption. Only increases in the product of adoption and capability create first-separation risk; applying the entire automation stock every month would repeatedly count the same exposure.

$$L_{s,m} = R_{s,m}\{1 - \exp[-\lambda \max(B_{s,m} - B_{s,m-1}, 0)]\}, \quad B_{s,m} = A_s(m/12)C(m/12) \tag{3}$$

R is the remaining never-displaced starting population and lambda is separation conversion. Direct job-to-job moves and re-employment permanently leave this first-displacement risk pool.

Half of separations are assumed to lead directly to another job. The remainder enter monthly unemployment-duration cells. Job finding is 5.65% per month at every duration, using BA's 2025 annual-average

unemployment-to-first-labour-market-employment outflow ratio, including training, as a proxy. This aggregate ratio is not an estimated hazard for AI-displaced workers. The default has no inactivity exits, no new entrants and no repeated displacement after re-employment. Sector results remain attributed to initial industry; destination industries are not estimated.

Separation conversion is fitted once to a 0.06% employment shortfall at month 36, the rounded employment-weighted German employer expectation reported by Yotzov et al. (2026), Table 4, from 2,289 January 2026 responses. The fit gives lambda approximately 0.0106751 and an end-2028 employment gap of about 20,904 people. At fixed labour supply this entire gap is assigned to unemployment. Employer expectations instead may be realised through reduced hiring, retirement or new firms, so this is a conditional scenario anchor rather than an identified displacement mechanism. The fitted conversion stays fixed when adoption, capability or job finding is varied in the dashboard.

The reference and shock describe new AI-associated transitions from the same initially employed population. The frozen reference therefore has zero new AI-transition unemployment, not zero unemployment in Germany. Ordinary/background unemployment is outside this incremental account. Monthly income stocks are measured before month-end transitions: a separation at the end of December 2035 has no unemployment income-month inside the observation window. Re-employment ends the unemployment fiscal exposure, while any subsequent earnings scarring remains a separate channel.

1.2 National fiscal account and conditional results

Hausner, Weber and Yilmaz (2025) estimate Germany's 2024 unemployment cost at EUR 76.6 billion: EUR 47.0 billion in benefit-budget spending and EUR 29.6 billion in net tax and contribution shortfalls. Dividing by 2.787 million annual-average registered unemployed gives EUR 27,484.75 per unemployed person-year, split into EUR 16,864.01 spending and EUR 10,620.74 net receipts lost. These historical averages price the modelled unemployment exposure.

$$\Delta C_y = \sum_{m \in y} \frac{U_m^A - U_m^0}{12} \times \frac{76.6 \times 10^9}{2.787 \times 10^6} \tag{4}$$

National conditional accounting in constant 2024 euros. U is the monthly stock in the modelled unemployment transitions; the ten-year total sums 120 months.

The account holds the 2024 claimant composition, earnings and fiscal relationship fixed in real terms, without discounting or future policy adjustment. It does not recalculate individual claims under the worker model's fixed 2025 rules. Benefit-financed insurance contributions are included in spending and already offset in net contribution shortfalls; they are not subtracted again. Finer rounded published components sum to EUR 76.7 billion, so the calculation uses the reported broad totals rather than inventing unrounded components.

The starting national projection produces 209,381 additional unemployed person-years and EUR 5.75 billion in cumulative covered cost over 2026-2035: EUR 3.53 billion spending and EUR 2.22 billion net receipts lost. Annual cost rises from EUR 0.169 billion in 2026 to EUR 0.711 billion in 2035. These are model outputs

conditional on the stated workplace allocation, survey anchor, diffusion and transition assumptions.

Table N1. National unemployment fiscal differences: shock minus reference

Period	Spending, EUR bn	Net receipts lost, EUR bn	Covered cost, EUR bn
2026 annual	0.104	0.065	0.169
2030 annual	0.387	0.244	0.632
2035 annual	0.436	0.275	0.711
2026-2035 cumulative	3.531	2.224	5.755

Constant 2024 euros, undiscounted. Reference AI-transition unemployment and its covered cost are zero under frozen adoption and capability; these are not total national unemployment or budget levels. Rounded cells may not sum exactly.

At the same fitted separation conversion, setting annual capability growth to 0% gives approximately EUR 2.75 billion over the decade, while 10% gives EUR 10.11 billion. The 5% starting value gives EUR 5.75 billion. These conditional sensitivity cases illustrate the importance of the assumed capability path; they are not confidence bounds or estimates of its probability distribution.

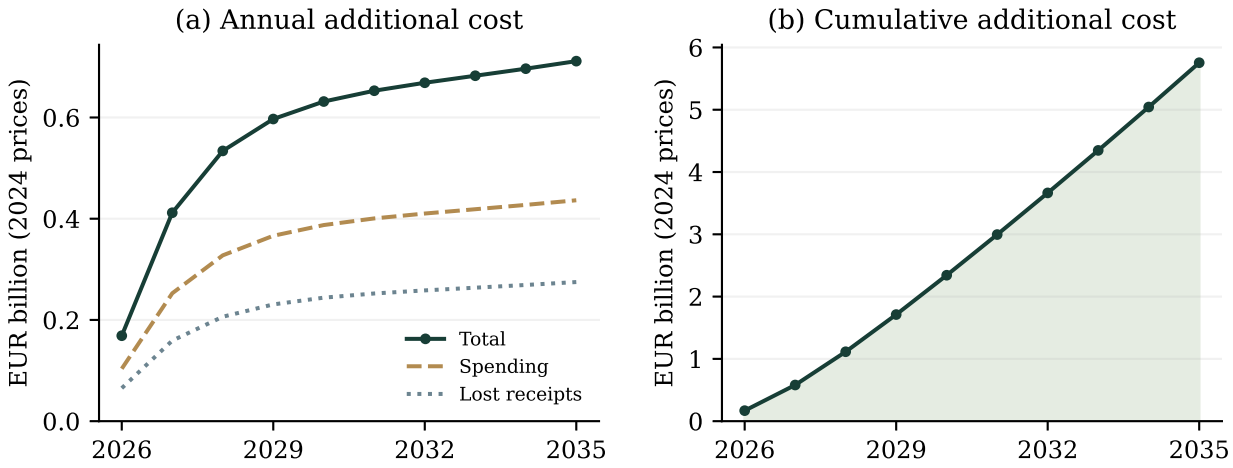


Figure N1. Annual and cumulative additional unemployment costs, 2026-2035

Conditional projection for 34.84 million insured employees. Annual differences reflect evolving adoption, capability and re-employment; cumulative values sum annual flows. Constant 2024 euros, undiscounted.

The advanced manual calculator retains the option to enter reference and shock unemployment paths directly. Annual-average inputs repeat within each year; its API also accepts monthly stocks. It provides a unit and accounting check separately from the main industry-driven projection.

The national fiscal account covers unemployment-related spending and receipt losses. Post-re-employment earnings scarring, active labour-market measures, productivity and new-job gains, and business-tax effects require additional compatible estimates. The historical unemployment mix may differ from AI-displaced workers' earnings, eligibility and durations. The national and worker-history costs must not be added for the same unemployment months.

Historical earnings-loss estimates containing employment losses likewise require decomposition before adding a scarring component.

2 Related literature and scope

Task-based analysis distinguishes displacement of production tasks from aggregate employment effects. Acemoglu and Restrepo (2018) describe displacement alongside productivity, capital accumulation and the creation of new tasks. Gmyrek et al. (2025) construct a refined occupational exposure index for generative AI. Such an index can inform which occupations are relatively exposed, but does not identify how many workers become unemployed. The synthetic worker-history model specifies total additional entries independently and permits exposure to affect their allocation only. The national industry account instead uses observed workplace adoption and an explicitly calibrated separation conversion, without imputing occupational task exposure.

The displacement literature motivates separating the end of a job from the end of earnings losses. Jacobson, LaLonde and Sullivan (1993) document persistent losses among displaced high-tenure workers; Davis and von Wachter (2011) show that losses vary with business-cycle conditions. These US results motivate a counterfactual earnings path and sustained follow-up, rather than providing numerical German AI coefficients. Schmieder and von Wachter (2016) review unemployment-insurance effects and welfare interpretation: mechanical receipt/spending contrasts alone cannot identify an optimal benefit policy. Guerreiro, Rebelo and Teles (2022) study optimal robot taxation in a model of occupational adjustment; their normative closure is distinct from the current conditional account.

German evidence illustrates why employment adjustment and post-displacement pay should be modelled separately. Dauth et al. (2021) study industrial robots and find manufacturing adjustment together with offsetting service employment and changes within incumbent establishments. That historical technology does not identify current generative-AI displacement. Schmieder, von Wachter and Heining (2023) document persistent German earnings losses following displacement and the importance of wages, subsequent employers and business-cycle conditions. Their results motivate an explicit earnings process; the current destination shares and recovery parameters have not been fitted to their estimates.

The institutional accounting follows the logic of tax-benefit microsimulation: household inputs, legal rules and validation are separate ingredients. Sutherland and Figari (2013) describe this distinction for EUROMOD. The present project does not run EUROMOD and does not use representative household microdata. Policy detail therefore cannot substitute for a representative joint distribution of worker and household characteristics. OECD Taxing Wages supplies employed-worker component anchors for the comparative module, while unemployment entitlement is reconstructed separately from country documentation.

The broader question of whether lost wage-related receipts return through capital income or other tax bases remains outside the main estimand. Moll, Rachel and Restrepo (2022) analyse automation and returns to wealth; Trammell and Korinek (2023, revised 2026) study growth under transformative AI; Korinek and Lockwood (2026) discuss a wider set of public-finance instruments. These contributions

motivate distinct labour, firm and fiscal ledgers. They do not calibrate the implemented displacement shock, German job-finding probabilities, corporate tax rate or growth path. This paper does not implement EU-wide AI supply-chain revenue recovery, imported-AI tax incidence, optimal taxation or general-equilibrium fiscal projections.

3 The German paired cohort model

3.1 Population, timing and estimand

Let i index N initial workers, m index months and z distinguish the reference (0) from the additional-entry path (A). Three timing concepts remain separate: the fixed observation period, 2026-2035 inclusive (120 months); the start and duration of the additional-entry window; and each worker's history-dependent benefit entitlement. A one-year shock still has employment, earnings and support consequences followed until December 2035. Income and benefits accrue in the state held at the start of a month, before month-end transitions. Therefore January-end separation first produces an unemployment income-month in February. End-of-month state stocks and within-month benefit recipient counts describe different instants and are labelled separately.

$$S_{im}^{z} \in \{E, U, I\}, \quad z \in \{0, A\}, \quad m = 0, \ldots, 12H - 1 \tag{5}$$

State and simulation indices; H = 10 calendar years in the integrated German dashboard.

The 10,000-worker cohort is a computational size, not a claim about Germany's workforce. A microsimulation of this size could support national estimates with representative profiles, suitable population weights and validated accounting. Those inputs are absent here: the restricted synthetic profiles each carry weight one. Increasing the number of simulated copies would reduce some numerical variation but would not repair population coverage or calibration. The separate national industry model uses observed population cells directly, as described in Section 1.1; it does not scale these profiles.

The default population is 10,000 initially full-time insured employees, aged 25-49, single and childless, in tax class I without church tax, publicly insured and renting alone. Every worker starts with 24 continuous insured months. The source inputs do not identify a consistent public/private employer boundary; public-payroll savings are not estimated. Broad occupation shares from 2025 and occupational mean full-time earnings from 2022 are proxies; they do not form an observed sample of this restricted population. Each 2022 earnings mean is uniformly updated to a 2025 nominal scale using the Destatis annual nominal wage index ratio 100.0/86.0 = approximately 1.163, before enforcing the EUR 12.82 hourly floor. The index covers all employees and special payments; it is an externally sourced temporal adjustment, not occupation-specific observed 2025 pay or a fitted cohort distribution. Its published levels are rounded to one decimal; the displayed-value ratio is retained for reproduction.

For year y, let R denote employment-related public receipts and B included cash transfers. The principal fiscal outcome is positive when the additional-entry path raises covered public cost:

$$C_y = (R_y^0 - R_y^A) + (B_y^A - B_y^0), \qquad C_{1:H} = \sum_{y=1}^{H} C_y \tag{6}$$

Undiscounted covered fiscal cost, conditional on the synthetic population, institutional rules and transition parameters.

For a scale-independent summary, cumulative covered cost is divided by the number of realized additional tagged job losses. This numerator is the whole-cohort reference-versus-shock difference, including later employment, earnings and support consequences; it is not the cost observed for an individual displaced worker. The unit is constant 2025 euros per assumed additional job loss over 2026-2035, not an annual unemployed-person cost or a national estimate. At zero additional entries the ratio is undefined, although the paired fiscal difference is zero.

Receipts include personal income tax, the solidarity surcharge, employee and employer public contributions and applicable employer flat tax. Transfers include ALG I and the implemented single-household assistance case. Contributions are current receipts; associated future pension liabilities are not valued. Worker income is a separate outcome. The cumulative amount is an undiscounted sum, not a net present value.

Both paths use the same starting workers and deterministic random numbers keyed by seed, worker, month and event stream. At zero additional shock the paths coincide. Common draws reduce noise in the paired contrast; they neither identify a causal treatment effect nor provide an uncertainty interval. Once states diverge, the same later draw may encounter different transition opportunities. The reference itself contains ordinary unemployment and inactivity, rather than guaranteed continuous employment.

3.2 Additional entries and occupational allocation

The shock is an additional number of distinct first AI-tagged separations. The start is selected as observation year 1-10; the window lasts a chosen number of years within the remaining decade. The default starts in 2026 and allocates entries across 2026-2030. If theta is the selected percentage of the initial cohort, the construction targets K entries over this window:

$$K = \mathrm{round}(N\theta/100), \qquad \sum_{m=0}^{12H-1} a_m = K \tag{7}$$

The integer monthly schedule a is constructed within the selected start/window; it is zero outside that window before any unmet-entry backlog. Explicit monthly counts can replace this construction.

The baseline assumes theta = 3% over the entire 2026-2030 entry window, not 3% each year. With N = 10,000 this gives 300 = 0.03 × 10,000 additional entries. The number 300 is arithmetic from the chosen scenario and computational size, not an observed count, a forecast for Germany or an estimate inferred from AI exposure.

Even timing allocates approximately equal entries to every month of the selected window. Front-loaded timing uses linearly declining monthly weights, placing more entries near its start. Back-loaded timing uses linearly rising weights, placing more near its end; it is a within-window pattern, not an automatic shift of the start year.

Integer allocation preserves the intended total. Ending the entry window neither ends unemployment nor switches off benefits, earnings losses or fiscal accounting.

At each month-end, eligible candidates are currently employed, have never been AI-tagged and have not already been assigned an ordinary separation or direct inactivity move. Scheduled entries plus any backlog are selected without replacement. Under uniform allocation every candidate has equal weight; exposure-weighted allocation uses a broad occupational score. The implementation orders exponential-race keys:

$$\kappa_{im} = \frac{-\log(\max\{10^{-12}, u_{im,7}\})}{\eta_i}, \qquad \eta_i = 1 \text{ or } e_{o(i)} \tag{8}$$

Select the lowest eligible keys up to the backlog. Exposure e changes the allocation of a fixed shock, not its requested total.

Unmet entries carry forward and are reported if eligibility remains insufficient. A tagged separation is not the same as an increase in the unemployment stock: workers may otherwise have separated later, find work at different dates, enter inactivity or experience repeat ordinary unemployment. Marginal inclusion probabilities under multi-person weighted selection are not simply the selected count times an individual exposure share.

3.3 Duration dependence and competing transitions

For an entered annual probability a expressed as a fraction, the implementation uses an absorbing monthly conversion mu. Ordinary employed-to-unemployed and employed-to-inactive moves occupy adjacent intervals of a common uniform draw. Their separate monthly conversions do not make annual competing-risk endpoints equal to the input probabilities.

$$\mu(a) = 1 - (1-a)^{1/12}, \qquad P(E \to U) = \mu(a_{EU}), \quad P(E \to I) = \mu(a_{EI}) \tag{9}$$

Ordinary exits are assigned before additional AI selection among the remaining eligible employed workers.

The historical job-finding comparator is quarterly: q is 0.34 below twelve months of unemployment and 0.12 thereafter. The scenario matching multiplier lambda applies to the quarterly input before monthly conversion only when the current unemployment spell follows the additional AI-tagged separation. Let J equal one for that current spell, zero otherwise:

$$q^*_{im} = q_{d_{im}} \lambda^{J_{im}}, \qquad f_{im} = 1 - (1 - q^*_{im})^{1/3} \tag{10}$$

The validation constraints require q-star no greater than one. J indicates the cause of the current unemployment spell, independently of earlier AI history.

Inactivity is applied first to unemployed workers. With j equal to the monthly unemployment-to-inactivity probability, the actual monthly competing transitions are:

$$P(U \to I) = j, \quad P(U \to E) = (1-j)f, \quad P(U \to U) = (1-j)(1-f) \tag{11}$$

Here j = mu(a_UI). Inactive workers return directly to similar employment with probability mu(a_IE); no inactive-to-unemployed move is implemented.

The conversion reproduces q only for an absorbing two-state approximation. Inactivity, return, repeated job exits and duration changes mean the complete model does not exactly match the original quarterly endpoint probabilities. The Eurostat comparators are experimental regression-based annual averages of quarterly transitions for ages 25-54 in 2025, rounded to whole percentage points. They are not hazards estimated for the restricted insured cohort or for AI-displaced workers.

3.4 Re-employment pay, hours and recovery

A move from unemployment to employment draws a similar, lower-paid or reduced-hours destination, with default shares 0.4, 0.4 and 0.2. Let t denote tenure since the latest destination reset. The retained share of the initial earnings loss is:

$$\psi(t) = \rho + (1-\rho)2^{-t/h} \tag{12}$$

Full recovery sets rho = 0; partial recovery uses the permanent-share parameter; persistent loss sets rho = 1. The half-life h applies to the recoverable component.

Let the wage-loss and hours-loss parameters select the AI inputs when the preceding unemployment spell is AI-tagged, and the ordinary-loss inputs otherwise. Let g denote the common annual earnings trend and G an optional additional hourly gain. With D the destination and w-bar initial hourly potential, earnings follow:

$$w_{im} = \max\{12.82,\ \bar{w}_{i0}(1+g)^{m/12}[1-\ell_w\psi(t)\mathbf{1}_{D\neq s}](1+G_{im})\} \tag{13}$$

The similar destination is denoted s. The hourly floor is EUR 12.82 under frozen 2025 rules.

$$L_{im} = \frac{40\cdot 52}{12}[1-\ell_h\psi(t)\mathbf{1}_{D=r}]\mathbf{1}_{S_{im}=E}, \quad Y_{im} = \mathrm{round}_{0.01}\,(w_{im}L_{im}) \tag{14}$$

The reduced-hours destination is denoted r. L is monthly hours and Y gross monthly earnings.

Reduced-hours destinations incur both hourly wage loss and hours loss. The cause of the unemployment spell immediately preceding each new job selects its AI or ordinary loss parameters. A later ordinary separation therefore uses ordinary parameters even after a prior AI separation. Within the new job, the selected loss recovers according to tenure until another destination reset. A direct inactivity return is a similar job with no loss. The previous implementation used a persistent flag; the corrected specification assigns losses to the immediately preceding spell. Similar destinations carry no modelled loss; re-employment is not absorbing.

All German flows are expressed in constant 2025 euros under fixed 2025 policy throughout 2026-2035. The baseline sets g = 0 and assumes no inflation, threshold indexation or future legal changes. A positive entered real-wage trend grows individual wage potential in both paths while contribution ceilings, tax thresholds, standard need and recognized housing remain fixed in 2025 purchasing-power terms. It is not calibrated GDP growth or an aggregate labour-demand response. Re-employment wage and hours losses and their recovery also alter earnings. Source earnings were first historically rebased from 2022 to 2025; that rebasing is separate from assumed future wage growth. Mixed source populations and vintages remain an empirical limitation.

3.5 German institutional accounts

Monthly payroll withholding is computed from the archived official 2025 BMF calculation plan using decimal arithmetic. Public contributions respect the implemented caps and employment regimes. Each worker has an annual earnings and deductible-employee-contribution ledger. In this restricted profile, wage income with annual ALG above EUR 410 triggers the implemented mandatory assessment; other years are assessed under the explicit full voluntary-filing assumption. If that assumption is disabled, non-mandatory years retain withholding. The individual income-year settlement is:

$$\delta_{iy}^{z} = \Phi_{2025}(Y_{iy}^{z}, \mathbf{c}_{iy}^{z}, U_{iy}^{z}) - W_{iy}^{z} \tag{15}$$

For an assessed year, Y is individual annual taxable wages, c deductible employee contributions, U annual ALG and W PIT/solidarity withholding. Non-assessed years set delta to zero. Cohort receipts and accrued worker income include the summed individual settlements in December, before cash collection.

Within the benefit subsystem, three statutory time limits are retained. Section 151(4) protects gross assessment earnings if a qualifying ALG benefit period occurred within the two years before the new claim, rather than if the old claim was merely created within two years. The last qualifying receipt month and its assessment basis are stored separately. Section 161(2) limits renewed assertion of an old claim after four years, but a timely resumed uninterrupted episode continues across that anniversary. Section 147(4) can add the unused residual to a new entitlement while the old claim is less than five years old, capped at the attained-age maximum. The model therefore preserves residual entitlement after standalone reactivation becomes unavailable. Suspension and registration-continuation exceptions are outside this monthly profile.

A new claim requires twelve unused insured months in the thirty-month qualifying frame; duration additionally uses the extended sixty-month frame and age schedule. The earnings assessment ends at the last insured month and uses twelve months, expanding to twenty-four if fewer than 150 earnings days are available. The default also assumes a requested hardship review: the two-year daily basis is used when it is strictly more than 110% of the one-year basis. Assessment earnings are not truncated merely because an earlier claim used the corresponding insurance. Reduced-hours destinations are new jobs, so they do not invoke the statutory exclusion for an hours reduction agreed within an existing job. Protected gross earnings are applied before the standardized benefit is recalculated. Fully unemployed months pay thirty daily amounts, subject to remaining entitlement; insufficient earnings days for fictional assessment are flagged unsupported. Standardized deductions determine entitlement and are not actual public receipts.

Restricted means-tested support uses the single-person standard need, entered recognized housing, liquid assets, receipt-based grace and earnings disregards. Legal work capacity is separate from labour-force participation: inactive workers remain work-capable and eligible for this means test by default, with compliant access and full take-up assumed. A false work-capacity setting removes this scoped SGB II payment without estimating disability, pension or SGB XII support. Full months without receipt preserve unused grace; a new period follows thirty-six complete months without modelled receipt, conditional on no relevant SGB XII receipt. The EUR 30 insurance allowance without earnings is not added again to the EUR 100 employment deduction.

Benefit expiry does not change employment state. Each unemployed worker is followed after ALG I ends and reassessed for assistance against counted income and assessable assets. Ordinary ALG duration can be six, eight, ten or twelve months, with longer entitlements only at the applicable older-age and insurance-history thresholds; the initially 24-month-insured profile is not assigned a blanket six-month cutoff. The fixed-2025 single-person assistance case uses EUR 563 monthly standard need plus entered recognized housing, with EUR 40,000 assessable-asset allowance during applicable grace and EUR 15,000 afterwards. A person can remain unemployed with no payment from either modelled programme; this does not establish absence of other real-world support.

For every income-month, unemployed people are partitioned into four mutually exclusive groups: ALG I only, ALG I plus assistance, assistance only, and no modelled benefit. Their sum equals unemployed people during that month. Total assistance recipients can also include employed or inactive people and therefore must not be added to ALG recipients without removing overlap. Annual people figures are averages of twelve monthly counts; annual person-months sum those counts. Ten-year person-months sum all 120 months, and dividing by 120 yields the decade's average monthly count. These measures are neither unique claimants nor December state stocks.

$$R_y = T_y + Z_y + C_{e,y} + C_{r,y} + F_y, \qquad B_y = U_y + A_y \tag{16}$$

T is final scoped PIT, Z the solidarity surcharge, C employee/employer contributions, F employer flat tax, U ALG and A assistance.

Employment status, paid hours and hourly pay determine gross earnings in each history. Those earnings pass through the same payroll, contribution and annual assessment rules. Revenue loss is the difference in resulting receipts; there is no independent annual wage-tax shortfall percentage or multiplication of a national receipt benchmark. Employee and employer contributions enter once. Payroll withholding plus its assessment adjustment equals final tax, so settlement is not a second tax. Cash ALG and assistance enter transfers, while benefit-financed transfers within government are excluded. The account is restricted to these worker-linked flows: absent employer-sector calibration, it is not a fully consolidated national public budget.

Accrued worker income is payroll net plus ALG and assistance minus the individual income-year settlement. A separate cash ledger collects or refunds that settlement after a selected lag: six months after December, hence June of the following year, by default. This is a simulation assumption, not a filing deadline or measured processing date. Refunds enter the assistance income test only in the receipt month; their unspent remainder can add to assets. Prior-year tax arrears do not reduce current assessable earnings. The implemented payment rule uses available current income and assets and carries uncovered tax debt; it is an allocation assumption, not a model of tax enforcement or protected-income seizure limits. Assets also cover unmet standard need and housing, while positive ordinary earnings are not saved endogenously. Asset drawdown is not income.

$$\mathcal{D}_H^z = \mathcal{K}_H^z + Q_H^{z,+} - Q_H^{z,-} \tag{17}$$

With zero opening tax positions, calligraphic D is the sum of accrued annual settlements, calligraphic K cash tax payments minus cash refunds, Q-plus terminal pending tax including unpaid debt, and Q-minus refunds not yet received. Unpaid debt is a subset of pending tax, not an additional amount.

Within either history, cumulative cash worker income minus accrued worker income equals terminal pending tax minus pending refunds. The corresponding scenario-minus-reference adjustment is the difference between those two net terminal positions. These balances reconcile timing; they are not added again to the assessed fiscal result. Neither income measure is consumption or full household welfare. The headline public account remains on an income-year assessment basis; changing the cash lag can nevertheless change it through refund means tests and asset-dependent assistance. No actual filing dates, debt interest, strategic repayment or borrowing behaviour are estimated.

3.6 Optional wage and firm channels

The wage-gain branch applies a specified hourly gain to named recipients from a stated year. Its fiscal offset is the difference between the core cost and a separately simulated wage-gain cost. Extra compensation includes employer contributions and is deducted from the independently specified firm profit experiment:

$$\Delta\Pi_y = \Delta\text{Sales}_y + \text{Savings}_y - \text{AIcost}_y - \text{Othercost}_y - \Delta\text{Comp}_y \tag{18}$$

Labour savings, sales, AI costs and other costs are independent assumptions; none is identified by the layoff count.

The optional business-tax calculation compares reference and scenario domestic taxable bases with separate simplified loss carryforwards and an entered rate. It is not a statutory German corporate-tax calculator. Combined cost subtracts the simulated wage and business-tax offsets from core cost. Both optional channels are inactive in the experiments below; their real economic contributions are unestimated, not estimated zeros. This paper consequently does not estimate the share of lost wage-related receipts recovered through AI firms or cross-border supply chains.

4 Evidence and numerical experiment design

Evidence enters at distinct levels. Institutional rules determine tax and benefit mappings. Published population statistics supply broad composition, earnings and transition proxies. Scenario assumptions determine additional entries, destination outcomes and recovery. A source being cited in the literature review does not imply that its estimates were used to fit a parameter. Table 1 records the principal distinctions.

Table 1. Principal inputs and their evidential status

Input	Implemented default	Status
Population	10,000 initially employed; ages 25-49	Synthetic numerical cohort; no national expansion weights
Composition / wages	2025 occupation shares / 2022 means x100/86	Different source populations and vintages; not a joint cohort sample
Additional AI entries	3% over five years; uniform allocation	Illustrative shock, not inferred from exposure
Quarterly job finding	34% below one year; 12% thereafter	Eurostat experimental historical comparator, ages 25-54
Destination shares	40% similar / 40% lower pay / 20% reduced hours	Scenario assumptions, not fitted German displacement outcomes
Initial AI losses	10% hourly wage; 25% hours in reduced jobs	Scenario assumptions; reduced jobs also have hourly loss
Recovery	24-month half-life; 50% permanent component	Scenario assumptions, reset with a new destination
Earnings trend / policy	0% annual trend; fixed 2025 rules	Historical aggregate earnings rebasing; no macroeconomic closure

See Appendix B and the machine-readable experiment file for all entered settings.

Seventeen paired parameterizations use cohort size 10,000 and seed 20261019. They vary entries, short-duration quarterly job finding, AI initial hourly wage loss and the common earnings trend, and separately examine cash-settlement lags of one or twelve months, no requested hardship review and mandatory filing only. Each case recomputes its own reference. Changing job finding or earnings growth therefore changes both histories, rather than holding one reference fixed across experiments.

Table 1a. Institutional access and timing assumptions

Input	Baseline	Interpretation
Inactive work capacity	Retained	Participation status alone does not remove scoped SGB II eligibility
Requested hardship review	Full eligible take-up	Two-year basis must exceed one-year basis by more than 10%
Annual filing	Mandatory plus full voluntary filing	Not an estimated filing rate; alternative removes voluntary filing
Cash settlement	Six months after December	June following year by assumption; one/twelve-month sensitivities

Institutional eligibility rules and take-up/timing choices are distinct. No registration exceptions, sanctions or strategic tax-payment behaviour are estimated.

The seventeen fixed-seed cases vary explicit assumptions rather than estimated parameter distributions. Four further cases hold the observation decade and assumed 3% entry share fixed while changing shock timing. Two small-cohort

diagnostics isolate benefit exhaustion and asset-tested support. The separate historical simulation-seed exercise is documented in Section 6.2.1.

4.1 National context and the worker-history weight boundary

Table 1b. Retained German national context, 2025

Benchmark	Observed amount / unit	Accounting scope
Employees in Germany	42.31 million; people, annual average	Employment accounts, workplace in Germany. All employed people total 45.98 million, including 3.67 million self-employed and unpaid family workers.
Employees covered by social insurance	34.89 million; people	Workplace-based stock. Does not cover all employees, all workers, or annual benefit claimants.
National wage-tax receipts	€262.69bn; EUR/year	Cash Lohnsteuer across government levels, after child-benefit reimbursement. Not the model's final assessed income tax plus solidarity surcharge.
Employment social-insurance contributions	€631.28bn; EUR/year	Employer (€327.629bn) plus employee (€303.651bn) actual contributions to statutory social insurance. Excludes private schemes, imputed contributions and other contributor categories; includes public employers.
Reported average ALG I entitlement	€1,324; EUR/recipient/month	Observed national benefit benchmark, not a uniform payment or entitlement duration. The simulation calculates each eligible worker's amount from insured earnings.
Average ALG I recipients	999,000; people, annual average	Average number receiving ALG I, distinct from unique claimants, unemployed people, and government tax receipts.

Sources: Destatis national-accounts labour-market figures (8 June 2026 vintage), Destatis/BA insured employment, BMF January 2026 receipts report, provisional GENESIS 81000-0303 contributions and BA annual report 2025. These observations are context, not simulated scenario totals. The contribution snapshot is provisional and later indexed revisions differ.

Destatis reports 42.311 million employees on an annual-average national-accounts basis for 2025, within 45.977 million employed people including self-employed people and contributing family workers (8 June 2026 publication vintage). The 34.89 million insured-employment figure is a narrower workplace stock on 30 June 2025. The 38.953 million all-age LFS employee count is a separate survey denominator used for occupational composition. Their different definitions and dates explain why these figures cannot be substituted for one another.

Within eight included LFS occupation groups, normalized counts and largest-remainder rounding allocate the 10,000 synthetic workers. These groups cover 98.24% of that LFS employee count, excluding skilled agricultural occupations, armed forces and nonresponse. This describes occupation coverage, not representative coverage of insurance histories, household resources or the national tax base.

A national estimate requires representative profiles and expansion weights, not a simulation containing every employee. Here, initial ages 25-49, full-time work and 24 insured months do not match all-age LFS coverage. SES earnings means cover specified industries and enterprises with at least ten employees, without joint distributions of wages, hours, insurance or household resources. Applying national employee counts to these restricted single, childless renter profiles would leave those gaps unchanged. Expansion of these synthetic profiles is therefore not performed. The national industry account in Section 1 instead uses observed employment counts and aggregate fiscal coefficients, with its own coverage and composition assumptions.

The fiscal benchmark definitions also require reconciliation before calibration. BMF wage tax is cash Lohnsteuer net of child-benefit reimbursement; the model calculates income-year assessed PIT plus solidarity surcharge. GENESIS employer and employee contributions are national-accounts flows and include public employers. These published series cannot simply be added to create a matched model reference budget. National use requires a defined target population, compatible joint microdata or cells, documented expansion weights including exclusions, aligned cash/accrual and government-sector boundaries, and validation against held-out employment, earnings and receipt totals. The integrated dashboard retains these sourced context figures. They are not multipliers in the industry unemployment account or fitted totals for the synthetic worker model.

5 A complementary comparative policy account

5.1 Standard worker and reference

The comparative module fixes an age-40 single childless adult living alone, with 21 continuous insured full-time years and previous earnings at 100% of country-specific OECD average wage. Involuntary dismissal, timely registration, active search, no sanction, no severance deferral, no other income and full take-up of the implemented insurance are assumed. Denmark requires long-standing full-time A-kasse membership; Japan assumes all benchmark pay is regular monthly pay without excluded bonuses. Dutch covered reference pay is assumed equal to the benchmark gross wage.

The reference is twelve months in the original job. A percentage alpha instead enters a jobless spell of M whole months at the start and returns once to full-time work at pay x times the initial wage. There are no ordinary transitions in this module. Group mode repeats the profile 1,000 times; person mode follows one affected worker whenever the affected share is positive. The profile conditions on insurance access and should not be interpreted as the average unemployed person.

5.2 Employment anchors, interpolation and gross insurance

For country c, annual vector v contains gross wages, PIT, employee/employer contributions, employed cash benefits and net income. OECD Taxing Wages 2025 provides policy-year 2024 anchors at 67%, 100% and 167% of average wage. Each component k is interpolated separately between adjacent anchors, with no extrapolation:

$$v_{ck}(x) = v_{ck}(x_L) + \frac{x - x_L}{x_H - x_L}[v_{ck}(x_H) - v_{ck}(x_L)] \quad (19)$$

Published independently rounded component residuals are retained; the tax wedge is not used as a PIT rate.

The OECD foreword states that French 2024 tax results omit 1.8% parameter indexation because of the timing of budget adoption. The frozen French anchors inherit that source limitation and overstate taxes relative to the effective rules. Annual employment cases are prorated by months in work; this does not reproduce final mixed-employment-year liabilities under a progressive tax system. Benefit taxation is not supplied by that proration.

Let n be the selected group size, a its affected count and e the fraction of the year employed after return. Annual employed components are:

$$a = n\alpha/100, \qquad e = (12 - M)/12, \qquad K_k = (n - a)v_{ck}(1) + ae\,v_{ck}(x) \quad (20)$$

The affected-count equation applies to group mode. In person mode, a is one if alpha is positive and zero otherwise. Direct job-to-job moves do not open an insurance claim.

Gross public insurance u is reconstructed from archived January 2024 OECD policy descriptions and national sources, rather than obtained as a complete evaluated TaxBEN case. Denmark employer G-days g are tracked separately. French and Dutch insurance can continue with eligible lower-paid work; other implemented out-of-work payments end on full-time return. Waiting periods, declining stages and duration limits use stated simplified payment calendars.

Table 2. Selected insurance mechanisms in the comparative module

System	Implemented gross rule and timing
Germany	Independent BA fixture: EUR 65.40/day; 30 paid days/month; at most twelve months at age 40.
France	57% of reference daily pay in this case; seven-day wait; 30-day model months; earnings cumulation and ceiling. Daily-cent rounding remains approximate.
Belgium	Single-person caps change across months 1-3, 4-6 and 7-12; 26 paid days/month. January 2024 parameters frozen.
Netherlands	75% for first two months, then 70%; stage rate multiplies reference-minus-new-earnings difference; 87.5% earnings cutoff.
Denmark	481 enhanced entitlement hours; 160.33 hours/month; employer G-days separate; a one-day deduction per four months (karens) reduces cash, not entitlement consumption.
Michigan, US	USD 362/week for twenty weeks; 52/12 weeks allocated per model month; final month prorated.
Japan	JPY 7,537/payable day for 270 days after seven-day wait; 30-day model months; re-employment grant excluded.

The standard worker is eligible by construction. These calculations are not claimant-level entitlement advice.

5.3 Comparative fiscal and worker-income measures

Let the receipt operator R(v) add PIT and employee/employer public contributions. Worker cash I includes employment take-home plus gross public insurance and gross employer G-days; public support B excludes the employer payment. The scenario accounts are:

$$I^A = K_{\text{net}} + a\sum_{m=1}^{12}(u_{cm} + g_{cm}), \quad R^A = \mathcal{R}(K), \quad B^A = K_{\text{cash}} + a\sum_{m} u_{cm} \tag{21}$$

The baseline uses twelve employed months at x = 1 and no newly opened insurance claim.

$$\Delta F_c = (R_c^A - R_c^0) - (B_c^A - B_c^0), \qquad P_c(X) = \frac{100\Delta X_c}{n\bar{W}_c} \tag{22}$$

Delta F is negative for covered additional cost, the opposite sign of German C. W-bar is country-specific annual gross average wage.

Neither I nor Delta F is a full after-benefit-tax outcome. Benefit taxation, lagged resident/health/pension charges where relevant, private compulsory charges, annual settlement, means-tested and housing support, and several other programmes are excluded. Missing compatible policy components remain unestimated rather than becoming factual zeros. Normalization by n times average wage permits a transparent scale comparison; it is not a percentage of GDP, public expenditure or a common purchasing-power unit.

The missing benefit-tax component is consequential for comparisons. German ALG I is income-tax exempt but enters progression for tax on other income; Japanese Employment Insurance is income-tax exempt while other out-of-work charges can remain. French, Belgian, Dutch, Danish and Michigan benefits are taxable under the documented conditions, with different exemptions or contribution rules. Adding gross insurance to wage take-home therefore does not establish a comparable disposable-income change. The dashboard leaves the after-benefit-tax income card unestimated in unemployment cases and suppresses signed cash-income comparisons; its chart retains separately labelled gross insurance and wage take-home. The partial fiscal balance still excludes benefit-tax offsets and must be read on that basis.

6 Numerical results

6.1 Fixed-seed baseline and fiscal decomposition

The assumed 3% shock produces all 300 intended entries within the 10,000-worker computational cohort. Its cumulative covered fiscal difference is EUR 18.708 million, equivalent to EUR 62,359 per additional entry over 2026-2035. The rounded summary is approximately EUR 62,000 per assumed additional job loss. Table 3a reconciles EUR 13.882 million in lost receipts and EUR 4.826 million in additional ALG and assistance. These are conditional whole-cohort differences; dividing by entries does not identify an individual causal effect or justify national multiplication. Optional wage-gain and firm-tax offsets are inactive.

Table 3. Reference and additional-entry scenario: covered fiscal levels

Period / history	Receipts, EUR m	Benefits, EUR m	Net receipts, EUR m
2026 / reference	351.346	4.223	347.123
2026 / shock	350.621	4.636	345.986
2030 / reference	332.458	10.259	322.199
2030 / shock	329.955	11.289	318.666
2035 / reference	324.593	11.592	313.000
2035 / shock	323.966	11.664	312.302
2026-2035 / reference	3,330.966	99.856	3,231.110
2026-2035 / shock	3,317.084	104.681	3,212.403

Year-labelled rows are annual flows. The final two rows sum ten years. Benefits are payments to people; receipts are government inflows. Both histories include ordinary transitions. Subtract shock net receipts from reference net receipts to obtain covered cost.

Table 3a. German cumulative fiscal decomposition, 2026-2035

Component	EUR million	Share of covered cost
Lost PIT and solidarity surcharge	5.372	28.7%
Lost employee contributions	4.310	23.0%
Lost employer contributions / flat tax	4.200	22.5%
Additional ALG I	3.139	16.8%
Additional scoped assistance	1.687	9.0%
Total covered fiscal cost	18.708	100.0%

N = 10,000; 300 additional entries over 2026-2030; fixed seed and frozen institutional rules. Shares may differ in the final decimal because of rounding.

Cumulative gross earnings are EUR 23.031 million below the paired reference and accrued worker income is EUR 8.524 million below it. The cash-income contrast is EUR -8.525 million, with its own terminal settlement position. The gross-versus-income gap reflects included deductions and transfers, not comprehensive welfare. These are whole-cohort paired differences, not observations on displaced workers.

Table 3b. Terminal tax settlement position, 2035

History	Pending tax, EUR m	Pending refunds, EUR m	Unpaid debt, EUR m
Reference	0.071	0.753	0.000
Additional-entry path	0.071	0.755	0.000

Pending tax includes unpaid debt. Refunds are recorded as positive receivables here. These balances reconcile accrued settlements with cash collection; they are not added to the accrued headline cost.

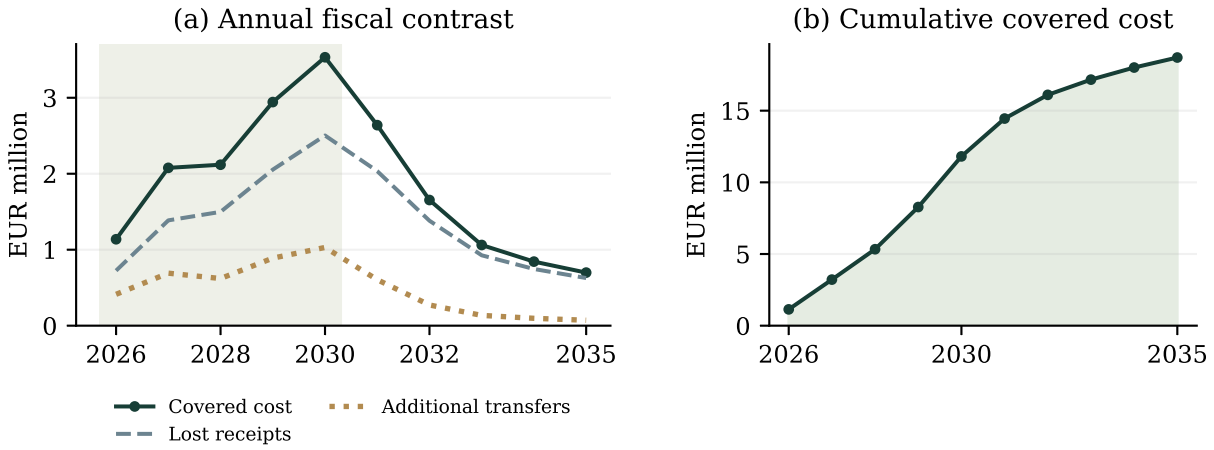


Figure 1. Time profile of the German conditional fiscal contrast

Seed 20261019. Left: annual covered cost and its receipt/transfer components. Right: cumulative undiscounted cost. New tagged entries are scheduled only through 2030; later consequences remain within the horizon.

Annual covered cost in the fixed-seed illustration peaks at approximately EUR 3.533 million in 2030 and remains EUR 0.699 million in 2035. The simulation therefore does not return to the reference immediately when additional entries stop. Annual additional ALG becomes slightly negative late in the horizon because subsequent employment and entitlement histories differ between paths. This is a difference between nonnegative gross payments, not negative unemployment benefits. The terminal-year cost also shows why the ten-year total is a truncated horizon.

6.1.1 Changes from the previous specification and cost layers

Table 3c. Archived version bridge and current earnings-loss layers

Calculation	Covered cost, EUR m
Archived v4.1 baseline, 2025-rebased	18.702
Archived v4.2 baseline, same earnings scale	18.708
Current v5.0 baseline	18.708
Current v5.0 without aggregate earnings rebasing	16.396
Current v5.0 with no AI wage or hours loss	13.780
Current v5.0 with no re-employment loss for anyone	14.191

Seed 20261019 and 300 scheduled entries throughout. The historical v4.1-to-v4.2 bridge combines repeat-claim corrections, work-capacity eligibility and tax-assessment/cash timing. The fresh v5.0 cases use the integrated engine; loss-removal cases have different reference processes and are not unemployment-only causal estimates.

In the archived correction bridge, the v4.2 baseline differs from the archived, already rebased v4.1 illustration by EUR 0.005 million. Within that historical v4.2 exercise, across the same 100 baseline seeds, mean cost changes from EUR 18.778 million to EUR 19.037 million, a mean paired increase of EUR 0.260 million. Thus the small single-seed change does not describe every simulated history. These archived versions use the same nominal earnings scale; this is not another wage uplift. The original v4.0 record and earlier spell-assignment/rebasing bridge are retained as historical outputs. All 272 comparable original total fields across the seventeen freshly rerun v5.0 cases match the archived v4.2 values exactly: integration preserves these baseline mechanisms while adding timing controls, support-state reporting and unified accounting presentation.

Uniform earnings rebasing raises the fixed-seed baseline by 14.1%. Turning off AI destination wage and hours losses gives EUR 13.780 million; the EUR 4.927 million difference is the conditional contribution of that selected earnings-loss specification. Unemployment duration, ordinary losses and their fiscal interactions remain. It is not an empirical decomposition of observed AI harm.

The headline is a current public-receipts and cash-support account. Pension contributions are included as current receipts without valuing the corresponding future pension entitlements; consequently it must not be interpreted as a lifetime fiscal loss. Additional covered receipts of EUR 18.708 million over this horizon would mechanically offset the default covered cost. That break-even requirement is not an estimate of AI profits, feasible taxation or revenue recovered elsewhere.

6.2 Sensitivity to transition and earnings assumptions

Table 4. One-at-a-time German parameter sensitivity

Parameterization	Covered cost, EUR m	Change from baseline
Baseline: 3% entries; q-short 34%; wage loss 10%; trend 0%	18.708	0.0%
No additional entries	0.000	-100.0%
Cash settlement: one month after December	18.722	0.1%
Cash settlement: twelve months after December	18.690	-0.1%
No requested two-year hardship review	18.708	0.0%
Mandatory assessment only; no voluntary filing	18.638	-0.4%
Additional-entry share: 1%	6.889	-63.2%
Additional-entry share: 5%	30.384	62.4%
Short-duration quarterly job finding: 24%	24.336	30.1%
Short-duration quarterly job finding: 44%	15.149	-19.0%
Initial AI hourly wage loss: 0%	16.179	-13.5%
Initial AI hourly wage loss: 20%	21.258	13.6%
Common annual earnings trend: 1%	19.396	3.7%
Common annual earnings trend: 2%	20.076	7.3%

Each row recomputes its matched reference. Omitted settings retain baseline values. Timing/access alternatives are declared institutional assumptions; sensitivity endpoints are not confidence bounds.

Reducing short-duration quarterly job finding from 34% to 24% raises fixed-seed cost to EUR 24.336 million; increasing it to 44% lowers it to EUR 15.149 million. These contrasts indicate that job-finding assumptions materially affect persistence in this design, without ranking parameters independently of the ranges selected. The historical v4.2 paired-seed results below illustrate the separate issue of simulation variation; they do not supply a rerun v5.0 distribution.

At the rebased earnings level, setting initial AI hourly wage loss to zero gives EUR 16.179 million; 20% loss gives EUR 21.258 million. Zero wage loss still allows unemployment, reduced hours and ordinary-transition scarring. A 1% or 2% common earnings trend gives EUR 19.396 million or EUR 20.076 million under fixed thresholds. This is a marginal shock contrast at higher individual earnings, not an estimate that GDP growth worsens public finances.

The one- and twelve-month cash-settlement alternatives give covered cost EUR 18.722 million and EUR 18.690 million, compared with the six-month baseline. Removing requested hardship review gives EUR 18.708 million; restricting assessment to the implemented mandatory cases gives EUR 18.638 million. These experiments concern take-up and administrative timing assumptions, not proposed

changes to tax law. A timing effect on accrued cost operates through assistance income and asset tests, while differences in cash worker income also reflect settlements pending beyond the horizon.

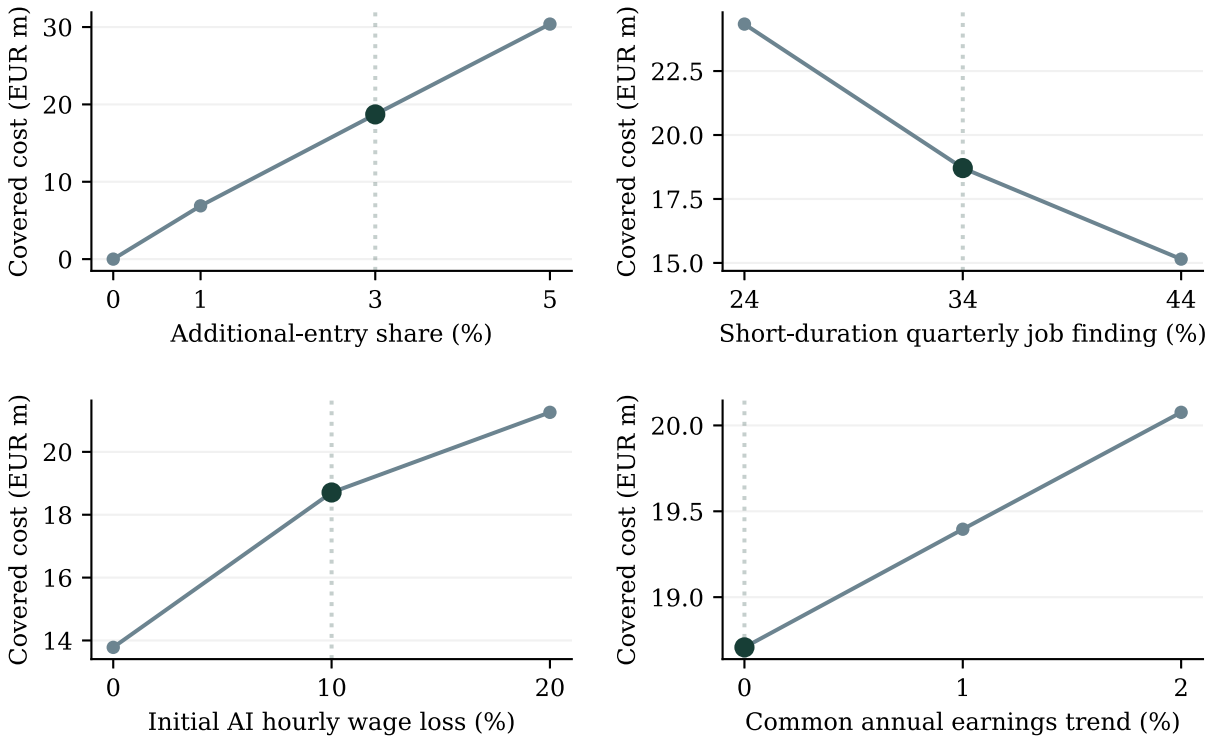


Figure 2. Conditional sensitivity curves for four entered parameters

Dots are actual paired runs using seed 20261019; connecting lines guide the eye and do not interpolate a probability distribution. The marked point in each panel is the default. Other parameters remain fixed.

6.2.1 Archived v4.2 simulation variability and paired differences

This subsection preserves the completed v4.2 ensemble as a historical reproducibility record. It is not recomputed with the integrated v5.0 engine, and none of its intervals is presented as a current v5.0 result. Current headline and sensitivity amounts elsewhere use freshly rerun v5.0 cases.

Table 4a. Archived v4.2 variation across simulation seeds

Case / replications	Mean cost, EUR m	Cost P5-P95	Mean paired change
Baseline / 100	19.037	16.994 to 21.436	Reference
Quarterly job finding 24% / 20	24.327	22.633 to 26.962	5.371
Quarterly job finding 44% / 20	15.013	13.889 to 17.462	-3.944
AI hourly loss 0% / 20	16.491	14.271 to 19.277	-2.466
AI hourly loss 20% / 20	21.433	19.599 to 24.036	2.476

Historical v4.2 outputs; not rerun for v5.0. Undiscounted EUR millions. Baseline 100 seeds; each sensitivity 20 matched seeds. A paired change subtracts its own seed baseline, not the 100-seed mean. P5-P95 are empirical simulation percentiles, not confidence intervals.

Table 4b. Archived v4.2 same-seed sensitivity differences

Change relative to same-seed baseline	Mean, EUR m	P5-P95, EUR m
Quarterly job finding 34% to 24%	5.371	3.900 to 7.523
Quarterly job finding 34% to 44%	-3.944	-5.089 to -2.494
AI hourly loss 10% to 0%	-2.466	-2.772 to -2.257
AI hourly loss 10% to 20%	2.476	2.277 to 2.778

Historical v4.2 outputs; twenty matched replications per row. Changes alter the declared input only. Levels in Table 4a and paired differences answer different questions.

The archived v4.2 default cost has simulation standard deviation EUR 1.352 million. Its mean is estimated with Monte Carlo standard error EUR 0.135 million under this fixed design. That standard error measures numerical averaging, while the broader fifth-to-ninety-fifth percentile range describes differences across realized synthetic histories. Neither quantity measures how accurately the assumed transitions, job losses or earnings process describe Germany.

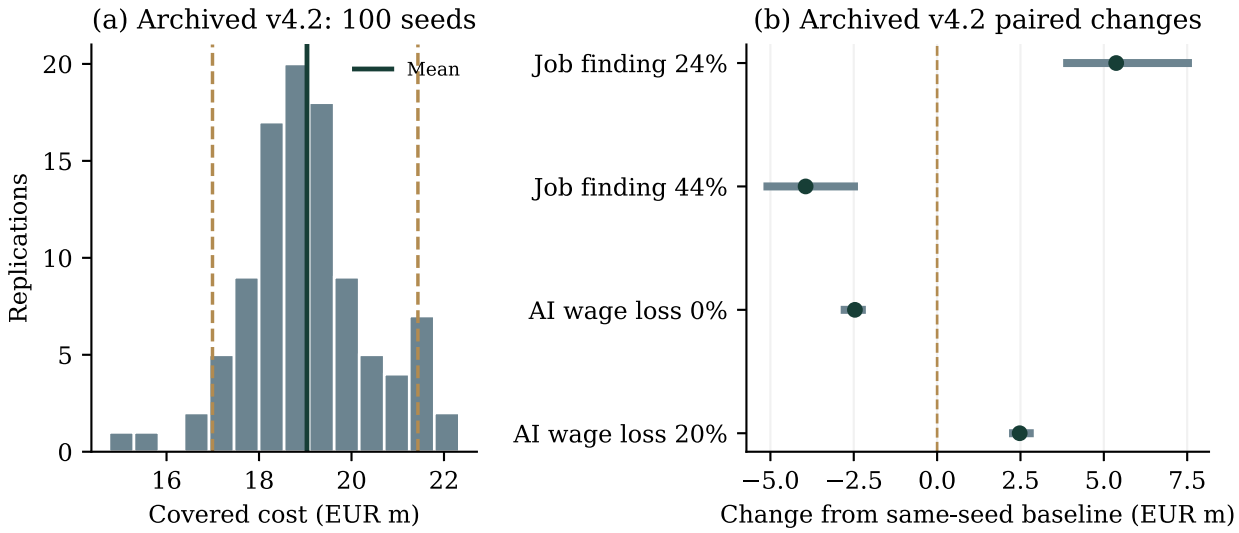


Figure 2a. Archived v4.2 simulation variation and paired sensitivity changes

Historical v4.2 ensemble, not rerun for v5.0. Left: baseline costs for 100 seeds, with mean and empirical 5th/95th percentiles. Right: same-seed changes for 20 replications per sensitivity. These are simulation distributions at fixed inputs, not empirical confidence bands.

6.2.2 Shock timing within the same observation decade

Table 4c. Current v5.0 timing experiments, fixed 300-entry total

Entry window / pattern	2026 cost, EUR m	2035 cost, EUR m	Ten-year cost, EUR m
2026-2030 / even	1.138	0.699	18.708
2026 only / even	5.673	0.539	20.503
2030 only / even	0.000	0.895	17.402
2026 only / front-loaded	7.029	0.578	20.718
2026 only / back-loaded	4.203	0.501	19.810

Every row observes 2026-2035 and N = 10,000. Annual columns are flows in the stated year; the final column is their ten-year sum. Start/window/pattern change while benefit rules and the observation endpoint remain fixed.

The timing cases illustrate two differences. Concentrating all entries in 2026 shifts exposure earlier but does not truncate it after twelve months. Moving an otherwise one-year even shock to 2030 leaves fewer post-shock years before the common 2035 endpoint. Front- and back-loaded patterns vary the distribution within 2026. Because eligible worker identities, re-employment and later ordinary histories can diverge, cost need not be proportional to a simple count of remaining years. These are fixed-seed conditional comparisons, not forecasts of a preferred shock path.

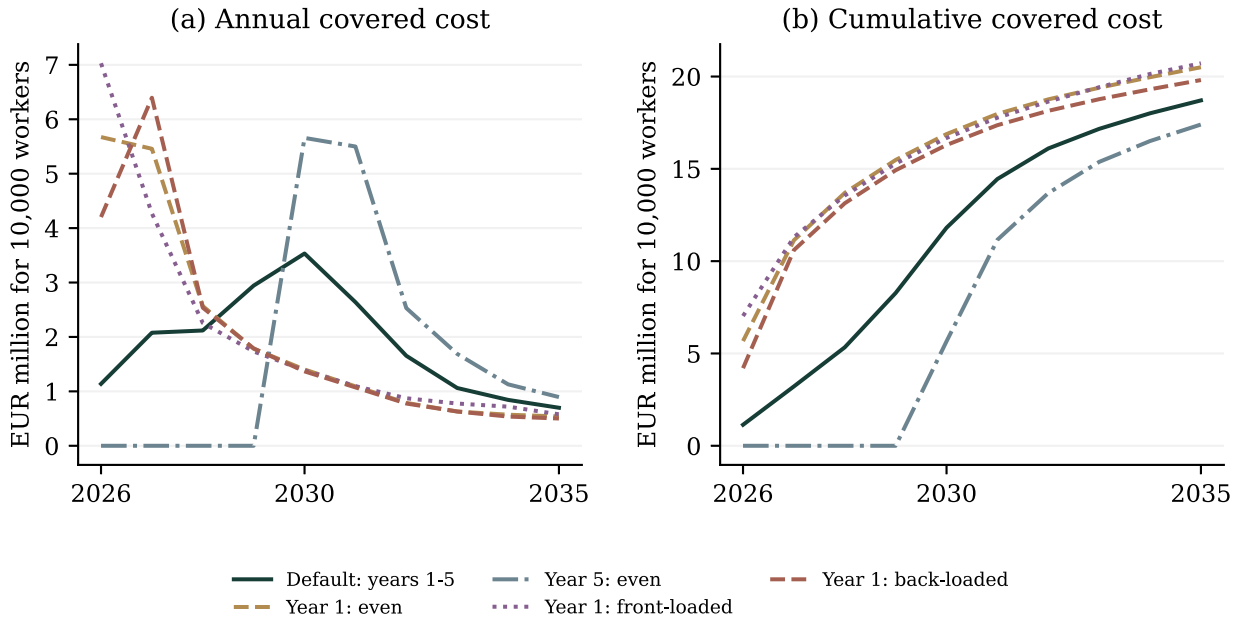


Figure 2b. Current v5.0 annual and cumulative costs under alternative entry timing

Five paths use 300 entries per 10,000 synthetic workers and the same 120-month observation. Left: annual EUR millions. Right: cumulative undiscounted EUR millions. One-year entry windows do not imply one-year consequences or one-year benefit entitlement.

6.2.3 Benefit exhaustion, means tests and continued observation

Table 4d. Current v5.0 unemployment support, annual average people

Year / history	Unemployed	ALG only	ALG + support	Support only	No benefit
2026 / Reference	179.8	164.5	15.3	0.0	0.0
2026 / Shock	197.9	180.9	17.0	0.0	0.0
2030 / Reference	458.4	268.2	18.7	171.2	0.4
2030 / Shock	510.3	296.2	22.7	191.1	0.4
2035 / Reference	470.6	252.1	28.3	189.8	0.4
2035 / Shock	474.6	251.9	28.3	194.0	0.4

Each of the last four columns is an exclusive subset of unemployed people during income-months. Annual averages may be fractional; multiplying an unrounded average by twelve gives person-months, not unique claimants. Rounding can affect the displayed sum. This table excludes employed/inactive assistance recipients and December state stocks.

Table 4e. Deterministic exhaustion mechanism: first month after ALG ends

Initial assets	Model month	Unemployed	ALG only / both	Support only	No benefit
EUR 0	14	20	0 / 0	20	0
EUR 50,000	14	20	0 / 0	0	20

Each case starts with 100 synthetic workers and separates 20 at the end of January 2026. Ordinary exits, inactivity and job finding are zero. All start with 24 insured months; only initial assets differ. Month 1 is January 2026. This illustration isolates entitlement and means tests and is not a calibrated population scenario.

In these diagnostics, remaining unemployed after exhaustion does not force a zero unemployment count. Low-asset workers move to assistance when the modelled need and income test permits it; high-asset workers can remain unemployed without a modelled benefit until drawdown and the applicable asset/grace test permit support. In the high-asset illustration, assistance begins for all 20 by observation month 24, but expiry of receipt-based grace removes it again by month 36; continued asset drawdown restores assistance to all 20 by month 57. In the low-asset case, June 2027 tax refunds temporarily remove assistance for two people in month 18 because refunds enter counted income; support resumes the following month. These transitions demonstrate distinct income, asset and grace tests, rather than a blanket benefit cutoff. Eligibility is reassessed monthly throughout the fixed observation decade. Re-employment is disabled only for this mechanism illustration; in the main simulation it remains a separate monthly transition that can occur before or after entitlement ends.

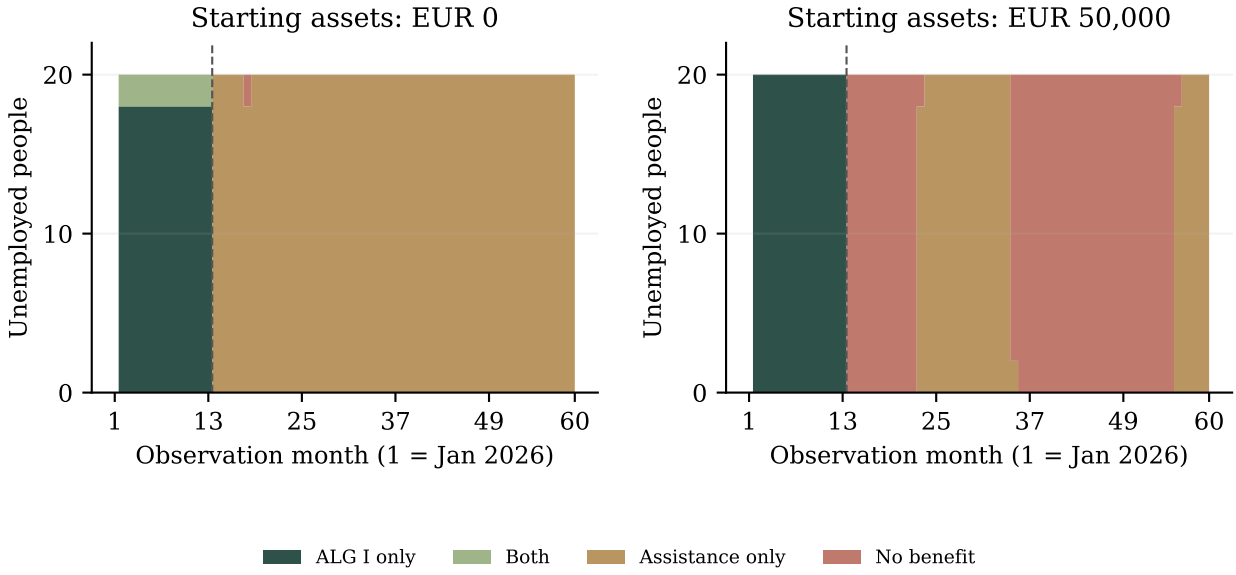


Figure 2c. Current v5.0 unemployment support before and after ALG exhaustion

First 60 months of two 120-month deterministic diagnostics: 100 workers, 20 January-end separations, 24 initial insured months and no subsequent employment transitions. Panels differ only in initial assets (EUR 0 or EUR 50,000). Stacked income-month people partition unemployment into ALG only, ALG plus assistance, assistance only and no modelled benefit; the total remains 20 after separation. Dashed lines mark ALG I exhaustion after month 13. Assistance grace expiry and later asset drawdown explain the high-asset reversals; counted tax refunds explain the small low-asset interruption. Mechanism illustration, not forecast.

6.3 Comparative duration experiments

The comparative experiment fixes the affected share at 20%, return pay at 100% of starting pay and jobless duration at zero, two, six or twelve months. Holding share and return pay fixed isolates the duration assumption more clearly than comparing presets that change several inputs. At zero months, every covered difference is exactly zero. Table 5 reports gross public insurance per affected worker, retaining local currencies.

Table 5. Annual gross public insurance per affected worker

System / currency	2 months	6 months	12 months
Germany / EUR	3,924	11,772	23,544
France / EUR	3,722	12,149	24,789
Belgium / EUR	4,289	12,372	23,441
Netherlands / EUR	8,223	23,572	46,596
Denmark / DKK	46,164	130,855	251,130
Michigan (US) / USD	3,137	7,240	7,240
Japan / JPY	399,461	1,303,901	2,034,990

Return pay is 100% in every case. Danish employer G-days (DKK 1,880) are excluded from public insurance. Amounts are rounded local units, not exchange-rate-equivalent rankings.

Duration limits generate nonlinearity. Michigan insurance is unchanged between six and twelve jobless months because twenty weeks are already exhausted. Japan pays until its 270 payable days are used after the waiting period. Declining stages and caps affect other systems. Lower covered cost can indicate lower insurance protection rather than higher economic welfare, so a fiscal-cost ranking alone is not a social evaluation.

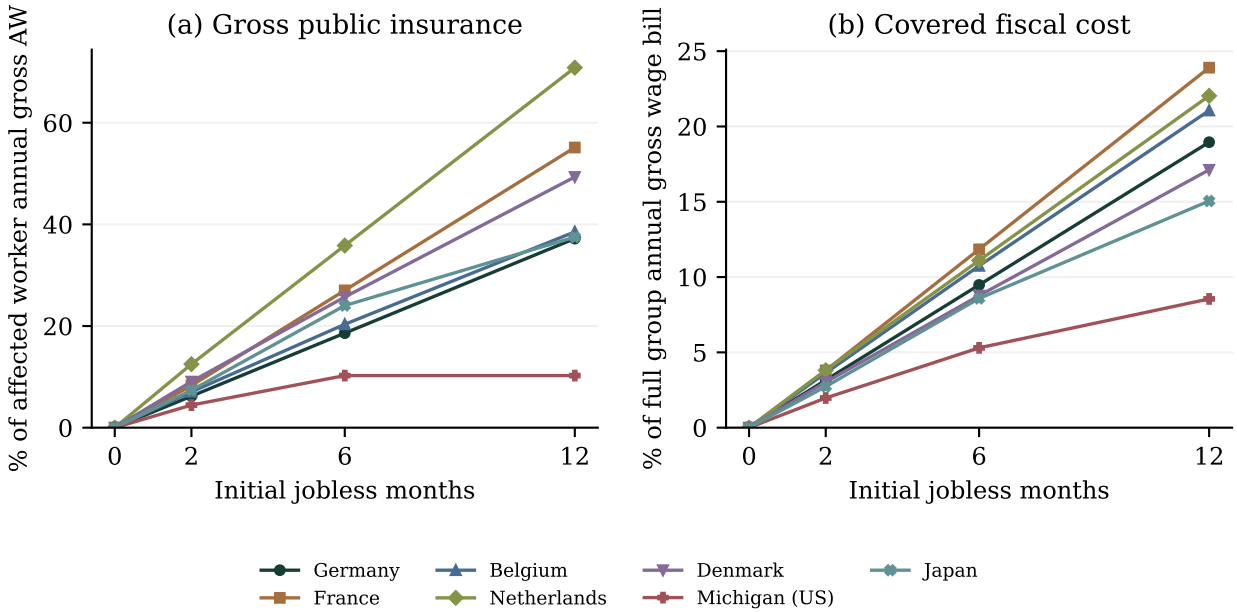


Figure 3. Duration, gross insurance and covered fiscal cost across systems

Left: annual gross public insurance per affected worker divided by the annual country average wage. Right: covered cost divided by the full 1,000-worker annual benchmark wage bill, with 200 affected. These denominators differ; neither is a net replacement rate.

The Dutch six-month value is EUR 23,572 at unchanged return pay. It differs from the dashboard difficult-transition preset (approximately EUR 27,025) because that preset returns workers at 85% pay and includes eligible WW continuation. The distinction illustrates why duration, return pay and benefit-with-earnings rules must be specified jointly. Gross insurance is not complete worker protection when taxes, other support and out-of-work charges are omitted.

7 Verification, validation and identification

National validation checks identical-path and zero-conversion results, adoption and capability effects, first-displacement limits, population conservation, sector contributions, re-employment, monthly-to-annual reconciliation and cumulative sums. The starting employment-gap calibration reproduces its target within numerical tolerance; this checks the fit rather than the empirical validity of the closure. Observed sector counts reconcile to the national insured stock after the disclosed exclusions.

Worker-history validation checks the fixed 120-month observation, zero-shock equality, reproducibility, population conservation and fiscal reconciliation. It tests early and later shock starts, even/front/back-loaded schedules, benefit exhaustion, subsequent asset-tested assistance and unemployment without modelled benefits. Every monthly unemployment count must equal its four support groups; annual

average people equal twelve-month counts divided by twelve, and person-month exposure, annual fiscal flows and cumulative totals reconcile. The seventeen v5.0 parameterizations and six integration cases store both histories, full monthly/annual ledgers and source hashes. The retained 52 benefit-rule checks cover receipt-based protection, four/five-year boundaries, episode continuation, qualification, hardship, work capacity, filing and cash/accrual reconciliation. The BA 2025 EUR 52.53/day fixture independently anchors a benefit amount; mixed-history cases are hand-worked rule boundaries. These are implementation checks, not observed claimant histories or empirical predictive validation.

Independent institutional evidence is narrower and more informative than a raw test count. Nine German BMF payroll fixtures and five BA 2025 benefit-amount cases match the implemented outputs. The comparative German ALG amount independently matches a dated BA 2024 calculator fixture. Other-country insurance is checked against dated policy descriptions, national rules and hand-worked cases, rather than independent claimant payment statements. Full independent mixed-year tax, assistance and heterogeneous-household validation remains incomplete.

No held-out observed cohort validates the joint transition and earnings process. The restricted cohort differs from the job-finding comparator population, and occupation earnings lack within-group dispersion. Inactive-state work capacity, full benefit and voluntary-filing take-up, hardship requests, the cash lag and arrears allocation remain declared assumptions. The model does not calculate disability or SGB XII support, statutory accident insurance, the U3 levy, sanctions, claim-suspension exceptions or filing behaviour. The frozen 2025 benchmark is not an application of later legal reforms; mutable source URLs must be read with their recorded legal dates. French daily-cent rounding, stylized payment calendars, the French indexation limitation and annual-anchor proration restrict comparative precision. Accounting consistency therefore does not establish empirical validity.

For empirical calibration, a suitable German longitudinal or administrative source must distinguish exits into employment from benefit cessation and inactivity, identify prior insurance and earnings, and follow post-displacement earnings and hours. The IAB SIAB 1975-2023 version 2 provides a documented potential route to day-level labour-market histories, subject to controlled access. It has not been accessed for this study. Administrative daily earnings are not automatically hourly wages or household disposable income. Estimation and held-out validation samples should be separated, and historical displacement must not be relabelled as identified AI treatment.

7.1 External accounting benchmark: IAB

Hausner, Weber and Yilmaz (2025) report IAB 2024 costs of unemployment of EUR 76.6 billion for approximately 2.787 million registered unemployed people, about EUR 27,500 per registered unemployed person-year. Roughly EUR 47 billion is expenditure and EUR 29.6 billion foregone receipts. Their expenditure includes contributions paid by government for benefit recipients; foregone contribution receipts are measured net of those payments. For example, insurance spending of EUR 18.6 billion includes EUR 10.7 billion cash ALG and EUR 7.9 billion contributions. The present restricted account counts household cash transfers and foregone employment receipts, without counting internal public transfers twice.

For a current v5.0 diagnostic scale check, the no-scarring-for-anyone paired paths generate 256.6 additional unemployed person-years, measured over income-accrual months. The no-scarring-for-anyone case costs approximately EUR 55,306 per extra unemployed year: EUR 18,927 in cash transfers and EUR 36,379 in foregone receipts. The baseline including earnings scarring gives EUR 72,910 per extra unemployed year. These ratios allocate downstream earnings and inactivity consequences to excess unemployment exposure; they are not the annual cost of an average registered unemployed person. Their difference from the IAB figure must be interpreted through population, counterfactual earnings and accounting coverage, rather than forced to match.

Thus IAB's 61% expenditure share is not the same quantity as this paper's cash-transfer share. If government-paid contributions are added to expenditure and subtracted from foregone contributions, their placement changes the decomposition without changing the consolidated sum, all else equal. IAB also includes EUR 2.4 billion indirect-tax losses and covers heterogeneous SGB II/SGB III populations, while the present starting cohort is employed and relatively well-paid. A matched-definition comparison would need aligned populations, annual unemployment exposure, benefit coverage, indirect taxes and contribution treatment. For the synthetic worker model, the aggregate IAB total is an external scale benchmark rather than a calibration target or evidence of external validation. The separate national account in Section 1 explicitly uses its historical per-person-year coefficients.

8 Discussion and research priorities

Both the national and worker-history accounts combine a revenue channel and a support channel. In the synthetic worker baseline, the larger component is lost current employment-related receipts. Reporting only unemployment insurance would understate the covered public cost; calling the combined contrast total net fiscal impact would overstate its scope. Future pension liabilities, consumption taxes, public services, capital-income taxation and international revenue allocation require additional models and evidence.

Insurance design changes the timing and level of protection, but the standard worker conditions on a long insured record and compliant access. Cross-country differences therefore describe an eligible vignette rather than coverage rates, take-up or welfare-state adequacy for all displaced workers. A credible protection comparison requires benefit taxation, other programmes, out-of-work charges and heterogeneous household resources. National expansion of the worker-history model additionally requires representative joint distributions and reconciliation of employment, earnings, tax, contribution and public-employer boundaries. The observed industry weights in Section 1 support the aggregate unemployment account; they do not supply those missing microdata.

The next empirical step is to align the population, wage level and transition definitions before fitting new parameters. Replace the uniform aggregate earnings uplift with occupation- and cohort-compatible pay; construct cohort-compatible weights; estimate duration-specific competing transitions; fit initial wage and hours losses and recovery; and evaluate event-time outcomes at six, twelve and twenty-four months. Parameter uncertainty should then be propagated separately

from finite simulation variation. Scenario perturbations remain useful while those tasks are unfinished, provided their interpretation is explicit.

A complete answer to the broader AI revenue-recovery question also needs evidence on productivity, compensation, domestic taxable profits, imported AI services and the geography of taxable income. The optional firm experiment is a transparent accounting placeholder for such assumptions, not a measured recapture mechanism. This separation preserves the usefulness of the current labour-adjustment model without implying that the broader SPAR project is already implemented.

9 Conclusion

Observed industry employment and workplace adoption support a transparent national unemployment-cost experiment. Under the starting survey-anchored conversion and explicit diffusion and re-employment assumptions, the covered 34.84 million insured employees generate EUR 5.75 billion in cumulative additional unemployment costs over 2026-2035, in constant 2024 euros. The changing annual path and its cumulative sum answer different accounting questions. The estimate covers the unemployment fiscal channel under a conditional closure, not the complete net effect of AI.

The worker-history model complements this account by retaining employment and earnings after benefit expiry. Representative worker and household histories, duration-specific transitions and compatible earnings and receipt data are needed to connect these nonlinear mechanisms to national scarring estimates. The two accounts remain distinct until their populations and fiscal overlap can be reconciled.

Appendix A Notation and event sequence

Table A1. Selected notation

Symbol	Meaning
i, m, y, z	Worker, month, calendar year and paired history
N, H	Initial cohort size and fixed H = 10 observation years
S in {E,U,I}	Start-of-month employment, unemployment or inactivity
theta, K, a_m	Additional-entry share, intended total and monthly schedule
eta, kappa	Allocation weight and exponential-race selection key
q, lambda, f, j	Quarterly comparator, matching multiplier, monthly job finding and inactivity
D, t, rho, h	Destination, tenure, permanent loss share and recovery half-life
w, L, Y, g	Hourly pay, monthly hours, gross earnings and annual earnings trend
delta_iy; script D_H, K_H	Individual tax settlement; summed accrual; net cash settlement
Q_H plus / minus	Pending tax including unpaid debt / pending refunds at the horizon
R, B, C	Covered receipts, included transfers and positive-cost fiscal contrast
n, a, M, x	Comparative group size, affected count, jobless months and return-pay ratio
u, g_cm, Delta F	Public insurance, employer support and comparative covered balance change

Calligraphic D and K distinguish tax settlement totals from destinations and entry counts. The employer-support symbol g_cm differs from the German earnings trend g.

Each German month first accrues payroll or ALG in the current state. Due tax cash positions are identified; a refund enters the assistance income test, while prior-year debt does not reduce assessable earnings. Assistance, cash tax payment, carried debt and asset use are then calculated and insured history appended. Annual ledgers accumulate these flows. December inserts assessed income-year tax into accrued receipts and worker income and schedules its later cash settlement. Ordinary exits and AI selection precede month-end state changes, destination draws, stocks and event-time observations. This distinction between accrual, cash and end-of-month transitions is essential when matching data.

A worker can have repeated ordinary spells after the single tagged separation. Current unemployment cause alone selects the matching multiplier. The cause of the spell immediately preceding each destination selects its wage and hours loss parameters; a subsequent ordinary destination clears the AI loss regime. The separate ever-AI indicator is retained for event tracking and allocation eligibility, never for assigning later ordinary losses or matching.

Appendix B Baseline parameter register

Table B1. Baseline entered parameters

Parameter group	Value / interpretation
Size, seed, calendar	10000 workers; seed 20261019; 2026-2035
Additional entries	3%; start observation year 1; window 5 years; even; uniform
Annual ordinary E-to-U / E-to-I	6% / 0.2% (separately converted)
Annual U-to-I / I-to-E	2% / 10%
Quarterly U-to-E proxies	34% below one year / 12% thereafter; AI multiplier 1
Destination shares	40% similar / 40% lower pay / 20% reduced hours
AI / ordinary hourly losses	10% / 10%; reduced-hours loss 25%
Recovery	partial; 24 months half-life; 50% permanent share
Earnings level / trend	2022 source means x 1.1627906976744187; annual trend 0%
Household assets / housing	EUR 5000 assessable initial assets; EUR 650 recognized rent/heating monthly
Inactive work capacity	Retained; full scoped SGB II take-up assumed
Hardship review	Requested when two-year basis exceeds one-year basis by more than 10%
Annual tax filing	Mandatory plus full voluntary assessment
Cash tax settlement	6 months after December accrual; timing assumption
Optional channels	Additional wage gain 0%; business experiment disabled

Every case stores the full parameter object. These are institutional profile and scenario choices, not fitted empirical estimates.

Fiscal cost decomposes exactly into PIT/solidarity loss, employee-contribution loss, employer-contribution/flat-tax loss, additional ALG and additional assistance, up to numerical rounding. The zero-shock run has identical monthly paths and zero headline differences. A component residual of approximately EUR 10^-8 from subtraction order is floating-point noise and disappears at cent precision. No confidence band is implied by exact reproduction.

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