

Institutional Stability

Systems Thinking · Module 8 — Institutional Systems

Node 8.5

Position in Knowledge Graph

This node formalizes when an institution persists under strategic behavior and perturbation.

It builds on: - Norms and Enforcement (8.2) - Collective Action (8.4)

It prepares for: - Constraint Architecture (9.1)

Institutional stability characterizes whether rule systems are self-sustaining equilibria.

Formal Statement / Definition / Construction

Let:

- $\mathcal{A}$ be action space,
- $\mathcal{I} \subseteq \mathcal{A}$ feasible actions under institution,
- $U_i(a)$ agent utilities.

Define effective utilities under enforcement:

$$\tilde{U}_i(a) = U_i(a) - E_i(a),$$

where $E_i(a) \geq 0$ is sanction.

Let $a^* \in \mathcal{I}$.

Definition (Institutional Stability)

Institution $\mathcal{I}$ is **stable** if:

1. a^* is Nash equilibrium under $\tilde{U}$,
 2. Deviations from $\mathcal{I}$ are unprofitable,
 3. Enforcement mechanism itself is incentive-compatible.
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Assumptions and Conditions

1. Agents rational.
2. Sanctions credible and enforceable.
3. Enforcement agents have incentive to enforce.
4. No external authority assumed.

Stability analyzed in strategic equilibrium framework.

Proof or Mathematical Development

First-Level Stability (Compliance)

For all i and a'_i :

$$\tilde{U}_i(a^*) \geq \tilde{U}_i(a'_i, a^*_{-i}).$$

Expanding:

$$U_i(a^*) \geq U_i(a'_i, a^*_{-i}) - S_i(a'_i).$$

Second-Level Stability (Enforcement Incentives)

Let enforcement require action e_j by agent j .

If enforcing imposes cost c_e , and failure to enforce yields benefit b_j , stability requires:

$$U_j^{\text{enforce}} \geq U_j^{\text{not enforce}}.$$

Thus:

$$-c_e + V_j^{\text{future}} \geq b_j.$$

Future continuation value must offset enforcement cost.

Dynamic Stability

Let institutional state variable $I_t \in \{0, 1\}$.

Transition probability:

$$\mathbb{P}(I_{t+1} = 1 \mid I_t = 1) = 1 - p_{\text{collapse}}.$$

Institution stable if:

$$p_{\text{collapse}} = 0 \quad \text{under equilibrium behavior.}$$

Structural Role

Institutional stability:

- Extends Nash equilibrium to rule systems.
- Requires enforcement incentive compatibility.
- Links micro-incentives to macro-rule persistence.
- Connects governance to dynamic equilibrium.

Institutions persist only if self-enforcing.

Structural Compression

Invariant

Institution stable if:

$$\tilde{U}_i(a^*) \geq \tilde{U}_i(a'_i, a^*_{-i}) \quad \forall i.$$

Mechanism

Sanctions and continuation values offset deviation gains.

Cross-System Echo

- Economics: subgame perfect equilibrium.
 - Biology: stable cooperative equilibria.
 - Control Theory: feedback maintaining constraint set.
 - Networks: protocol stability under strategic nodes.
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Concepts: institutions, nash-equilibrium, stability

Prerequisites: 8.2, 8.4

Enables: 9.1

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