

Shadow Pricing ESG: Constraint Interactions and Feasibility Boundaries in Romanian Mandatory Pension Portfolios

Razvan Alexandru Rusu¹, Daniela Ioana Manea²,
Liana Ioana Paraschiv³ and Alexandra Stefan⁴

¹⁾²⁾³⁾⁴⁾ Bucharest University of Economic Studies, Bucharest, Romania.

E-mail: rusurazvan23@stud.ase.ro; E-mail: daniela.manea@csie.ase.ro;

E-mail: paraschivliana23@stud.ase.ro; E-mail: stefanalexandra24@stud.ase.ro

Please cite this paper as:

Rusu, R. A., Manea, D. I., Paraschiv, L. I. & Stefan A. (2026). Shadow Pricing ESG: Constraint Interactions and Feasibility Boundaries in Romanian Mandatory Pension Portfolios. In C. Vasiliu, D.-C. Dabiya, A. Tziner, D. Pleșea, & V. Dinu (Eds.), *Proceedings of BASIQ International Conference on New Trends in Sustainable Business and Consumption, 12th Edition* (pp. 72-79). Editura ASE. DOI 10.24818/BASIQ/2026/12/036

Abstract

Mandatory pension systems bind fiduciaries to a welfare objective whose primary content is limiting adverse outcomes, not maximising return. Imposing Environmental, Social, and Governance (ESG) criteria on funds that already face binding concentration limits, liquidity constraints, and downside-risk obligations raises a question distinct from the one that occupies most of the ESG literature: not whether ESG characteristics carry a return premium, but whether ESG constraints impose a welfare cost in an already constrained allocation problem. This paper develops a scenario-based mean–Conditional Value-at-Risk (CVaR) optimisation framework in which ESG enters as a binding portfolio-level constraint alongside an implementability cap. Applied to seven Romanian Pillar II funds over March 2022–March 2024, the framework produces three findings. Away from the binding frontier, ESG requirements are effectively costless. Once binding, they can worsen the tail-risk-optimal allocation. Beyond a specific threshold, the joint constraints produce infeasibility. Near that boundary the shadow price of ESG rises sharply and non-linearly, and both the boundary location and the shadow price magnitude are endogenous to the implementability cap. The mechanism generalises to any mandatory pension setting where ESG requirements interact with concentration, liquidity, and downside-risk objectives.

Keywords: Pension funds; ESG constraints; fiduciary duty; mean–CVaR; risk budgeting

DOI: 10.24818/BASIQ/2026/12/036

Introduction

The governance of mandatory pension funds sits at an uncomfortable intersection. On one side stands the ESG integration agenda, now embedded in EU sustainable-finance regulation through the Sustainable Finance Disclosure Regulation (SFDR). On the other stands the fiduciary standard operative in mandatory systems — protecting the retirement incomes of beneficiaries who cannot opt out and bear investment risk directly. When ESG requirements are imposed on funds that already face binding concentration limits, liquidity constraints, and downside-risk obligations, the interaction between these constraints determines the welfare effect.

The research gap this paper addresses is specific. Pedersen et al. (2021) derive the ESG-efficient frontier in an unconstrained setting; Pástor et al. (2021) show that apparent ESG return premia are largely artefacts of factor exposure and sector composition rather than ESG characteristics per se; Rockafellar and Uryasev (2000) establish the CVaR framework that underpins downside-risk-focused fiduciary optimisation. None of these frameworks accounts for the layered institutional constraints — concentration limits, downside-risk budgets, and implementability caps — that define the actual feasible set in a mandatory system. None asks at what point an ESG threshold becomes incompatible with adequate tail-risk protection for beneficiaries. The answer, as we show, depends on the intersection of multiple constraints simultaneously, not on any one of them in isolation.

This paper makes three contributions. First, it develops a scenario-based mean–CVaR framework in which ESG enters as a binding constraint alongside an implementability cap, and derives the shadow price of ESG as the marginal welfare cost of tightening the threshold. Second, it applies this to Romanian Pillar II, where seven funds with measurably different CVaR and ESG profiles make the constraint interactions analytically tractable. Third, sensitivity analysis over the implementability cap shows that the feasibility boundary and shadow price are endogenous to market structure — a finding with direct regulatory implications.

The paper is organised as follows. Section 1 reviews the literature and institutional context. Section 2 describes the data and optimisation framework. Section 3 reports results. Section 4 integrates findings, limitations, and implications. Section 5 concludes.

1. Review of the Scientific Literature

1.1 Institutional and Market Context

Romanian Pillar II operates as a mandatory defined-contribution system. Its regulatory architecture is shaped by EU sustainable-finance law: SFDR imposes disclosure and classification requirements without directly dictating portfolio composition, while the broader framework creates governance pressure toward ESG integration. Three structural features are analytically critical. First, ESG exclusions in a concentrated market accelerate the point at which the ESG constraint becomes binding, because substitutes are scarce. Second, the implementability cap reflects the combined pressure of liquidity constraints, governance limits on single-asset concentration, and peer-group dynamics. Third, because participants bear investment risk directly, the fiduciary's distributional concern centres on tail outcomes — not tracking error — making CVaR the natural risk metric (Rockafellar and Uryasev, 2000). In this setting the seven funds are treated as asset sleeves whose return and ESG heterogeneity map the feasible set, not as allocation targets per se.

1.2 ESG Integration and Fiduciary Risk Management

The case for treating ESG factors as financially material rather than merely normative rests on evidence that has accumulated unevenly. Townsend (2020) traces how the risk-based framing of ESG displaced the earlier values-screening logic, aligning ESG integration with existing fiduciary obligations rather than requiring their expansion. Krüger (2015) documents negative market reactions to adverse sustainability events, interpreted as evidence that ESG signals proxy for risk management quality. Krueger et al. (2020) find through survey evidence that climate-related risks are already incorporated into institutional portfolio oversight; for pension funds, ignoring material ESG risks may itself breach fiduciary duty (Hoepner et al., 2011). Hammond et al. (2023) find no systematic reduction in financial performance from ESG integration, while Wang and Wu (2025) confirm that institutional investors with longer horizons increasingly price climate exposure.

Where the literature is clearer is on what ESG integration is not. Pástor et al. (2021) show that in a market where ESG preferences shift equilibrium prices, green assets will have lower expected returns going forward, because their prices have already been bid up. This is the correct framing for mandatory pensions: ESG integration cannot be justified on return grounds, but neither does it need to be. The question is whether it imposes a welfare cost through its interaction with other binding constraints — and that is what this paper analyses. The modelling approach closest to ours is Pedersen et al. (2021), who derive the ESG-efficient frontier in an unconstrained setting. Once concentration limits, downside-risk budgets, and implementability caps are imposed simultaneously, the relevant analytical object is not the frontier but the boundary at which the feasible set disappears.

1.3 ESG Measurement and Regulatory Frictions

ESG rating divergence across providers is substantial — Berg et al. (2022) show it is driven primarily by measurement differences and that average pairwise correlations between major raters can barely exceed 0.50. Billio et al. (2021) and Gibson Brandon et al. (2021) confirm that this divergence affects portfolio construction and introduces uncertainty into constraint implementation. The implication for this paper is that feasibility boundaries are rating-methodology-specific, not structural properties of the investment universe — a limitation addressed directly in Section 4.2. On the regulatory side, Becker et al. (2022) and Scheitza and Busch (2024) document that SFDR has affected fund flows and labelling behaviour, while Abouarab et al. (2025) find its effects on actual greenwashing to be asymmetric and concentrated among Article 9 funds. For Romanian Pillar II, SFDR's force is currently indirect — shaping governance context

rather than imposing specific portfolio thresholds — so the ESG constraint levels used in this paper are scenario parameters, not current regulatory requirements.

2. Research Methodology

2.1 Data

The empirical application uses monthly data for the full population of seven active Romanian Pillar II funds — AEGON, Allianz Țiriac, BCR, BRD, Generali, Metropolitan, and NN — from March 2022 through March 2024 (25 monthly observations per fund). The period post-dates pandemic disruptions, captures the SFDR consolidation phase, and contains sufficient cross-sectional variation to identify constraint interactions. Returns are monthly net returns (after fees) from ASF regulatory filings. ESG Risk Scores are time-averaged portfolio-level scores from Sustainalytics; lower values indicate lower assessed ESG risk. With 25 observations, CVaR at the 95th percentile is estimated from the one or two worst monthly returns — statistically precarious, and why the exercise is better understood as an illustration of constraint geometry than as a precise empirical calibration. Summary statistics are reported in Table no. 1.

Table no. 1. Summary statistics for Romanian Pillar II pension funds (March 2022–March 2024)

Fund	Mean Return (%/mo)	CVaR ₉₅ Loss (%/mo)	ESG Risk Score (avg)
AEGON	0.779	3.157	22.44
Allianz Țiriac	0.790	3.457	21.85
BCR	0.770	3.400	21.90
BRD	0.760	3.300	22.60
Generali	0.820	4.057	22.30
Metropolitan	0.800	3.200	22.10
NN	0.790	3.900	22.00

Notes: CVaR₉₅ = expected loss conditional on exceeding the 95th-percentile threshold. ESG Risk Score = time-averaged Sustainalytics portfolio-level score; lower values = lower assessed ESG risk.

Two observations are critical for what follows. ESG score dispersion is narrow (21.85 to 22.60), so constraints bind within a limited range. More importantly, the two lowest-ESG funds — Allianz Țiriac (21.85) and BCR (21.90) — are not the lowest-CVaR funds. This misalignment between ESG-optimal and risk-optimal assets drives the main results: any ESG threshold forcing substitution toward the low-ESG funds simultaneously moves the allocation away from tail-risk-minimising positions.

2.2 Optimisation Framework

The framework treats each monthly observation as a discrete scenario of equal probability — a non-parametric setup avoiding distributional assumptions. Let r_{it} be the net return of fund i in month t , w_i the portfolio weight, with $\sum_i w_i = 1$ and $w_i \geq 0$. Portfolio return in scenario t is $R_t = \sum_i w_i r_{it}$; loss is $L_t = -R_t$. Risk is measured by CVaR at the 95th confidence level, computed via the Rockafellar–Uryasev (2000) linear formulation. Two problems are solved: minimising CVaR subject to a return floor, and maximising return under a CVaR ceiling, together tracing the constrained opportunity set from its minimum-risk to its maximum-return endpoint.

Two binding constraints are imposed. First, an implementability cap $w^T \leq c^T$ (baseline 0.40) reflects the combined pressure of regulatory concentration limits, liquidity constraints, and governance norms. Second, the ESG constraint $\sum_i w_i \cdot \text{ESG}_i \leq \bar{\text{ESG}}$ imposes a ceiling on the weighted-average ESG Risk Score. Stricter $\bar{\text{ESG}}$ values require greater weight in lower-scoring funds. ESG is modelled as a constraint, not a return source — grounded in the evidence that ESG characteristics do not reliably generate excess returns after controlling for factor exposures (Pástor et al., 2021), and consistent with recent multi-criteria ESG optimisation approaches that also treat risk measures such as CVaR as primary portfolio objectives (Taheripour et al., 2025). The shadow price of ESG — the gain in maximum achievable return per unit relaxation of $\bar{\text{ESG}}$ under a fixed CVaR ceiling — is the key output of the analysis.

3. Results

3.1 Baseline Constrained Opportunity Set

Under $c^T = 0.40$ with no ESG constraint, the minimum-CVaR portfolio holds AEGON (40%), Metropolitan (40%), and BRD (20%), delivering 0.779%/mo return and 3.157% CVaR. The maximum-return portfolio holds Generali (40%), Metropolitan (40%), and NN (20%), achieving 0.820%/mo but with CVaR of 4.057%. The 4.1 bps return gap against a 90 bps CVaR gap summarises the system's nature: limited return differentiation but substantial risk differentiation, a direct consequence of overlapping fund portfolios. ESG constraints enter an already narrow feasible set. Table no. 2 records the anchor portfolios.

Table no. 2. Baseline anchor portfolios ($c^T = 0.40$; no ESG constraint)

Portfolio	Return (%/mo)	CVaR ₉₅ (%/mo)	ESG avg	Weights
Min CVaR	0.779	3.157	22.34	AEGON 40%, BRD 20%, MET 40%
Max Return	0.820	4.057	22.16	GEN 40%, MET 40%, NN 20%

Notes: MET = Metropolitan; GEN = Generali. CVaR₉₅ = expected loss in the worst 5% of monthly scenarios.

3.2 When ESG Becomes Binding

Imposing $\bar{\text{ESG}} \leq 22.0$ — binding because it lies between the anchor portfolios' weighted-average scores (22.34 and 22.16) and the theoretical minimum (21.90) — forces measurable substitution. Under CVaR minimisation, weight shifts from Metropolitan and AEGON toward BCR and Allianz Țiriac; CVaR rises from 3.157% to 3.457% (+30 bps) while the portfolio ESG score falls to 21.99. The return gain is negligible (+1.1 bps). Under return maximisation, the constraint reduces the maximum achievable return from 0.820% to 0.803% (−1.7 bps). ESG is not neutral once binding: it simultaneously worsens tail protection and caps return. Table no. 3 presents the full comparison.

Table no. 3. Effect of imposing ESG constraint ($\bar{\text{ESG}} \leq 22.0$; $c^T = 0.40$)

Portfolio	Ret (%/mo)	CVaR ₉₅	ESG avg	Δ Ret (bps)	Δ CVaR (bps)	Weights
Min CVaR, no ESG	0.779	3.157	22.34	—	—	AEGON 40%, BRD 20%, MET 40%
Min CVaR, $\text{ESG} \leq 22.0$	0.790	3.457	21.99	+1.1	+30.0	BCR 40%, MET 40%, ALL 16%, BRD 4%
Max Ret, no ESG	0.820	4.057	22.16	—	—	GEN 40%, MET 40%, NN 20%
Max Ret, $\text{ESG} \leq 22.0$	0.803	4.075	22.05	−1.7	+1.9	MET 40%, ALL 37%, GEN 23%

Notes: Δ values relative to the unconstrained solution. Positive Δ CVaR = worsened tail protection. ALL = Allianz Țiriac.

3.3 Welfare Interpretation under Varying Risk Aversion

A mean-CVaR utility function $U = E[R] - \lambda \cdot \text{CVaR}_{95}(L)$ is evaluated at $\lambda \in \{0, 0.05, 0.20\}$. At $\lambda = 0$ the ESG constraint costs 1.7 bps in return with negligible CVaR change. At $\lambda = 0.05$ the constrained portfolio deteriorates on both dimensions simultaneously (−1.3 bps return; +2.9 bps CVaR). At $\lambda = 0.20$ the unconstrained optimum violates the ESG threshold; the constrained solution is the same as at $\lambda = 0.05$, but the utility loss is larger because tail-loss aversion is higher. The welfare cost of the ESG constraint is not concentrated at a single preference configuration — it is distributed across the realistic range of fiduciary objectives. Table no. 4 reports results in full.

Table no. 4. Sensitivity to risk-aversion parameter λ : constrained and unconstrained portfolios

λ	ESG Regime	Ret (%/mo)	CVaR ₉₅	ESG avg	Weights
0	No ESG	0.820	4.057	22.16	GEN 40%, MET 40%, NN 20%
0	$\text{ESG} \leq 22.0$	0.803	4.075	22.05	MET 40%, ALL 37%, GEN 23%
0.05	No ESG	0.814	3.445	22.28	GEN 40%, MET 40%, BRD 20%
0.05	$\text{ESG} \leq 22.0$	0.801	3.474	22.04	MET 40%, BCR 40%, GEN 15%, ALL 5%
0.20	No ESG	0.779	3.157	22.34	AEGON 40%, BRD 20%, MET 40%
0.20	$\text{ESG} \leq 22.0$	0.801	3.474	22.04	MET 40%, BCR 40%, GEN 15%, ALL 5%

Notes: Utility = $E[R] - \lambda \cdot \text{CVaR}_{95}(L)$. Higher λ = greater tail-loss aversion.

3.4 Shadow Price and the Feasibility Boundary

Fixing the CVaR ceiling at 3.4%/mo and varying $\bar{E}SG$ from 22.00 to 22.25 reveals the feasibility boundary and shadow price. Below $\bar{E}SG = 22.05$ the problem is infeasible — no portfolio satisfies all three constraints simultaneously. At $\bar{E}SG = 22.05$ the maximum return is 0.789%; relaxing to 22.10 gains 22 bps per ESG unit. Further relaxation yields sharply diminishing returns: 8 bps to 22.15, 8 bps to 22.20, and 2 bps to 22.25. Table no. 5 records these results; Figure no. 1 visualises the non-linear shadow price curve and the feasibility boundary.

Table no. 5. Feasibility and shadow price of ESG (CVaR limit = 3.4%/mo; $c^T = 0.40$)

ESG Threshold ($\bar{E}SG$)	Feasible	Max Ret (%/mo)	CVaR ₉₅ (%/mo)	Marginal Gain (bps/ESG pt)
22.00	No	—	—	—
22.05	Yes	0.789	3.40	—
22.10	Yes	0.800	3.40	22
22.15	Yes	0.804	3.40	8
22.20	Yes	0.808	3.40	8
22.25	Yes	0.809	3.40	2

Notes: Marginal gain = increase in max return per one-unit relaxation of $\bar{E}SG$, in bps. No entry at 22.00: infeasible.

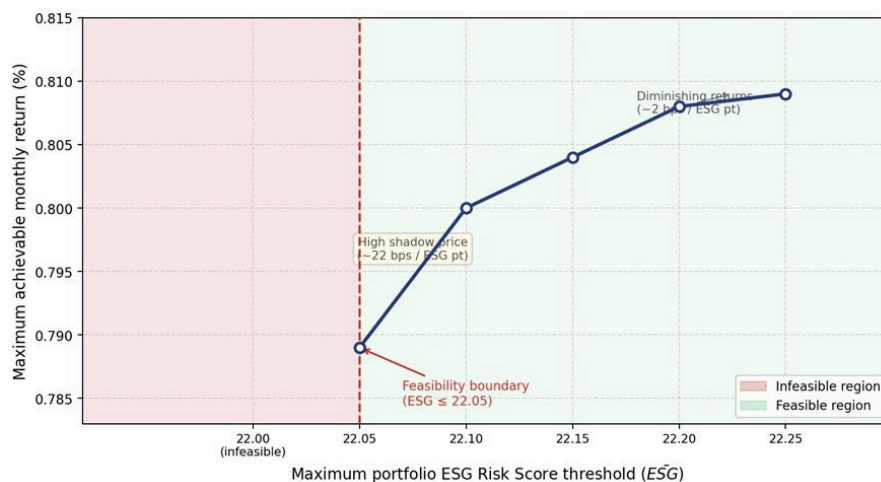


Figure no. 1. Maximum achievable monthly return under a fixed CVaR₉₅ constraint across ESG thresholds (CVaR limit = 3.4% per month; $w_i \leq 0.40$).

The non-linearity is the key regulatory finding. A small relaxation from an infeasible threshold buys 22 bps; a small tightening from a slack threshold costs almost nothing. Regulators who set thresholds without accounting for joint feasibility conditions can produce requirements that are formally well-intentioned but operationally unattainable in concentrated markets.

3.5 Sensitivity to the Implementability Cap

The feasibility boundary is a joint product of the ESG threshold and the implementability cap, not a fixed property of the ESG constraint. A tighter cap limits concentration in the low-ESG funds, raising the minimum attainable ESG score and shifting the boundary upward. Table no. 6 makes this visible across five cap values: moving the cap from 0.40 to 0.30 shifts the boundary from ≈ 22.05 to ≈ 22.10 — a 5-bps shift comparable to the gap between several fund pairs. ESG compliance requirements calibrated for deep liquid markets will be differentially costly in concentrated mandatory systems even if the thresholds are numerically identical.

Table no. 6. Sensitivity of the feasibility boundary to the implementability cap (CVaR limit = 3.4%/mo)

Cap (c ^T)	Min ESG	Feasibility Boundary ($\bar{E}SG^{\min}$)	Max Ret, No ESG (%/mo)
0.30	21.94	≈ 22.10	0.790
0.35	21.91	≈ 22.07	0.803
0.40	21.90	≈ 22.05	0.820
0.45	21.88	≈ 22.03	0.820
0.50	21.88	≈ 22.00	0.820

Notes: Min ESG = minimum achievable portfolio ESG score (exact, analytical). Feasibility boundaries for caps $\neq 0.40$ are directional. Plateau at 0.820 for caps ≥ 0.40 reflects saturation of the GEN–MET–NN combination.

4. Discussions

4.1 Interpretation of Findings

The evidence supports a reading of ESG integration in mandatory pension systems that differs from the one implicit in much policy discourse. ESG requirements are typically justified on two grounds: that ESG-integrated portfolios perform comparably to conventional ones (Hammond et al., 2023; Hoepner et al., 2011), and that ignoring material ESG risks may violate fiduciary duty (Krueger et al., 2020). Both survive this paper's evidence across most of the feasible range. The difficulty arises specifically near the boundary: when the ESG threshold is set tightly enough, tail-risk protection deteriorates, creating a genuine conflict between the ESG mandate and the core welfare objective.

The shadow price framework makes this conflict quantifiable. A board that knows the shadow price of its current ESG threshold — in units of CVaR deterioration or return loss — can make an informed decision about whether the requirement is appropriately calibrated to the fund's market structure and risk budget. The non-linearity is also governance-relevant: most of the feasible range is essentially cost-free from a welfare perspective, while the cost concentrates sharply near the boundary. Boards should identify where the boundary lies for their specific market structure and stay meaningfully below it, rather than targeting the minimum achievable ESG score.

4.2 Limitations

Five limitations bound the applicability of the findings. First, the 25-observation sample yields CVaR estimates based on one or two tail realisations per series, making the quantitative results illustrative rather than precisely calibrated. Second, fund-sleeve treatment abstracts from securities-level implementation costs — liquidity, position-change constraints, and market impact — that would further shrink the feasible set in practice. Third, use of a single ESG rating provider (Sustainalytics) means the specific boundary locations are methodology-contingent; the qualitative mechanism should be robust across providers, but the thresholds are not. Fourth, the framework is asset-side only; a full asset-liability model incorporating contribution patterns and benefit obligations would be required for complete fiduciary assessment. Fifth, the static model does not capture rebalancing costs or time-varying ESG scores, both of which are relevant for the practical cost of ESG tightening.

4.3 Policy and Managerial Implications

For regulators, the central implication is that ESG threshold-setting must be market-structure-aware. Uniform thresholds appropriate for deep pension markets will produce different constraint geometries — and different welfare outcomes — in concentrated mandatory systems with limited substitutability. The feasibility boundary should be estimated before a threshold is mandated. For fund boards, the shadow price provides a practical governance tool: assess the marginal cost, in CVaR and return terms, of the current ESG threshold, and distinguish zones where tightening is essentially free from zones where the boundary is near. In concentrated markets, engagement-based ESG integration — working with portfolio companies to improve ESG scores rather than excluding them — may be preferable to exclusion precisely because it avoids accelerating feasibility collapse.

4.4 Directions for Further Research

The most direct extension is to the securities level, which would yield implementable rather than illustrative allocations and allow the ESG–risk misalignment to be traced to underlying portfolio composition. A cross-country comparison of feasibility boundaries across pension systems with varying concentration would provide an empirical basis for market-structure-adjusted threshold calibration. Dynamic extensions

incorporating transaction costs, rebalancing constraints, and time-varying ESG scores would capture the path costs of ESG tightening, which may be as policy-relevant as the steady-state costs identified here. Multi-provider robustness analysis of boundary locations is also needed before the specific thresholds can be used prescriptively.

Conclusions

This paper has argued that the welfare effects of ESG requirements in mandatory pension systems cannot be assessed by examining the ESG constraint in isolation. What matters is its intersection with the concentration limits, downside-risk budget, and implementability caps that define the investment problem. In an already narrow feasible set, these interactions create a boundary beyond which no portfolio can simultaneously satisfy all constraints, and the shadow price of ESG rises sharply in that boundary's neighbourhood.

Three central findings emerge. First, even without ESG constraints, Romanian Pillar II offers its fiduciaries a narrow return range (0.779%–0.820%/mo) against a wide CVaR range (3.157%–4.057%); the opportunity set is already tight. Second, once the ESG constraint binds at $\bar{ESG} = 22.0$, tail-risk protection deteriorates by 30 bps in the CVaR minimisation problem, because the ESG-satisfying funds are not the tail-risk-minimising funds. Third, the feasibility analysis reveals a shadow price exceeding 22 bps per ESG unit near the boundary, dropping to 2 bps within five threshold steps — a non-linearity whose location depends as much on the implementability cap as on the ESG threshold itself.

The primary methodological contribution is the shadow price framework, which translates ESG threshold choices into fiduciary welfare terms — specifically downside-risk terms — and generates quantitative outputs directly actionable in governance contexts. The Romanian application is illustrative and bounded by acknowledged limitations: short sample, fund-sleeve abstraction, single ESG provider, no liability-side modelling, and a static setup that omits rebalancing costs. These limitations point toward natural extensions: securities-level implementation, cross-country comparison, multi-provider robustness, and dynamic modelling of transition costs.

The broader implication is that the sustainability of ESG requirements — their compatibility with the fiduciary standard — depends on calibration to market structure. The mechanism identified here, by which ESG thresholds interact with concentration constraints to produce non-linear welfare effects, is present whenever a mandatory system faces a narrow investable universe. Estimating the feasibility boundary and calibrating thresholds accordingly is not an optional refinement: in concentrated markets, it is the analysis without which the governance decision cannot be made responsibly.

Acknowledgement

This paper was co-financed by The Bucharest University of Economic Studies during the PhD program.

Generative Artificial Intelligence (GenAI) usage statement:

Claude Sonnet (claude-sonnet-4, Anthropic) was used for language editing and structural revision. All substantive analysis, modelling choices, and results are the authors' own. The authors reviewed all generated content and take full responsibility for the final manuscript.

References

- Abouarab, R., Mishra, T., & Wolfe, S. (2025). Does the EU sustainable finance disclosure regulation mitigate greenwashing? *The European Journal of Finance*, 31(8), 957–989. <https://doi.org/10.1080/1351847X.2025.2457944>
- Becker, M. G., Martin, F., & Walter, A. (2022). The power of ESG transparency: The effect of the new SFDR sustainability labels on mutual funds and individual investors. *Finance Research Letters*, 47, 102708. <https://doi.org/10.1016/j.frl.2022.102708>
- Berg, F., Kölbel, J. F., & Rigobon, R. (2022). Aggregate confusion: The divergence of ESG ratings. *Review of Finance*, 26(6), 1315–1344. <https://doi.org/10.1093/rof/rfac033>

- Billio, M., Costola, M., Hristova, I., Latino, C., & Pelizzon, L. (2021). Inside the ESG ratings: (Dis)agreement and performance. *Corporate Social Responsibility and Environmental Management*, 28(5), 1426–1445. <https://doi.org/10.1002/csr.2177>
- Gibson Brandon, R., Krueger, P., & Schmidt, P. S. (2021). ESG rating disagreement and stock returns. *Financial Analysts Journal*, 77(4), 104–127. <https://doi.org/10.1080/0015198X.2021.1963186>
- Hammond, P. B., Maurer, R., & Mitchell, O. S. (Eds.). (2023). *Pension Funds and Sustainable Investment: Challenges and Opportunities*. Oxford University Press.
- Hoepner, A. G. F., Rezec, M., & Siegl, K. S. (2011). Does pension funds' fiduciary duty prohibit the integration of environmental responsibility criteria in investment processes? A realistic prudent investment test. *SSRN Working Paper*. <https://doi.org/10.2139/ssrn.1930189>
- Krueger, P., Sautner, Z., & Starks, L. T. (2020). The importance of climate risks for institutional investors. *The Review of Financial Studies*, 33(3), 1067–1111. <https://doi.org/10.1093/rfs/hhz137>
- Krüger, P. (2015). Corporate goodness and shareholder wealth. *Journal of Financial Economics*, 115(2), 304–329. <https://doi.org/10.1016/j.jfineco.2014.09.008>
- Pástor, L., Stambaugh, R. F., & Taylor, L. A. (2021). Sustainable investing in equilibrium. *Journal of Financial Economics*, 142(2), 550–571. <https://doi.org/10.1016/j.jfineco.2020.12.011>
- Pedersen, L. H., Fitzgibbons, S., & Pomorski, L. (2021). Responsible investing: The ESG-efficient frontier. *Journal of Financial Economics*, 142(2), 572–597. <https://doi.org/10.1016/j.jfineco.2020.11.001>
- Rockafellar, R. T., & Uryasev, S. (2000). Optimization of conditional value-at-risk. *The Journal of Risk*, 2(3), 21–41. <https://doi.org/10.21314/JOR.2000.038>
- Scheitza, L., & Busch, T. (2024). SFDR Article 9: Is it all about impact? *Finance Research Letters*, 62, 105179. <https://doi.org/10.1016/j.frl.2024.105179>
- Taheripour, E., Sadjadi, S. J., & Amiri, B. (2025). A multi-criteria approach to ESG-based portfolio optimization incorporating historical performance, forward-looking insights, and credibilistic CVaR: A case study on the DJIA. *Scientific Reports*, 15(1), 39088. <https://doi.org/10.1038/s41598-025-24242-x>
- Townsend, B. (2020). From SRI to ESG: The origins of socially responsible and sustainable investing. *The Journal of Impact and ESG Investing*, 1(1), 10–25. <https://doi.org/10.3905/jesg.2020.1.1.010>
- Wang, Z., & Wu, K. (2025). How do institutional investors respond to climate change exposure? International evidence. *Global Finance Journal*, 68, 101202. <https://doi.org/10.1016/j.gfj.2025.101202>