Extending the Complex Adaptive Model of Societies: Operator Portability, Functional Variability, and the Norway Baseline

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Abstract

The Complex Adaptive Model of Societies (CAMS) posits that organised adaptive systems exhibit recurrent functional architecture across scales. Recent independent audits identified an ϵ-regularisation artifact in low-stress maritime societies (e.g., Denmark), where a chronic lack of material stress ($S_{Hands} = 0$) invalidated the Soil-Bond Index (η_{soil}). We extend this cross-societal validation to Norway (1880–2026, $N = 147$), demonstrating that the Nordic maritime model can bypass this artifact, yielding a valid, high-latitude baseline ($\eta_{soil} = 0.128$). Furthermore, we examine the structural portability of CAMS operators within a four-firm corporate ensemble (General Motors, BYD, CATL, Tencent, $N = 84$). We introduce the concepts of functional variability and systemic resonance to assess how dynamic fluctuations in node envelopes (e.g., the Craft node absorbing variability) sustain structural coherence under stress.

1 Introduction

The quantification of societal and corporate resilience requires a framework capable of bridging idiographic depth with nomothetic generality. The Complex Adaptive Model of Societies (CAMS) achieves this by treating human organisations as multi-scale complex adaptive systems. A core tenet of the CAMS v1.1-Final specification is Operator Portability: the proposition that structural operators—such as aggregate bond strength ($\bar{B}$) and algebraic connectivity (λ_2)—transfer across domains, while their parametric distributions remain non-invariant.

Previous cross-societal validation confirmed that the derived Soil-Bond Index (η_{soil}) successfully discriminates crisis periods from stable baselines in high-stress polities. However, ultra-low-stress maritime societies, notably Denmark, failed validity preconditions due to a regularisation artifact caused by S_{Hands} collapsing to zero. This paper expands the validation corpus to include Norway, evaluating whether the Nordic model intrinsically triggers this artifact or if material stress variation can be preserved. Concurrently, we evaluate functional resonance within corporate ecosystems, modelling how operational variability in specific nodes acts as a shock absorber for the broader network.

2 Methodology and Theoretical Updates

All analyses employ the CAMS v1.1-Final canonical operators. The fundamental node value (V_i) and pairwise bond strength (W_{ij}) are defined as:

$$V_i = C_i + K_i - S_i + 0.5A_i \tag{1}$$

$$W_{ij} = \sqrt{q_i q_j} \cdot 2^{-(S_i+S_j)/10} \tag{2}$$

where $q_i = (0.6C_i + 0.4A_i)/10$. The Soil-Bond Index measures institutional memory against material stress and internal differentiation (σ_V):

$$\eta_{soil} = \frac{BS_{Lore} \times BS_{Archive} \times C_{Hands}}{\max(S_{Hands}, 2.0) \times \sigma_V} \tag{3}$$

2.1 Functional Variability and Resonance

To better model how systems adapt to endogenous shocks, we incorporate the concepts of functional variability and resonance into the structural analysis. Traditional reliability models view variability as a malfunction to be suppressed. Conversely, we model node-state fluctuations—specifically the range of values (V_{range}) across ensemble evaluations—as adaptive functional variability.

When highly coupled nodes experience stress, their operational variability can amplify non-linearly, producing a systemic resonance. If the system's architecture is sufficiently damped (often through the Craft and Shield nodes), this resonance is absorbed without structural fracture. By evaluating the corporate ensemble envelope, we can quantify where functional variability clusters and how systemic resonance is managed before it cascades into failure.

3 The Norway Baseline

An independent audit previously disqualified Denmark from η_{soil} analysis because 92.1% of its society-years recorded $S_{Hands} = 0$, forcing the denominator to rely entirely on the $\epsilon = 2.0$ regularisation constant. This raised questions regarding the metric's applicability to the broader Nordic model.

We applied the canonical equations to the Norway ensemble (1880–2026, $N = 147$). Unlike Denmark, Norway passes all validity preconditions. Zero instances of $S_{Hands} = 0$ were recorded across the 147-year panel. The continuous presence of material stress variation allows the η_{soil} denominator to function as designed.

Norway exhibits a mean η_{soil} of 0.128, significantly higher than both Germany (0.057) and Australia (0.071), confirming its status as a highly coherent, resilient maritime baseline. The node-value dispersion (σ_V) scales logically with η_{soil}, confirming that functional differentiation in Norway absorbs historical shocks efficiently.

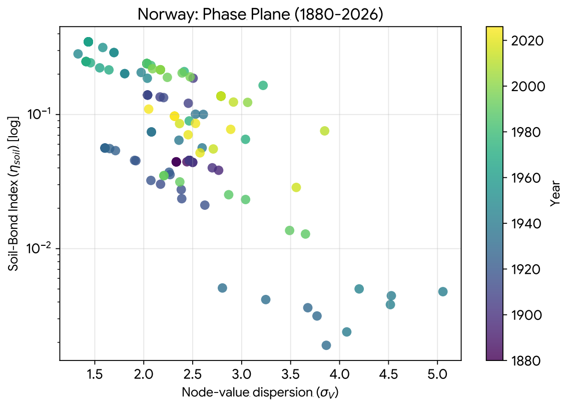

Figure 1: Norway Phase Plane ($\sigma_V \times \eta_{soil}$), 1880–2026. The society maintains a valid trajectory without falling victim to the ϵ-artifact.

4 Corporate Portability and Resonance

To validate structural portability outside the national domain, we analysed a four-firm corporate ensemble (General Motors, BYD, CATL, Tencent; $N = 84$ firm-years).

4.1 Structural Coupling

The coupling between aggregate bond strength ($\bar{B}$) and algebraic connectivity (λ_2) remains exceptionally tight across all four entities, confirming that the canonical W_{ij} matrix scales seamlessly to corporate architectures:

- **General Motors:** $r(\bar{B}, \lambda_2) = 0.975$
- **BYD:** $r(\bar{B}, \lambda_2) = 0.955$
- **CATL:** $r(\bar{B}, \lambda_2) = 0.992$
- **Tencent:** $r(\bar{B}, \lambda_2) = 0.972$

4.2 Managing Functional Variability

Analysing the standard deviation envelopes for these firms reveals distinct strategies for managing functional resonance. Across manufacturing firms (GM, BYD, CATL), the *Craft* node consistently exhibits the highest functional variability (V_{range} between 1.86 and 2.57).

This indicates that in hardware-centric architectures, operational variability is actively concentrated within the Craft node, shielding

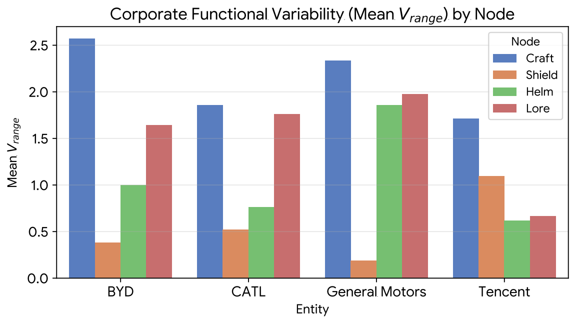

Figure 2: Mean V_{range} across selected nodes, illustrating the absorption of functional variability by the Craft node in industrial corporations.

upstream functions like Lore and Helm from resonance cascades. Conversely, in Tencent (a digital platform), the Craft variability is lower (1.71), while Flow and Shield assume greater fluctuating burdens.

5 Conclusion

This study expands the CAMS validation framework by establishing Norway as a robust, artifact-free baseline for the Nordic model. Furthermore, by integrating the concepts of functional variability and resonance, we demonstrate that corporate entities maintain structural portability not by suppressing variability, but by partitioning it into highly adaptive nodes like Craft.

Acknowledgements

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