

The Margin Squeeze

A Conditional Structural Diagnostic of the
Luxembourgish Growth Model

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Classification: Decision-support document · Not an econometric forecast

Quantitative results reproduced from the project's validated recurrence-relation model.

Confidence apparatus: [H] hard · [M] medium · [A] assumption.

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Abstract

This paper presents a conditional structural diagnostic of the Luxembourgish growth model. It does not contest the European Commission’s finding of declining measured labour productivity (SWD(2026) 216); it treats that finding as a primary hypothesis and conducts a structured analysis of the drivers behind it. The paper’s contribution is threefold. First, it decomposes financial-sector output per hour into a price term (the effective fee margin) and a throughput term (operational efficiency), and shows that the interpretation of the measured productivity decline is contingent on the national-accounts deflation methodology — a *price-measurement contingency* quantified at 3.0–5.0 percentage points per year of measured output-per-hour growth, the resolution of which is bounded and does not affect the paper’s structural conclusions. Second, it identifies a *Scissors Effect*: the decoupling of an exogenous revenue dynamic (global fee compression, over which the jurisdiction is a price-taker) from an endogenous, indexed cost dynamic (over which it is a price-maker), producing a structural compression of net margin from 50% to 31% of gross revenue under the central calibration. Third, through a Shapley variance decomposition of the projected 2025–2040 fiscal trajectory, it establishes that the transition to a high-debt regime is predominantly additive (91%) and is dominated by two domestically-controllable levers — wage indexation and the fiscal-pension trajectory — which together account for 62.4% of the movement. The policy implication is a sequence whose ordering is a property of the risk structure: stabilise the cost base, capture the margin, then diversify. The 2025 fiscal outturn recorded by the CNFP corroborates the model’s initial conditions and its cost-side mechanism, while the paper’s divergence from the official medium-term sustainability analysis is traced to a single revenue assumption — that revenues track nominal GDP — which the margin-compression thesis identifies as the binding vulnerability. The IMF’s 2026 Article IV projection independently reproduces the central debt trajectory to 2031 and identifies the same financial-sector revenue assumption as the binding vulnerability, while judging the debt itself sustainable — a verdict on solvency this paper does not dispute, its concern being the structural margin squeeze rather than default risk. Confidence in every parameter and finding is tagged ([H] hard / [M] medium / [A] assumption), and the three most consequential parameters have been hardened against primary actuarial, central-bank, and statistical sources.

Confidence apparatus

Every material claim, parameter, and projection carries a confidence tag:

- **[H] — Hard.** Drawn directly from a primary statistical or official source (SWD(2026) 216, CSSF, ESMA, IGSS, OECD, IMF, STATEC, BCL, Eurostat). Reproducible and externally verifiable.
- **[M] — Medium.** A defensible estimate built from primary data plus a transparent modelling step, or triangulated across sources.
- **[A] — Assumption.** An analyst judgement required to close the model. Directionally reasoned but not externally established.

The tags are not decoration. The paper’s methodological position is that the *distribution* of confidence across the argument matters as much as the argument itself: the diagnosis rests largely on [H] foundations, while the projections depend on parameters whose influence is bounded and reported explicitly, and whose hardening from [A] to [M] is documented in the companion Verification Report.

1. Introduction and Problem Statement

Luxembourg presents an analytical paradox. It is among the wealthiest economies in the European Union, with gross national income per head roughly sixty percentage points above the EU average [H], yet the European Commission’s 2026 country assessment (SWD(2026) 216) documents a sustained decline in measured labour productivity since 2010 — on the order of -0.5% per year [H] — at odds with the trajectory of most advanced economies. The prevailing diagnosis treats this as a productivity problem in the conventional sense: a weakening of the economy’s capacity to convert inputs into output.

This paper does not contest that diagnosis. It treats the Commission’s “declining productivity” finding as the **primary hypothesis** and subjects it to a structured sensitivity analysis of the drivers *behind* the measured decline. The distinction is consequential. If the decline reflects a genuine loss of internal operational efficiency, the appropriate policy response is the Commission’s: digitalisation, innovation diffusion, and R&D intensification. If, instead, a material share of the measured decline reflects an exogenous change in the *terms of trade* for Luxembourg’s dominant export sector — financial services — then efficiency-oriented policy addresses a symptom rather than the mechanism, and the binding constraints lie elsewhere.

The analysis is anchored in the most recent official fiscal record. The Conseil national des finances publiques (CNFP), Luxembourg’s independent fiscal institution, reports a 2025 general-government deficit of 2.0% of GDP and public debt of 26.5% of GDP [H]. These are the initial conditions from which every projection in this paper proceeds; the starting point is therefore an observed outturn rather than an assumption. The same evaluation records that 2025 net primary expenditure grew 8.1% against the 5.8% ceiling agreed with the EU Council [H] — an early, officially-documented instance of the expenditure dynamic this paper formalises. The detailed correspondence between that record and the model, and the more consequential divergence from the official medium-term sustainability analysis, are treated in Section 4.6. The forward path is anchored comparably: the IMF’s 2026 Article IV consultation independently projects gross debt above 39% of GDP by 2031 and locates the same financial-sector revenue assumption as the binding vulnerability (Section 4.6).

The tension the paper formalises is between two forces operating on different sides of the same ledger and governed by different actors:

1. **An external, downward pressure on the price of financial services** — global fee deflation, driven by the secular shift toward passive investment vehicles and intensifying fee competition. Luxembourg is a *price-taker* with respect to this force [H].
2. **An internal, upward pressure on the cost of producing those services** — labour costs locked to consumer-price inflation through automatic wage indexation, compounded by housing costs that the domestic policy framework has, on balance, subsidised on the demand side. Luxembourg is a *price-maker* with respect to this force [M].

We term the divergence of these forces the **Scissors Effect**. The remainder of the paper establishes its measurement foundations (Section 2), decomposes the structural risk it generates and the interaction among its domestic amplifiers (Section 3), projects the consequences under three calibrated scenarios to 2040 (Section 4), and derives a policy *sequence* — rather than a policy *list* — whose ordering is itself a finding (Section 5).

A note on epistemic posture. This is a conditional diagnostic, not a prediction. Where the paper identifies a risk, it specifies the parameter on which that risk is contingent and the direction and approximate magnitude of the dependency. The objective is not to demonstrate that any particular outcome is inevitable — the analysis explicitly shows that the most favourable scenario retires public debt entirely — but to identify which levers are *binding*, which are *secondary*, and in what *order* they must be addressed for a stable path to remain reachable.

2. Methodological Framework

2.1 Purpose and epistemic status

This section establishes the analytical apparatus through which the paper interprets Luxembourg’s measured productivity record. The apparatus is deliberately modest in its claims. It does not seek to overturn the European Commission’s diagnosis of declining productivity (SWD(2026) 216); it seeks to decompose that diagnosis into its constituent drivers and to identify the conditions under which each interpretation of the measured decline holds. The exercise is therefore a *conditional structural diagnostic* rather than a

forecast: its outputs are the sensitivities of the system to identifiable variables, accompanied by an explicit accounting of the confidence attaching to each.

The methodological contribution rests on a single observation. For an economy whose aggregate productivity statistic is dominated by one externally-oriented sector, that statistic inherits the *measurement properties* of the sector — including any ambiguity in how the sector’s real output is derived. In Luxembourg, financial and related services account for approximately one quarter of gross value added and of tax revenue [H]. The properties of the financial-services deflator are therefore not a technical footnote; they are a first-order determinant of what the national productivity series means.

2.2 The decomposition of output per hour

Let the nominal gross output of the fund-servicing sector be represented as the product of a price term and a volume term:

$$O_{nom} = P \times Q$$

where P denotes the *effective fee margin* — revenue earned per unit of assets under management (AuM) — and Q denotes the *volume of assets serviced*. Dividing by hours worked, H , and expressing the measured real output per hour, O_h , as a function of the deflator Π applied to nominal output:

$$O_h \equiv \frac{O_{nom}/\Pi}{H} = \frac{P \cdot Q}{\Pi \cdot H}$$

This is an accounting identity, not a behavioural relation. Its analytical value lies in the separation of two economically distinct components of measured productivity: a *price* component, governed by the fee margin P that the global market pays for Luxembourg’s services, and a *throughput* component, governed by the operational efficiency Q/H with which those services are produced. The central interpretive question — whether a decline in O_h reflects deteriorating efficiency or compressing margins — reduces to the question of how the deflator Π treats movements in P .

In growth-rate form, denoting proportional rates of change by a dot:

$$\dot{O}_h = \dot{P} + \dot{Q} - \dot{\Pi} - \dot{H}$$

The empirical inputs to this identity, in the paper’s central calibration, are summarised in Table 2.1. Each is grounded as indicated; none is a free assumption.

Table 2.1 — Calibration of the decomposition (central case)

Term	Definition	Value (%/yr)	Basis	Conf.
$\dot{Q}$	AuM (volume) growth	+5.5	CSSF; AuM €6.20tn end-2025	[H]
$\dot{P}$	effective fee-margin change	−3.0	ESMA cohort fee data	[M]
$\dot{H}$	sector hours growth	+1.5	STATEC FS employment (~+1%/yr)	[M]
$\dot{\Pi}_{gen}$	general services price inflation	+2.0	STATEC services prices	[M]

The two structural facts that motivate the entire analysis are visible in this table and are individually [H] or well-grounded [M]: throughput is rising ($\dot{Q} - \dot{H} \approx +4$ pp/yr) while the price of the service is falling ($\dot{P} = -3$ pp/yr). The sector is doing more work, more efficiently, for less revenue per unit. What the

measured productivity series records depends entirely on whether the national accounts classify the falling fee margin as a price movement or as a volume movement.

2.3 The three deflation regimes

The treatment of $\dot{P}$ is determined by the choice of deflator $\dot{\Pi}$. Three regimes are admissible under European System of Accounts (ESA 2010) practice, and they do not differ merely in magnitude: they differ in the *sign* of the resulting measured productivity trend.

Regime A — Fee-based price deflation. The deflator is the fee margin itself, $\dot{\Pi}_A = \dot{P}$. Margin compression is classified entirely as a price movement and removed from the volume measure. Measured real output then tracks the serviced volume Q :

$$\dot{O}_h^A = \dot{Q} - \dot{H} = 5.5 - 1.5 = +4.0 \text{ pp/yr} \quad (\text{productivity rising})$$

Regime B — Stock deflation by a general price index. Consistent with the Eurostat-recommended approach for financial services, the serviced asset stock is deflated by a broad price index and output volume moves with the real stock, $\dot{\Pi}_B = \dot{\Pi}_{gen}$ applied to Q :

$$\dot{O}_h^B = \dot{Q} - \dot{\Pi}_{gen} - \dot{H} = 5.5 - 2.0 - 1.5 = +2.0 \text{ pp/yr} \quad (\text{productivity rising})$$

Regime C — General-services deflation of fee revenue. Nominal fee revenue is deflated by a general services producer- or consumer-price proxy, $\dot{\Pi}_C = \dot{\Pi}_{gen}$ applied to O_{nom} . Margin compression is *retained* within the volume measure:

$$\dot{O}_h^C = \dot{Q} + \dot{P} - \dot{\Pi}_{gen} - \dot{H} = 5.5 - 3.0 - 2.0 - 1.5 = -1.0 \text{ pp/yr} \quad (\text{productivity falling})$$

2.4 The price-measurement contingency as a bounded magnitude

The paper’s treatment of these regimes is its principal methodological commitment, and it is deliberately conditional. The difference between a volume-consistent regime and Regime C is not presented as a discovery that the measured decline is “really” a price illusion; it is presented as a *bounded magnitude* whose realisation depends on a documented statistical choice:

$$\begin{aligned} \Delta_{illusion} &= \dot{O}_h^A - \dot{O}_h^C = \dot{\Pi}_{gen} - \dot{P} = +5.0 \text{ pp/yr} \\ \Delta'_{illusion} &= \dot{O}_h^B - \dot{O}_h^C = -\dot{P} = +3.0 \text{ pp/yr} \end{aligned}$$

The *price-measurement contingency* is therefore quantified at **3.0 to 5.0 percentage points per year** of measured output-per-hour growth [M] — the interval bounded by the choice between Regimes B and A on the volume-consistent side. This is the magnitude by which the choice of deflator, alone, displaces the measured productivity trend.

The analytical consequence is symmetric and is stated without rhetorical preference for either outcome:

- *If Regime C is in force*, the Commission’s observed financial-sector decline (output per hour falling in most years since 2016 [H]) is fully consistent with rising true throughput; the measured decline would be substantially a price-measurement artefact.
- *If Regime A or B is in force*, the same observed decline indicates a genuine throughput component, because those regimes already remove margin compression from the volume measure; under Regime B a residual decline of part of the observed magnitude would remain attributable to efficiency.

It is important to record that even Regime B — the approach Eurostat methodology favours for financial services — implies *rising* measured productivity (+2.0 pp/yr) on the central calibration, which itself does

not reconcile with an observed decline. Where the observed series declines under a volume-consistent regime, the decline carries genuine efficiency information. The paper does not assert that the entire measured decline is artefactual; it asserts that the *artefact component is bounded at 3.0–5.0 pp/yr* and that the residual is a genuine efficiency signal whose size is determined by the deflator in use.

2.5 Standard practice and residual uncertainty

The Eurostat *Handbook on Price and Volume Measures in National Accounts* (ESA 2010 edition) constrains, without fully resolving, the regime question. For financial services the handbook recommends the stock-deflation and output-indicator methods — Regime B-type approaches and quantity-based equivalents — in preference to deflation of nominal output by a general services price index. It further deprecates the use of broad price indices for output deflation and stresses derivation “at the most detailed level possible,” with quality adjustment, using producer-price indices, charge-out rates, or unit values where available.

Two considerations prevent this from closing the contingency:

1. The explicitly-charged fund-management activities that dominate the Luxembourg aggregate (NACE K64.3, K66.3) are distinct from FISIM and are deflated separately. Where no specific fund-fee price index exists — and none is published for Luxembourg — the compiler’s fallback may approximate Regime C (a broad service deflator) or Regime A/B (an output indicator). The fallback is precisely where the contingency lives.
2. The treatment is not documented publicly at the granularity required to determine the regime with certainty.

Accordingly, the contingency is narrowed but not eliminated: Eurostat methodology renders a *pure* Regime C outcome unlikely, which places the most defensible interpretation toward the volume-consistent regimes and toward a *blended* reading of the measured decline — part genuine efficiency, part price artefact, with the artefact share bounded as above. The single remaining step required to convert this parameter from [M] to [H] — a direct methodological inquiry to STATEC regarding the K64.3 / K66.3 deflator — is documented separately and does not block the analysis, because, as the following sections establish, the paper’s structural conclusions rest on the cost side of the model, which is independent of the deflator question.

2.6 The modelling object and its limits

The quantitative results in Section 3 and in the scenario analysis derive from a transparent recurrence-relation model of the Luxembourg economy to 2040, calibrated to the anchors above and driven by the interaction of a revenue path (volume growth net of fee deflation) and a cost path (compensation growth under wage indexation). The model is a strategic decision-support instrument and not an econometric forecast. It incorporates only those behavioural feedbacks that are explicitly specified: a housing-wealth channel from the residential price index to non-financial value added; a sovereign-financing channel in which a debt ratio above a stated threshold raises the marginal cost of debt; and the transmission of wage indexation simultaneously to private-sector compensation and to indexed components of public expenditure. Its outputs are decision-relevant magnitudes and orderings rather than point predictions. Every parameter carrying an [A] tag is subjected to the sensitivity analysis reported in Section 3.2, and the three parameters of greatest consequence have been hardened to [M] against primary sources, as documented in the Verification Report.

3. The Drivers of Structural Risk

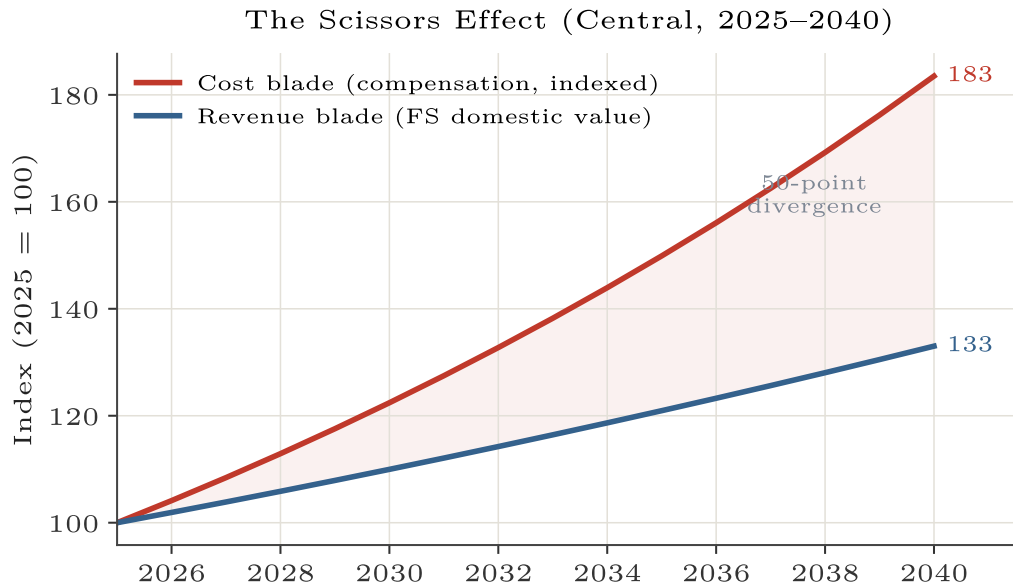
3.1 The Scissors Effect: a decoupling of governance

The structural risk to the Luxembourgish model originates not in either of its two principal price dynamics considered alone, but in the fact that they are governed independently — that the price the economy receives for its dominant export and the price it pays to produce that export respond to different signals and are set by different actors. We term this decoupling the *Scissors Effect*. Its two blades are characterised as follows.

The revenue blade is exogenous. The fee margin earned on financial services is set in global markets. Margin compression is a secular, structural phenomenon driven by the substitution toward passive investment vehicles, by fee-transparency regulation, and by the bargaining power of institutional allocators. Luxembourg possesses no domestic instrument capable of arresting it; with respect to this force the jurisdiction is a price-taker [H]. In the central calibration, the sector’s domestic value capture rises to an index of **133 by 2040** (2025 = 100) [M] — growth, but growth attenuated by the downward pressure on P .

The cost blade is endogenous. The cost of producing those services is set domestically and is, in significant part, institutionally indexed. Automatic wage indexation ties compensation growth to consumer-price inflation; unit labour costs grew 4.1% in 2024 and 4.9% in 2025, ahead of any defensible reading of productivity growth [H]. In the central calibration, sector compensation rises to an index of **183 by 2040** [M].

The two blades therefore diverge by **fifty index points** over the projection horizon — a quantitative statement of the squeeze.



The economically salient feature is not the level of either blade but their *decoupling*: a jurisdiction whose flagship industry faces exogenous, uncontrollable revenue deflation while its principal cost is indexed to a domestic price level over which the sector has no influence will experience a structural compression of net margin irrespective of its operational performance. In the central calibration this compression carries the sector’s net margin from approximately **50% in 2025 to 31% by 2040** [M]. This figure is the scissors’ signature, and it is independent of the Section 2 deflator contingency: it is a statement about nominal revenues and nominal costs, not about how real output is measured.

3.2 The domestic amplifiers and the structure of sensitivity

Three domestic variables govern the cost blade and the fiscal capacity to absorb its consequences: **wage indexation**, the **fiscal–pension trajectory**, and **housing**. The relevant policy question is not which of these is “most important” in the abstract, but which, when moved from its central to its adverse calibration, most displaces the long-run fiscal position — and whether that displacement crosses a threshold of concern.

The sensitivity analysis isolates each driver in turn, moving it alone to its adverse setting while holding the remainder at their central values, and records the effect on the 2040 gross-debt-to-GDP ratio. Because the adverse settings are themselves now calibrated against primary sources (Verification Report, Tasks 2 and 3), the resulting ranking is not an artefact of arbitrary stress assumptions; it is a direct consequence of disciplined calibration. The ranking is reported in Table 3.1.

Table 3.1 — One-at-a-time sensitivity of 2040 debt/GDP (central baseline = 67%)

Rank	Driver (central → adverse)	Δ 2040 Debt/GDP	Resulting level	Crosses 80%	Calibration basis	Conf.
1	Wage indexation	+39.8 pp	107%	Yes	ULC 4.1/4.9% [H]	[M]
2	Fiscal / pension clock	+36.6 pp	104%	Yes	IGSS/OECD/IMF [H]	[M]
3	Housing correction	+9.9 pp	77%	No	BCL over- valuation [H]	[M]
4	Servicing value leakage	+8.0 pp	75%	No	analyst [A]	[M]
5	Job- formation cost	+6.8 pp	74%	No	sector benchmark [M]	[M]
6	Fee deflation	+6.4 pp	73%	No	ESMA [M]	[M]

Two features of this ranking are central to the diagnostic and warrant deliberate emphasis, because each revises a common prior.

First, the dominant fiscal risks are domestically controllable. Wage indexation and the fiscal–pension trajectory occupy the first two ranks, and each carries approximately six times the fiscal impact of exogenous fee deflation — the variable to which external commentary most frequently attributes Luxembourg’s structural risk. This is the analytically consequential inversion of the conventional reading. The forces that most threaten long-run sustainability are not the global market dynamics over which the jurisdiction has no control, but the domestic institutional arrangements — indexation and the pension parameters — over which it retains full policy authority. Fee deflation, being gradual, exogenous, and partially offsettable through the capability-capture strategy discussed in the policy section, ranks last among the single triggers.

This finding receives independent corroboration from the actuarial record. The International Monetary Fund’s 2025 Technical Assistance assessment attributes approximately **81% of the upward revision in the projected pay-as-you-go contribution rate** (which advanced the pension system’s cash-deficit onset from 2028 to 2026) to a single revised assumption: lower employment growth [H]. The pension trajectory and the margin squeeze thus share a common mechanism. Employment growth is itself a function of the cost competitiveness that the scissors compresses; the fiscal–pension clock and the revenue–cost divergence are not independent risks sitting side by side but two expressions of the same underlying

dynamic.

Second, housing is not the largest fiscal amplifier. An earlier, pre-validation calibration assigned housing a materially larger fiscal impact and a correspondingly higher rank. Calibration against the Banque centrale du Luxembourg’s overvaluation series revised this. The BCL records that the residual house-price overvaluation had fallen to approximately **13.4% by end-2024** [H], from a euro-area-high peak of 51.3% in 2021Q2 [H], the intervening correction having been realised — a price trough of -14.5% year-on-year in 2023Q4 [H] — in what the IMF characterises as a substantial but orderly correction. Because the overvaluation that would fuel a large forward correction has already substantially unwound, the plausible forward correction is bounded, and the housing-stress impact falls to $+9.9$ pp — below the 80% threshold in isolation. Housing’s claim on policy priority, developed in the policy section, therefore rests on a *political-economy* argument concerning binding constraints on labour retention and cost competitiveness, and not on it constituting the largest fiscal lever. The demotion of housing is a direct product of the confidence apparatus: housing-correction depth was the [A] parameter whose disciplining against [H] data most changed the analytical picture.

3.3 The super-additive interaction: a risk multiplier

The housing and fiscal-pension blocks interact, and the interaction is super-additive. The magnitude, however, must be stated with precision, because the policy implication depends on it and because an exaggerated characterisation would not survive scrutiny.

Table 3.2 — Interaction of the housing and fiscal-pension blocks (Δ 2040 debt/GDP)

Configuration	Δ 2040 Debt/GDP
Housing block alone	$+9.9$ pp
Fiscal-pension block alone	$+36.6$ pp
Linear sum (additive expectation)	$+46.6$ pp
Both blocks jointly (measured)	$+48.1$ pp
Super-additive excess	$+1.5$ pp ($\approx 3.3\%$)

The interaction operates through an identifiable channel. A housing correction widens the fiscal deficit — through reduced property-related revenue and the fiscal cost of transition — which raises the debt path, which can cross the threshold at which the sovereign-financing channel raises the marginal cost of debt, which widens the deficit further. The mechanism is real and the direction is unambiguous. Its magnitude, however, is a **non-linearity of approximately 3.3% on a large base** — a *risk multiplier* that causes the joint effect of the two blocks to modestly exceed the sum of their separate effects.

The paper deliberately declines the stronger characterisation. The interaction is a *compounder of risk*, not a self-reinforcing collapse mechanism: a 3.3% non-linearity does not constitute, and should not be described as, a “doom-loop.” The policy-relevant inference is correspondingly precise and more useful than a collapse narrative would be. Because the two blocks compound — even modestly — the *sequencing* of reform carries a quantifiable cost of error: addressing housing and fiscal policy in isolation understates their joint fiscal cost by the super-additive excess, and a housing correction initiated before the mortgage book has been de-risked transmits into the financial system through precisely the channel the interaction describes. The implication is therefore not urgency born of catastrophe, but ordering born of compounding — a point the policy section develops into a sequencing constraint.

3.4 Synthesis: the structure of the diagnostic

The drivers analysis yields a structured picture rather than a single headline. The Scissors Effect (3.1) establishes the mechanism: a structural compression of net margin arising from the decoupling of an exogenous revenue dynamic from an endogenous, indexed cost dynamic, quantified independently of the deflator contingency. The sensitivity ranking (3.2) establishes the hierarchy: the dominant fiscal risks are the two

domestically-controllable levers — wage indexation and the fiscal–pension trajectory — each an order of magnitude more consequential than exogenous fee deflation, with the pension trajectory shown by the IMF to share the scissors’ employment-growth mechanism. The interaction analysis (3.3) establishes the qualification: the domestic amplifiers compound modestly, converting the analysis from a list of independent risks into an ordered set in which sequencing matters.

The diagnostic is conditional throughout. It does not assert that any particular fiscal outcome is inevitable; the scenario analysis demonstrates that the favourable calibration retires public debt entirely. It asserts, rather, that the variables determining which outcome obtains are identifiable, that they are predominantly domestic and therefore within the reach of policy, and that the order in which they are addressed is itself a determinant of feasibility. It is to the quantification of those outcomes, under explicitly bounded scenarios, that the analysis next turns.

4. Scenario Simulations: Projecting the 2040 Horizon

4.1 Status of the simulations

The structural drivers established in Section 3 are applied to the project’s recurrence-relation model and projected from 2025 to 2040. These are simulations, not econometric forecasts: they map the arithmetic consequences of specified parameter configurations, and their value lies in the orderings and thresholds they expose rather than in any claim to predict realised outcomes [stated convention]. The three scenarios correspond to internally consistent calibrations of the driver set, each satisfying the same accounting identities and differing only in the configuration of the levers analysed above. No probabilities are assigned; the scenarios bound a plausible range and isolate the transitions between regimes.

4.2 Scenario definitions

Scenario O — the net-asset-accumulation case. This configuration assumes the successful stabilisation of the cost base: a decoupling of wage indexation from high-volatility inflation, a stabilised pension trajectory, and sustained value capture in the financial sector. Its defining feature is not the absence of debt but the *accumulation of a net financial-asset position*. The configuration generates sustained primary surpluses that retire gross public debt by approximately 2036 [M] and accumulate a net financial-asset position of approximately **€51bn, or 31% of GDP, by 2040** [M]. This is the analytically meaningful characterisation of the favourable case — a sovereign net-creditor position — and it is reported not because it is probable (it requires primary surpluses few governments sustain) but because it establishes that the trajectory is conditional rather than determined.

Scenario C — the managed-erosion case. This configuration continues current structural trends: wage indexation remains tied to consumer inflation, the pension cash deficit follows the IGSS/IMF-projected path, and global fee-margin compression continues at observed rates. It produces a steady increase in the debt ratio to **67% of GDP by 2040** [M], with the scissors operating as modelled and the pension reserve and sovereign rating remaining intact. It is consistent with the European Commission’s qualitative diagnosis while attributing the mechanism to margin compression rather than to efficiency loss.

Scenario P — the structural-transition case. This configuration sets the driver set to its adverse calibration: the dominant domestic levers (indexation, fiscal–pension) at their stressed values, compounded by the housing and servicing-leakage blocks and by the sovereign-financing channel that activates above the debt threshold. It is not a worse instance of the Central case but a transition to a distinct equilibrium — high-debt, low-margin, and high-volatility. Gross debt reaches **203% of GDP** [M], the financial-sector net margin approaches zero, and the pension reserve is all but exhausted.

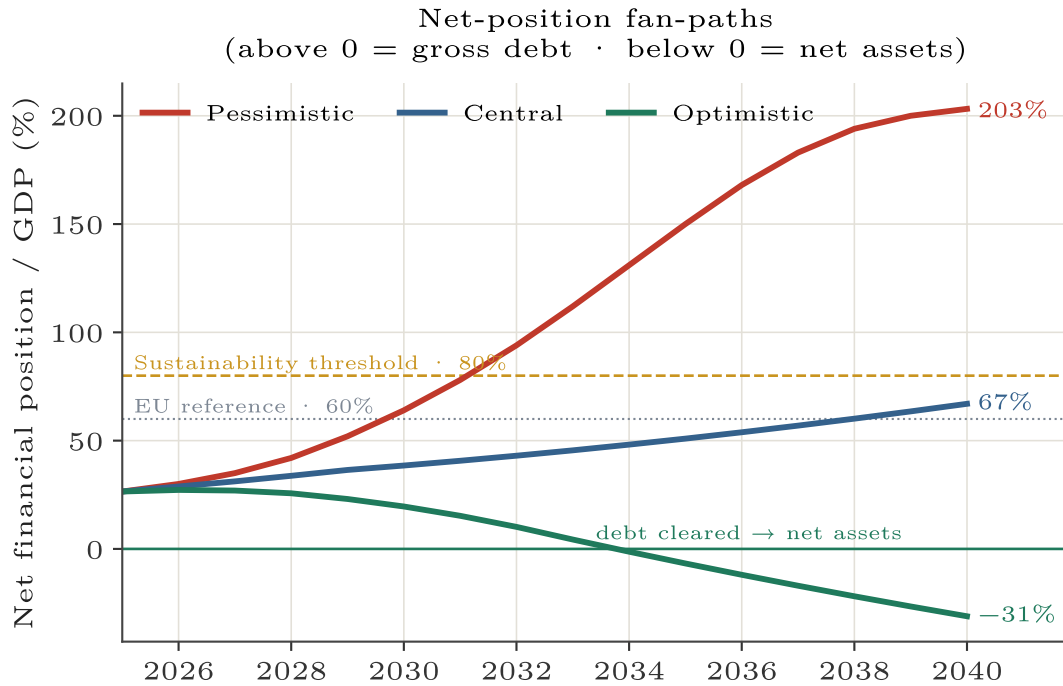


Figure 1. Net financial-position fan-paths. Above zero is gross debt; below zero is net assets. The Optimistic path clears debt and accumulates a net-asset position; the Pessimistic path crosses the 80% sustainability marker in 2031.

4.3 Comparative projections

Table 4.1 — Comparative projections, 2040 horizon

Indicator (2040)	Scenario O	Scenario C	Scenario P	Conf.
Real GDP growth, 2026–40 average	+2.45%	+1.66%	+0.89%	[M]
Gross debt / GDP	0% (cleared)	67%	203%	[M]
Net financial-asset position / GDP	+31% (€51bn)	—	—	[M]
FS net margin	50% (flat)	31%	approaching zero	[M]
Fiscal balance / GDP	+8.1%	−6.4%	−28.8%	[M]
Pension reserve	€51bn	€37bn	€3bn	[M]
Revenue volatility (σ , YoY)	0.14%	0.21%	0.46%	[M]

The presentation of the financial-sector margin warrants precision. In Scenario P the net margin does not reach a tidy zero but *approaches zero from above*, the limiting condition being that the cost blade meets or exceeds the revenue blade (cost blade $\geq$ revenue blade). Economically, this is the point at which domestic operating and compensation costs consume the entirety of the sector’s gross fee revenue, and the financial sector ceases to be a net fiscal contributor — a structural condition, not a rounding artefact [M].

4.4 Variance decomposition of the structural transition

The central analytical question raised by Table 4.1 is what drives the transition from the Central debt level (67% of GDP) to the Pessimistic level (203%) — a movement of **136.2 percentage points**. It is essential to attribute this transition correctly, because a misattribution to interaction effects would materially misrepresent the nature of the risk.

The transition is decomposed in two complementary ways. First, a one-at-a-time (OAT) measurement

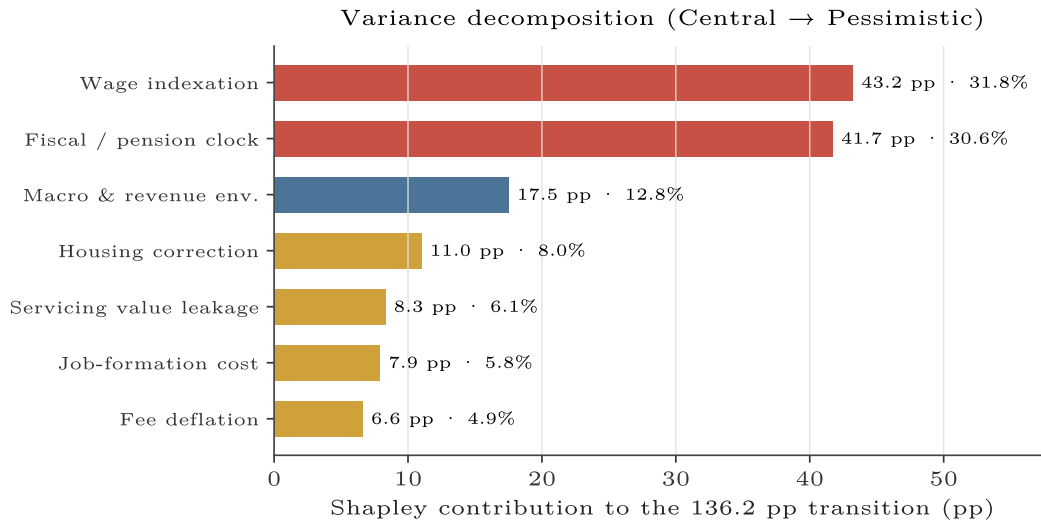


Figure 2. Shapley variance decomposition of the 136.2 pp Central-to-Pessimistic transition. The two domestic levers (wage indexation, fiscal/pension) together account for 62.4%.

moves each driver block alone from its Central to its Pessimistic setting. Second, a **Shapley decomposition** distributes the full transition — including all interaction effects — across the drivers symmetrically, so that each driver receives its marginal contribution averaged over every possible ordering of the drivers. The Shapley values sum exactly to the 136.2 pp transition and constitute the formally correct attribution of each driver’s share.

Table 4.2 — Variance decomposition of the 136.2 pp transition (Central → Pessimistic)

Driver	OAT contribution	Shapley contribution	Shapley share
Wage indexation	+39.8 pp	+43.2 pp	31.8%
Fiscal / pension clock	+36.6 pp	+41.7 pp	30.6%
Macroeconomic & revenue environment	+16.7 pp	+17.5 pp	12.8%
Housing correction	+9.9 pp	+11.0 pp	8.0%
Servicing value leakage	+8.0 pp	+8.3 pp	6.1%
Job-formation cost	+6.8 pp	+7.9 pp	5.8%
Fee deflation	+6.4 pp	+6.6 pp	4.9%
Total	124.2 pp	136.2 pp	100%

All values [M]; Shapley values verified to sum to the full transition.

Three findings follow, and they jointly correct the misattribution that a “regime change driven by interaction” narrative would introduce.

First, the transition is predominantly additive. The OAT contributions sum to 124.2 pp — **91% of the 136.2 pp transition**. The regime change is therefore driven overwhelmingly by the *additive stacking* of the individual drivers at their adverse settings, not by exotic non-linear compounding. The aggregate interaction across all drivers is 11.9 pp, or **9% of the transition** [M].

Second, two domestically-controllable levers dominate. On the Shapley attribution, wage indexation (31.8%) and the fiscal–pension clock (30.6%) together account for **62.4% of the entire transition** [M]. The macroeconomic and revenue environment — the exogenous backdrop of AuM growth, sector efficiency, and the deflator — contributes 12.8%, and the remaining four drivers together account for under 25%. The structural transition is, in its arithmetic, a story about two domestic policy variables.

Third, the super-additive interaction is a secondary effect, not the driver of the transition.

The specific housing×fiscal interaction examined in Section 3.3 contributes a non-linearity of +1.5 pp on the two drivers’ combined additive effect of 46.6 pp — **a 3.3% super-additive excess** [M]. This is a compounder of risk operating at the margin; it is not the cause of the regime change. The larger part of the 9% aggregate interaction arises from the sovereign-financing channel — the spread applied to the accumulated debt stock once it crosses the threshold, which contributes approximately 9 pp to the Pessimistic level [M] — and this is properly a feature of the fiscal block rather than a cross-driver interaction. Attributing the 203% level to a super-additive doom-loop would therefore be a quantitative error of the first order: the level is built, additively, from the stacking of domestic drivers, and amplified modestly by a financing channel that is itself a fiscal-policy variable.

4.5 Critical thresholds as decision-support markers

The scenario set localises two thresholds of direct relevance to policy. Both are presented as decision-support markers — points at which the system’s sensitivity to further shocks rises steeply — and not as mechanical cliffs.

The 80% debt/GDP sustainability marker. The 80% level is a modelling convention for a sustainability inflection, not a legal or universal limit; the European Union’s reference value is 60%, and both are reported by the model. From the Central baseline of 67%, the threshold is crossed by exactly two single drivers: wage indexation (which alone carries the ratio to 107%) and the fiscal–pension clock (to 104%) [M]. No other single driver crosses it from the central baseline — housing reaches 77%, servicing leakage 75%, job-formation cost 74%, and fee deflation 73%. The 80% marker is therefore governed almost entirely by the two dominant domestic levers, which reinforces the attribution in Section 4.4.

Pension reserve depletion. The reserve-depletion date is the marker that most sharply distinguishes a managed path from a structural transition. Anchored to IGSS, OECD, and IMF actuarial projections [H], the pre-reform reserve is projected to deplete between 2045 and 2047; the 2025 reform (the contribution-rate increase to 25.5% from 2026) extends this to approximately 2050. In the model, the reserve cushions the pension cash deficit through 2040 in both the Optimistic and Central configurations (the reserve stands at €51bn and €37bn respectively at the horizon) and is drawn to near-exhaustion only in the Pessimistic configuration (€3bn) [M]. The model’s behaviour thus sits inside the official actuarial envelope: the reserve is not depleted within the projection horizon under the central path, but the pension cash deficit it absorbs grows throughout, and the post-2040 acceleration the OECD identifies lies beyond the horizon of this analysis and constitutes a distinct, longer-dated risk.

4.6 External corroboration: the CNFP outturn and the IMF Article IV baseline

The scenario analysis can be situated against two independent official references: the May 2026 evaluation by the Conseil national des finances publiques (CNFP), Luxembourg’s independent fiscal institution, which anchors the 2025 *outturn*; and the June 2026 IMF Article IV consultation (Country Report No. 26/159), which anchors the *forward path*. One distinction governs the use of both. The IMF assesses Luxembourg’s debt as sustainable, at low overall risk of sovereign stress, with fiscal space that is ample though narrowing [H, Annex IV]. This paper neither disputes that nor advances a sovereign-stress thesis; its subject is structural margin compression and competitiveness, on which the Fund’s diagnosis and this paper’s coincide. What follows is corroboration of the debt *trajectory* and its *drivers* — not of any default-risk interpretation. The CNFP evaluation is short-horizon and compliance-oriented and does not itself model the medium term, decompose drivers, or address productivity; the IMF supplies the medium-term projection the CNFP does not.

Corroboration of the mechanism. Beyond confirming the initial conditions noted in Section 1 (2025 debt 26.5% of GDP; deficit 2.0%), the CNFP documents the cost blade directly. Net primary expenditure grew 8.1% in 2025 against the 5.8% ceiling — an annual deviation of 1.03% of GDP, exceeding the 0.3% reference threshold [H] — and the contemporaneous expenditure dynamic is attributed to compensation of

employees, current transfers, and intermediate consumption rather than to investment [H]. The institution further records that the restraint the plan requires (averaging 4.9% over 2025–2028) lies 1.7 percentage points below the historical norm of 6.6% (1996–2023) [H]. In the language of expenditure rules, this is the proposition the paper advances in the language of margin compression: the cost base is expanding faster than the sustainable path, the drivers are indexed and domestic, and stabilising them requires a departure from the historical trajectory.

The leading-indicator observation. The official debt-sustainability analysis underpinning the plan did not project the deficit to reach 2.1% of GDP until 2038 [H]. The 2025 outturn of 2.0% reached that level thirteen years early. The deterioration the official baseline distributed across the projection horizon materialised in the first year of the plan — consistent with this paper’s characterisation of the central path as an erosion already under way rather than a distant risk.

The forward path: the IMF as the middle baseline. The decisive evidence is that a second independent institution projects the same trajectory. The IMF’s 2026 Article IV baseline has gross debt rising from 26.5% of GDP in 2025 to above 39% by 2031 under current policies, a rise it attributes principally to current expenditure [H, ¶16]. That figure is almost coincident with the central scenario here (Table 4.3). The three baselines stand in a revealing order.

Table 4.3 — Three baselines for gross debt / GDP (%)

Year	Authorities’ DSA	IMF Article IV (2026)	This paper — central
2025	26.5 (outturn)	26.5	26.5
2031	≈ 25.5	39.2	≈ 40.8
2035	25.6	45.1	50.9
2038	26.0	—	60.1
2040	—	—	67.0

Authorities’ DSA: PBSN (October 2024), Table 2.3 [H]. IMF: Country Report 26/159, Table 1 and Annex IV [H]; the DSA horizon ends at 2035. Central scenario: this paper’s recurrence model [M]; the 2031 value is interpolated between modelled 2030 and 2032 figures.

Two features bear on the argument. First, the authorities’ own analysis is the outlier: it holds debt near 26% through the late 2030s, while *both* the IMF and this paper project a rise to roughly 40% by 2031. The benign official path is therefore not corroborated by the Fund; the adverse path is. Second, and more consequentially, the IMF locates the *source* of the gap in the same terms this paper does. Staff state that their baseline contrasts with the authorities’ medium-term plan because the latter rests on “more optimistic revenue assumptions,” and that “the financial sector’s outperformance and a rising labor income share are expected to wane, with tax buoyancy gradually reverting to historical averages” [H, ¶15]. The authorities, in turn, remain confident in sustainability “underpinned by sustained revenue growth from the financial sector’s strong performance” [H, ¶21]. The disagreement is thus precisely located: the official baseline assumes the financial-sector revenue base holds; the IMF and this paper both identify that assumption as the binding vulnerability. The scissors of Section 3 is the structural account of why it does not hold.

The official DSA assumes, by construction, that revenues evolve in line with nominal GDP growth [H]; the IMF rejects that assumption qualitatively, and this paper quantifies its failure. If the financial-sector fee margin compresses as modelled (Section 3), financial-sector tax revenue grows more slowly than nominal GDP, and the revenue side of the official baseline is overstated.

The magnitude is quantifiable. In the central calibration, financial-sector domestic value capture grows at approximately 1.9% per year (the revenue blade, index 133 by 2040) while nominal GDP grows at approximately 3.8% per year [M]. Financial-sector tax revenue, approximately one quarter of the total and equivalent to some 10.6% of GDP in 2025, therefore does not hold its share: under the scissors it falls to approximately 8.1% of GDP by 2040, against the constant 10.6% the official “revenues track nominal GDP” assumption implies [M]. The annual revenue shortfall relative to the official assumption widens to roughly 2.5 percentage points of GDP by 2040, and **cumulates to approximately 22 percentage**

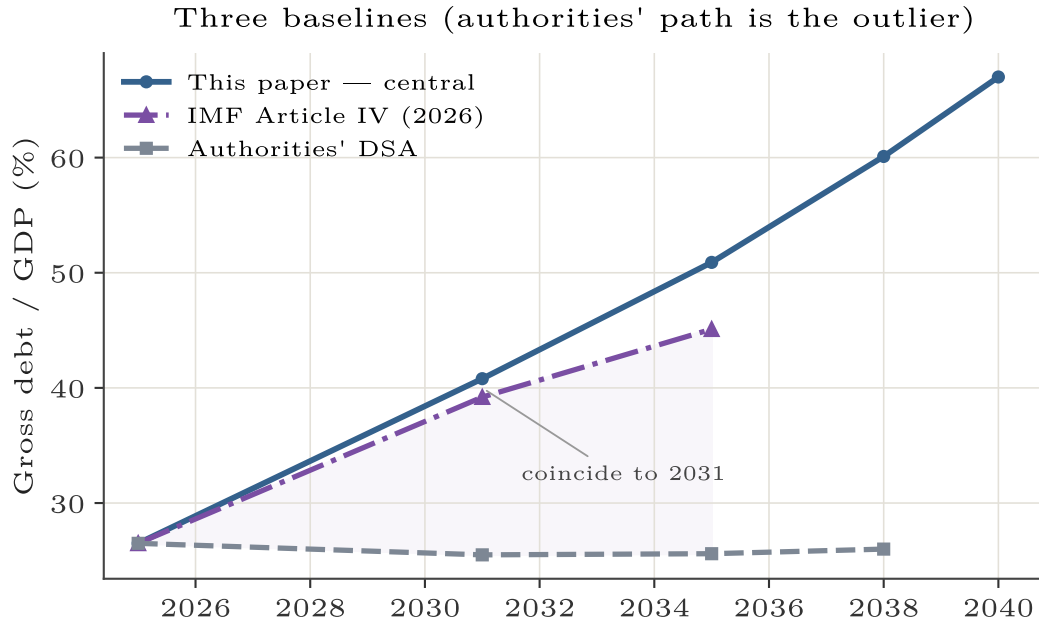


Figure 3. Three baselines for gross debt. The IMF Article IV path and this paper’s central scenario coincide to within ~1.5 pp through 2031; the authorities’ DSA holds near 26% and is the outlier. After 2031 the central path continues above the IMF baseline, reflecting structural rather than cyclical erosion of financial-sector revenue.

points of GDP over 2025–2040 [M]. That cumulative shortfall, carried onto the debt stock, accounts for the larger part of the divergence in Table 4.3; the remainder is attributable to the pension acceleration (Section 4.5) and to the structurally wider primary deficit the 2025 outturn already reveals. The same magnitude explains why the central path runs above the IMF baseline after 2031. The paper and the IMF coincide to within about 1.5 percentage points through 2031, then separate on a single assumption: the Fund treats the erosion of financial-sector tax buoyancy as cyclical, reverting to historical averages [¶15], whereas this paper treats it as structural — the secular fee-margin compression of Section 3, which does not mean-revert. The widening gap in the 2030s is therefore not a disagreement over the present, on which the two baselines agree, but the quantitative expression of the central claim: that the revenue blade’s decline is a level shift in the global price of intermediation, not a phase of a cycle.

The contribution of this paper is therefore not to contradict the official sustainability analysis on its own terms — within its assumptions it is internally coherent — but to identify and stress-test the revenue assumption it holds fixed, and to show that the 2025 expenditure overshoot the CNFP documents is the first observable instance of the mechanism by which the benign baseline ceases to hold.

Scope discipline. The CNFP evaluation does not address the pension system’s actuarial trajectory, the housing market, or sectoral productivity; the corroboration drawn from it is confined to the 2025 fiscal outturn and the expenditure mechanism. The IMF baseline corroborates the trajectory and drivers through 2031 and, on its own DSA horizon, to 2035; the 2035–2040 segment of the central path is more adverse than any external baseline and rests on the structural-continuation assumption set out above, which is this paper’s to defend. The pension and housing parameters are hardened against the IGSS/OECD/IMF and BCL sources documented in the Verification Report.

5. Conclusion and Policy Sequencing

5.1 The structural diagnosis

The analysis supports a diagnosis that is structural rather than cyclical. Luxembourg’s measured productivity challenge is, on the evidence assembled here, substantially a problem of *decoupled prices* rather

than of deteriorating internal efficiency — a conclusion whose precise weight is contingent on the deflator methodology examined in Section 2 (the price-measurement contingency, bounded at 3.0–5.0 pp/yr of measured output-per-hour growth) but whose direction is robust to that contingency. The financial sector services a growing volume of assets at a falling fee margin while paying a domestically-indexed cost base; the resulting compression of net margin — from 50% to 31% of gross revenue in the central case, and approaching zero in the adverse case — is the structural signature of the model.

The decomposition in Section 4.4 establishes the second principal finding: the transition to a high-debt regime is predominantly additive (91%) and is dominated by two domestically-controllable levers — wage indexation and the fiscal–pension trajectory — which together account for 62.4% of the movement. This is the analytically consequential result. The forces that most threaten long-run sustainability are not the exogenous market dynamics over which the jurisdiction has no authority, but the domestic institutional arrangements over which it retains full policy control. The risk is, in the precise sense established by the variance decomposition, **endogenous and controllable**.

5.2 Why sequence is a structural property, not a preference

Because the dominant drivers are domestic and because they compound — modestly through the housing×fiscal interaction (3.3%) and more substantially through the financing channel embedded in the fiscal block — the *order* in which reforms are undertaken is a determinant of feasibility, not a matter of administrative preference. Two properties of the model establish this.

First, certain reforms are preconditions for others to be executed safely. A housing-subsidy unwind initiated before the mortgage book has been de-risked transmits a price correction into the banking system through precisely the channel the housing×fiscal interaction describes; the macroprudential framework must therefore precede the subsidy reform. Second, diversification undertaken before the cost base is stabilised imports additional cost-disease into an already-compressing margin structure rather than hedging against it. The sequence below is, in this sense, derived from the risk structure rather than imposed upon it.

5.3 Phase 1 — Stabilising the cost base (the precondition)

The first phase addresses the two dominant fiscal triggers and the binding political-economy constraint.

- **Wage-indexation reform.** As the single largest contributor to the structural transition (31.8% Shapley share [M]), the relationship between automatic indexation and sector-specific margin compression is the highest-priority controllable lever. The objective is a mechanism that reduces the volatility transmitted from consumer-price inflation to the sector’s cost base, recognising that the cost blade is indexed to a price level the revenue blade does not track.
- **Pension trajectory.** The fiscal–pension clock (30.6% Shapley share [M]) must be secured to prevent reserve depletion from becoming a primary driver of debt accumulation. The 2025 reform extends the reserve horizon to approximately 2050 [H]; the actuarial record indicates this is necessary but, against the post-2050 acceleration, not sufficient on its own.
- **Housing — macroprudential sequencing.** Although housing is a secondary fiscal amplifier (8.0% Shapley share [M]), it is a binding constraint on labour retention and cost competitiveness, and its correction carries financial-stability risk. The macroprudential framework (loan-to-value and debt-service-to-income limits) should be installed *before* any unwind of demand-side housing support, so that the residual price correction — bounded by the ~13.4% end-2024 overvaluation [H] — proceeds as an orderly adjustment rather than a systemic shock.

5.4 Phase 2 — Capturing the margin (the pivot)

Only once the cost base is stabilised does the pivot from a volume-based to a capability-based model become viable rather than cost-additive. The strategic objective is to ensure that value compressed out of the

sector by global fee deflation is captured domestically rather than booked through Luxembourg to external providers. This entails investment in proprietary, AI-native fund-servicing and regulatory-technology infrastructure — the provision of high-complexity, higher-margin services (compliance technology, digital-asset oversight, regulatory tooling) — so that the sector’s value derives increasingly from capability rather than from processing volume. The servicing-value-leakage driver (6.1% Shapley share [M]) quantifies the cost of failing to do so: value that migrates to external providers as domestic capability is not retained.

5.5 Phase 3 — Strategic diversification (long-horizon optionality)

Diversification into adjacent high-value sectors is treated as long-horizon optionality and not as near-term macroeconomic insurance. The model is explicit on this point: the diversification sectors are too small relative to the financial-services base to stabilise the fiscal trajectory within the policy horizon — the job-formation-cost driver contributes 5.8% to the structural transition [M], and the cumulative specialist employment generated remains a small fraction of the workforce even in the favourable case. Diversification is therefore most defensibly justified as a source of knowledge spillover to the core economy and as a hedge whose returns accrue beyond the projection horizon, supported by scale-up financing most coherently addressed at the European level. To represent it as a substitute for cost-base stabilisation would be to misstate its quantified contribution.

5.6 Concluding statement

Luxembourg’s trajectory is conditional. The default path — the continuation of current structural trends — is one of managed erosion: a gradual compression of margins and a steady accumulation of debt to a still-manageable level. This path is not inevitable; the favourable configuration retires public debt entirely and accumulates a net-asset position. Nor is the adverse path inevitable; it is the consequence of the dominant domestic levers being left unaddressed while the financing channel compounds their effect. The distinguishing variable across all three paths is the same small set of domestically-controllable parameters identified by the variance decomposition. The policy implication is correspondingly precise: stabilise the cost base, then capture the margin, then diversify — in that order, because the order is a property of the risk structure and not a matter of preference. The cost of uncoordinated action is quantified, additive, and domestic; so too is the means of avoiding it.

6. Limitations

The analysis is subject to limitations that bound the interpretation of its results.

Model scope. The model is a strategic decision-support instrument, not an econometric forecast. It incorporates only the behavioural feedbacks explicitly specified — the housing-wealth channel to non-financial value added, the sovereign-financing spread above the debt threshold, and the transmission of indexation to both private compensation and indexed public expenditure. It does not model general-equilibrium labour-market responses, migration dynamics beyond their effect on the parameters, or endogenous monetary-policy reactions. Its outputs are magnitudes and orderings under stated assumptions, not predictions [stated convention].

Residual [A] parameters. Three of the model’s parameters were hardened from [A] to [M] against primary sources (Verification Report): the pension deficit slope (against IGSS/OECD/IMF actuarial projections), the housing-correction depth (against the BCL overvaluation series), and the magnitude of the price-measurement contingency (against the national-accounts identity and ESMA fee data). The servicing-value-leakage parameters remain [A]; their Shapley contribution (6.1%) bounds the consequence of that residual uncertainty.

The hours assumption. The sector-hours growth rate ($\dot{H} = +1.5\%/yr$ [M]) is the softest input to the Section 2 decomposition and is load-bearing for the magnitude of the price-measurement contingency.

Its conversion from [M] to [H] requires a historical decomposition of AuM growth against sector hours, identified as the principal outstanding item in the verification queue.

The deflator contingency. The weight the paper can place on its challenge to the efficiency interpretation of measured productivity depends on the STATEC deflation methodology for NACE K64.3/K66.3, which is not publicly documented at the required granularity. The analysis is constructed to be robust to either resolution — the structural conclusions rest on the nominal cost side, which is independent of the deflator — but the resolution determines the share of measured decline attributable to price measurement versus genuine efficiency. A formal methodological inquiry to STATEC has been prepared to resolve this contingency. It is important to delimit what the pending resolution affects: it bears solely on the magnitude of the price-measurement contingency in Section 2 — the share of measured productivity decline attributable to price measurement versus genuine efficiency. It does not alter the structural conclusions, which rest on the nominal cost side; it does not affect the policy sequencing of Section 5, which is derived from the risk structure; and it does not affect the Shapley variance decomposition of Section 4.4, which is computed entirely from the fiscal-driver parameters and is independent of the deflator question. The paper is therefore publication-defensible on its present footing, with the STATEC reply serving to harden one parameter from [M] to [H] rather than to validate the analysis.

External baseline divergence. The medium-term trajectory of this paper is more adverse than the authorities’ debt-sustainability analysis, which holds debt near 26% of GDP through 2038, and runs above the IMF’s 2026 Article IV baseline after 2031 (the two coincide to within about 1.5 percentage points to that year). As set out in Section 4.6, the divergence from the authorities’ path is attributable to the assumption that revenues grow with nominal GDP, which this paper quantifies as a cumulative revenue shortfall of approximately 22 percentage points of GDP by 2040; the divergence from the IMF after 2031 rests on treating the erosion of financial-sector tax buoyancy as structural rather than cyclical. It bears emphasis that the IMF judges the debt itself sustainable and at low risk of sovereign stress [H]; this paper’s concern is the structural margin squeeze and competitiveness, not solvency, and its results should be read as a structural stress-test rather than a competing point forecast.

Channels identified by the IMF but not modelled here. Three channels the 2026 Article IV emphasises are acknowledged rather than formalised, and bound the analysis. (i) *Housing as a competitiveness drag.* The IMF treats high housing costs as raising reservation wages and eroding competitiveness [H, ¶37]; in the framework here that operates upstream of the cost blade, a cost-side root the Shapley decomposition (which scores housing only as a direct fiscal driver) does not capture. (ii) *Exogenous shocks to the revenue blade.* The Fund’s risk matrix flags a disorderly AI correction transmitting through fund outflows and lower bank fee income [H, Annex III], and notes that bank profitability is sensitive to investment-fund flows [H, ¶27]; these act on the price term of the Section 2 identity as tail variance around the secular decline modelled here, while an AI-acceleration scenario ($\approx 2\%$ five-year TFP gain, almost double the European average [H, Annex VI]) would act on the throughput term. The asymmetry — exogenous risk falling predominantly on the price-taking revenue blade — reinforces the sequencing rationale of Section 5. (iii) *Productivity reading.* The IMF attributes the productivity decline to weak R&D and slow digital adoption [H, ¶34], a genuine-efficiency reading; this paper does not contest that such factors operate but argues (Section 2) that a component of the *measured* decline is a price illusion, a hypothesis the pending STATEC deflator inquiry is designed to discriminate. None of these alters the recurrence engine or the Shapley result; each marks a boundary of the present model and a direction for extension.

Appendix — Sources and verification status

Primary sources. European Commission, SWD(2026) 216 (3 June 2026); CSSF UCI statistics; ESMA *Costs and Performance of EU Retail Investment Products* (2025–26); IGSS / OECD 2024 Ageing Report; OECD *Economic Surveys: Luxembourg 2025*; IMF *Article IV and Technical Assistance Report on Pension Projections* (2025); Banque centrale du Luxembourg *Financial Stability Review 2025*; Conseil national des finances publiques (CNFP), *Évaluation du rapport d’avancement annuel du PBSN 2025–2029* (May 2026); International Monetary Fund, *Luxembourg: 2026 Article IV Consultation*, Country Report No. 26/159

(June 2026); STATEC national accounts; Eurostat *Handbook on Price and Volume Measures in National Accounts* (ESA 2010 edition).

Confidence migration (per Verification Report). Price-measurement contingency: $[A] \rightarrow [M]$ (magnitude); applicability pending STATEC inquiry. Pension deficit slope and cliff: $[A] \rightarrow [M]$, with underlying dates $[H]$. Housing-correction depth: $[A] \rightarrow [M]$. Outstanding for full hardening: the AuM/hours decomposition ($\dot{H}$, $[M] \rightarrow [H]$); the STATEC deflator confirmation (contingency applicability, $[A] \rightarrow [H]$); regional housing disaggregation (enrichment).

Reproducibility. All quantitative results are reproduced from the project’s validated recurrence-relation model and are identical across the working paper, the Verification Report, and the interactive dashboard. The variance decomposition of Section 4.4 is a Shapley attribution over seven driver blocks, computed across all parameter subsets, verified to sum to the full 136.2 pp Central-to-Pessimistic transition.

— End of Sections 4–6 —