

Economic Impact Assessment of Periodic Technical Inspection in Germany

*Cost–Benefit Analysis of an Annual HU for Passenger Cars Aged Ten and Above in Germany,
based on Empirical Findings of HTW Dresden*

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Abbreviations

The following abbreviations are used throughout the report. German institutional names are given in their original spelling with an English gloss.

Abbreviations

Abbreviation	Definition
AP	Arbeitspaket - Work Package (HTW Dresden 2026b)
BAST	Bundesanstalt für Straßen- und Verkehrswesen - Federal Highway and Transport Research Institute
BCR	Benefit-Cost Ratio
CBA	Cost-Benefit Analysis
CITA	The International Motor Vehicle Inspection Committee (AISBL, Brussels)
DEKRA	Deutscher Kraftfahrzeug-Überwachungs-Verein e.V.
Destatis	Statistisches Bundesamt - Federal Statistical Office
EM / VM / VU	Erheblicher / Verkehrsunsicherer / Verkehrsunfähiger Mangel (HU classifications)
EU	European Union
GebOST	Gebührenordnung für Maßnahmen im Straßenverkehr
HU	Hauptuntersuchung - German periodic technical inspection (PTI)
HTW	Hochschule für Technik und Wirtschaft Dresden
IERC	Schulz-Institute for Economic Research and Consulting GmbH (trading name)
JEL	Journal of Economic Literature classification codes
KBA	Kraftfahrt-Bundesamt - Federal Motor Transport Authority
M1 / N1	EU vehicle classes: M1 passenger cars; N1 light commercial vehicles
MiD	Mobilität in Deutschland - National Mobility Survey
PDO	Property Damage Only (accident classification)
PTI	Periodic Technical Inspection
StVZO	Straßenverkehrs-Zulassungs-Ordnung - German Road Traffic Licensing Regulation
TÜV	Technischer Überwachungsverein - Technical Inspection Association

Note. German institutional names appear in their original spelling with an English gloss.

Executive Summary

Policy question

This report evaluates whether Germany should replace the current biennial roadworthiness test (HU) for passenger cars aged ten years and above with an annual inspection, moving from a 3/2/2/2/2 regime to a 3/2/2/2/1 regime for the 10+ cohort. The assessment covers the German M1 passenger-car fleet over the period 2024–2035 and focuses on social welfare rather than fiscal or distributional impacts.

Headline result

- The central FORSA-informed, scenario-weighted, undiscounted benefit-cost ratio (BCR) for 2024–2035 is **1.86**.
- Aggregate marginal inspection costs amount to roughly EUR 12.2 billion, while aggregate monetized accident-cost savings amount to roughly EUR 22.6 billion, implying a net social benefit of about EUR 10.4 billion in constant 2024 prices.
- Across FORSA-consistent weighting variants, the BCR lies in a narrow **band of 1.81–1.88**, indicating that the result is robust to reasonable changes in the scenario weights.

Under the 2024 evidence base, an annual HU for passenger cars aged ten years and above therefore **passes the aggregate benefit-cost test**: the safety benefits clearly outweigh the additional inspection costs.

Empirical foundation

The analysis combines three types of German evidence, complemented by a representative consumer survey and official unit costs:

- A DEKRA-led accident-reconstruction study of **2,429 severe accidents (2014–2025)**, which identifies the share and age profile of accidents causally linked to technical defects.
- A 2025 in-traffic field survey of **11,604 passenger cars**, measured in three stages (in-traffic, first HU presentation, post-repair), documenting defect prevalence, removal rates, and the effect of the HU on real repairs.
- Three HTW Dresden fleet-dynamic scenarios (A, B, C) for vehicles aged twelve years and above, describing alternative stock developments for older cars up to 2035.
- A FORSA consumer survey on behavioral responses of older-vehicle owners to an annual HU, used to derive the FORSA-consistent scenario weights.
- BASt 2024 social accident unit-costs for six severity categories, including pure property-damage-only accidents.

Analytical approach

The benefit side measures avoided social accident costs in six severity categories (fatalities, serious injuries, slight injuries, property-damage components of injury accidents, serious property-damage accidents, and pure PDO events). For each year, severity-specific reduction rates from the HTW scenarios (adjusted by a compliance uplift factor κ) are applied to the passenger-car-caused accident pool attributable to ten-plus vehicles. Avoided accidents are monetized using BAST unit costs and aggregated over 2024–2035.

The cost side is defined by the **marginal inspection cost** of the additional annual HU round for the 10+ cohort. The central calculation uses the **ADAC HU-only market-average fee of EUR 90** per inspection, resulting in approximately **EUR 1.01 billion** in marginal inspection costs per year, given an estimated 11.25 million additional inspections. A transfer-share parameter $\theta \in [0, 0.10]$ allows for profit margins and other non-resource components embedded in posted fees.

The central welfare test uses an **undiscounted aggregate BCR** over 2024–2035, treating both accident-cost savings and inspection costs as recurring annual resource flows. Present-value BCRs with social discount rates of 0.7 percent and 3 percent are reported as robustness checks.

Robustness and sensitivities

The central result is robust along several dimensions:

- FORSA-consistent scenario-weighting variants with ε_A (epsilon) = 0.01 and $\varepsilon_A = 0.05$ yield BCRs between 1.81 and 1.88.
- Parameter perturbations in the detection, remediation, interval-reset, and compliance pathways, as well as alternative assumptions on the non-resource share of inspection fees, do not push the BCR below unity.
- Present-value variants with social discount rates of 0.7 percent and 3 percent preserve a BCR comfortably above one.

The international PTI literature is used only to bound plausible parameter ranges; the calibration itself relies on the German accident-reconstruction and fleet-survey evidence.

Policy implications

For Germany, given the current PTI infrastructure and the documented defect profile of older cars, moving the 10+ cohort from biennial to annual inspections is a **welfare-improving tightening of the HU regime**. The result supports the option of stricter inspection frequencies for older cars within the flexibility allowed by Directive 2014/45/EU. The analysis does not, however, prescribe a uniform solution for all member states, as effectiveness depends on local fleet characteristics, enforcement quality, and inspection capacity.

The study is an aggregate welfare test and does not allocate the net benefit across stakeholders. It highlights that distributional and affordability issues, especially for low-income households relying on older vehicles, should be addressed through **complementary policy instruments** rather than by weakening the inspection regime itself.

Limitations

The main limitations are:

- **Repair costs** are not treated as a separate cost item; the HU is assumed to enforce an existing legal obligation to keep vehicles roadworthy, rather than to create new obligations.
- **Owner time, travel, and transaction costs are not monetized** due to the lack of robust Germany-specific unit costs; they are discussed qualitatively in the limitations section.
- The cost side holds the number of additional inspections **constant over time**, which is conservative if an annual HU induces accelerated scrappage or substitution away from older vehicles.
- The HTW scenarios are explicitly presented as **sensitivity cases rather than point forecasts**; the report therefore aggregates them using FORSA-informed weights instead of presenting separate scenario-specific BCRs as predictions.

Despite these limitations, the evidence base and the robustness checks support the central conclusion that an annual HU for passenger cars aged ten years and above is **socially desirable on the 2024 parameter set**.

Plain-language summary of the mechanism and result

In everyday terms, this report asks a simple question: *Does it pay off for society if older passenger cars in Germany must go to the HU every year instead of every two years?* The answer is based on how often technical defects in older cars contribute to crashes, how many of these defects are found and repaired around the HU, and how drivers change their behavior when they know that the next inspection is coming sooner.

The analysis shows that older cars are more likely to have safety-relevant defects and that these defects play a measurable role in severe accidents. When the HU is more frequent, more of these defects are detected and repaired, and the average time that a dangerous defect remains on the road becomes shorter. In addition, some owners repair known defects earlier simply because they expect to be checked again sooner.

Using German accident data, large-scale HU field surveys, and official BAST unit costs, the model translates this combined effect into the number of accidents and casualties that can be avoided each year. It then compares the social value of these avoided accidents with the additional cost of the extra HU visit for owners of 10+ cars.

Over the period 2024–2035, the benefit side clearly dominates: for every euro spent on the additional inspections, society saves almost 1.9 euros in accident costs, and the total net benefit is around EUR 10.4 billion in constant 2024 prices. This result remains stable even when the key parameters and behavioral assumptions are varied within realistic ranges.

Abstract

This report quantifies the welfare effects of replacing Germany's biennial periodic technical inspection regime with an annual inspection requirement for passenger cars aged ten years and older. The assessment is designed as a regulatory cost-benefit analysis with 2024 as the base year and 2024–2035 as the evaluation horizon.

The empirical calibration is built on the HTW Dresden evidence package and the FORSA consumer survey. Three elements are central to the causal identification strategy. First, the DEKRA accident-reconstruction sample of 2,429 severe accidents from 2014–2025 identifies the role of technical defects as causal, contributory, or accident-favoring factors and documents the age gradient of accident-relevant defects. Second, the 2025 in-traffic field survey of 11,604 passenger cars, conducted by TÜV Süd, TÜV Nord, TÜV Rheinland, and DEKRA, measures the same vehicles at three stages: in-traffic condition, first presentation for the HU, and post-repair condition. This evidence establishes fleet-level defect prevalence and shows that the HU removes identified defects in practice. Third, HTW Dresden's fleet-dynamic scenarios project alternative stock developments for the passenger-car cohort aged twelve years and older through 2035. The FORSA survey provides the behavioral anchor for assigning scenario weights by capturing older-vehicle owners' likely responses to an annual inspection requirement.

The cost side is measured by the marginal inspection fee for the additional annual inspection round. At approximately 11.25 million additional inspections per year and an ADAC reference fee of EUR 90, the annual marginal cost amounts to approximately EUR 1.01 billion in constant 2024 prices. The benefit side aggregates six avoided accident-cost streams: fatalities, serious injuries, slight injuries, the property-damage component of injury accidents, serious property-damage accidents, and pure property-damage-only events. All categories are monetized using the BASt 2024 social accident unit-cost catalog.

The report's headline result is a FORSA-informed, scenario-weighted, undiscounted benefit-cost ratio for the period 2024–2035. Under the headline weighting variant, Scenario A receives a residual weight of ϵ_A (epsilon) = 0.01 because it is least compatible with the FORSA evidence; the remaining 0.99 is split agnostically between Scenarios B and C. This specification yields an aggregate benefit-cost ratio of 1.86. Aggregate costs amount to approximately EUR 12.2 billion, while aggregate monetized benefits amount to approximately EUR 22.6 billion, implying a net benefit of approximately EUR 10.4 billion. Two sensitivity variants using the weaker convention $\epsilon_A = 0.05$ produce benefit-cost ratios of 1.81 and 1.88. The resulting FORSA-consistent bandwidth is therefore 1.81–1.88.

Under the headline specification, annual HU for passenger cars aged ten years and older passes the aggregate benefit-cost test on the 2024 parameter set. This conclusion is conditional on two assumptions: that the inspection-induced compliance mechanism documented by HTW Dresden operates as modeled, and that the behavioral response captured by the FORSA survey materializes. The result is robust across the FORSA-consistent weighting variants and the parameter perturbations reported in Section 8. The inclusion of all six BASt severity categories, including pure property-damage-only events, follows a consistent welfare-cost convention and is documented separately in Section 7.

Keywords: periodic technical inspection; road safety regulation; cost-benefit analysis; EU Directive 2014/45/EU; compliance; fleet aging.

JEL codes: R41, R48, H54, K32.

1. Introduction

This report provides a cost-benefit analysis of a regulatory change to Germany's Hauptuntersuchung (HU) regime. The policy assessed is the introduction of an annual HU requirement for passenger cars aged ten years and older, replacing the current biennial inspection cycle for this cohort. In inspection-cycle notation, the policy variant corresponds to a 3/2/2/2/1 regime: the first inspection after three years, biennial inspections up to age ten, and annual inspections thereafter.

The object of assessment is the German passenger-car fleet (M1). The regulatory change applies to the subset of passenger cars aged ten years and older. According to the Kraftfahrt-Bundesamt (KBA), the German passenger-car stock stood at 49.10 million vehicles on 1 January 2024. The average vehicle age was 10.3 years, and vehicles aged thirty years and above accounted for 2.8 percent of the stock. The calculation uses 2024 as the base year. Annual benefits and costs are computed for each year from 2024 to 2035. The headline criterion is the undiscounted aggregate benefit-cost ratio for 2024–2035, defined as total undiscounted benefits divided by total undiscounted costs over the evaluation horizon. A present-value variant using a 3 percent social discount rate is reported in Section 8 as a robustness check.

The benefit side comprises six categories of avoided accident costs. Each category is measured as the avoided number of passenger-car-caused accidents or casualties in the respective severity class and monetized using the BASt 2024 social accident unit-cost catalog (volkswirtschaftliche Unfallkosten; Bundesanstalt für Straßen- und Verkehrswesen, 2025). The six categories are avoided fatalities, avoided serious injuries, avoided slight injuries, avoided property-damage components of injury accidents, avoided serious property-damage accidents, and avoided pure property-damage-only (PDO) accidents. PDO accidents are included explicitly. Although this category is often omitted from PTI cost-benefit analyses, Destatis (Verkehrsunfälle, 2024) reports approximately 1.45 million passenger-car-caused PDO events per year.

The cost side is defined by the marginal inspection cost of the additional annual HU round for the affected cohort. This cost is borne by vehicle owners at the point of inspection. In the central calculation, the marginal inspection cost is monetized using the ADAC HU-only reference fee of approximately EUR 90 per inspection. To account for the fact that the posted inspection fee may contain profit margins or other transfer-like components rather than only real resource costs, a transfer-share sensitivity parameter $\theta \in [0, 0.10]$ is applied.

Repair costs are not included as a separate cost item in the central welfare calculation. This convention reflects the fact that the technical defects and the legal obligation to maintain a roadworthy vehicle exist independently of the inspection. The HU reveals, verifies, and enforces compliance with an existing obligation; it does not create the underlying defect. This treatment is reported explicitly as a modeling assumption. Any inspection-induced change in the timing of repairs is discussed as a limitation in Section 11.

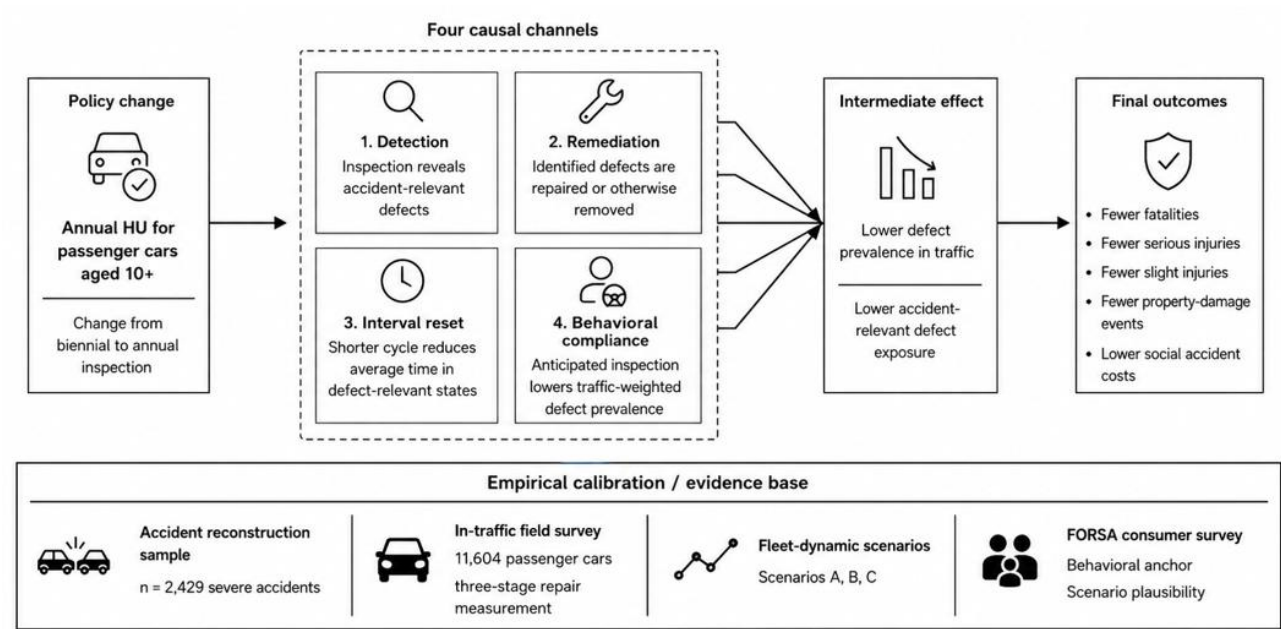
Owner time, travel, and transaction costs are also not monetized separately. The reason is not that these costs are assumed to be negligible, but that the present calculation does not use a robust Germany-specific unit cost estimate for them. This omission is reported as a limitation in Section 11.

The benefit-cost test reported here is an aggregate allocative test based on social accident unit costs. It is not a stakeholder-incidence analysis. The distribution of costs and benefits across vehicle owners, inspection

organizations, the Treasury, insurers, and other affected parties is therefore outside the scope of the central welfare test. The aggregate test identifies whether the regulatory change is expected to improve social welfare; it does not determine how the resulting net benefit should be distributed or which complementary policy instruments may be appropriate.

The regulatory change is modeled as reducing social accident costs through four causal channels, formalized in Section 3.2 and illustrated in Figure 1.

Figure 1
Causal Pathways Linking Annual HU to Lower Social Accident Costs



Note. Source: Own illustration based on HTW Dresden (2026a, 2026b, 2026d) and the FORSA consumer survey reproduced in HTW Dresden (2026d).

These channels are the detection of accident-relevant defects during inspection; the remediation of identified defects between inspections; the interval-reset effect, which captures the reduction in average defect exposure when the inspection cycle is shortened from biennial to annual; and behavioral compliance, which captures a reduction in traffic-weighted defect prevalence induced by the anticipated inspection itself, independently of what is recorded at the inspection event. These channels are calibrated using the HTW Dresden evidence base. This evidence base comprises two independent empirical surveys: an accident-reconstruction sample of 2,429 severe accidents (HTW Dresden, 2026a, 2026b), and an in-traffic field survey of 11,604 passenger cars with three-stage repair measurement (HTW Dresden, 2026a, 2026b). It is complemented by three fleet-dynamic scenarios derived from these empirical anchors (HTW Dresden, 2026d). The FORSA consumer survey reproduced in HTW Dresden (2026d) provides the behavioral anchor used to assess the plausibility of the scenario weights.

The three HTW fleet-dynamic scenarios A, B, and C – defined in HTW Dresden (2026d) – describe alternative stock dynamics of the passenger-car cohort aged 12 and above. They are aggregated via a FORSA-informed weighting convention to yield a single benefit-cost ratio. The decision tree underlying the aggregation, the

FORSA empirical anchors, and the calibration of the residual-weight parameter ϵ_A (epsilon) are documented in Section 6.1; the cost-benefit analysis is computed once, on the weighted reduction rates of Section 6.2. Table 1 reports the resulting headline BCR together with the three reference weighting variants.

Table 1

Headline BCR under the Headline Weighting Variant and Three Reference Weighting Variants

Calibration	Description	Weights (w_A, w_B, w_C)	Aggregate 2024–2035 BCR
Headline	$\epsilon_A = 0.01$ on Scenario A, which is least compatible with the FORSA evidence; agnostic split of the remaining 0.99 between Scenarios B and C.	(0.010, 0.495, 0.495)	1.86
Sensitivity S1	$\epsilon_A = 0.05$ as a weaker residual-weight convention; agnostic B/C split.	(0.050, 0.475, 0.475)	1.81
Sensitivity S2	$\epsilon_A = 0.05$ with a tilt toward Scenario C informed by the FORSA magnitude findings.	(0.050, 0.400, 0.550)	1.88
Reference (FORSA ignored)	Equal weights; reported for diagnostic comparison only.	(0.333, 0.333, 0.333)	1.43

Note. Aggregate BCR = total undiscounted benefits 2024–2035 divided by total undiscounted costs 2024–2035, constant 2024 prices. Cost: 11.25 million additional inspections per year $\times$ ADAC EUR 90 per inspection. The equal-weight reference (final row) ignores the FORSA evidence and is reported only as a diagnostic baseline against which the role of the FORSA findings can be read. Source: reduction rates from HTW Dresden (2026c); unit costs from Bundesanstalt für Straßen- und Verkehrswesen (2025).

The three HTW fleet-dynamic scenarios describe alternative trajectories for the stock and mileage of passenger cars aged twelve years and older between 2025 and 2035 (HTW Dresden, 2026d). Scenario A represents a linear continuation of the 2016–2025 trends in stock and mileage across all age groups. It therefore serves as the counterfactual case without an HU-induced behavioral response. Scenario B keeps the under-twelve cohort on its linear trend but reduces the growth increment of the cohort aged twelve years and older by 50 percent. This scenario represents a moderate HU-induced substitution from older to newer vehicles. Scenario C also keeps the under-twelve cohort on its linear trend but holds the cohort aged twelve years and older constant at its 2025 level. It therefore represents a stronger substitution response, with no further growth in the older-vehicle cohort. Mileage follows its linear trend in all three scenarios; the scenario differentiation is confined to the stock trajectory of the cohort aged twelve years and older. HTW Dresden (2026d) explicitly presents these scenarios as sensitivity calculations rather than point predictions. This report, therefore, aggregates them into a single FORSA-informed weighted benefit-cost ratio instead of treating them as separate forecast results.

Annual weighted benefit-cost ratios are reported for each year of the evaluation horizon in Section 6.4, Table 6. The headline criterion is the FORSA-informed weighted aggregate benefit-cost ratio for 2024–2035. It is defined as the sum of undiscounted weighted benefits over the evaluation horizon divided by the sum of undiscounted costs over the same period. Present-value robustness checks using social discount rates of 3 percent and 0.7 percent are reported in Section 8.

The headline benefit-cost ratio of 1.86 exceeds the reduced-form estimate of approximately 1.3 reported for Germany by Joisten, Franck, Geilenberg, and Witte (2025). The two results, however, should not be read as directly competing estimates, because they rest on different empirical specifications. The present analysis

applies the scenario-specific reduction potentials from HTW Dresden (2026c) for the HU cycle 3/2/2/2/1 and adds a compliance uplift of $\kappa = 0.55$ calibrated against HTW Dresden (2026a). Joisten et al. (2025), by contrast, follow an elasticity-based identification strategy and use the BAST 2018/19 unit-cost vintage. The difference in results is therefore attributable to both the identification approach and the valuation basis.

The international PTI literature is used in this report to bound plausible parameter ranges, not to resolve the broader methodological debate on inspection effectiveness. The elasticity-based literature, including Christensen and Elvik (2007), Elvik (2023), and Martín-delosReyes et al. (2021), provides external bounds for severity-specific reduction effects. The German evidence base—comprising accident reconstruction, fleet-level defect prevalence, and before-and-after repair evidence from HTW Dresden (2026a, 2026b)—provides the empirical anchors for detection, remediation, the interval-reset factor, and the compliance uplift. The report, therefore, uses international evidence for plausibility checks and German evidence for calibration. It does not attempt a formal synthesis of the two identification traditions.

The remainder of the report is structured as follows. Section 2 describes the regulatory baseline. Section 3.1 reviews the literature to the extent that it informs or constrains the parameter values used in the analysis. Section 3.2 specifies the benefit-cost framework. Section 4 documents the data inputs, including KBA fleet figures, Destatis accident counts, the HTW Dresden empirical surveys, the scenario construction, the FORSA evidence, the defect-age curves, the corrected HTW Dresden partner deliverable on 2035 reduction potentials, and the BAST 2024 social accident unit costs. Section 5 sets out the empirical strategy. Section 6 reports the baseline one-year results, the 2024–2035 benefit and cost trajectories, the annual benefit-cost ratios, the undiscounted aggregate benefit-cost ratio, the aggregate net benefit, and descriptive statistics for the annual BCR series. Section 7 presents the welfare assessment, including the sensitivity to the transfer component. Section 8 reports robustness checks, including the present-value variants under 3 percent and 0.7 percent social discount rates. Sections 9 through 12 provide discussion, policy implications, limitations, and conclusion.

2. Policy and Regulatory Baseline

The European Roadworthiness Package comprises three legal instruments adopted in 2014: Directive 2014/45/EU on the periodic roadworthiness tests for motor vehicles and their trailers; Directive 2014/46/EU on the registration documents for vehicles; and Directive 2014/47/EU on the technical roadside inspection of commercial vehicles. Directive 2014/45/EU establishes minimum inspection frequencies for passenger cars at four years after first registration and every two years thereafter, with explicit permission for member states to adopt stricter regimes. Following the Commission's amendment proposal of April 2025 and the European Parliament's confirmation of its mandate to enter interinstitutional negotiations in May 2026, trilogue negotiations were under way by early July 2026.

The German transposition is contained in § 29 of the Straßenverkehrs-Zulassungs-Ordnung (StVZO) and in its Anlage VIII. The inspection regime is documented in the Gebührenordnung für Maßnahmen im Straßenverkehr (GebOSt) and the standardized inspection protocols of the Technical Service organizations (TÜV Süd, TÜV Nord, TÜV Rheinland, DEKRA, and smaller providers). The headline fee reference applied in this report is the ADAC market-average HU-only fee of approximately EUR 90 (ADAC, 2024).

Two institutional features of the German inspection regime shape the cost side and the behavioral mechanism of the cost–benefit framework.

1. First, inspection fees are borne directly by vehicle owners at the point of use. Moving older vehicles from biennial to annual inspections, therefore, raises the private compliance burden for the affected cohort. The welfare calculation captures this burden through the marginal inspection fee, while separate public administrative costs are assumed to be of second-order magnitude relative to this fee-based proxy.
2. Second, inspection frequency is not merely an administrative parameter; it also affects owner behavior. Shorter inspection intervals increase the expected proximity of regulatory control, thereby strengthening incentives to undertake legally required repairs before the next inspection. The compliance-uplift parameter is designed to precisely capture the additional repair response induced by the annual inspection regime.

3. Related Literature and Benefit-Cost Framework

This chapter sets out the analytical foundations of the report. Section 3.1 reviews the international and German PTI literature to the extent that it informs the parameter ranges used in the calculation, distinguishing the elasticity-based and German evidence-based identification traditions. Section 3.2 then specifies the benefit-cost framework itself, including the notation, the causal channels linking inspection frequency to accident-relevant defect exposure, and the annual accounting structure applied throughout the report.

3.1 Related Literature

The empirical literature on PTI does not converge on a common sign or magnitude of the effect, and two research traditions coexist, estimating different objects and using different identification strategies. The international literature is used in the present report to bound parameter ranges, not to provide the calibration; the calibration of d , r , i , κ , and the scenario-specific reduction rates relies on the German evidence base of HTW Dresden (2026a, 2026b).

The elasticity tradition exploits regional or temporal variation in inspection requirements to identify the effect of inspection on accident rates. Reported estimates range from indistinguishable from zero for passenger cars under periodic inspection in Norway (Christensen & Elvik, 2007) to economically material reductions for heavy goods vehicles under roadside inspection (Elvik, 2023). The systematic review by Martín-delosReyes et al. (2021) identifies six studies with heterogeneous results — individual estimates range from no significant effect to crash-rate reductions of approximately 8 to 9 percent — and concludes, without attempting a quantitative synthesis, that periodic inspection may be associated with a modest reduction in road crashes; see also the synopsis of 15 international studies in Schulz (2026). These point estimates and ranges discipline the upper-bound sensitivity of η in Scenario C of the present report.

The German accident reconstruction evidence reconstructs the causal chain of individual accidents through expert inspection of damaged vehicles and reports that accident-relevant defect shares are in the order of five to ten percent of severe accidents (HTW Dresden, 2026a, 2026b). Accident reconstruction evidence identifies whether technical defects were relevant to the accident's occurrence; it does not define a separate cost-

benefit method. Together with the fleet defect-prevalence evidence and the before/after repair evidence, it supplies the calibration inputs for d , r , i , and κ . The behavioral response of vehicle owners to an upcoming inspection – the compliance mechanism – is implicit in the elasticity literature but is made explicit through the κ uplift in the present model.

The report does not attempt a formal synthesis of the two identification traditions; it uses the international literature to bound parameter ranges and the German evidence base for calibration.

3.2 Benefit-Cost Framework

This section defines the benefit-cost framework used in the report. The analysis evaluates a regulatory change that shifts passenger cars aged ten years and older from the current biennial HU cycle to an annual inspection cycle. For each year from 2024 to 2035, the framework estimates the social accident costs avoided by the regulatory change and compares them with the marginal inspection costs generated by the additional annual inspection round. The analytical structure is summarized in Figure 2.

The headline criterion is the FORSA-informed, scenario-weighted, undiscounted aggregate benefit-cost ratio for 2024–2035. It is complemented by the aggregate net benefit, the annual BCR trajectory, and descriptive statistics for the annual BCR series. The framework is an aggregate allocative welfare test. It assesses whether the regulatory change increases aggregate social welfare; it does not estimate the distribution of costs and benefits among vehicle owners, inspection organizations, insurers, the Treasury, or other stakeholder groups.

Benefits are measured as avoided social accident costs. For each severity category, the model applies a severity-specific reduction rate to the relevant passenger-car-caused baseline accident pool. The resulting avoided accidents are monetized using the BAST 2024 social accident unit costs. The benefit side includes six categories: fatalities, serious injuries, slight injuries, the property-damage component of injury accidents, serious property-damage accidents, and pure property-damage-only events. This convention follows the BAST welfare-cost framework and treats accident costs as social resource losses rather than merely private financial transfers.

The effect of the annual HU requirement enters the calculation through severity-specific reduction rates derived from the HTW fleet-dynamic scenarios. These rates reflect the causal pathway through which inspection frequency affects accident-relevant defect exposure: detection of defects, remediation of identified defects, the interval-reset effect of a shorter inspection cycle, and behavioral compliance induced by the anticipated inspection. The three HTW scenarios are aggregated by the FORSA-informed weighting convention developed in Section 6.1. The cost-benefit calculation is therefore performed on the weighted reduction rates, not on separately reported per-scenario BCRs.

Costs are measured as the marginal inspection costs generated by the additional annual inspection round. The central calculation uses the ADAC HU-only fee of approximately EUR 90 as the reference value for the marginal inspection cost. Three conventions govern the cost side. First, the cost concept is restricted to real resource use. Profit margins and tax-like components embedded in market prices are treated as transfers between agents and are not counted as social costs in their own right. Second, the full HU-only fee is used in the central calculation as a conservative proxy for marginal resource cost; a robustness check applies a transfer-share parameter θ to hold out the share of the posted fee that may represent profit margins or other transfer-like

components. Third, repair costs are not included as a separate cost item. The technical defect and the legal obligation to maintain a roadworthy vehicle exist independently of the inspection. The HU reveals, verifies, and enforces compliance with an existing obligation; it does not create the underlying defect. Inspection-induced changes in the timing of repairs are therefore treated as a limitation rather than as a separate cost stream.

The framework uses a yearly accounting structure. Annual benefits are computed as avoided accidents multiplied by BAST unit costs, summed across severity categories. Annual costs are computed as the number of marginal additional inspections multiplied by the marginal inspection fee, adjusted in sensitivity analysis by the transfer-share parameter. Annual benefits and costs are then aggregated over the 2024–2035 horizon. The headline BCR is the ratio of total undiscounted benefits to total undiscounted costs over that horizon. The aggregate net benefit is the corresponding difference between total undiscounted benefits and total undiscounted costs.

The notation used throughout the report is summarized in Table 2. The compliance term is denoted by κ rather than c to avoid confusion with cost variables. The equations below define the avoided-accident calculation, annual benefits, annual costs, the annual BCR, the undiscounted aggregate BCR, and the aggregate net benefit.

Table 2
Notation Used in the Benefit-Cost Framework

Symbol	Meaning
$A_{j,t}$	Annual passenger-car-caused baseline accident pool in year t , severity category j (fatal, serious injury, slight injury, injury-accident property damage, serious PDO, pure PDO)
m_{PC}	Passenger-car main-cause share; $m_{PC} = 0.68$ (Destatis FS8R7, ten-year average)
q_{10+}	Ten-plus cohort allocation; share of passenger-car-caused accidents attributable to vehicles aged ten and above; $q_{10+} = 0.40$
p	Age-weighted accident-relevant defect factor for vehicles aged ten and above; derived from the Survey 1 accident-relevance curve and weighted by the in-traffic exposure structure of Survey 2
η (eta)	Technical PTI-effectiveness parameter (inspection-induced effect)
d	Detection probability
r	Remediation probability
i	Interval-reset model factor; $i \approx 0.625$ under Poisson first-passage logic
κ (kappa)	Compliance uplift; central calibration $\kappa = 0.55$ (HTW Dresden 2026a)
$\rho_{j,t}^z$ (rho)	Final effective severity-specific reduction rate for severity category j and year t ; the superscript indexes Scenario A, Scenario B and Scenario C. The rate is capped at 0.50.
u_j	BAST 2024 social accident unit cost (volkswirtschaftliche Unfallkosten) for severity category j
f	Marginal inspection fee per additional annual round; central $f = \text{EUR } 90$ (ADAC HU-only)
V_t^{10+}	Number of passenger cars aged ten years and above in year t
M_t	Number of marginal additional inspections in year t ; $M_t \approx 0.5 \cdot V_t^{10+}$
θ	Non-resource share of f in the cost-side sensitivity; central $\theta = 0$; sensitivity $0 \leq \theta \leq 0.10$
w_A, w_B, w_C	FORSA-informed scenario weights on Scenarios A, B, and C, with $w_A + w_B + w_C = 1$; Headline weighting variant (0.010, 0.495, 0.495)
ϵ_A (epsilon)	Residual weight assigned to Scenario A in the FORSA-informed weighting convention; Headline $\epsilon_A = 0.01$; sensitivity variants $\epsilon_A = 0.05$

Note. The compliance term is denoted κ (kappa) rather than c to avoid confusion with cost variables.

Technical effectiveness equation. The four causal channels of the model – detection (d), remediation (r), interval reset (i), and compliance uplift (κ) – combine multiplicatively to determine the scenario-specific reduction rate that is applied to the baseline accident pool. The severity-specific reduction rates used in the present calculation are taken directly from the HTW Dresden (2026c) corrected partner deliverable for the three fleet-dynamic scenarios A, B, and C, multiplied by the compliance uplift ($1 + \kappa$).

$$\eta = d \cdot r \cdot i.$$

Detection and remediation enter as probabilities. The interval-reset effectiveness factor enters multiplicatively. The compliance uplift κ acts on the partner-reduction rate as a separate proportional add-on. The scenario-specific reduction rates $\rho_{j,t}^z$ used in this report are taken directly from HTW Dresden (2026c) for the three fleet-dynamic scenarios A, B, and C, multiplied by ($1 + \kappa$). They are not recomputed from d , r , and i ; those channels are documented as the conceptual model of Section 3.2 but do not enter the numerical calculation as independent multipliers.

Bridge from η , κ , q_{10+} , and P to the scenario reduction rate. The scenario-specific reduction rate $\rho_{j,t}^z$ collapses four model elements into a single final post-uplift rate applied to the baseline accident pool: the ten-plus cohort allocation q_{10+} , the age-weighted accident-relevance factor P , the technical effectiveness η of the relevant scenario, and the compliance uplift κ . The exact mapping from $\{\eta, q_{10+}, P, \kappa\}$ to $\rho_{j,t}^z$ varies by severity category j because the corrected partner deliverable HTW Dresden (2026c) reports severity-specific percentages that are not a single multiplicative function of η . The partner reductions are reproduced in Table 4; their application to the annual BCR trajectory is documented in Section 6 and Table 6. $\rho_{j,t}^z$ is reported in this report as a final post-uplift rate. The compliance uplift κ is therefore not applied a second time inside the avoided-accident equation.

Avoided-accident equation. The number of accidents avoided in year t for severity category j is

$$\Delta A_{j,t}^z = A_{j,t} \cdot \rho_{j,t}^z.$$

The superscript z is a compact index for the three scenarios; the equation is applied separately to Scenarios A, B, and C.

The 0.50 cap applies to the final combined effective reduction rate $\rho_{j,t}^z$ before its multiplication with the baseline accident pool. It is a precautionary ceiling that rules out a physically implausible reduction of more than half of defect-attributable accidents in any severity category.

Weighted headline reduction rate. The three scenario-specific reduction rates are aggregated to a single headline rate using the FORSA-informed weights (w_A , w_B , w_C). The corresponding headline avoided accidents and headline annual benefit follow as

$$\bar{\rho}_{j,t} = w_A \cdot \rho_{j,t}^A + w_B \cdot \rho_{j,t}^B + w_C \cdot \rho_{j,t}^C, \text{ with } w_A + w_B + w_C = 1.$$

$$\Delta \bar{A}_{j,t} = A_{j,t} \cdot \bar{\rho}_{j,t}.$$

$$\bar{B}_t = \sum_j \Delta \bar{A}_{j,t} \cdot u_j.$$

The headline BCR is calculated from the weighted benefits $\bar{B}_t$ divided by the (scenario-invariant) annual cost C_t , not from an arithmetic average of the three per-scenario BCRs. The Headline weighting variant uses $(w_A, w_B, w_C) = (0.010, 0.495, 0.495)$; see Section 6.1 for the FORSA-informed weight derivation.

Annual benefit. The monetized annual benefit in year t is the sum, across the six severity categories, of avoided accidents valued at the BAST 2024 social accident unit costs:

$$B_t^z = \sum_j \Delta A_{j,t}^z \cdot u_j.$$

Annual cost. The marginal annual cost in year t is

$$C_t = M_t \cdot f \cdot (1 - \theta), \text{ with } M_t \approx 0.5 \cdot V_t^{10+}.$$

In the 2024 base year, $V_t^{10+} \approx 22.5$ million and $M_t \approx 11.25$ million, so the central annual marginal cost is approximately EUR 1,012.5 million in constant 2024 prices, conditional on the ADAC EUR 90 fee reference. The transfer-share parameter $\theta \in [0, 0.10]$ holds out the share of the posted fee that represents profit margins or other transfer-like components; the sensitivity range $0 \leq \theta \leq 0.10$ is adopted as an illustrative sensitivity range, broadly consistent with the order of magnitude of gross-margin indicators from major PTI providers with publicly available annual reports (TÜV Süd, TÜV Nord, TÜV Rheinland, DEKRA).

The cost line is held constant at the 2024 level of the affected cohort. This is a conservative simplification if the annual HU induces scrappage or substitution away from vehicles aged ten years and older, because the number of marginal additional inspections would then decline over time. A fully scenario-consistent cost specification would require annual estimates of the 10+ vehicle stock under each HTW fleet-dynamic scenario. Since these stock trajectories are not separately available for the 10+ policy cohort, the report retains the constant-cost assumption and documents it as a limitation in Section 11.

For each year t , the annual benefit-cost ratio is defined as annual benefits divided by annual costs:

$$BCR_t^z = B_t^z / C_t.$$

The headline criterion is the FORSA-informed, scenario-weighted, undiscounted aggregate BCR for 2024–2035. It is defined as the sum of weighted annual benefits over the evaluation horizon divided by the sum of annual costs over the same period:

$$\bar{BCR}_{2024-2035} = \frac{\sum_{t=2024}^{2035} \bar{B}_t}{\sum_{t=2024}^{2035} C_t}.$$

The corresponding aggregate net benefit is:

$$\bar{NB}_{2024-2035} = \sum_{t=2024}^{2035} \bar{B}_t - \sum_{t=2024}^{2035} C_t.$$

This undiscounted specification is used as the headline criterion because both benefits and costs are modeled as recurring annual resource effects over a finite evaluation horizon rather than as a one-time investment outlay followed by a stream of future returns. Annual accident-cost savings are interpreted as social resource savings realized in the year the accidents are avoided, while annual inspection costs are incurred within the same yearly accounting structure. To assess the sensitivity of the result to conventional time-discounting assumptions, Section 8 provides present-value robustness checks using social discount rates of 3 percent and 0.7 percent.

Schulz (1994) conceptual basis. Schulz (1994, pp. 44–50) distinguishes between the annualization of investment costs and the annual representation of benefits. For costs, the relevant treatment depends on the financing and reinvestment assumptions: investment outlays can either be spread over the lifetime or converted into annual costs using present-value and annuity-factor calculations. For benefits, Schulz shows that the average annual benefit equals the benefit annuity when realized benefits are understood to be available for productive reuse over time. In this sense, the annual benefit can be represented as the annual resource saving rather than as a financial cash flow that mechanically declines in value merely because it occurs later.

The headline criterion is the undiscounted aggregate BCR for 2024–2035. This choice reflects the interpretation of annual accident-cost savings as social resource savings realized in each year of the evaluation horizon. Present-value BCRs using social discount rates of 0.7 percent and 3 percent are reported as robustness checks and for comparability with conventional cost-benefit practice. These variants place annual benefits and costs on a common time basis, whereas the headline criterion preserves the report’s primary welfare perspective: the aggregate balance of social accident-cost savings and marginal inspection costs over the full horizon. For brevity, the FORSA-informed, scenario-weighted, undiscounted aggregate 2024–2035 BCR is referred to in the remainder of the report as the headline BCR.

Avoided accident costs are social resource savings, not automatic financial cash inflows. The report therefore does not add a separate reinvestment return on avoided accident costs. Doing so would require a separate macroeconomic model of resource reuse and could otherwise double-count the benefit already captured by the BAsT social accident unit costs.

Descriptive time-series statistics—arithmetic mean, median, and annual BCR range—are reported as complements to the headline aggregate criterion. They describe the shape and stability of the annual BCR trajectory but do not replace the aggregate welfare test. The annual ratios are not averaged as the primary decision criterion, because such an average would assign equal weight to years with different benefit and cost magnitudes. By contrast, the aggregate BCR weights years implicitly by their economic size. The numerical statistics are reported in Section 6 and Table 7.

Each parameter is calibrated on the German evidence base; the mapping from parameter to source is summarized in Table 3.

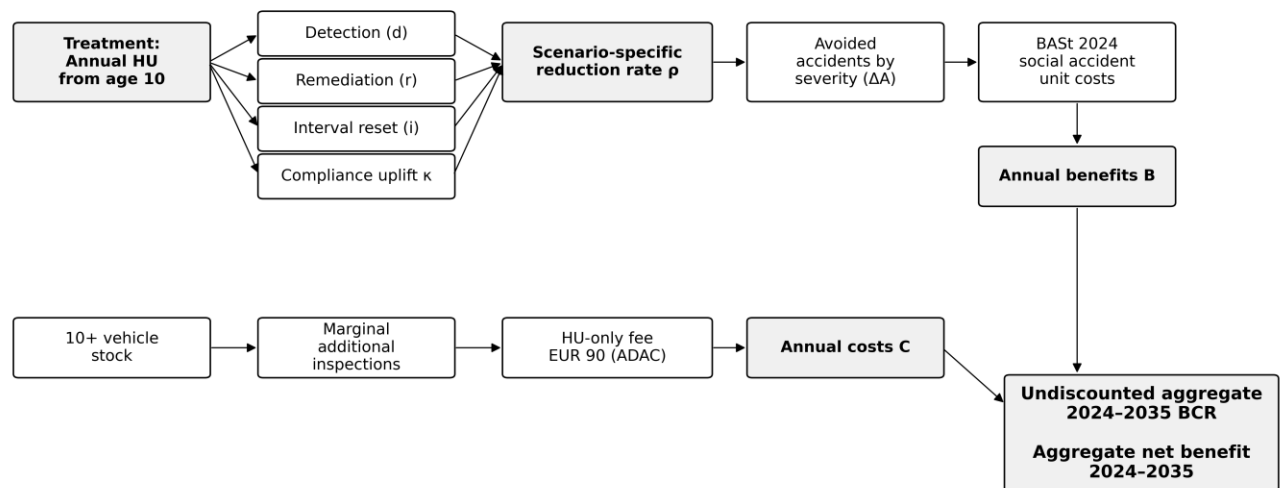
Table 3
Empirical Anchors of the Model Parameters

Parameter	Empirical anchor	Source
d	Survey 2 three-stage paired measurement	HTW Dresden (2026b)
r	Survey 2 three-stage paired measurement	HTW Dresden (2026b)
i	Survey 2 in-traffic prevalence under Poisson first-passage logic; $i \approx 0.625$	HTW Dresden (2026a, 2026b)
κ	Projection that the traffic-weighted share of defect-carrying vehicles falls by more than half under annual inspection; $\kappa = 0.55$	HTW Dresden (2026a)
$\rho_{j,t}^z$	Severity-specific reduction percentages from the reduction-potential assessment for 2035, in combination with κ	HTW Dresden (2026c, 2026d)

Note. Each parameter is calibrated on the German evidence base of HTW Dresden (2026a, 2026b).

Figure 2 summarizes the analytical architecture of the benefit-cost framework. The upper branch represents the benefit mechanism: the annual HU requirement affects accident-relevant defect exposure through detection, remediation, interval-reset effects, and behavioral compliance, which jointly determine the scenario-specific reduction rates. These reductions translate into avoided accidents by severity category and, after monetization with the BAST 2024-unit costs, into annual social benefits. The lower branch represents the cost mechanism: the number of additional marginal inspections generated by the annual HU regime is multiplied by the marginal inspection fee to obtain the annual inspection costs. The framework then aggregates annual benefits and costs over the 2024–2035 horizon to derive the headline aggregate benefit-cost ratio and aggregate net benefit.

Figure 2
Benefit-Cost Framework



Note. The four causal channels (detection, remediation, interval reset, compliance) translate the regulatory change into the scenario-specific reduction rate ρ , the avoided accidents ΔA , the annual benefits B, and the annual costs C, and finally into the undiscounted aggregate 2024–2035 BCR and the aggregate net benefit over 2024–2035. The equation is applied separately to Scenarios A, B, and C. Source: Own figure.

4. Data

This chapter documents the data inputs used in the cost-benefit calculation. Section 4.1 reports the passenger-car stock figures from the Kraftfahrt-Bundesamt, and Section 4.2 the accident baselines from Destatis. Section 4.3 introduces the four-element German evidence base — two independent empirical surveys, the theoretical fleet-dynamic scenarios, and the FORSA consumer survey — on which the causal calibration rests; Sections 4.4 and 4.5 present the two defect-age curves and the HTW Dresden 2035 reduction potentials derived from them. Section 4.6 documents the BAST 2024 social accident unit costs used for monetization.

4.1 Fleet Data (KBA, 1 January 2024)

The Kraftfahrt-Bundesamt (KBA) reports a total passenger-car stock of 49.10 million on 1 January 2024, with an average age of 10.3 years and a 2.8 percent share of vehicles aged thirty and above (approximately 1.37 million). The cohort of interest for the regulatory change is vehicles aged ten and above, estimated at 22.5 million (10-14 years: 7.60 million; 15-29 years: 13.53 million; ≥ 30 years: 1.37 million). Under the staggered biennial baseline, annualization adds approximately 11.25 million additional inspections per year for this cohort.

4.2 Accident Data (Destatis, 2024)

The Federal Statistical Office (Destatis), Press Release 075/2025, reports for the calendar year 2024: 2,780 fatalities, 50,300 seriously injured and approximately 312,700 slightly injured road users; 289,000 injury accidents; and approximately 2.5 million police-recorded accidents in total, of which approximately 80,000 are classified as serious property-damage accidents and approximately 2.13 million as other property-damage accidents. The passenger-car share of accidents in which the passenger car is the main cause is 0.68 (Destatis Fachserie 8 Reihe 7, ten-year average). Applying the passenger-car main-cause share as an allocation proxy to the Destatis 2024 baseline yields, for the purposes of this calculation, an estimated 1,890 fatalities, 34,200 seriously injured, 212,600 slightly injured, 196,520 injury accidents, 54,400 serious property-damage accidents, and 1.45 million pure PDO events per year associated with passenger-car-caused accidents. The main-cause share is an accident-based allocation proxy applied across severity categories; it is not a direct severity-specific extraction.

4.3 The German Evidence Base: Two Empirical Surveys, the Fleet-Dynamic Scenarios, and FORSA

The German evidence base for the present analysis comprises four elements documented in HTW Dresden (2026a, 2026b, 2026d): two independent empirical surveys, the theoretical construction of three fleet-dynamic scenarios, and the FORSA consumer survey. The two empirical surveys answer two different questions about technical defects and the HU; the scenario construction projects the resulting fleet dynamics under the regulatory change; and the FORSA consumer survey, added through the final HTW report, supplies the empirical behavioral anchor that plausibilizes the scenarios. Taken together, these four elements close the causal chain that the cost-benefit analysis monetizes.

4.3.1 Survey 1 – Accident-reconstruction sample (DEKRA, n = 2,429)

Survey 1 is the DEKRA gerichtliche Unfallgutachten sample of 2,429 severe accidents covering 2014–2025, documented as Arbeitspaket 3 of HTW Dresden (2026b) and summarized in HTW Dresden (2026a). Design:

ex-post forensic reconstruction of the causal chain of individual accidents by certified DEKRA experts. Question answered: how often are technical defects the principal cause of severe accidents, and how does the accident-relevant defect share vary with vehicle age. Key result for the present analysis: a logistic age curve of accident-relevant defects rising from approximately 2.9 percent at age three or less to approximately 17.5 percent at age twenty-four; an all-ages accident-relevant defect share of approximately 7.0 percent.

4.3.2 Survey 2 – In-traffic field survey with three-stage measurement (n = 11,604)

Survey 2 is the in-traffic field survey conducted in 2025 by TÜV Süd, TÜV Nord, TÜV Rheinland, and DEKRA jointly, documented as Arbeitspaket 4 of HTW Dresden (2026b) and summarized in HTW Dresden (2026a). Design: ex ante state assessment of 11,604 passenger cars drawn from the circulating in-traffic fleet, with three-stage paired measurement on the same vehicles – vehicle state in traffic (before the HU), first presentation for the HU, and state after repair and maintenance at the HU. Questions answered: (i) what is the age-dependent prevalence of accident-relevant technical defects in the circulating fleet; and (ii) does the HU empirically remove identified defects? Key results: an EM/VM/VU-combined defect share rising from approximately 25 percent at age three to approximately 70 percent at age fifteen, with the narrow EM/VU measure before repair reaching 61.9 percent at age twenty-four; and a defect-rate increment before repair (EM/VU) of 13.6 to 29.7 percent that is removed at the inspection event, documenting that the HU has both a detection and a remediation effect.

4.3.3 The theoretical construction of three fleet-dynamic scenarios

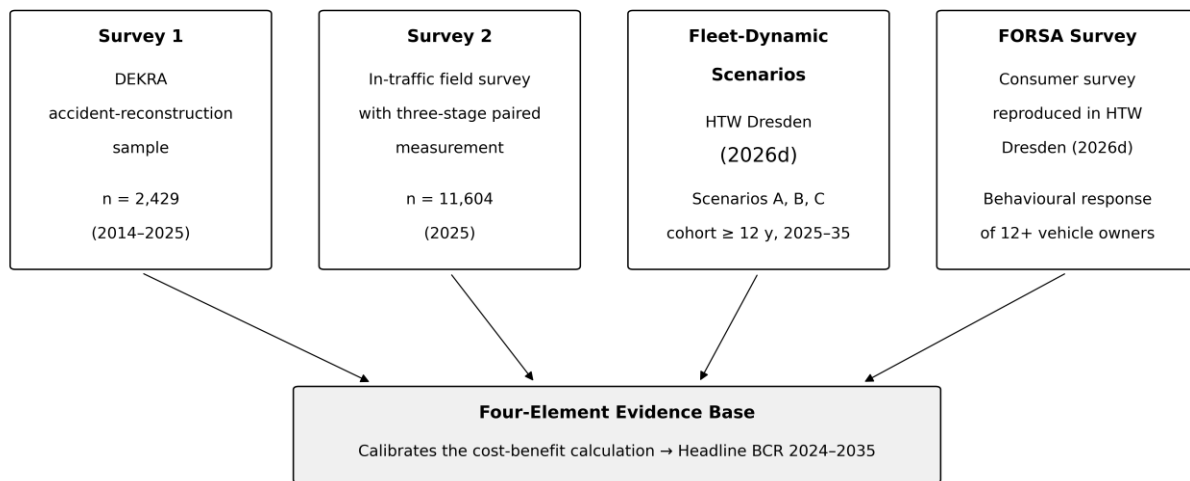
The third element of the HTW evidence base is not a survey but the theoretical construction of three fleet-dynamic scenarios A, B, and C, defined in HTW Dresden (2026d). The scenarios project alternative paths of the passenger-car stock and mileage for the cohort aged 12 and above between 2025 and 2035 – linear continuation under no HU-induced behavioral effect (Scenario A); halved growth of the cohort stock reflecting a moderate HU-induced substitution (Scenario B); and stabilized cohort with no further growth reflecting a strong HU-induced substitution (Scenario C). HTW Dresden (2026d) explicitly describes the three scenarios as sensitivity calculations, not point predictions. The scenarios are theoretical constructs derived from the two empirical surveys above and from documented disposal-and-substitution patterns in the German passenger-car market (HTW Dresden, 2026d). The behavioral plausibility of the scenarios is anchored empirically by the FORSA consumer survey (Section 4.3.4).

4.3.4 The FORSA consumer survey and why the four-element structure matters

The FORSA consumer survey, commissioned in the context of the HTW study and reproduced in HTW Dresden (2026d), is the fourth element of the evidence base; it was added through the final HTW report. The survey characterizes the behavioral response of owners of passenger cars older than 12 years to the upcoming Hauptuntersuchung: three out of four owners visited a workshop in the past four years specifically because of the upcoming HU; three out of four would scrap their vehicle if the cost of a necessary repair exceeded its residual value; and only 6 percent would purchase another vehicle older than 12 years on their next purchase, while 62 percent would purchase a vehicle younger than 6 years and 9 percent would not purchase any vehicle at all. The four-element structure closes the causal chain that the cost-benefit analysis monetizes: Survey 1 identifies the share of severe accidents in which technical defects are causally relevant, contributory, or accident-favoring, and quantifies the age gradient of accident-relevant defects; Survey 2 establishes that defect-carrying vehicles are present in the in-traffic fleet in increasing numbers and that the HU empirically

removes identified defects; the theoretical scenarios A, B, and C project the resulting fleet dynamics; and FORSA provides the empirical behavioral anchor that plausibilizes the scenarios. Figure 3 summarizes the resulting evidence chain.

Figure 3
Four-Element Evidence Chain



Note. Survey 1 (DEKRA accident-reconstruction sample, n = 2,429, 2014–2025) supplies the age gradient of P. Survey 2 (in-traffic field survey, n = 11,604, with three-stage paired measurement on the same vehicles) supplies fleet prevalence, the exposure weights for P, the detection-and-remediation evidence, and the calibration of i and κ . The three fleet-dynamic scenarios A, B, and C (HTW Dresden, 2026d) project the resulting passenger-car stock dynamics for the cohort aged 12 and above. The FORSA consumer survey (HTW Dresden, 2026d) provides the empirical behavioral anchor for the scenarios. Source: Own figure based on HTW Dresden (2026a, 2026b).

4.4 The Two Defect-Age Curves

The two empirical surveys yield two empirically distinct defect-age curves that should be distinguished. Earlier drafts of this report conflated the two; the present version separates them and identifies which curve anchors which model parameter.

Survey 1 accident-relevance curve. The logistic curve of HTW Dresden (2026a, 2026b) rises from approximately 2.9 percent at age three or less to approximately 17.5 percent at age twenty-four; confidence intervals widen beyond age twenty-four. This curve measures the share of vehicles involved in severe accidents that are classified as carrying an accident-relevant defect, conditional on age. It anchors the age gradient of P in the benefit-cost framework.

Survey 2 fleet-prevalence curve. The EM/VM/VU-combined share in the in-traffic field survey rises from approximately 25 percent at age three to approximately 70 percent at age fifteen; the narrow EM/VU measure before repair reaches 61.9 percent at age twenty-four (HTW Dresden, 2026b). This curve measures the share of in-traffic vehicles that carry at least one EM/VM/VU defect at any given moment, independent of whether an accident occurs. It supports exposure weighting for P and calibrating i and κ .

The age-weighted defect share of 10.9 percent for vehicles aged 10 and above is derived from an age-weighted average of the Survey 1 accident-relevance curve, using the in-traffic exposure weights from Survey 2. This is the parameter P.

4.5 Reduction-Potential Assessment for 2035

HTW Dresden (2026d) applies a periodic reset model of the defect probability to the two-survey evidence base, augmented by the theoretical scenarios and the FORSA consumer survey, and derives direct reduction potentials in the count of passenger-car-caused accidents under alternative HU cycles, separately for the three HTW fleet-dynamic scenarios A, B, and C. The numerical reduction percentages for the HU cycle 3/2/2/2/1 (annual HU from age ten) – the policy variant of interest in this report – are summarized in Table 4 and applied in the cost-benefit calculation in Section 6.

Table 4

HTW Dresden Direct Reduction Potentials for the HU Cycle 3/2/2/2/1, by Fleet-Dynamic Scenario

Severity	Scenario A (linear continuation)	Scenario B (halved growth)	Scenario C (stabilized cohort)
Injury accidents (raw reduction)	1.40 %	3.70 %	6.30 %
Fatalities (raw reduction)	1.64 %	3.86 %	6.34 %
Serious injuries (raw reduction)	1.54 %	3.89 %	6.49 %
Slight injuries (raw reduction)	1.37 %	3.65 %	6.14 %

Note. Raw reduction percentages are taken from HTW Dresden (2026c). The effective reduction rates used in the welfare calculation are obtained by multiplying the raw rates by the compliance uplift factor $(1 + \kappa) = 1.55$. Source: HTW Dresden (2026c); HTW Dresden (2026d).

4.6 Unit-Cost Data (BASt 2024 reference year)

Monetization uses the unit-cost catalog published by the Bundesanstalt für Straßen- und Verkehrswesen in November 2025 – Volkswirtschaftliche Kosten von Straßenverkehrsunfällen in Deutschland, Bezugsjahr 2024 (BASt, 2025) – at constant 2024 prices. The key parameters are summarized in Table 5.

Table 5

Key Parameters of the Cost-Benefit Framework, 2024 Base Year

Parameter	Value	Source
Total passenger-car fleet (1 January 2024)	49.10 M	KBA
Fleet ≥ 10 years (cohort of interest)	22.50 M	KBA (derived)
Marginal additional inspections per year (2024)	11.25 M	Derived
Marginal inspection fee (HU-only, single fee reference)	EUR 90	ADAC (2024)
Accident-relevant defect share (all ages)	7.0 %	Survey 1; n = 2,429
Age-weighted defect share (≥ 10) - parameter P	10.9 %	Survey 1 $\times$ Survey 2 weights
Ten-plus cohort allocation (q_{10+})	0.40	Derived from Survey 1 age gradient + KBA fleet shares
Defect-rate increment before repair (EM/VU)	13.6-29.7 %	Survey 2
Passenger-car main-cause share (m_{PC})	0.68	Destatis FS8R7
Compliance uplift κ (medium calibration)	0.55	HTW Dresden (2026a) projection
Cost per fatality	EUR 1,465,820	BASt (2025)
Cost per seriously injured	EUR 149,147	BASt (2025)
Cost per slightly injured	EUR 6,603	BASt (2025)
Cost per injury accident (PDO part)	EUR 18,891	BASt (2025)
Cost per serious-damage accident	EUR 27,175	BASt (2025)
Cost per other property-damage accident	EUR 8,811	BASt (2025)

Note. Cost values are BASt 2024 social accident unit costs (volkswirtschaftliche Unfallkosten) in constant 2024 prices.

5. Empirical Strategy

This chapter sets out the empirical strategy that links the data inputs of Chapter 4 to the welfare estimates reported in Chapters 6 through 8. Section 5.1 documents how the passenger-car-caused, defect-attributable accident pool is constructed. Section 5.2 sets out the decomposition of the inspection-induced effect into detection, remediation, and interval-reset channels, and Section 5.3 introduces the behavioral-compliance mechanism through which vehicle owners respond to the anticipated inspection. Section 5.4 summarizes the welfare framework on which the aggregate benefit-cost test is built.

5.1 Identification of Defect-Attributable Accidents

Defect-attributable accidents are constructed as follows. First, the Destatis counts of injury accidents and PDO accidents are multiplied by the passenger-car main-cause share $m_{PC} = 0.68$ (Destatis FS8R7, ten-year average), applied as an accident-based allocation proxy across severity categories rather than as a severity-specific extraction, to obtain the passenger-car-caused baseline of approximately 196,520 injury accidents and 1,448,400 pure PDO accidents per year. Per-severity baseline counts $A_{j,t}$ are then obtained by applying the standard injury-accident severity distribution to this passenger-car-caused base. The cohort allocation parameter q_{10+} and the age-weighted accident-relevance factor P are upstream components of the HTW Dresden reduction potentials reported in Table 4 and are therefore not applied again in the present welfare calculation.

5.2 PTI Effectiveness Decomposition

The present report adopts the HTW fleet-dynamic Scenarios A, B, and C (HTW Dresden, 2026d). The corresponding severity-specific reduction rates for the 3/2/2/1 inspection cycle — annual HU from vehicle age ten onward — already embed the differentiated fleet dynamics and age-structure effects underlying the three scenarios.

5.3 Behavioral-Compliance Mechanism

The behavioral-compliance mechanism captures the reduction in traffic-weighted defect exposure that arises because vehicle owners anticipate the upcoming inspection and undertake legally required repairs earlier than they otherwise would. It is implemented as a multiplicative uplift $(1 + \kappa)$ on the inspection-induced effect. The central calibration is $\kappa = 0.55$, derived from the projection of HTW Dresden (2026a) and HTW Dresden (2026b) that the traffic-weighted share of vehicles with serious or dangerous defects declines by more than half under annual inspection from age ten.

The calibration logic proceeds in three steps. First, the severity-specific reduction rates delivered by HTW Dresden (2026c) are generated by a periodic reset model of the defect probability. They therefore capture the channels that operate at or through the inspection event itself: detection, remediation, and the interval reset. Second, HTW Dresden (2026a) projects the total fleet-level effect of the annual inspection regime: under an annual HU from age ten, the traffic-weighted share of vehicles with serious or dangerous defects declines by more than half. This projection includes the anticipatory repair response of vehicle owners, which the event-based reduction rates do not capture. Third, the compliance uplift closes the gap between these two quantities: κ is set so that the effective reduction rates are consistent with the projected decline in the traffic-weighted defect share, yielding $\kappa = 0.55$ and hence the multiplicative factor $(1 + \kappa) = 1.55$.

In numerical terms, the uplift is a single multiplication. Under the headline weighting variant, the aggregated raw reduction rate for injury accidents is approximately 4.96 percent; multiplied by 1.55, it becomes the effective rate of approximately 7.69 percent that enters the welfare calculation (Section 6.2). The behavioral pattern captured by the uplift is familiar from the economics of law enforcement: conduct adjusts in anticipation of a control, not only at the control event itself. The FORSA consumer survey documents this anticipation directly for the HU: approximately three out of four owners of passenger cars older than twelve years report having visited a workshop in the past four years specifically because of an upcoming HU (HTW Dresden, 2026d).

The projection that annual HU reduces the traffic-weighted defect share by more than half is a modeled projection, not a causally identified effect from a natural experiment. It is produced by applying the reset logic – the observation, in Survey 2's three-stage paired measurement, that the HU empirically removes identified defects – to the Survey 2 fleet-prevalence curve, conditional on the Survey 1 accident-relevance gradient. The projection is therefore underpinned by the German evidence base of two independent empirical surveys, not by a single anchor. The compliance uplift is not an external add-on; it is calibrated from the German evidence base.

5.4 Welfare Framework

The annual benefit is the sum of avoided injury-accident costs (fatalities, serious injuries, slight injuries, and the PDO component of injury accidents), avoided serious property-damage accident costs, and avoided other property-damage accident costs, monetized at the BASt 2024 social accident unit costs in constant 2024 euro. The annual cost is the marginal inspection fee multiplied by the number of additional inspections: 11.25 million $\times$ EUR 90 $\approx$ EUR 1,012.5 million in the 2024 base year. The annual net benefit is benefit minus cost; the annual BCR is benefit divided by cost. The aggregate welfare statistics are reported in Section 6 (undiscounted aggregate 2024–2035 BCR, aggregate net benefit) and in Section 8 (present-value robustness).

6. Results

Section 6.1 sets out the FORSA-informed decision tree that yields the weights on the three HTW fleet-dynamic scenarios. Section 6.2 applies these weights to the per-scenario reduction rates of HTW Dresden (2026c) and reports the aggregated severity-specific reduction rates that enter the cost-benefit calculation. Section 6.3 applies the weighted rates to the 2024 base year. Section 6.4 reports the annual trajectory of the benefit-cost ratio over 2024–2035. Section 6.5 reports the sensitivity to the compliance uplift κ . Section 6.6 presents the headline weighted aggregate 2024–2035 BCR with a numerical audit trail. The cost-benefit analysis is computed once, on the aggregated behavioral inputs from Section 6.2; per-scenario benefit-cost ratios are not reported as separate results.

6.1 The FORSA-Informed Decision Tree for Scenario Weighting

6.1.1 The Three HTW Fleet-Dynamic Scenarios

The three HTW fleet-dynamic scenarios A, B, and C are defined in HTW Dresden (2026d). They differ exclusively in the assumed future stock dynamics of the passenger-car cohort aged twelve years and older between 2025

and 2035. Annual mileage continues on its linear 2016–2025 trend in all three scenarios; the differentiation is confined to the stock trajectory of the older-vehicle cohort.

Scenario A represents a linear continuation of the 2016–2025 stock and mileage trend for the cohort aged twelve years and older and therefore corresponds to a no-behavioral-response case. Scenario B retains the same structure but halves the growth increment of the older-vehicle stock relative to Scenario A, representing a moderate HU-induced substitution from older to newer vehicles. Scenario C holds the older-vehicle cohort at its 2025 stock level, representing a stronger substitution response with no further growth in that cohort.

HTW Dresden (2026d) explicitly presents the three scenarios as sensitivity calculations rather than point predictions of the 2035 vehicle stock. They therefore span a range of plausible behavioral responses to the regulatory change; the analytical question for this report is how these scenarios can be aggregated into a single benefit-cost ratio.

6.1.2 The FORSA Consumer-Survey Findings

The FORSA consumer survey reported in HTW Dresden (2026d) provides the behavioral evidence used to assess the plausibility of the three fleet-dynamic scenarios. It characterizes how owners of passenger cars older than twelve years respond to an upcoming Hauptuntersuchung. Three findings are particularly relevant for the scenario aggregation. First, approximately three out of four owners report having visited a workshop in the past four years specifically because of an upcoming HU. Second, approximately three out of four owners state that they would scrap their vehicle if the cost of a necessary repair exceeded its residual value; only about one in four would repair the vehicle regardless. Third, among owners in this group, only 6 percent state that they would purchase another vehicle older than twelve years as their next car, whereas 62 percent would purchase a vehicle younger than six years and 9 percent would not purchase another vehicle at all.

Taken together, these findings make Scenario A—the counterfactual of no HU-induced behavioral response—empirically implausible. They do not, however, identify with precision whether the resulting stock dynamics of the cohort aged twelve years and older are closer to Scenario B, which assumes halved growth, or to Scenario C, which assumes a stabilized cohort. The FORSA evidence is therefore used not to estimate a point prediction, but to justify assigning only a small residual weight to Scenario A and distributing the remaining weight across Scenarios B and C.

6.1.3 The FORSA-Informed Residual-Weight Convention

The three HTW fleet-dynamic scenarios must be aggregated into a single benefit-cost ratio. This requires a set of scenario weights, w_A , w_B , and w_C , with $w_A + w_B + w_C = 1$. Without an explicit weighting convention, the aggregation would depend on an arbitrary analyst choice. The present report therefore adopts a transparent FORSA-informed residual-weight convention.

The convention assigns a small residual weight, ϵ_A , to Scenario A, which is least compatible with the FORSA evidence. The remaining weight, $1 - \epsilon_A$, is distributed across Scenarios B and C. The parameter ϵ_A is not a statistical test result. It is an explicit aggregation parameter that preserves a small but positive probability mass for the possibility that a residual share of older-vehicle owners does not respond behaviorally to the annual HU requirement, even though the FORSA evidence strongly disfavors a no-response scenario.

The Headline weighting variant sets $\epsilon_A = 0.01$. This reflects the interpretation that the three mutually reinforcing FORSA findings—workshop visits triggered by the upcoming HU, high stated scrappage propensity when repair costs exceed residual value, and strong substitution toward younger vehicles—make Scenario A empirically implausible but do not allow it to be ruled out completely on the basis of survey evidence alone. The remaining 0.99 is split agnostically between Scenarios B and C. The resulting weights are therefore $w_A = 0.010$, $w_B = 0.495$, and $w_C = 0.495$.

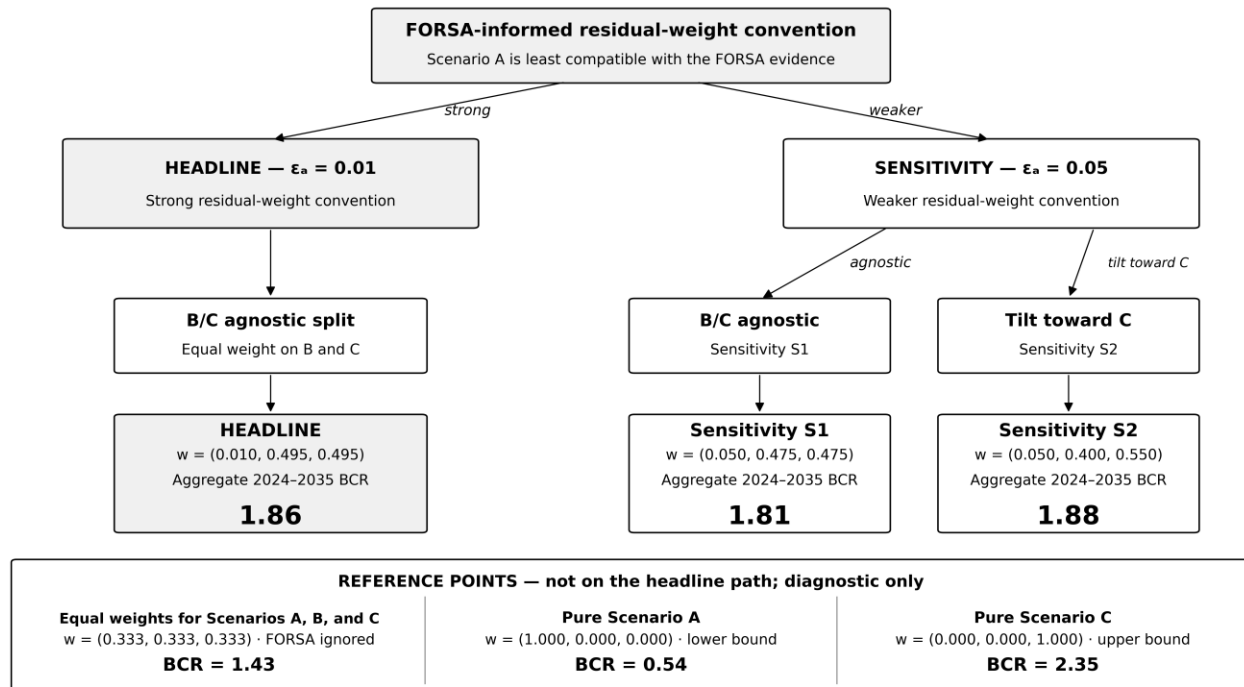
Two sensitivity variants are reported. Sensitivity S1 applies the weaker residual-weight convention $\epsilon_A = 0.05$ and again splits the remaining weight agnostically between Scenarios B and C, yielding $w_A = 0.050$, $w_B = 0.475$, and $w_C = 0.475$. Sensitivity S2 also sets $\epsilon_A = 0.05$, but shifts more of the remaining weight toward Scenario C in light of the FORSA magnitude findings, especially the high stated disposal rate and the strong stated substitution toward younger vehicles. This yields $w_A = 0.050$, $w_B = 0.400$, and $w_C = 0.550$. An equal-weight reference case, $w_A = w_B = w_C = 1/3$, is reported only for diagnostic comparison. It represents a FORSA-ignored benchmark and is not used as a recommended weighting convention.

6.1.4 Decision Tree and Bandwidth

To operationalize the FORSA-informed aggregation procedure, the report employs a transparent weighting framework for combining the three HTW fleet-dynamic scenarios. The framework distinguishes between (i) the residual weight assigned to Scenario A and (ii) the allocation of the remaining weight between Scenarios B and C. Because the FORSA evidence suggests that Scenario A is substantially less plausible than Scenarios B and C, the aggregation requires an explicit weighting convention. Figure 4 summarizes the resulting decision structure used to derive the aggregate benefit-cost estimates.

Figure 4

Decision Tree for the FORSA-Informed Weighting of the Three HTW Fleet-Dynamic Scenarios



Note. The Headline path applies a residual-weight parameter $\epsilon_A = 0.01$ to Scenario A, which is least compatible with the FORSA evidence, and an agnostic 50/50 split of the remaining 0.99 between Scenarios B and C. Two sensitivities at the weaker convention $\epsilon_A = 0.05$ —one with an agnostic B/C split and one with a tilt toward Scenario C informed by FORSA substitution evidence—are shown for completeness. Reference points (equal weights, pure Scenario A, pure Scenario C) are bounding cases, not weighting recommendations. The three-variant FORSA-consistent bandwidth is BCR 1.81–1.88. Source: FORSA findings reproduced from HTW Dresden (2026d).

Figure 4 displays the weighting structure underlying the FORSA-informed aggregation. The first branch reflects the residual-weight choice for Scenario A, while the second branch determines the allocation of the remaining weight between Scenarios B and C. The Headline path assigns a residual weight of 0.01 to Scenario A and applies an agnostic B/C split. The sensitivity paths and reference points are included to make the weighting structure fully transparent.

The three FORSA-consistent weighting variants yield aggregate 2024–2035 BCRs in the range of 1.81 to 1.88, with the Headline estimate at 1.86. The benefit-cost result is therefore robust to both the precise residual weight assigned to Scenario A and the allocation of the remaining weight between Scenarios B and C. By contrast, the FORSA-ignored equal-weight reference yields a lower BCR of 1.43. The result is therefore robust within the FORSA-consistent bandwidth, but not to disregarding the FORSA evidence altogether.

6.2 The Aggregated Reduction Rates

The FORSA-informed weights derived in Section 6.1 are applied to the per-scenario reduction percentages of HTW Dresden (2026c) to obtain a single set of aggregated severity-specific reduction rates. These weighted rates—one number per severity category—are the inputs to the cost-benefit calculation in Sections 6.3

through 6.6. The cost-benefit analysis is computed once, using the weighted rates; per-scenario benefit-cost ratios are not reported as separate analytical results.

For each severity category j , the aggregated raw reduction rate is the weighted average of the per-scenario raw rates. Under the Headline weighting variant, this yields the weighted raw reduction rates summarized below. The compliance uplift $\kappa = 0.55$ (HTW Dresden, 2026a) is then applied multiplicatively to obtain the effective weighted rates carried into the welfare calculation.

Under the Headline weighting variant, the weighted raw reduction rates are approximately 4.96 percent for injury accidents, 5.06 percent for fatalities, 5.16 percent for serious injuries, and 4.86 percent for slight injuries. After applying the compliance uplift, the effective weighted rates are 7.69 percent, 7.85 percent, 7.99 percent, and 7.54 percent, respectively. These four values form the single set of behavioral parameters carried into the cost-benefit calculation. For the two property-damage streams (serious property-damage accidents and pure PDO events), which the reduction-potential assessment does not cover separately, the injury-accident rate is applied as the closest empirical proxy; the baseline counts of these two streams are held constant at their 2024 Destatis levels.

Because the benefit calculation in Section 3.2 is linear in the severity-specific reduction rate, aggregating the reduction rates before the calculation yields the same headline benefit as aggregating the per-scenario benefits afterward. The FORSA-informed headline BCR is therefore identical under both procedures. The present report performs the aggregation at the reduction-rate level because this representation is conceptually closer to the underlying behavioral model in HTW Dresden (2026d).

6.3 Baseline One-Year Estimate (2024 Base Year, before Compliance Uplift)

Applying the weighted raw reduction rates of Section 6.2 to the 2024 Destatis baselines and monetizing at the BAsT 2024 unit costs across all six severity categories yields an annual avoided social-cost benefit of approximately EUR 1,362 million in the 2024 base year, before the compliance uplift κ is applied. After the compliance uplift ($\times 1.55$), the corresponding annual benefit is approximately EUR 2,112 million. At an annual marginal cost of approximately EUR 1,012.5 million, the implied 2024 base-year benefit-cost ratio is approximately 1.35 before the compliance uplift and approximately 2.09 after.

The headline result combines three sources of differentiation. The fleet-dynamic differentiation across the three HTW scenarios enters through the per-scenario reduction rates of HTW Dresden (2026c). The behavioral-compliance channel enters through the multiplicative uplift $\kappa = 0.55$ (HTW Dresden 2026a). The FORSA-informed Headline weighting variant of the scenario weights – $(w_A, w_B, w_C) = (0.010, 0.495, 0.495)$ – collapses the three scenarios into one headline result. Section 6.6 reports the headline figure with a full numerical audit trail.

6.4 Fleet-Dynamic Trajectory 2024–2035 (with Compliance Uplift)

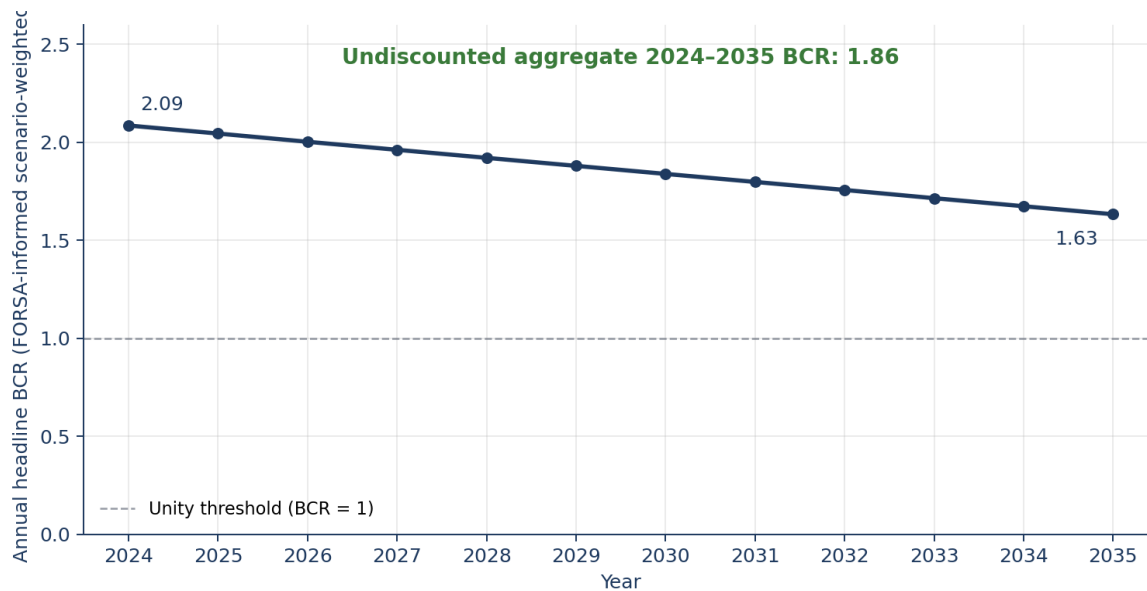
The annual trajectory is obtained by applying the weighted effective reduction rates of Section 6.2 to the annual passenger-car-caused accident baselines, yielding the annual benefit-cost ratio trajectory reported in Table 6 and shown in Figure 5. The annual BCR is approximately 2.09 in the 2024 base year and declines smoothly to approximately 1.63 by 2035 as the accident baselines themselves decline; the undiscounted aggregate 2024–2035 BCR is 1.86.

Each row of Table 6 reports the year-by-year FORSA-informed scenario-weighted annual benefit-cost ratio over the 2024–2035 horizon under the Headline weighting variant. The bottom row is the undiscounted aggregate 2024–2035 BCR.

Table 6
Annual FORSA-Informed Scenario-Weighted BCR and Undiscounted Aggregate 2024–2035 BCR

Year	Annual BCR
2024	2.09
2025	2.04
2026	2.00
2027	1.96
2028	1.92
2029	1.88
2030	1.84
2031	1.80
2032	1.76
2033	1.72
2034	1.67
2035	1.63
Undiscounted aggregate 2024–2035 BCR	1.86

Note. The annual ratios are computed using the aggregated effective severity-specific reduction rates from Section 6.2 applied to the year-by-year baseline accident counts. Compliance uplift $\kappa = 0.55$ (HTW Dresden 2026a). Cost: 11.25 million additional inspections per year $\times$ ADAC EUR 90, in constant 2024 prices. The aggregate row is the sum of annual benefits over 2024–2035 divided by the sum of annual costs. Source: per-scenario reduction rates from HTW Dresden (2026c); annual injury-category baselines linearly interpolated to HTW Dresden (2026d) 2035 projections (property-damage baselines held constant at the 2024 level); unit costs from Bundesanstalt für Straßen- und Verkehrswesen (2025); HU fee ADAC (2024).

Figure 5**Annual FORSA-Informed Scenario-Weighted BCR Trajectory, 2024–2035**

Note. Annual weighted benefit-cost ratios over 2024–2035 under the Headline weighting variant (w_A, w_B, w_C) = (0.010, 0.495, 0.495). Source: own calculation; reduction rates HTW Dresden (2026c); HU fee ADAC (2024); unit costs BAST (2025).

6.4.1 Aggregate net benefit 2024–2035

Over the 2024–2035 horizon, the aggregate undiscounted cost is approximately EUR 12,150 million (annual marginal cost $\approx$ EUR 1,012.5 million $\times$ 12 years). The aggregate undiscounted weighted benefit is approximately EUR 22,592 million. The aggregate net benefit is therefore approximately +EUR 10,442 million and the headline weighted aggregate 2024–2035 BCR is 1.86.

6.4.2 Descriptive statistics of the annual BCR series

As complements to the headline aggregate BCR, the report provides the arithmetic mean, the median, and the range of the annual FORSA-informed scenario-weighted BCR series. These statistics describe the year-by-year shape of the benefit-cost trajectory but are not the primary welfare test, since equal-weight averaging would assign the same weight to years with very different baseline accident counts.

Table 7**Descriptive Statistics of the Annual BCR Series, 2024–2035**

Specification	Mean of annual BCR	Median of annual BCR	Range of annual BCR
FORSA-informed scenario-weighted (Headline)	1.86	1.86	1.63 – 2.09

Note. Computed from Table 6 (annual headline BCR series). These descriptive statistics are complements to the undiscounted aggregate 2024–2035 BCR – they are not the primary welfare criterion. Source: own calculation.

The near identity of the mean, median, and aggregate BCR indicates that the annual trajectory is smooth and not driven by a single outlier year. The range from 1.63 to 2.09 shows that the annual benefit-cost result remains above unity throughout the horizon. These statistics are descriptive complements to the aggregate BCR, not alternative welfare criteria.

6.5 Sensitivity to the Compliance Uplift

The compliance uplift κ is the single most influential parameter in the calculation. Moving κ from 0.50 to 0.60 shifts the headline BCR within a range of approximately 1.80 to 1.92. Holding all other parameters at their central values, the headline BCR remains above unity across the full empirically plausible range of the compliance uplift.

6.6 Headline Result

Under the FORSA-informed headline specification, the annual HU for passenger cars aged ten and above passes the aggregate benefit-cost test in Germany. The headline BCR result is an undiscounted 2024–2035 BCR of 1.86 and an aggregate net benefit of approximately EUR 10.4 billion against an aggregate cost of approximately EUR 12.2 billion. The conclusion is robust across the three FORSA-consistent weighting variants (BCR bandwidth 1.81–1.88). Across the four core parameter and valuation perturbations reported in Section 8, the BCR ranges from 1.81 to 2.07. The separate conservative owner-time upper-bound stress test yields a BCR of 1.36. Including this stress test, the overall robustness range is therefore 1.36 to 2.07.

The headline figure of this report is the single FORSA-informed scenario-weighted undiscounted 2024–2035 benefit-cost ratio of 1.86 under the Headline weighting variant ($\epsilon_A = 0.01$; agnostic B/C). The aggregate net benefit over the 2024–2035 horizon is approximately +EUR 10,442 million, against an aggregate undiscounted cost of approximately EUR 12,150 million. The FORSA-consistent bandwidth – across the Headline and the two sensitivity weighting variants – is 1.81–1.88. Robustness to alternative parameter assumptions is reported in Section 8.

The headline aggregate 2024–2035 BCR of 1.86 is the product of a transparent seven-step chain. Each step is traceable to a single published source or a single equation in Section 3.2.

Step 1. The per-scenario raw severity-specific reductions for the policy cycle 3/2/2/2/1 (annual HU from age ten) are taken from HTW Dresden (2026c): for injury accidents, Scenario A 1.40 percent, Scenario B 3.70 percent, Scenario C 6.30 percent. Analogous values apply to fatalities, serious injuries, and slight injuries; see Table 4.

Step 2. The per-scenario raw rates are aggregated to a single set of severity-specific rates using the FORSA-informed Headline weights (w_A, w_B, w_C) = (0.010, 0.495, 0.495). The aggregated raw rates are approximately 4.96 percent for injury accidents, 5.06 percent for fatalities, 5.16 percent for serious injuries, and 4.86 percent for slight injuries (Section 6.2).

Step 3. The aggregated raw rates are multiplied by the compliance uplift factor $(1 + \kappa) = 1.55$ (HTW Dresden 2026a) to obtain the effective severity-specific reduction rates: approximately 7.69 percent for injury accidents, 7.85 percent for fatalities, 7.99 percent for serious injuries, and 7.54 percent for slight injuries.

Step 4. The effective weighted rates are applied year-by-year to the annual passenger-car-caused accident baselines (Destatis 2024 baselines linearly interpolated to the HTW Dresden 2026d projections to 2035), monetized at the BASt 2024 social accident unit costs, and summed across the six severity categories. The annual avoided social-cost benefit is approximately EUR 2,112 million in the 2024 base year and declines to approximately EUR 1,650 million by 2035.

Step 5. Summed over the 2024–2035 horizon in constant 2024 prices, the aggregated undiscounted benefit is approximately EUR 22,592 million.

Step 6. The aggregated undiscounted cost is 11.25 million additional inspections per year $\times$ EUR 90 ADAC fee $\times$ 12 years = EUR 12,150 million in constant 2024 prices.

Step 7. The headline BCR is therefore $22,592 / 12,150 = 1.86$, and the aggregated net benefit is $22,592 - 12,150 = +\text{EUR } 10,442$ million.

Substituting $\epsilon_A = 0.05$ (Sensitivity S1, agnostic B/C split) shifts the headline BCR to 1.81; $\epsilon_A = 0.05$ with a tilt toward Scenario C (Sensitivity S2) shifts it to 1.88. Ignoring the FORSA evidence entirely (equal-weight reference weighting variant) yields 1.43. The FORSA-consistent bandwidth – 1.81 to 1.88 – is the relevant robustness statement of the benefit-cost result.

7. Welfare and Cost-Benefit Assessment

Welfare assessment – three modeling choices. The welfare assessment rests on three modeling choices documented in this section. First, the benefit side aggregates six severity categories at the BAST 2024 social accident unit costs in constant 2024 prices; the inclusion of the pure-PDO stream – 1.45 million passenger-car-caused pure-PDO events per year – follows the BAST 2024 social accident unit-cost convention; the welfare-theoretic basis for including this stream is set out in the subsection below. Second, the cost side uses the ADAC HU-only fee of approximately EUR 90 per passenger car as a single fee reference; the resource-cost interpretation of the cost line is held out through the transfer-share sensitivity parameter θ . Third, the headline test is the headline BCR, computed as the sum of FORSA-weighted annual benefits over the horizon divided by the sum of annual costs.

The BAST 2024 unit-cost convention treats pure property-damage events as social accident costs. The present report follows this convention consistently across all six severity categories. Pure-PDO events involve real resource use, including repair or replacement of damaged property and associated administrative and transaction costs. Insurance may redistribute the private burden of such losses, but it does not eliminate the underlying resource cost. The report therefore includes the pure-PDO stream in the headline calculation. Its exclusion is not treated as a robustness check, because it would alter the welfare accounting scope rather than vary a model parameter.

Transfer-component sensitivity. The full ADAC HU-only fee of approximately EUR 90 per passenger car is used as a conservative proxy for the marginal resource cost in the central calculation. A transfer-share sensitivity parameter $\theta \in [0, 0.10]$, adopted as an illustrative sensitivity range consistent with the order of magnitude of gross-margin indicators from major PTI providers with publicly available annual reports, extracts the share of the posted fee that represents profit margins or other transfer-like components rather than real resource consumption. The bandwidth of the headline weighted aggregate 2024–2035 BCR over $\theta \in [0, 0.10]$ is approximately 1.86 to 2.07.

The bandwidth of the headline weighted aggregate 2024–2035 BCR across the transfer-share parameter is illustrated in Figure 6.

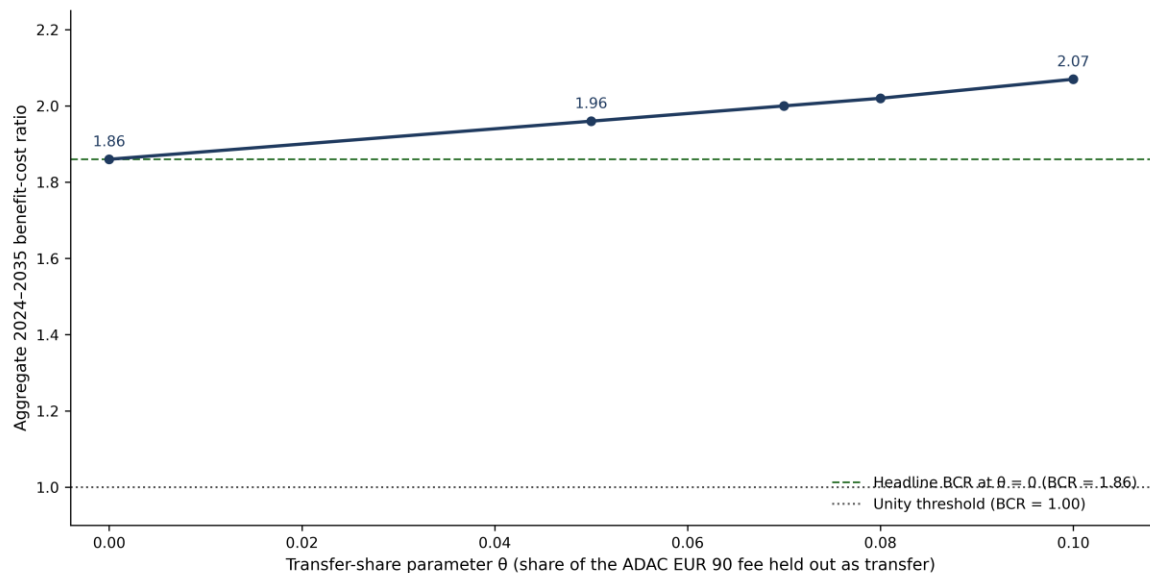
Each row of Table 8 corresponds to a different value of the transfer-share parameter θ – that is, the share of the posted EUR 90 fee that is classified as non-resource (transfer-like) rather than as real resource consumption. The right-most column reports the FORSA-informed scenario-weighted 2024–2035 benefit-cost ratio at the corresponding effective fee.

Table 8
Transfer-Component Sensitivity, Undiscounted Aggregate 2024–2035 BCR

Specification	θ	Effective fee (EUR)	Headline BCR
Baseline - no transfer extraction	0.00	90.00	1.86
Lower edge of illustrative range	0.05	85.50	1.96
Mid-range illustrative value	0.07	83.70	2.00
Upper edge of illustrative range	0.08	82.80	2.02
Upper-bound sensitivity	0.10	81.00	2.07

Note. θ is the transfer-share parameter applied to the ADAC EUR 90 HU-only fee reference (ADAC, 2024). The 0.05–0.10 range is an illustrative sensitivity range consistent with the order of magnitude of gross-margin indicators from major PTI providers with publicly available annual reports (TÜV Süd, TÜV Nord, TÜV Rheinland, DEKRA – Geschäftsberichte 2024). The right-most column reports the headline BCR under the Headline weighting variant. Source: own calculation; HU fee reference ADAC (2024); unit costs BAST (2025); per-scenario reduction rates HTW Dresden (2026c).

Figure 6
Transfer-Component Sensitivity



Note. The headline BCR is plotted against the transfer-share parameter θ over the interval $[0, 0.10]$. The dashed green line marks the headline BCR at $\theta = 0$ (BCR = 1.86); the dotted gray line marks the unity threshold at BCR = 1.00. Source: own calculation; HU fee reference ADAC (2024); unit costs BAST (2025); per-scenario reduction rates HTW Dresden (2026c).

Beyond the three modeling choices set out above, four further conventions frame the scope and interpretation of the welfare test: the treatment of owner time and transaction costs, the treatment of repair

costs, the distinction between the aggregate welfare test and stakeholder incidence, and the external benchmarks against which the headline result is compared. Each is documented briefly below.

Owner time and transaction costs. Owner time, travel, and transaction costs are not monetized separately because no robust Germany-specific unit cost estimate is used in the current calculation. This is reported as a limitation in Section 11; it is not a claim that these costs are negligible.

Repair-cost convention. Repair costs are not included as a separate cost item in the central welfare calculation. The technical defect exists independently of the inspection, and the legal duty to maintain a roadworthy vehicle exists independently of the inspection; the HU reveals and enforces compliance with an existing obligation, it does not create the underlying defect. Any change in the timing of repairs induced by the inspection cycle is discussed in Section 11.

Aggregate test versus stakeholder perspective. The benefit-cost test reported in this section is an aggregate, allocative test, valued at social accident unit costs. The distribution of incidence across stakeholders (vehicle owners, inspection organizations, and the Treasury via fee-related revenue) is not the focus of this report. Distributional considerations support – but do not replace – the aggregate benefit-cost result. The uniform per-vehicle inspection fee is regressive in incidence, while avoided-harm benefits accrue disproportionately to occupants of older-cohort vehicles and to other road users sharing the road with those vehicles. A formal distributional weighting is beyond the present scope.

External benchmarks. The aggregate result is benchmarked against two external reference points. First, the reduced-form benefit-cost ratio of approximately 1.3 reported by Joisten, Franck, Geilenberg, and Witte (2025) for Germany – an elasticity-path estimate calibrated against the BASt 2018/19 unit-cost vintage. Second, the FORSA-ignored equal-weight calibration of this report (a priori weights $w_A = w_B = w_C = 1/3$), which yields an aggregate 2024–2035 BCR of 1.43. The headline FORSA-informed scenario-weighted BCR of 1.86 lies above both reference points and is robust to the precise FORSA-consistent weighting variant (bandwidth 1.81–1.88).

8. Robustness Checks

Five parameter perturbations are reported below, each relative to the headline BCR of 1.86. Each perturbation varies a single model parameter while holding the rest of the calculation at its central specification. The aim is to characterize the benefit-cost result across the structurally most influential parameter choices in the model.

1. *Passenger-car main-cause share.* $m_{PC} = 0.68$ is a ten-year average; substituting the 2024 point estimate of $m_{PC} = 0.66$ from Destatis Fachserie 8 Reihe 7 scales benefits proportionally, reducing the headline BCR to approximately 1.81 ($1.86 \times 0.66/0.68$).
2. *Mileage-weighted cohort allocation.* Using the MiD 2017 average mileage distribution rather than fleet-share weighting raises the aggregate BCR to approximately 1.92.
3. *Social discount rate.* The present-value sensitivity follows the temporal-consistency logic of cost-benefit analysis: annual benefit and cost streams are transformed to a common valuation basis before the benefit-cost ratio is calculated. Schulz (1994, pp. 44–50) distinguishes between the annualization of investment costs (which depends on the financing and reinvestment assumption)

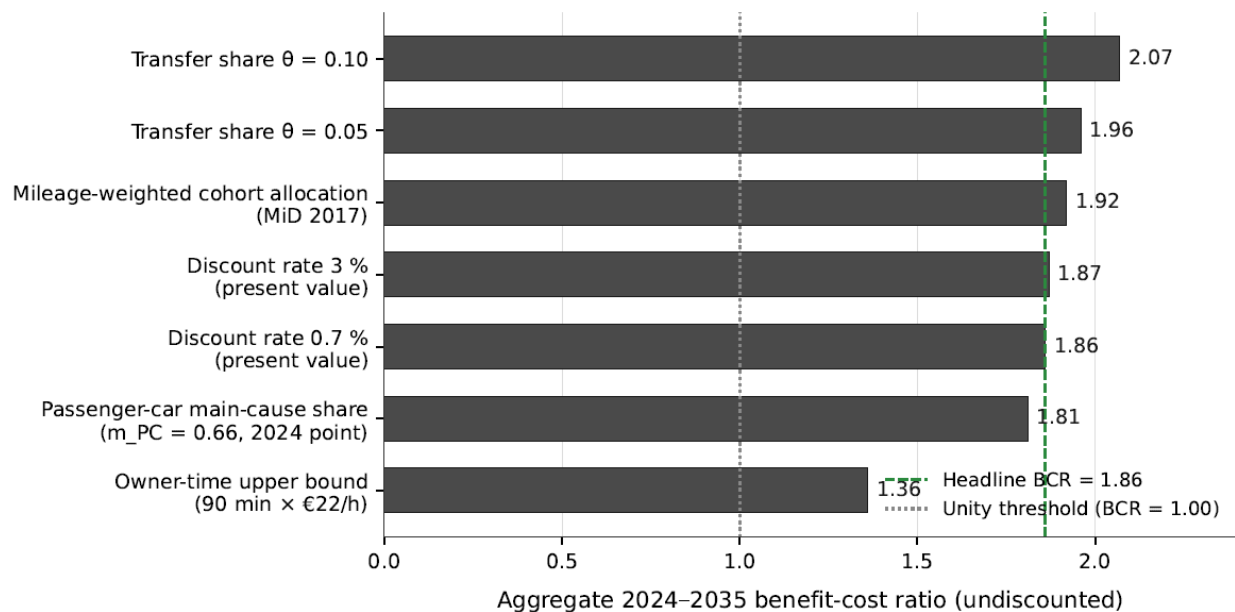
and the annual representation of benefits (where the average annual benefit equals the benefit annuity when already realized benefits are available for productive reuse). In the present report the cost item is a recurring annual inspection service cost rather than an upfront capital investment, so no annuitization of capital expenditure is required. The present-value sensitivity is therefore a robustness transformation, not the primary welfare criterion; the headline result follows the annual resource-saving logic set out in Section 3.2. The robustness check discounts the FORSA-informed scenario-weighted annual benefit and annual cost streams from Table 6 symmetrically over 2024–2035. At a 3 percent social discount rate, the present-value BCR is approximately 1.87; at a near-zero discount rate of 0.7 percent, it is approximately 1.86. Discounting slightly raises the present-value BCR because annual benefits decline over the horizon while annual costs are approximately constant, so the discount factor places more weight on the higher-BCR early years. The result is robust to the choice of discount rate within the range customarily used in EU policy appraisal.

4. Transfer-component extraction. Reclassifying a portion of the ADAC EUR 90 posted fee as a non-resource (transfer-like) component proportionally raises the headline BCR. At $\theta = 0.05$, the headline BCR is approximately 1.96; at $\theta = 0.10$, approximately 2.07. The transfer-share sensitivity is documented in Table 8 and Figure 6.
5. Owner time and transaction-cost upper bound. As an additional conservative sensitivity, the report assigns an upper-bound time cost to the additional inspection round. Assuming 90 minutes of owner time per additional HU, valued at EUR 22 per hour, yields an additional transaction cost of approximately EUR 33 per inspection. Applied to 11.25 million marginal inspections per year, this corresponds to approximately EUR 371 million in additional annual costs. Adding this amount to the central annual inspection-cost estimate raises annual costs from approximately EUR 1,012.5 million to approximately EUR 1,383.5 million. Holding benefits constant, the headline aggregate BCR falls from 1.86 to approximately 1.36. The result, therefore, remains clearly above unity even under a deliberately conservative owner-time specification.

This sensitivity should be interpreted as an upper-bound stress test rather than as the central welfare specification. Owner time is not necessarily fully incremental from a social-resource perspective. In practice, inspection visits are frequently bundled with scheduled maintenance, tire changes, repair appointments, or other workshop interactions. Earlier defect detection may also reduce later unplanned downtime, breakdown-related waiting time, towing, emergency repair coordination, and other forms of disruption. These offsetting time effects are difficult to quantify without detailed microdata, but they imply that a gross owner-time estimate is likely to overstate the net social transaction cost of the annual inspection regime.

The headline BCR remains above unity across all reported perturbations. Across the four core parameter and valuation perturbations, the BCR ranges from 1.81 to 2.07. The separate conservative owner-time upper-bound stress test yields a BCR of 1.36. Including this stress test, the overall robustness range is therefore 1.36 to 2.07; the bandwidth across the three FORSA-consistent weighting variants is 1.81 to 1.88. The benefit-cost result is therefore robust to the precise calibration of the passenger-car main-cause share, the cohort-allocation parameter, the social discount rate, and the transfer-component extraction.

Figure 7
Robustness Ranking Around the Headline BCR



Note. Headline BCR under four core parameter and valuation perturbations (passenger-car main-cause share, discount rate, mileage-weighted cohort allocation, transfer share) plus a separate conservative owner-time upper-bound stress test (90 min $\times$ €22/h), sorted by ascending BCR. The dashed green line marks the headline at 1.86; the dotted gray line at BCR = 1.0 marks the unity threshold. Source: own calculation based on Section 8 and Tables 5 and 8; per-scenario reduction rates HTW Dresden (2026c); unit costs BAST (2025); HU fee reference ADAC (2024).

Figure 7 shows how selected parameter perturbations affect the headline BCR. The variations reported here concern model parameters or valuation conventions that can reasonably be varied without altering the welfare-accounting scope of the analysis. Across these perturbations, the headline result remains above unity. The figure, therefore, supports the conclusion that the benefit-cost result is not driven by a single calibration parameter.

9. Discussion

Five findings are discussed below.

1. *The role of the compliance uplift.* The compliance uplift $\kappa = 0.55$ captures the behavioral response of vehicle owners in anticipation of the upcoming HU. It is calibrated against the projection in HTW Dresden (2026a) that the traffic-weighted share of vehicles with serious or dangerous defects declines by more than half under annual inspection from age ten, and is supported by Survey 2 of HTW Dresden (the in-traffic field survey with three-stage paired measurement). The compliance mechanism is a modeled construct, not a causally identified effect from a natural experiment; the role of the compliance uplift in shaping the headline result is therefore a methodological-design question, treated as limitation 3 in Section 11.
2. *The role of the FORSA evidence.* The FORSA empirical evidence reproduced in HTW Dresden (2026d) is least compatible with Scenario A and most compatible with Scenarios B and C jointly;

the headline result therefore lies close to a balanced average of Scenarios B and C, at 1.86. The benefit-cost result is robust within the FORSA-consistent bandwidth but is not robust against ignoring the FORSA evidence altogether.

3. The role of welfare accounting scope. The headline result depends on a consistent application of the BASt 2024 social accident unit-cost convention across all six severity categories, including pure property-damage-only events. This choice is not a discretionary parameter assumption, but a welfare-accounting convention. Pure-PDO events involve real resource use through repair, replacement, administrative handling, and transaction costs. Their inclusion therefore follows the same logic as the inclusion of injury-related property-damage components and serious property-damage accidents. Excluding this stream would not constitute a standard robustness check; it would redefine the scope of the welfare test.
4. Property-damage-only events are sometimes dismissed in public debate as “mere fender-benders.” From a welfare-economic perspective, however, these events consume real resources. Vehicle repairs require labor hours, replacement parts, workshop capacity, logistics services, insurance processing, and administrative handling. These resources are economically scarce and cannot simultaneously be used elsewhere in the economy. The fact that insurance may redistribute the financial burden across private parties does not eliminate the underlying resource consumption. The BASt welfare-cost framework therefore treats pure property-damage-only events as genuine social costs rather than as purely private inconveniences. The present report follows this convention consistently across all severity categories.
5. Comparison with the earlier elasticity-based estimate. The lower benefit-cost ratio reported by Joisten, Franck, Geilenberg, and Witte (2025), approximately 1.3, should not be interpreted as contradictory evidence to the present report’s headline estimate of 1.86. The two studies identify different analytical objects using different empirical strategies. The earlier study used a reduced-form elasticity approach to infer inspection effectiveness indirectly from aggregate variation in inspection frequency and accident outcomes. The present report instead relies on a structurally richer identification framework based on the HTW Dresden evidence package. This framework combines accident reconstruction evidence, in-traffic defect prevalence measurements, paired before-and-after-repair observations, fleet dynamics scenario modeling, and FORSA-based behavioral calibration. The higher headline estimate, therefore, reflects a broader empirical representation of the compliance and remediation mechanisms through which inspection frequency affects accident-relevant defect exposure. The difference between the two studies is thus primarily a consequence of identification depth rather than a simple recalibration of parameter values.

The external validity of the headline result is bounded by three institutional features of the German inspection regime. First, the existing three-year grace period before the initial inspection concentrates the incremental inspection burden on a comparatively homogeneous cohort of older vehicles. Second, the regulated, near-uniform inspection fee structure largely prevents price-based selection into inspection behavior. Third, the German PTI system is characterized by a comparatively high level of institutional standardization and technical oversight across approved inspection organizations. In regulatory environments with broader variation in inspection scope, more fragmented provider structures, weaker enforcement consistency, or differentiated

pricing regimes, the behavioral-compliance mechanism may operate less strongly, and the resulting welfare effects may therefore be correspondingly smaller.

10. Policy Implications

Four policy propositions follow from the welfare analysis.

First. Under the FORSA-informed headline specification, the introduction of an annual HU for passenger cars aged ten and above in Germany passes the aggregate benefit-cost test on the 2024 parameter set. The headline BCR is 1.86, and the conclusion is robust to the precise FORSA-consistent weighting variant (bandwidth 1.81–1.88), across the four core parameter and valuation perturbations reported in Section 8 (bandwidth 1.81 to 2.07), and to the present-value sensitivities at 3 percent and 0.7 percent social discount rates. The separate conservative owner-time upper-bound stress test yields a BCR of 1.36; including this stress test, the overall robustness range is 1.36 to 2.07.

Second. The compliance mechanism – the behavioral adjustment of vehicle owners in anticipation of the inspection, empirically documented by the three-stage paired measurement in Survey 2 and modeled in the projection by HTW Dresden (2026a) – is the most influential design parameter. Policy instruments that strengthen this mechanism (predictable inspection windows, clear pass/fail communication, transparent repair cost information) are complements to the cycle change and should be considered part of the same policy package.

Third. The distributive incidence of the inspection fee warrants explicit policy attention. A uniform fee on older vehicles is regressive in incidence. Mitigation options include age-differentiated fees that decline for vehicles with very low residual values, or a targeted subsidy for inspection costs for vehicles registered to lower-income households. These measures are policy-technical and could be assessed at the national level, subject to legal review.

Fourth. The result has direct implications for the ongoing review of Directive 2014/45/EU. The evidence presented here supports, for member states with an aging passenger-car fleet and an established inspection infrastructure, a move toward annual inspections for older cohorts. It does not support a blanket tightening at the Union level, given the external validity caveats in Section 9. A differentiated approach that permits and recognizes stricter national regimes for older cohorts, rather than mandating them, is consistent with the present evidence.

11. Limitations

The analysis is subject to seven substantive limitations, documented below for transparency.

1. *Cohort allocation parameter.* The cohort allocation parameter $q_{10+} = 0.40$ is a preliminary estimate. A refined extraction from the Destatis age-by-cause breakdown is likely to change the numerical result by several percentage points in either direction.

2. *Single-country evidence base.* The empirical anchors for d , r , i , and κ are calibrated on a single national evidence base. The external validity caveats in Section 9 are not merely cautionary; they bound the transfer of the numerical result to other member states.
3. *Projected, not identified, compliance effect.* The compliance uplift κ is calibrated on a projection from the German evidence base, not on a causally identified effect from a natural experiment. The projection is underpinned by the two-survey evidence base and by Survey 2's three-stage paired measurement, but remains a modeled construct.
4. *Owner time, travel, and transaction costs* are difficult to monetize precisely because the net incremental burden depends on the extent to which inspection visits are bundled with maintenance, repair, or other workshop activities. Section 8, therefore, reports a conservative upper-bound owner-time sensitivity rather than adopting a central point estimate. More precise monetization would require Germany-specific microdata on workshop bundling behavior, inspection duration, repair timing, and counterfactual maintenance patterns.
5. *Repair-timing channel.* Repair costs are not included as a separate cost item under the modeling convention of this report. The convention rests on the position that the technical defect and the legal duty to repair exist independently of the inspection; the HU enforces compliance with an existing obligation. A change in the timing of repairs induced by the inspection cycle – accelerating repairs that would otherwise be deferred – could in principle generate a transitional welfare effect not captured by the present framework. The direction of this effect is ambiguous (deferred repairs increase exposure to defect-related accidents; earlier repairs absorb resources sooner) and would require Germany-specific microdata to monetize. This is a limitation, not a claim of zero magnitude.
6. *Partner-study revisions.* HTW Dresden (2026d) refers to the version made available to the authors on 12 May 2026; no later version was available for incorporation by the editorial cut-off date of the present report. The methodology, the scenario definitions, the FORSA consumer-survey findings, and the structural framework are stable and do not depend on the final partner-report publication. Numerical values could shift marginally if the final Destatis 2025 and KBA 2025 baselines used in the partner report are revised; the direction and magnitude of any revision cannot be determined before the final partner-report baseline is available.
7. *10+ / 12+ cohort extrapolation.* The policy threshold is age ten, whereas the FORSA consumer evidence and the HTW fleet-dynamic scenarios are defined for the 12+ cohort. Applying the 12+ behavioral evidence to the 10+ policy cohort is a modeling assumption. It is plausible because the behavioral response is expected to be concentrated in the older part of the treated cohort, but it is not directly observed for all vehicles aged ten and eleven.

12. Conclusion

This report presents a cost-benefit analysis of an annual HU for passenger cars aged ten and above in Germany. The analysis is calibrated on the HTW Dresden evidence base – two independent empirical surveys (the DEKRA accident-reconstruction sample, $n = 2,429$, and the in-traffic field survey of 11,604 passenger cars with three-stage paired repair measurement), the theoretical construction of three fleet-dynamic scenarios A, B, and C, and the FORSA consumer survey reproduced in HTW Dresden (2026d) – all documented in HTW Dresden

(2026a, 2026b, 2026d). The headline criterion is the FORSA-informed scenario-weighted undiscounted 2024–2035 benefit-cost ratio.

The headline result is an undiscounted aggregate 2024–2035 BCR of 1.86 and an aggregate net benefit of approximately +EUR 10.4 billion against an aggregate undiscounted cost of approximately EUR 12.2 billion. The FORSA-consistent bandwidth across the Headline and the two sensitivity weighting variants is 1.81–1.88. The benefit-cost result is robust to the precise weighting variant.

The result follows the BAST 2024 social accident unit-cost convention applied consistently across all six severity categories. This includes pure property-damage-only events, which are treated as social resource costs within the headline welfare accounting scope rather than as a discretionary robustness component.

13. Declarations

Funding. This report was commissioned by CITA AISBL — The International Motor Vehicle Inspection Committee, Rue du Commerce 123, 1000 Brussels, Belgium. The terms of engagement preserve the authors' scientific independence with respect to study design, data analysis, and interpretation.

Competing interests. Schulz-Institute for Economic Research and Consulting GmbH (trading as IERC) declares that no commercial or financial relationship with the German inspection industry has influenced this report. The principal investigator discloses past research collaborations with TÜV-affiliated and DEKRA-affiliated institutions; no affiliated party had editorial control over this report.

Author contributions. W.H.S.: conceptualization, methodology, formal analysis, writing – original draft, project administration, funding acquisition. N.J.: methodology, formal analysis, writing, review, and editing. Research assistance: Schulz-Institute research team.

Data availability. Fleet data (KBA), accident data (Destatis), and BAST unit costs are publicly available from the cited sources. The DEKRA expert report sample, the in-traffic field survey, and the paired before-and-after repair sample are documented in HTW Dresden (2026b). Access to the underlying microdata is subject to the data-sharing policies of the data custodians.

Ethics approval. Not applicable. The study uses only secondary, non-personal data.

Use of AI tools. AI-assisted tools were used for manuscript drafting, language editing, and consistency checks.

Numerical verification. Numerical results were calculated and checked by the authors against the cited sources where the underlying data are publicly available (KBA, 2024; Destatis, 2025; BAST, 2025); for the proprietary HTW evidence base the calculation rests on the documentation in HTW Dresden (2026a, 2026b, 2026d).

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