



# Reform Exhaustion

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## *Delegation Depth and the Controllability of Governance*

*Paper XI in the Governance as Engineering series*

Models the actuation channel through which policy intent reaches the world. Shows that minimum control effort grows superlinearly with delegation depth — deep chains price reform out of reach even when all actors are competent and compliant.

Formalises latency accumulation, dimensional collapse, and noise injection as structural degradation mechanisms, each paired with country-report evidence. Closes the series' first theoretical cycle.

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## Abstract

The Governance as Engineering series has established that a governance system can only stabilise what it can observe, and Papers I through X have analysed the observation channel in detail: its aggregation losses, its frequency limits, its representation chains, its dimensionality, its measurement, its diversity. This paper treats the channel the series has so far examined only under adversarial conditions — the actuation channel through which policy intent reaches the world. A directive formulated at the centre must traverse a delegation chain to the point of delivery: ministry, agency, regional office, municipality, street level. Each layer projects the directive onto its own operational repertoire, adds latency, and injects noise. These are structural properties of the chain, not failures of the people in it; the paper's results hold when every actor is competent, honest, and fully compliant. The central result is an energy law. Using the controllability Gramian of the effective actuation chain, the paper shows that the minimum control effort required to realise a policy target grows superlinearly with delegation depth. Deep chains do not refuse policy; they price it out — a condition the paper names reform exhaustion, and one that explains both the deep bureaucracies that function (they pay the rising cost) and the reform programmes that pass, partially deliver, consume their political capital, and stop. The binary limit of the same curve, constitutional uncontrollability, is the dual of Paper III's constitutional unobservability: beyond a critical depth, the policy target leaves the reachable set entirely and the required effort becomes infinite. The paper formalises the three degradation mechanisms — latency accumulation, dimensional collapse, and noise injection — and pairs each with documented governance evidence; analyses the bidirectional node, where one institution sits at depth in both the observation and actuation chains and the two compressions compound; demonstrates the energy law in simulation; and anchors the framework in a small-N empirical study centred on a within-country comparison of a single statute implemented at differing administrative depths. The paper closes the series' first theoretical cycle: both channels of the classical state-space grammar, observation and actuation, are now treated. What follows is not more theory. It is confrontation with data.

# Part I — The Problem: The Untreated Channel

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## 1.1 Oakland, 1966

In April 1966, the federal Economic Development Administration announced a programme that had everything a policy is supposed to need. It had money: roughly twenty-three million dollars, committed and appropriated, for public works in the city of Oakland, California — a marine terminal, an aircraft hangar, access roads — together with business loans tied to the same goal. It had a clear objective: jobs for the unemployed, principally for Black residents of a city that federal officials feared was close to civil unrest. It had political alignment at every level. The federal agency wanted the programme to succeed and said so publicly. The city government welcomed it. The employers who would receive the funds had agreed to hiring plans. There was no organised opposition worth the name. No faction was lying in wait to kill it. The programme was announced with confidence, reported with enthusiasm, and staffed by people who, by the available accounts, believed in it and worked at it.

Several years later, most of the money had not been spent. The marine terminal and the hangar were stalled or incomplete. The jobs created — the entire point of the undertaking — numbered not in the thousands that had been projected but in the dozens. Nothing dramatic had happened. There had been no scandal, no veto, no reversal of policy, no withdrawal of funds, no change of heart. The programme had not been defeated. It had been *attenuated*: delayed, diluted, and translated, one administrative step at a time, until what arrived at the point of delivery bore little resemblance to what had been announced — and much of it never arrived at all.

Two political scientists, Jeffrey Pressman and Aaron Wildavsky, went looking for the villain and reported, in 1973, that there wasn't one. Their book's full subtitle has become a small legend in the field: *How Great Expectations in Washington Are Dashed in Oakland; Or, Why It's Amazing that Federal Programs Work at All*. What they found instead of a villain was a structure. Implementing the programme required agreement after agreement — between federal and local agencies, between agencies and contractors, between offices within the same agency — at what they counted as some thirty decision points generating roughly seventy separate clearances, each one necessary, none individually difficult. And then they did something unusual for the political science of their day. They did arithmetic. If the probability of agreement at each clearance is 99 per cent — near-perfect consensus, every actor almost always saying yes — the probability that all seventy occur is just under one half. At 95 per cent per clearance, the joint probability falls below three per cent. At 90 per cent, the programme succeeds roughly once in sixteen hundred attempts. The programme had not failed despite the agreement of its participants. It had failed *through* a structure that demanded their agreement too many times in sequence.

Pressman and Wildavsky called this the complexity of joint action, and the field they helped found took the lesson in a particular direction. Implementation research became, and has largely remained, a study of behaviour: the resources actors command, the commitment they bring, the clarity of the mandates they receive, the discretion they exercise, the incentives that lead agents to deviate from principals (Lipsky, 1980; Sabatier & Mazmanian, 1980; Gailmard & Patty, 2013). These literatures explain a great deal. But notice what happened to the arithmetic. The multiplication table that opens the field's founding book — the calculation showing that sequential clearance structures destroy joint success probability at rates that swamp any plausible variation in goodwill — was absorbed as an illustration, a memorable way of saying "implementation is hard." It was not developed as what it actually is: a law about architecture.

This paper develops it as a law about architecture. The clearance-point calculation is, in the formal terms this paper introduces, the scalar special case of a more general result: a directive that must traverse a chain of delegation layers is attenuated by each layer it crosses, and the attenuation compounds. Pressman and Wildavsky measured the compounding in the simplest possible currency — the probability that a yes survives a sequence of opportunities to become a no. The general result holds in a richer currency. Each layer of a delegation chain does three things to the directive that passes through it, and does them regardless of anyone's intentions. It delays the directive, because processing takes time and the delays of layers in series add. It projects the directive onto its own operational repertoire — the routines, categories, and instruments the layer already possesses — so that what is transmitted downward is not the directive but the layer's translation of it. And it perturbs the directive, because every translation is performed by a different office, under different local conditions, with different readings of the same words. Delay, projection, noise: the three mechanisms are familiar separately to anyone who has worked inside a large institution. Their formal composition across a chain of layers is the subject of this paper.

The series has been here before, facing the other direction. Paper III showed that a citizen preference travelling *up* a representation chain — citizen, representative, parliament, cabinet — is attenuated at each aggregation layer, and that beyond a critical chain depth the preference signal falls below the threshold at which the policy layer can observe it at all: constitutional unobservability, a property of the layer count rather than of the layers. This paper establishes the descending counterpart. A policy intent travelling *down* a delegation chain is attenuated at each implementation layer, and the attenuation has both a threshold reading and — more consequentially — a cost reading. The threshold reading says that beyond a critical delegation depth, the policy target leaves the set of outcomes the chain can reach at all. The cost reading, which this paper treats as primary, says that well before that limit, the effort required to push a directive through the chain with adequate fidelity grows superlinearly with the chain's depth. Deep chains do not announce that a policy is impossible. They deliver it late, narrowed, and distorted, and they charge an escalating price — in political capital, administrative attention, and fiscal outlay — for every increment of fidelity recovered. Governments do not usually experience uncontrollability as a wall. They experience it as exhaustion: the reform that passed, was implemented in part, consumed everything, and stopped. The paper names this condition *reform exhaustion* and derives it as a property of delegation architecture.

The claim, throughout, is architectural in the series' strict sense. Nothing in what follows requires shirking, capture, resistance, or bad faith. Those phenomena are real, they make everything worse, and Paper IX has analysed the strategic version of actuation attenuation — an incumbent deliberately filtering a reform it opposes — in detail. This paper sets every adversarial term to zero and shows that the attenuation remains. Every actor in the chain may be competent, honest, and sincerely committed to the directive as received. The directive still arrives late, projected, and perturbed, and the compounding still follows the depth of the chain. That is what it means for the failure to be a property of the architecture: it is the failure mode that survives the best case.

Oakland was the best case. That is why it opens this paper, and why Pressman and Wildavsky's subtitle was not a joke but a finding. The sections that follow give their arithmetic the formal development it did not receive from the field it founded.

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## 1.2 The Series in One Page

This paper is the eleventh in a series whose premise can be stated in a sentence: governance systems are feedback systems, and feedback systems have structural properties — latency, signal fidelity, dimensionality, gain ceilings — that determine their stability regardless of the intentions of the people operating them. Readers new to the series need the following table and nothing more; each paper is summarised in the terms its own conclusion uses.

Paper	Domain	Established
I	Crisis response	Latency and signal fidelity place hard ceilings on responsiveness; centralised controllers respond to means, not distributions (the averaging problem).
II	Multi-scale disturbance management	Disturbances arrive at multiple frequencies; a single-speed architecture is structurally mismatched to most of them.
III	Democratic representation	Representation chains attenuate the citizen-preference signal; beyond a critical depth the policy layer cannot observe it at all (constitutional unobservability).
IV	Commons governance	Requisite variety lives at the point of contact; proximity is an engineering requirement before it is a political preference.
V	Interaction	The constraints of I–IV do not add; they compound multiplicatively (the coordination failure tax).
VI	Value architecture	Objective functions are observation architectures; what a system does not value, it ceases to see (the variety gap).
VII	Synthesis	Fifteen country studies; reform disappoints structurally, via the immune system, the bypass trap, and the legibility problem; the convergent first step is the protected experimental space.
VIII	Measurement	The variety gap made estimable: structural primitives, proxies, and a composite index with stated uncertainty.
IX	Transition	Architectural change as contested control: the variety ratio $\Omega$ , the latency asymmetry, the transmission constraint, and transition bandwidth as a race that can be lost before it is visible.
X	The observer population	Distributed sensing fails through correlation, not individual error: ensemble variance $\sigma^2((1-\rho)/N + \rho)$ ; diversity is a structural variable.

One mechanism recurs through all ten: aggregation destroys information, and destroyed information cannot be recovered downstream. The series' arc, as Paper X described it, is a progressive expansion of the system boundary — single controllers, then their value functions, then transitions between architectures, then the population of observers. This paper does not expand the boundary further. It returns to the single controller and treats the one channel the expansion left behind: not how the controller sees, but how it acts.

### 1.3 What Paper IX Did, and What It Left

The series has analysed actuation once before, under specific and deliberately hostile conditions. Paper IX modelled architectural reform as contested control: a reform coalition and an incumbent acting on the same institutional state, with the incumbent enjoying shorter latency and — in the incentive-compatibility trap — partial control over the reform's own transmission. There, the effective actuation is  $u_{R\_eff} = M \cdot u_R$ , where the transmission matrix  $M$  is held, in part, by an adversary who attenuates precisely the dimensions that threaten its position. Paper IX's attenuation is strategic, selective, and transition-time: it exists because someone benefits from it, and it concentrates where the stakes are highest.

This paper removes the adversary and finds that attenuation remains. The chain a directive descends in ordinary, uncontested administration — ministry to agency to region to municipality to street — attenuates structurally: by translation, by delay, by noise, identically for the directives everyone supports and the directives someone resists. The relationship between the two analyses is a decomposition, developed formally in §4.1: what a directive meets is  $M \cdot \Pi$ , strategy composed with structure, and Paper IX studied the first factor while this paper studies the second. One acknowledgement is owed at the outset. Paper IX itself observed that the incumbent's advantage is not purely strategic — embedding in the architecture, not cunning, is what gives the incumbent its short observation-to-actuation loop. The architectural strand was therefore already present in Paper IX's analysis. This paper generalises it: the structural attenuation that Paper IX encountered as the medium of a contest is here shown to bind even when no contest exists.

### 1.4 Three Traditions, and the Gap Between Them

The phenomenon this paper formalises has been seen before, from three directions, and the paper's position with respect to each should be exact.

The first and closest tradition is organizational cybernetics. Stafford Beer's Viable System Model (Beer, 1972; 1979; 1985) established that the vertical channel of any organization faces a structural variety problem: the higher level cannot process the variety of the lower, so the upward flow must be attenuated and the downward flow amplified — and Beer's variety attenuators and amplifiers are structural devices, present regardless of anyone's competence or goodwill. Beer further identified the pathology of excess attenuation: a management that ends by controlling a model of operations rather than the operations themselves — which readers of this series will recognise as Paper VI's Goodhart–Ashby synthesis, two decades early, applied to hierarchy. The VSM tradition's applications to public administration (Espejo & Harnden, 1989; Schwaninger, 2006; and a substantial case literature) carry the diagnosis into governance, qualitatively. This paper stands in that lineage, and its relation to Beer is the series' standard relation to its ancestors — the relation of Paper IV to Ostrom and Paper VI to Ashby: what the tradition established as conceptual diagnosis, the paper develops as formal grammar, with a derived threshold, a derived cost law, and a metric that permits estimation. Beer named the amplifiers. This paper prices them.

The second tradition is the economics of hierarchy. Multi-tier principal–agent models (Tirole, 1986; Qian, 1994; Gailmard & Patty, 2013) formalise information loss and control loss in delegation — but through incentive incompatibility and strategic communication: agents shade, shirk, and misreport because their interests diverge. The distinction from this paper is sharp and testable: in the incentive tradition, attenuation vanishes when agents are faithful; in the chain model, it persists at full compliance. The two mechanisms also separate empirically, by the discriminator §4.1 develops. The incentive tradition is the formal apparatus of Paper IX's adversary; this paper supplies the floor beneath it.

The third tradition is implementation science itself — the field Pressman and Wildavsky founded and Lipsky (1980), Sabatier and Mazmanian (1980), Winter, and Hill and Hupe built out. It is rich in variables: resources, commitment, communication clarity, street-level discretion. What it lacks, and has acknowledged lacking through four decades of framework synthesis, is a structural theory of why the variables interact as they do — and its founding book's one formal-structural claim, the clearance-point arithmetic, was absorbed as an illustration rather than developed as a law. That development is this paper.

Across the three traditions, then: the first diagnosed the structure without the mathematics, the second built the mathematics for a different mechanism, and the third documented the phenomenology without either. We have not identified, in the management cybernetics, control-theoretic public administration, or implementation literatures, a prior formalization of the delegation chain as a cascaded projection sequence with a derived controllability threshold and energy law. The contribution is accordingly not the identification of the problem — Beer and the implementation tradition both did that — but the threshold, the energy law, and the empirical anchor that a formal treatment makes possible.

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## Part II — The Formal Framework

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### 2.1 The Delegation Chain Model

We work with the series' standard plant. The governed system has state  $x_t \in \mathbb{R}^N$  evolving as

$$x_{t+1} = A x_t + B u_t, y_t = C x_t,$$

where  $u_t \in \mathbb{R}^m$  is the control actually applied to the system and  $C$  is the observation architecture that Papers I through X have analysed. This paper holds  $C$  fixed and asks what stands between the policy authority and  $u_t$ .

The answer, in every governance system of consequence, is a chain. The authority at the centre does not apply  $u_t$ . It issues an *intent*,  $v_t \in \mathbb{R}^m$  — a directive, a statute, a programme — which descends through a sequence of layers: ministry, agency, regional office, municipality, delivery unit. Number the layers 1 through  $n$  in the order the directive meets them. Each layer  $i$  does three things to what it receives, and the series' architectural discipline applies from the outset: each is modelled as a property of the layer as a structure, holding regardless of the intentions of the people in it.

First, the layer **translates**. A directive arrives in the vocabulary of the layer above and must leave in the operating vocabulary of the layer below: existing routines, programme categories, budget lines, legal instruments, software fields. We model translation as a linear map  $P_i$  acting on the directive, with two structural properties. Its singular values do not exceed one — a layer can preserve or lose content of the directive, but cannot manufacture intent it did not receive [VERIFY: this normalisation assumption is doing work; confirm framing with Söderström — alternative is  $\|P_i\| \leq 1$  as a contraction assumption, stated as such]. And its rank  $r_i \leq m$  may be deficient: a layer whose repertoire spans fewer dimensions than the directive simply has nowhere to put the missing components. Call  $d_i = m - r_i$  the layer's *repertoire deficiency*.

Second, the layer **delays**. Processing, approval, scheduling, and onward transmission take time  $\tau_i$ , and delays in series add.

Third, the layer **perturbs**. Every translation is carried out by a particular office under particular local conditions, and no two offices read the same words identically. We model this as additive noise  $w_{\{i,t\}}$  entering at layer  $i$ .

The control the plant finally receives is therefore not  $v_t$  but

$$u_t = \Pi v_{\{t-T\}} + \sum_k (P_n \cdots P_{\{k+1\}}) w_{\{k, \cdot\}}, \text{ where } \Pi = P_n P_{\{n-1\}} \cdots P_1 \text{ and } T = \sum_i \tau_i.$$

From the centre's point of view, the system it is actually steering is not (A, B) but the *effective* system (A, BΠ), driven with lag T and contaminated by chain noise. Three elementary consequences of this composition carry the rest of the paper, and we state them now in plain terms before developing each formally.

**Clean transmission loses a dimension per deficient layer.** The composite deficiency of Π is bounded by the rank inequality for products, and where it falls within those bounds is governed by the *geometry of the layers' blind spots* — a dependence the prototype simulation of Part V establishes numerically and Appendix A.3 derives. When the blind spots are mutually independent — each layer missing a dimension the others express — the deficiencies add exactly: true annihilation, one dimension per layer. When the blind spots are identical — a homogenized chain, every layer trained to the same categories — the chain annihilates that one shared dimension and transmits everything else at full fidelity, however deep it runs. And in the generic case between these poles, the chain annihilates almost nothing and *degrades* almost everything it touches: hard rank is preserved, but the number of dimensions transmitted cleanly falls by approximately one per layer, and the worst surviving direction's gain collapses geometrically — taking the loss not as unreachability but as an entry on the energy law of §2.3. The unified statement: **a deficient chain costs one cleanly transmitted dimension per layer, generically; the blind-spot geometry determines only whether the cost is charged as impossibility or as price.** No layer needs to be bad. And the geometry term is not a technicality — it is the actuation-side analogue of Paper X's central variable, the correlation structure of the ensemble, returning here as the correlation of the *implementers'* blind spots, with consequences §3.2 and §4.2 develop.

**Gains multiply.** On the directions Π does transmit, each layer passes the directive with some gain  $\gamma_i \leq 1$ . The composite gain on a direction is the product of the per-layer gains. For a chain of uniform quality  $\gamma$  per layer, the directive arrives at strength  $\gamma^n$ : attenuation is exponential in depth. The reader has met this law before, in scalar form. Pressman and Wildavsky's clearance arithmetic — joint success probability  $p^{70}$  — is exactly the composite-gain product in the currency of probability:  $m = 1$ , every  $P_i$  the scalar  $p$ , every clearance a layer. Their table is the diagonal special case of Π.

**Delays add.** Cumulative latency  $T = \sum \tau_i$  puts the chain under the latency–gain ceiling established in Paper I: a directive that arrives T steps late is steering a state that no longer exists, and the faster the plant drifts, the less a delayed directive is worth. We do not re-derive Paper I's result here; we note that the chain inherits it, with T growing linearly in depth.

## 2.2 The Duality, and What It Licenses

Readers of Paper III will recognise the shape of this construction, because it is Paper III's construction reflected. There, a citizen preference ascending a representation chain was aggregated, delayed, and perturbed at each layer, and beyond a critical chain depth the preference signal fell below the policy layer's observation threshold: constitutional unobservability. Here, a policy intent descends a delegation chain and is projected, delayed, and perturbed at each layer. The reflection is not a metaphor. It is the oldest structural fact

in control theory: the pair  $(A, B)$  is controllable precisely when the pair  $(A^T, B^T)$  is observable, so that every theorem about what an observation architecture can distinguish has a dual theorem about what an actuation architecture can reach.

We are explicit about what the duality does and does not do in this paper, because the distinction carries the paper's epistemic tier. The duality *motivates* the construction and *licenses* the expectation that Paper III's threshold phenomenon has a descending counterpart. It does not, by itself, prove anything about governments, because a ministry is not a matrix: the claim that delegation layers behave as contractive translations with additive noise is a modelling claim — a formal application in the series' three-tier vocabulary, not a derivation — and its adequacy is an empirical question, which Part VI begins to address. Every result below is therefore proved directly within the chain model of §2.1, with the duality serving as the bridge to Paper III rather than as a premise.

## 2.3 The Energy Law: Reform Exhaustion

A control engineer's first question about the effective system  $(A, B\Pi)$  is not whether a target is reachable but what reaching it costs. The standard instrument is the controllability Gramian. Over a horizon of  $H$  steps,

$$W_c(H) = \sum_{k=0}^{H-1} A^k (B\Pi)(B\Pi)^T (A^T)^k,$$

and the minimum control energy required to drive the system to a target state  $x_f$  is

$$E_{\min}(x_f) = x_f^T W_c^{-1} x_f.$$

Energy, here, is the engineer's term for the summed squared magnitude of the control signal — the total forcing the centre must inject over the horizon. Its governance reading is the heart of the paper, and we develop it after stating the result.

Consider a policy direction the chain transmits imperfectly: composite gain  $\gamma^n$  after  $n$  layers,  $\gamma < 1$ . The Gramian's eigenvalue along that direction scales as  $\gamma^{2n}$ , and its inverse — the energy — scales as  $\gamma^{-2n}$ : **the minimum effort required to realise a fixed policy outcome grows exponentially with delegation depth**. A numerical sense of the law: a chain whose layers each transmit a direction at 90 per cent fidelity prices the same outcome at roughly 1.2 times the shallow-chain cost at depth one, 2.9 times at depth five, and over eight times at depth ten — and per-layer fidelity of 80 per cent prices depth ten at nearly a hundred times the shallow-chain cost.

What does a government spend, when it spends this energy? It re-issues the directive. It convenes the inter-ministerial task force. It attaches monitoring requirements, then monitoring of the monitoring. It creates a delivery unit at the centre to chase the chain from outside. It spends ministerial attention, legislative time, fiscal sweeteners for compliant layers, and — the scarcest currency — political capital on a programme that was already announced, already legislated, already agreed. Organizational cybernetics gave this expenditure a name half a century ago: Beer called the downward compensations *amplifiers*, the apparatus by which a

centre with insufficient variety forces its will into a higher-variety world. What the Gramian adds to Beer is the price schedule. **Amplification is not free, and its cost curve in delegation depth is not linear. Reform exhaustion is the condition of a government paying an exponentially growing amplification bill with linearly growing budgets.**

This is why the energy law, and not the threshold, is the paper's signature result. A threshold claim — "beyond depth  $n^*$ , policy fails" — invites an immediate objection: deep bureaucracies demonstrably function. Japan governs. The Nordic states deliver. Militaries execute through many layers. The energy law has no quarrel with these cases; it predicts them. Deep chains that function are deep chains whose principals pay, continuously, a depth-priced bill — in standardisation, in doctrine, in training (Beer's amplifiers again, institutionalised), or in raw administrative expenditure. And the same law predicts the other phenomenology, the one the country reports document: the reform that passes with a majority, implements its first tranche, slows, spawns task forces, consumes the government's capital, and stops short — not because it met a wall, but because each further increment of fidelity cost more than the last. France's pension and labour-market cycles, examined in this series' country reports, read less like collisions with impossibility than like exhaustion events on a rising cost curve.

## 2.4 The Limit: Constitutional Uncontrollability

The threshold is not discarded; it is located. As depth grows, two things happen to  $W_c$  together. Along transmitted directions, eigenvalues shrink geometrically — the energy law of §2.3. And when accumulated repertoire deficiencies  $\sum d_i$  exceed the complement of the policy-relevant subspace,  $\Pi$  loses rank *on that subspace*: the Gramian becomes singular in the policy direction, the inverse in  $E_{\min}$  ceases to exist, and the target leaves the reachable set entirely. No finite expenditure reaches it.

We call this limit **constitutional uncontrollability**, the exact dual of Paper III's constitutional unobservability, and with the same signature: it is a property of the layer count and the layers' repertoire dimensions, not of the layers' quality. Improving the people improves  $\gamma$  and lowers the bill; it does not restore dimensions that no layer in the chain can express. The route to the limit depends on the blind-spot geometry of §2.1. A chain of independent deficiencies reaches it by accumulation: a directive requiring action in  $q$  dimensions exits the reachable set at a depth of order  $(m - q)/d$ . A homogenized chain sits at it from the first layer, in the one dimension its shared repertoire cannot express — shallowly uncontrollable, invisibly, everywhere at once. And the generic chain approaches it asymptotically through the energy law, its worst directions priced out before they are walled off. Part V exhibits all three routes by simulation; Part VI confronts them with cases.

The two results are one curve. Reform exhaustion is the rising face of the curve; constitutional uncontrollability is its asymptote. Governance failure, in this model, is not stepping off a cliff. It is climbing a slope that steepens without bound, and the lived experience of the climb — each reform costlier than the last, each delivered more narrowly than designed — is the energy law felt from inside.

## 2.5 Actuator Variety: The Street Level

One element of the model has so far been treated as a defect, and the series' own first law requires us to reverse that reading before Part III. The projections  $P_i$  lose dimensions; the last layer's repertoire,  $r_n$ , bounds what the chain can express at the point of delivery. But the point of delivery is where the governed world's variety is highest — Paper IV's result, approached now from the actuation side. Ashby's law applied at the street level says the delivery repertoire must match the variety of local conditions, or regulation fails there regardless of what the chain transmits.

Street-level workers resolve this in the only way available to them: they act beyond the directive. The caseworker bends the category; the teacher adapts the curriculum; the inspector exercises judgment the statute never specified. The implementation literature has studied this for forty-five years under Lipsky's name, largely as a deviation problem — discretion as the gap between policy and delivery. The chain model forces a different reading. Formally, the street level applies  $u_t = \Pi v_{\{t-T\}} + D\delta_t$ : the transmitted directive plus a discretionary term, chosen locally, informed by local observation. **Discretion is the system's only source of requisite actuation variety at the point of contact.** Remove it, and delivery is bounded by  $r_n$  — a repertoire calibrated, after  $n$  translations, to a world that does not exist. License it without closure, and the discretionary term decouples from the policy intent it was meant to serve, invisibly, because the centre's knowledge of  $\delta_t$  travels up the very observation chain whose attenuation Paper III established.

Discretion is therefore not the enemy of fidelity and not its substitute; it is a second channel whose value depends entirely on whether a *local* loop closes around it — local observation correcting local action, without a round trip through either chain. The full treatment of the node where both chains meet, and of what happens when neither loop is short, belongs to §7.3. Here we register the structural point the formalism makes unavoidable: the choice facing a deep chain is not fidelity versus discretion. It is closed-loop discretion versus open-loop discretion, because at the street level, the directive alone was never going to be enough.

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## Part III — Three Mechanisms, and Where They Are Documented

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The chain model of Part II compresses everything a delegation layer does to a directive into three operations: delay, projection, noise. This Part takes the operations one at a time. Each section states the mechanism's formal consequence within the model, then turns to a governance system in which the series' country studies have already documented the consequence at national scale — under its local name, in its local idiom, years before this paper supplied the common structure. The mechanisms are presented separately because they are formally distinct. The final section shows why they cannot be experienced separately: they compound, and the compounding is the chapter's real subject.

### 3.1 Latency Accumulates — and Lowers the Ceiling

The formal point is brief because Paper I did the work. Delays in series add: a directive that spends  $\tau_i$  steps in layer  $i$  reaches the point of delivery after  $T = \sum \tau_i$  steps. Two consequences follow, and the second is less obvious than the first.

The first is staleness. The directive that arrives is calibrated to the state of the world at the moment of issuance,  $T$  steps ago; against a drifting plant, the intervention addresses a state that no longer exists. The second is structural, and it is Paper I's gain ceiling inherited whole: a feedback loop with dead time  $T$  cannot safely operate at gain above approximately  $K_{\max} \approx 1/(T \cdot |A|)$ . Pushing harder does not produce faster correction; it produces oscillation — interventions arriving out of phase with the system they steer, amplifying what they were meant to suppress. In the chain context this means something that no quantity of administrative competence can repair: **every layer added to a delegation chain lowers the maximum safe aggressiveness of the entire policy loop.** A government at depth  $n$  is not merely slower than a government at depth  $n/2$ . It is constrained to be *gentler*, everywhere, at all times, on pain of instability — and a controller that must be both late and gentle is a controller whose crises outrun it.

The series' clearest documentation is Germany — the country whose Coherence Table signature is, precisely, *paralysed spending*. The German case is valuable because it controls for everything the behavioral literature would reach for first. Administrative competence is high. Corruption is low. Fiscal resources are, by the standards of the cases in this series, abundant — appropriated, committed, and waiting. What the country study documents is money that cannot move: funds for infrastructure, digitalisation, and defence procurement that pass the legislature and then enter a vertical sequence of planning approvals, federal–Land coordination rounds, administrative court windows, and procurement procedures, each individually defensible, whose latencies add. The Onlinezugangsgesetz — the 2017 statute requiring federal, Land, and municipal administrations to bring public services online by the end of 2022 — passed with broad support,

was funded, missed its deadline by a margin that made the statute a byword, and was still being re-legislated years later. No actor in the chain failed. The chain itself put the delivery date on the far side of the political cycle that ordered it — and the gain ceiling explains the secondary symptom the report records: a state that, knowing its own latency, systematically under-doses its interventions, because in a high-T architecture, boldness is destabilising.

### 3.2 Dimensions Collapse — and the Losses Are Different Everywhere

The projection mechanism carries the paper's least intuitive and most consequential formal result, established in §2.1 and exhibited numerically in Part V: a deficient chain costs approximately one cleanly transmitted dimension per layer, and the *geometry* of the layers' blind spots determines how the cost is charged. A layer cannot transmit what it has no vocabulary for — no budget line, no legal instrument, no software field, no trained role. When the layers' missing vocabularies are independent — each blind where the others see — the annihilations add: a directive of dimensionality  $m$ , descending a chain whose every layer is only one dimension short, arrives missing up to  $n$  dimensions outright. When the missing vocabularies are shared — a chain homogenized by common training, common categories, common software — the chain is dimensionally cheap, losing only the one dimension no layer can express; but it loses that dimension absolutely, at every depth, invisibly, because no layer exists that could even register the loss. And the generic chain between these poles annihilates little and degrades much, delivering its weakest dimensions at gains so low that restoring them is priced out by the energy law rather than forbidden by the algebra. Each layer, audited alone, is nearly perfect. The chain is not — and *how* it is not depends on whether its layers are blind together or blind apart.

One further consequence matters for everything that follows: the projection operators are *local*. Two chains of identical depth, descending from the same centre with the same directive, apply different compositions  $\Pi$  and  $\Pi'$  — and therefore deliver different policies. Uniformity at the top guarantees nothing at the bottom; it guarantees only that the variation at the bottom is invisible from the top.

This is India's Patchwork State, as the series' India study names it. A centrally designed scheme must be implemented across twenty-eight states of radically varying administrative quality, and the study's diagnosis is exactly the model's: the central policy is calibrated to a state that does not exist — neither the high-capacity southern states nor the low-capacity northern ones, but an average that matches neither. Read through the chain model, the diagnosis sharpens into three claims. The same statute  $v_t$  enters twenty-eight different chains. Each state's chain projects it onto a different repertoire — different administrative categories, staffing realities, records systems, payment infrastructures — so that twenty-eight different policies are delivered under one name. And the deficiency is largest precisely where need is greatest, because the lowest-capacity states have the lowest-rank repertoires: the components of the scheme that required the most administrative expression are annihilated exactly where their intended beneficiaries are concentrated. The series' synthesis report called this spatial blindness when it analysed the observation channel. The actuation channel gives it a second, independent life — and gives Part VI its design. A single federal statute

crossing chains of varying depth and rank, with documented variation in delivered outcomes, is as close to a controlled experiment on  $\Pi$  as governance offers, and the within-India comparison is the empirical anchor's centrepiece for that reason.

### 3.3 Noise Enters Late — and Late Noise Wins

The third mechanism has a structure that repays a moment of algebra. Noise  $w_k$ , injected at layer  $k$ , passes through only the layers below it: it reaches the point of delivery attenuated by the gains of layers  $k+1$  through  $n$ . The directive passes through everything: it arrives attenuated by all  $n$  layers. The deeper the chain, the worse the signal fares *relative to* the noise injected near the bottom. Two consequences follow. The signal-to-noise ratio of the actuation channel falls with depth — the descending dual of Paper III's central result for representation chains, and derived in Appendix A alongside it. And the composition of what is actually delivered shifts downward along the chain: in a deep chain, the directive's contribution to delivered action shrinks geometrically while the last few layers' translations, readings, and local circumstances persist nearly at full strength. **What the street delivers is mostly what the street heard, not what the centre said.**

The United Kingdom's mental-health vignette, which the series has used once already, is used here deliberately a second time — because it has two halves, and the series has so far told one. Paper VII read the episode upward: the minister who announces 8,500 new mental-health workers is responding to a national mean that has destroyed the distributional signal — a failure of observability, in the paper's words, not of intention. This paper reads the same episode downward. The announcement is a directive of unusual simplicity — one number, one role, national scope — and it descends into local delivery contexts that constitute the final and dominant noise term. In Nottingham, where the youth services, housing support, and community infrastructure that prevent crises from developing have already been cut, the marginal worker arrives into a vacuum and delivers a fraction of the intended intervention; in an affluent borough, the same worker arrives into a functioning ecosystem that amplifies her. Same directive, same chain depth, same good faith — and a delivered policy whose variance across sites exceeds its mean effect, because the last layer's circumstances entered the channel after everything that could have compensated for them. The UK study's signature loop — centralise, fail, centralise — is what this looks like iterated: the centre responds to noisy delivery by adding targets, monitoring regimes, and reporting layers, which deepens the chain, which attenuates the next directive further relative to the noise it is meant to override. The remedy raises the bill. The bill is the subject of §3.4 — and the fact that this one episode required both Paper VII's reading and this one is the fact §7.3 exists to formalise.

### 3.4 The Mechanisms Compound — Pressman and Wildavsky, Recovered

Each mechanism alone is survivable. A slow chain delivering a full-dimensional, low-noise directive is a late success. A fast chain that drops a dimension is a partial success. What the model forbids is experiencing them alone. The composite gain on any transmitted direction is the product  $\prod \gamma_i$  across layers, and the products multiply across mechanisms too: delay makes the directive staler, which makes the projections' translations less apt, which raises the effective noise of every layer below — and the energy law of §2.3 prices the total, not the parts.

The multiplication is where the paper's opening returns with its formal identity. Set  $m = 1$  — a directive reduced to a single dimension, "does the project proceed" — and let every layer's  $P_i$  be the scalar probability  $p$  that the layer agrees. The composite gain is  $p^n$ . That is Pressman and Wildavsky's table, entry for entry: seventy clearances at 95 per cent yielding a joint success probability below three per cent is the chain model evaluated on the diagonal, in the currency of probability, fifty years early. What the general model adds is everything the scalar case cannot express: directions, so that a chain can pass a policy's budget while annihilating its purpose; rank, so that losses can be permanent rather than probabilistic; energy, so that "unlikely to survive the chain" becomes "survivable at a price that grows with depth."

The series has met multiplicative composition before, and the convergence should be stated rather than left for reviewers to notice. Paper V established that coordination failures across a governance system's subsystems compound multiplicatively — the coordination failure tax — and Paper VII, surveying fifteen countries, elevated the pattern to a finding: the failures don't add; they multiply. Both results concern composition *across* a system's parallel parts. This paper finds the same law running *vertically*, down the inside of a single delegation chain — and the agreement of the horizontal and vertical results is not a coincidence but a single structural fact: governance architectures are compositions, and composition multiplies. The practical corollary is the one Paper VII drew and Part VII of this paper will inherit: partial repairs to a multiplicative chain buy less than their cost suggests, because the remaining factors still multiply. A chain repaired at every layer but one is, to the directive passing through it, still a chain with a hole in it.

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## Part IV — Boundaries and Objections

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A structural claim earns its keep by what it survives. This Part subjects the chain model to the four challenges a careful reader should already have formulated: that the real cause of implementation failure is resistance, not architecture; that hierarchy is ubiquitous because it works; that technology dissolves the problem; and that the paper is claiming more than it is. Each section sharpens the result rather than defending it.

### 4.1 Architectural Versus Adversarial Attenuation

Paper IX analysed what happens to a directive that an incumbent does not want implemented: the transmission matrix  $M$  through which the embedded controller strategically filters a reform, slow-walking, reinterpreting, and outlasting it. This paper has assumed throughout that no such adversary exists. The relationship between the two analyses should be stated formally, because it is a decomposition, not a competition. What a directive meets on its way down is  $M \cdot \Pi$  — adversarial filtering composed with structural attenuation. Paper IX studied  $M$  with the structure held implicit. This paper sets  $M = I$ , the identity: no resistance, no capture, no strategy. The attenuation that remains,  $\Pi$ , is the floor. Every directive pays it, including the ones everyone wants.

Two consequences of the decomposition deserve emphasis. The first revises Paper IX's accounting in a direction that strengthens it: the transition energy costs derived there are lower bounds, because a reform coalition fighting an incumbent through a deep chain pays the strategic bill *and* the structural bill, and the structural bill compounds with depth regardless of how the strategic contest goes. Buying out the incumbent, in Paper IX's vocabulary, removes  $M$ . It does not shorten the chain.

The second consequence is a testable discriminator, and it may be the most empirically useful sentence in this Part. **Adversarial attenuation is directive-dependent; structural attenuation is not.** An incumbent filters selectively — directives that threaten its position attenuate more than routine ones, because filtering is costly and the adversary spends where it matters. The chain's  $\Pi$  is indifferent: it projects the threatening and the anodyne directive through the same repertoires, the same delays, the same noise. The two hypotheses therefore come apart in data. If implementation fidelity in a given system varies systematically with how threatening a policy is to the layers implementing it, the attenuation is substantially adversarial, and Paper IX's apparatus applies. If fidelity tracks chain depth and directive dimensionality while remaining indifferent to threat, the attenuation is structural, and this paper's apparatus applies. Part VI's coding protocol carries a threat-coding column for exactly this purpose.

One honesty note, owed to a reviewer of this paper's outline: the boundary drawn here is an analytical separation, not an ontological one. Real chains exhibit both attenuations simultaneously, and Paper IX itself observed that the incumbent's latency advantage is partly architectural — embedding, not strategy, gives the

incumbent its short loop. The decomposition  $M \cdot \Pi$  is a tool for telling the components apart, not a claim that nature keeps them in separate boxes.

## 4.2 "Hierarchies Exist Because They Work"

The strongest objection to this paper is not a counterexample but a fact of institutional history: delegation chains are everywhere, in every successful state, firm, and army, and arrangements that ubiquitous are presumptively solving a problem. The objection is correct, and the paper's claim must be located precisely so that it does not collide with it.

Depth buys real goods. It buys span — no centre can transact directly with every delivery point. It buys uniformity, which in governance is not a convenience but a constitutional value: equal treatment under law is a low-variance  $\Pi$ , deliberately engineered. It buys accountability structure, auditability, and the containment of local abuse. The paper's claim is not that these goods are illusory. The claim is that they are *priced*, that the price schedule is the energy law of §2.3, and that the schedule is invisible in the institutional design process — no legislative impact assessment, in any system this series has examined, carries a line item for delegation depth. Politics buy depth as if it were free. The paper's contribution to the objection is the invoice.

Read with the invoice in hand, the canonical counterexamples invert. Militaries execute through many layers because they prepay the energy bill in fixed costs: doctrine, drill, standardisation, and training are Beer's amplifiers institutionalised — enormous standing expenditures that convert the variable, per-directive cost of pushing intent through depth into an amortised investment in making every layer's  $P_i$  predictable. Highly standardised administrative traditions buy depth the same way. These systems do not refute the energy law; they are what solvency under it looks like. And the model prices that solvency exactly: standardisation is the homogenized geometry of §2.1 — prepaid amplification lowers the  $\gamma$ -losses on everything the shared repertoire expresses, and concentrates the chain's entire deficiency into the dimensions the shared repertoire cannot express. Fidelity for the routine, absolute and invisible blindness for the novel. The series has already documented that bargain's end state at national scale: Japan's Continuity Trap — an architecture so finely tuned to faithful transmission within its paradigm that the signals requiring paradigm replacement are meticulously documented and structurally unanswerable — is the homogenized chain's failure signature, diagnosed by the Japan report years before this paper supplied the matrix form.

The design implication is assignment, and it is the exact dual of the fractal assignment principle Papers II and III established for observation. The observation-side principle asked: which decisions should be made at which scale, given where information lives? The actuation-side principle asks: which deliveries should be routed through which depth, given what fidelity they require? A pension payment — low dimensionality, low local variety — tolerates depth and rewards uniformity. A community mental-health intervention — high dimensionality, high local variety — is annihilated by the same chain. Routing both through the same

architecture because the architecture exists is the design failure; the chain is not. Part VII develops the principle. Here it suffices to dissolve the objection: the paper is not against hierarchy. It is against unpriced hierarchy.

### 4.3 The Digital Bypass, and Its Limit

If depth is the problem, the era appears to offer a solution: disintermediate. Deliver the policy from the centre to the citizen directly — a payment rail, a portal, an automated entitlement — and the chain collapses to depth one or two. The series has already recorded the existence proof. Brazil's PIX, built by the central bank and delivered directly to users, is cited in the series' Brazil material as a genuine institutional breakthrough: near-direct actuation, national scale, delivered fidelity that the country's conventional chains could not have approached. The chain model endorses the reading and explains the success — and then states the condition the success depended on, which is where the enthusiasm must stop.

In the model's terms, digital disintermediation trades depth for rank. It removes layers —  $n$  falls, the  $\gamma$ -products shorten, the latency sum collapses — but it delivers through an automated terminal repertoire whose rank  $r_n$  is whatever the system's designers managed to encode. The energy law improves; the variety constraint of §2.5 tightens. PIX succeeded because payments are the rare governance task that is genuinely low-variety: money is fungible, the action space is small, and a low-rank actuator is sufficient by the nature of the task. The model's prediction for high-variety tasks pushed through the same architecture is the opposite — and the United Kingdom ran the experiment. Universal Credit's digital-by-default delivery compressed a high-dimensional task — the assessment of complex, unstable personal circumstances — into the categories its system could express, with the documented consequences for claimants whose circumstances the categories could not hold. Depth fell;  $d$  rose; the annihilated dimensions returned as casework, appeals, and the parallel human chain that grew back around the digital one — regrown depth, paying the old bill plus the new system's.

The principle for Part VII: disintermediation is a genuine instrument, and the model gives its applicability condition. Collapse depth where the task's intrinsic variety is low. Where it is high, the choice is not between a deep chain and a shallow portal; it is between a deep chain and a shallow *high-rank* terminal — which, as §2.5 established, means closed-loop local discretion, not automation. The digital bypass and the street-level professional are not rivals. They are the low-variety and high-variety halves of the same design rule.

### 4.4 What This Paper Does Not Claim

Four disclaimers, stated once and binding throughout.

The paper does not claim that delegation depth is the sole or dominant cause of implementation failure. Resources, commitment, design quality, and adversarial dynamics all operate; Part VI's anchor tests whether depth carries signal at all, not whether it carries everything. The shallow-chain successes cited there are

existence proofs of the possibility, not single-cause explanations.

The paper does not claim a normative theory of delegation. Nothing here says what depth a polity *ought* to buy — uniformity, accountability, and equal treatment are values whose price a democratic system is entitled to pay with open eyes. The paper supplies the eyes, not the choice.

The paper does not claim its model is the mechanism. Delegation layers are modelled as linear contractive translations with additive noise in an LTI frame; real layers are nonlinear, time-varying, and strategic. The model's standing is the series' standard one — a formal application whose adequacy is an empirical question — and its limitations are inventoried in Part VIII rather than discovered by reviewers.

And the paper does not claim priority over the traditions of §1.4. It claims a specific, falsifiable addition to them: the threshold, the energy law, and a metric. If the addition fails the tests Part VI begins, the traditions stand and the addition falls — which is, the series has argued since Paper VIII, exactly the arrangement a research programme should want.

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## Part V — Simulation

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### 5.0 Purpose and Conventions

The simulations serve the series' standard disciplinary function: they force the formal claims of Part II to produce numbers, and they expose the claims' dependence on assumptions that prose can leave comfortable and algebra can leave implicit. The discipline operated on this paper before publication, and the episode is reported rather than smoothed over, because it changed a theorem. An early draft of §2.1 asserted that per-layer repertoire deficiencies accumulate additively in the generic case. The prototype falsified the assertion as stated: generic blind spots do not annihilate additively — they *degrade* additively, and the distinction between annihilation and degradation turns out to be governed by a variable the draft had not identified, the alignment geometry of the layers' blind spots, which Simulation B now treats as a primary experimental axis and Appendix A.3 derives. The corrected result is stronger than the original claim, and it connects the actuation chain to Paper X's correlation framework. This is what simulations are for.

Conventions, per the series: open-source Python, all parameters declared in the repository, Monte Carlo over 100 seeds with distributions reported rather than single runs, illustrative rather than empirically calibrated parameters, commit hash cited in the published version. Plant:  $x_{t+1} = Ax_t + Bu_t$  with  $A$  diagonal-stable (entries uniform [0.85, 0.98] unless stated),  $B = I$ ,  $m = 6$ . Layers as in §2.1: random contractive translations with singular values uniform [0.7, 1.0] unless an experiment varies them.

### 5.1 Simulation A — The Energy Law

**Design.** Sweep delegation depth  $n$  from 0 to 7. At each depth, compose the chain  $\Pi$ , solve the discrete Lyapunov equation for the controllability Gramian of  $(A, B\Pi)$ , and compute the minimum energy  $E_{\min} = x_f^T W_c^{-1} x_f$  for random unit policy targets. Report  $E_{\min}(n)/E_{\min}(0)$  distributions across seeds.

**Prototype result.** Median energy ratios: 1.41, 1.94, 2.76, 3.85, 5.78, 8.03, 11.18 for depths one through seven — a measured per-layer growth factor of approximately 1.40 against an analytic prediction of 1.399 from the layer singular-value distribution (the factor  $\exp(-2 \cdot E[\ln \sigma])$ ; derivation in Appendix A.2). The exponential form of the energy law is confirmed in the prototype to within sampling error.

**A second finding the formal analysis did not predict.** The interquartile range of the energy ratio widens with depth — [8.84, 13.96] at depth seven against [1.30, 1.53] at depth one. Depth does not only raise the median price of policy; it makes the price *less predictable*, because the composed orientation of seven

random translations varies more across realisations than the orientation of one. The governance reading anticipates §3.3's variance observation from the cost side: a deep chain is not merely an expensive instrument but an instrument whose expense cannot be reliably budgeted.

## 5.2 Simulation B — Blind-Spot Geometry

**Design.** Layers carry repertoire deficiency  $d_i = 1$ : each is an orthogonal projection annihilating one direction (its blind spot), composed with the contraction of 5.1 switched off to isolate the rank mechanism. Three geometries: *independent* (blind spots mutually orthogonal), *generic* (blind spots drawn uniformly at random), *homogenized* (all layers share one blind spot). Track, by depth: hard rank of  $\Pi$ ; cleanly transmitted dimensions (singular values  $\geq 0.99$ ); minimum nonzero singular value.

**Prototype result.** Independent geometry: rank falls exactly one per layer, 6, 5, 4, 3, 2, 1, 0 — additive annihilation, the  $(m - q)/d$  route to constitutional uncontrollability of §2.4. Homogenized geometry: rank 5 at every depth from one onward, all surviving dimensions at full fidelity — one absolute, depth-independent blind spot and nothing else. Generic geometry: hard rank constant at 5, while cleanly transmitted dimensions fall almost exactly one per layer (6.0, 5.0, 4.0, 3.0, 2.0, 1.1, 0.45) and the worst surviving direction's gain collapses geometrically (1.0, 1.0, 0.36, 0.18, 0.095, 0.059, 0.033) — at depth six, recovering that direction costs on the order of  $(1/0.033)^2 \approx 900$  times the direct-actuation energy.

**Critical finding.** The invariant across the independent and generic regimes is the clean-transmission count: one dimension per deficient layer, charged as impossibility in one geometry and as exponential price in the other — the unified law of §2.1, here exhibited rather than asserted. And the homogenized regime stands apart in a way the country evidence of §3.2 and §4.2 makes legible: a chain whose layers share their blind spot is dimensionally cheap and absolutely, invisibly blind in the one dimension no layer can express. Implementer correlation is to the actuation channel what observer correlation is to Paper X's ensemble — the variable that determines whether the parts' deficiencies cancel, compound, or coincide.

## 5.3 Simulation C — Noise Placement

**Design.** Fix depth  $n = 6$  with the contractive layers of 5.1. Inject unit-variance noise at each layer; compute each injection point's share of delivered noise variance at the actuator.

**Prototype result.** Shares by layer, top of chain to street: 6.7, 9.0, 12.4, 17.1, 23.1, 31.7 per cent. The last two layers contribute 54.8 per cent of delivered noise variance. The asymmetry of §3.3 — the signal passes everything, late noise passes almost nothing — is confirmed: what the street delivers is mostly what the street heard.

**Critical prediction for Part VI.** If the mechanism operates in real chains, implementation-fidelity audits should find variance concentrated near the point of delivery rather than distributed evenly along the chain — a coding-level prediction the MGNREGA state comparisons can in principle check, since social-audit data localises discrepancies by administrative tier.

## 5.4 Simulation D — Architectures Compared

**Design (full simulation; prototype ran the depth comparison only).** Four architectures at matched per-layer quality: A, uniform depth 7; B, uniform depth 4; C, uniform depth 2; D, *fractal assignment* — the directive split by intrinsic dimensionality, low-variety components routed through the deep uniform chain, high-variety components through depth  $\leq 2$  with closed local loops (§2.5). Outputs: delivered fidelity,  $E_{\min}$ , latency, and delivered SNR per architecture; the design prediction is that D approaches C's fidelity on high-variety components at near-A's uniformity on low-variety ones — the assignment principle of §4.2 made quantitative.

**Prototype depth table.** Median energy ratio and mean delivered signal power: depth 2 — 1.94 and 0.544; depth 4 — 3.85 and 0.299; depth 7 — 11.18 and 0.117. A depth-7 chain delivers roughly a fifth of the signal power of a depth-2 chain and prices targets at roughly six times the energy, at identical per-layer quality.

## 5.5 Simulation E — The Discriminator (specification only)

Operationalise §4.1's separation. Generate directives with a coded *threat* parameter; run two worlds: structural ( $M = I$ , chain  $\Pi$  as above) and adversarial ( $M(\theta)$  attenuating threatening dimensions per Paper IX's incentive-compatibility mechanism, composed with the same  $\Pi$ ). The signature: delivered fidelity is independent of threat in the structural world and monotonically decreasing in threat in the adversarial world, at matched mean attenuation. The simulation establishes the signature's visibility at realistic noise levels before Part VI looks for it in coded cases — the in-silico power analysis for the empirical discriminator.

## 5.6 What the Simulations Do and Do Not Establish

Per the series' standing discipline: the simulations establish internal consistency — that the formal mechanisms produce the claimed behaviour under the model's assumptions — and they have already earned their keep by correcting one of those claims. They establish nothing about real delegation chains. The parameters are illustrative; the layers are linear; the geometry sweep explores a space whose real-world distribution is an empirical unknown. The bridge from exhibited mechanism to tested mechanism is Part VI, and the series' position since Paper VIII is that the bridge is mandatory: a mechanism that cannot be confronted with data is not yet a contribution, however well it simulates.

## Part VI — The Empirical Anchor

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### 6.0 Design and Pre-Commitments

The preceding Parts have exhibited a mechanism. This Part begins the work of testing whether the mechanism operates in real delegation chains, on the smallest scale at which a test is meaningful: a coded comparison of documented policy implementations, six to ten cases, two variables, one registered prediction. The series' position since Paper VIII applies with full force — this is an illustrative test of sign and rough magnitude, not a validation — and three commitments are registered before any coding occurs. First, the case roster and coding protocol (Appendix C) are fixed before fidelity values are assigned, and every case coded is reported. Second, the prediction under test is directional and stated in §6.4 in falsifiable form. Third, a null or contrary result is published in this paper with the same prominence as a confirming one, because the energy law's standing in the series depends on the honesty of the first confrontation more than on its outcome.

### 6.1 Two Variables, and a Third Column

**Delegation depth** is coded as the number of formal decision-and-transmission layers between the authority that fixed the policy's content and the point of delivery — the chain's  $n$ , counted per the rules of Appendix C (what counts as a layer, how parallel clearances are handled, how within-case variation is treated). The construct is deliberately austere: it ignores layer quality, resources, and intent, because the model's claim is precisely that a signal survives in the layer count alone.

**Implementation fidelity** is coded as the documented gap between the policy's stated, quantified objective and its delivered outcome at a defined horizon, normalised to  $[0, 1]$  per the protocol. The coding involves judgment; the protocol's discipline is to use only published, third-party evaluations (audit institutions, randomised evaluations, official statistics), to record the source of every value, and to flag every case where two defensible readings diverge.

**The threat column** operationalises §4.1's discriminator. Each case is additionally coded for how threatening the policy was to the material interests of its implementing layers (low / medium / high, with the evidentiary basis recorded). The structural hypothesis predicts fidelity tracks depth and is indifferent to threat; the adversarial hypothesis predicts the reverse. Six to ten cases cannot settle the contest — but they can reveal whether the structural signal survives controlling for the variable the entire behavioral tradition, from principal–agent theory to the ESID studies of MGNREGA's political economy, would reach for first.

## 6.2 The Centerpiece: One Statute, Many Chains

The Mahatma Gandhi National Rural Employment Guarantee Act is the roster's centerpiece because it is the cleanest available approximation of the controlled experiment §3.2 specified: a single federal statute — uniform text, uniform entitlement, a demand-driven right to one hundred days of waged work — implemented through the administrative chains of India's states, which differ in depth, capacity, and structure while the directive they receive does not. The documented variation is the design's raw material. Implementation outcomes differ enormously across states: the development literature distinguishes a group of strong implementers (Kerala, Tamil Nadu, Rajasthan, Himachal Pradesh, Andhra Pradesh are the five "star states" of one prominent assessment) from states with severe rationing — in Bihar, Odisha and Jharkhand, the 2009–10 round found roughly a quarter of rural households obtaining work while a further fifth sought work and did not get it. Average person-days delivered to demanding households in Andhra Pradesh ran roughly twice the level of Assam or West Bengal.

Three features make the case better still, and each must be handled with its caveat. First, a fidelity instrument exists that is rare in implementation research: where independent household surveys have been run against the official delivery database, the discrepancy is itself a measured quantity — in the Bihar study's control areas, households confirming MGNREGS work amounted to only 59 per cent of those officially recorded as having worked — a direct, quantified gap between the chain's reported delivery and its actual delivery. Second, the roster's only *experimental* depth variation lives here: Banerjee, Duflo, Imbert, Mathew and Pande randomised a fund-flow reform that reduced the number of administrative tiers in wage disbursement, finding a 24 per cent decline in programme expenditure with no detectable decline in employment or assets created — the removed tier's share, measured. Two cautions attach. The experiment (the Bihar BETS trial) must not be conflated with the e-FMS system extended nationally over 2012-2015, which predates it; and the study has a published methodological critique by a major MGNREGA scholar (Dreze, "On the perils of embedded experiments"), which the paper cites alongside the study rather than discovering in review. Third, the terminal layer has its own documented intervention: the Andhra Pradesh biometric smartcard programme — a change to the *last P\_i*, not to the chain's depth — reduced leakage by 12.2 percentage points at a cost roughly one-ninth of the annual leakage reduction. Read against Simulation C, a terminal-layer intervention producing effects of this size is exactly what the noise-placement asymmetry predicts: the last layers are where the variance lives, so the last layers are where repairs buy most.

The caveats: state capacity and elite commitment are documented rivals for explaining the cross-state variation, and depth coding must not smuggle capacity in through the back door — the protocol codes depth from organograms and process documents, not from performance. And the literature's own state rankings are unstable across studies and periods (later assessments elevate Chhattisgarh, Telangana and Tripura while demoting others); the coding therefore fixes its measurement window in advance.

## 6.3 The Supporting Roster

**Oakland, 1966–1971** enters as the founding case, pre-coded by its discoverers: thirty decision points, seventy clearances, a programme of roughly twenty-three million dollars delivering few of its projects and a small fraction of its promised jobs. Its table anchors the depth scale's upper end.

**Universal Credit** enters as §4.3's depth-for-rank trade, documented by the National Audit Office across two reports: a six-benefit consolidation delivered digital-by-default; one in five claimants not receiving their first full payment on time, with higher rates for vulnerable groups; online identity verification planned for 90 per cent of claimants and achieving, in January 2020, 20 per cent attempting with 40 per cent of attempters succeeding; infrastructure costs rising from £2bn to £2.85bn; manual verification — the regrown human chain — priced at some £40m over ten years. The case codes shallow in formal depth and low in terminal rank, and its fidelity entry must respect that its objective (employment effects) was judged unmeasurable by the NAO itself — the protocol uses payment timeliness and verification performance as the delivery-fidelity proxies.

**The Onlinezugangsgesetz** enters as §3.1's latency case with unusually clean numbers: a 2017 federal statute requiring 575 administrative services online across Bund, Länder and municipalities by the end of 2022; at the deadline's turn, roughly 105 services online by the Bundestag's own account, with the federal audit office finding 4 per cent implemented to the statute's specifications and 19 per cent online in any form; an additional €3.3bn appropriated mid-course; and the 2024 successor statute resolving the failure by abolishing the deadline rather than meeting it. The audit office's published diagnosis — no common technical base, every level developing incompatible solutions, a *Flickenteppich* — is, in the model's vocabulary, uncoordinated parallel chains with misaligned repertoires; the German federal press reached for the word *patchwork* unprompted.

**PIX** enters as the shallow-chain existence proof, with the §4.3 condition attached. Launched by the Central Bank of Brazil in November 2020 as a free, instant, centrally operated payment rail, it reached on the order of 170 million users — over 90 per cent of Brazil's adult population — within five years, displacing card rails whose fees ran three to seven times its cost. The coding notes what the success does and does not show: near-direct actuation of a genuinely low-variety task, delivered at national scale — an existence proof that depth is a choice, not a law of nature; not a demonstration that shallow chains suffice for high-variety tasks, which is Universal Credit's lesson, nor that depth was the sole variable in either case.

## 6.4 Predictions, Registered Before Coding

Stated in advance, in falsifiable form. (1) *Sign*: across the coded roster, fidelity decreases with coded depth; rank correlation negative. (2) *Localisation*: where audit data localise discrepancies by tier — MGNREGA social audits are the test bed — the discrepancy mass concentrates toward the delivery end of the chain, per Simulation C. (3) *Discriminator*: the depth–fidelity relation survives stratification by the threat column; if

instead fidelity tracks threat and not depth, the cases are evidencing Paper IX's mechanism, not this paper's, and the text will say so. (4) *The failure condition*: if coded depth carries no signal — rank correlation indistinguishable from zero with the roster's (admittedly weak) power — the energy law's empirical standing is unestablished, the result is reported, and the construct returns to revision per the series' roadmap before any successor paper builds on it.

## 6.5 What the Anchor Cannot Do

Six to ten cases, observational save one randomised entry, with a judgment-laden fidelity construct, cannot validate a theory; the anchor's function is narrower and stated plainly. It disciplines the paper's claims against the temptation the series has diagnosed in itself — formal apparatus accumulating without empirical contact — and it produces the protocol, the construct definitions, and the first coded data points that the full study (roadmap Phase 2, Study 3) extends. The bandwagon objection from the implementation literature — clearances are not independent; each agreement raises the probability of the next — is acknowledged and absorbed rather than resisted: correlated layers are precisely the geometry axis of §2.1 and Simulation B, and the full study should code for it. What this Part delivers, if its predictions hold, is the right to the sentence the paper's conclusion wants to write: that delegation depth is a measurable structural variable carrying a measurable fidelity cost. What it delivers if they fail is a documented null and a revised construct — which the series has argued, since Paper VIII, is the more valuable of the two outcomes to be capable of producing.

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## Part VII — Design Implications

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The chain model would be a diagnosis without consequences if depth, geometry, and terminal rank were facts of nature. They are not. They are design variables — among the most legible and most cheaply auditable design variables a governance architecture possesses — and the preceding Parts determine, with unusual specificity, what can be done with them. This Part states five principles. None abolishes hierarchy; all of them price it, route around it, or compensate it. The reader who has followed the argument will notice what the principles have in common, and Part VIII will say it once: every one of them moves either variety or observation closer to the point where the world's variety actually lives, and pays openly for whatever distance remains.

### 7.1 Price Depth at Design Time

**Failure mode answered:** unpriced depth — the energy law of §2.3 operating invisibly, discovered as exhaustion after passage rather than as cost before it.

The most elementary implication is also the least practiced. No legislative impact assessment in any system this series has examined carries a line item for delegation depth. Polities estimate fiscal cost, regulatory burden, and distributional incidence; they do not estimate the layer count their directive will traverse, the clearance width it will accumulate, or the energy bill — in administrative attention, re-issuance, monitoring apparatus, and political capital — that the depth schedule of §2.3 attaches to those numbers. The principle is procedural and modest: **every directive of consequence should be accompanied, at design time, by its chain map** — the layers it will descend, coded by the rules this paper's Appendix C already operationalises, with the fidelity-critical components of the directive identified and their routing stated. The OZG case shows what the map would have shown in 2017: a single deadline binding 575 service bundles routed through a federal Flickenteppich of uncoordinated parallel chains, with no common terminal infrastructure — a structure whose energy requirement was, on the model's arithmetic, never within the appropriation that accompanied it, €3.3bn supplements included. The map does not forbid the design. It prices it, and a polity that buys depth with open eyes is exercising a sovereignty that a polity surprised by exhaustion is not.

The corollary is symptomatic diagnosis. A government that finds itself re-issuing the same directive, convening task forces about task forces, and attaching monitoring to the monitoring is not managing an implementation problem; it is paying the variable-rate amplification bill of §2.3, and the menu of structural responses is the remainder of this Part. More amplification is also on the menu — it is what doctrine-rich systems buy, in advance and in bulk — but it should be bought as the militaries buy it, as a priced standing investment, not discovered as an open-ended commitment after the political window has closed.

## 7.2 Route by Variety, Close the Local Loop

**Failure modes answered:** uniform routing (§4.2); open-loop discretion (§2.5); the depth-for-rank trade taken blind (§4.3).

The assignment principle is the exact dual of the fractal assignment that Papers II and III established for observation, and the coding variables of Appendix C make it operational. A directive's components should be routed by their task variety  $V$ . Low- $V$  components — payments, registrations, entitlements whose faithful delivery is the same transaction everywhere — tolerate depth and reward uniformity, and are the legitimate domain of the digital bypass: PIX is the existence proof that a low- $V$  task can be delivered at depth one to ninety per cent of a nation's adults. High- $V$  components — anything whose faithful delivery is a different action in every locality — are annihilated or priced out by the same architectures, and Universal Credit is the documented cost of routing a high- $V$  task through a low-rank terminal because the depth reduction looked, from the centre, like the whole of the gain.

For the high- $V$  components, the design target is the shallow chain ending in a high-rank terminal — which, as §2.5 established, has a name and a salary: the street-level professional, exercising discretion inside a closed local loop. The engineering content of "closed" is specific. The loop requires local observation of local outcomes, local authority to correct within a stated envelope, and — the element existing systems most conspicuously lack — an upward channel that transmits *exceptions rather than compliance*. What the centre needs from the street is not the report that the directive was executed; it is the report of what the directive could not express — the cases the categories would not hold, the components the repertoire annihilated. Call this the **repertoire-gap channel**: a reporting obligation keyed to the layer's  $d_i$  rather than to its throughput. It is cheap, it is the only signal that distinguishes fidelity loss from discretionary adaptation, and its absence is why the centre in the UK vignette learns about delivery variance from charities and auditors years after the street could have told it.

## 7.3 Engineer the Blind-Spot Geometry

**Failure modes answered:** the shared blind spot of the homogenized chain; the patchwork degradation of the diverse chain (§2.1, Simulation B).

This principle did not exist in this paper's outline. It exists because the simulation falsified a draft claim and the corrected theorem put a second axis on the design table: at fixed depth, a chain's dimensional fate is governed by the correlation of its layers' blind spots, and each pole of that axis has a known failure signature and a known compensator.

A **homogenized chain** — common training, common categories, common software, the deliberate product of every professionalised administrative tradition — is dimensionally cheap: it loses only what no layer can express, and transmits the rest at high fidelity to any depth. That is what solvency under the energy law looks like, and it is also a structure that is absolutely, invisibly blind in its one shared missing dimension, because

no layer exists that could register the loss. Its compensator therefore cannot come from inside the chain: it is the **heterogeneous external observer** — an audit channel, in Paper IX's vocabulary an independent observation channel, whose repertoire is deliberately decorrelated from the chain's own. The prescription is Paper X's, transposed: the value of the auditor is not its quality but its decorrelation. A homogenized chain audited by a body trained in the chain's own categories has, in the precise sense of Simulation B, not been audited in its missing dimension at all.

A **diverse chain** — heterogeneous repertoires by federalism, history, or neglect — protects hard rank and degrades almost everything partially, which is the patchwork signature: nothing impossible, everything expensive, and the energy bill compounding with depth. Its compensators are the previous two sections': shorten where V is high, and prepay amplification (standards, interoperable infrastructure, doctrine) where depth must stand — which is, to the letter, what the German audit institutions prescribed for the OZG and what the 2024 novelle began, late, to buy.

The design map, then, has two axes — depth and geometry — and the practical instruction is that they be chosen *together* and audited together: homogenize and watch the shared blind spot from outside; diversify and pay for it or shorten it. What no designer should do is what most systems have done, which is inherit a position on both axes and discover its failure signature in production.

## 7.4 The Perceptual-Actuation Trap

**Failure mode answered:** the bidirectional node — one institution at depth in both chains at once.

The series' two chain results meet in a single place, and it is a place with an address: the mid-tier institution — the municipality, the regional authority, the district office — that simultaneously aggregates local reality upward through Paper III's representation chain and projects central directives downward through this paper's delegation chain. State the composition plainly. Such a node receives directives that are miscalibrated *because* its own upward compression destroyed the signal that would have calibrated them; it must implement those directives through the narrowed repertoire that is its downward projection; and it cannot report the resulting friction, because the channel for that report is the same attenuated upward path that caused the miscalibration. The two compressions are not parallel defects. They feed each other, within one institution, and the node experiences the composite as a permanent, inexplicable mismatch between what it is told to do and what its territory needs — which is as close to a formal definition of mid-tier administrative despair as the series is likely to produce.

The design response already exists in the series, and the trap explains *why* it works. Paper IX's protected experimental space was specified as a site with genuine actuation authority and a shortened observation channel — and identified, across fifteen jurisdictions, as the convergent first step of viable reform. Read against the trap, the protected space is precisely the **double-short node**: both chains cut at the same institution. The conjecture this paper registers — testable in the full simulation, stated here within the scope fence — is that the gains are superadditive: shortening one chain at a node buys less than half of what

shortening both buys, because each chain's residual attenuation re-poisons the other. If the conjecture holds, it converts the series' most consistent empirical observation into a derived design theorem, and subsidiarity acquires its engineering form: not a preference for the local, but the instruction that observation and actuation be shortened *at the same node*, because the benefits live in the conjunction.

## 7.5 Depth Is the Most Auditable Primitive the Series Has

**Failure mode answered:** the measurement gap — Paper VIII's framework lacking an actuation-side primitive.

The paper closes its design argument with a measurement claim. Delegation depth  $n$ , clearance width  $W$ , task variety  $V$ , and blind-spot geometry are candidate structural primitives for the Paper VIII estimation framework — and the first two have a property no existing primitive in the series shares: **they are auditable from public documents alone**. Coding a polity's representation-chain SNR or value-function dimensionality requires inference and proxies; coding the delegation depth of a statute requires organograms, process rules, and the counting discipline of Appendix C — no internal data, no institutional cooperation, no consent. A depth audit of a government's ten largest programmes is a desk exercise, and §6 has already begun it. The integration of these variables into the composite framework — including whether depth enters as the eleventh primitive, a count to be fixed against Paper VIII's published list rather than asserted here — is deferred to the measurement programme, and the deferral is paid for: unlike its predecessors, this paper defers integration having already delivered protocol, prototype, and first data points. The instrument exists. What remains is the survey.

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One sentence of synthesis, owed before Part VIII says it formally. The five principles are one principle under five constraints: a governance architecture is viable when its variety sits where the world's variety is, its observation sits where its discretion is, and everything it cannot shorten, it prices. The series has been circling that sentence for ten papers. This paper's contribution is the second clause.

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## Part VIII — Limitations and Conclusion

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### 8.1 Limitations

The paper's standing claim is a formal application in the series' three-tier vocabulary, and its honesty contract (§2.2) is repaid here in full. Eight limitations, each with its consequence and the work it implies.

**1. A ministry is not a matrix.** The chain model represents delegation layers as linear contractive translations with additive noise. Its adequacy as a description of real administrative layers is an empirical question, not a settled premise; Part VI begins the answering, and nothing in the paper's formal results survives the model's failure. This is the master limitation; the seven below are its components.

**2. The contraction assumption excludes amplifying layers.** Modelling every  $P_i$  with singular values at most one encodes the claim that a layer cannot manufacture intent it did not receive. Real layers sometimes do — the phenomenon documented in the European transposition literature as gold-plating, and familiar everywhere as the zealous agency that over-implements. Over-implementation is a fidelity failure in the other direction, and the current construct partially hides it: a fidelity ratio capped at one cannot distinguish faithful delivery from overshoot. The full study should code fidelity as distance from the stated objective rather than as a capped ratio, and the model should be extended to layers with amplifying components — whose interaction with the energy law (amplification that the centre did not order is energy the centre did not spend, steering somewhere the centre did not choose) is an open and interesting problem.

**3. The model is linear and time-invariant where reality is neither.** The paper inherits Paper IX §7.7's caveat without improvement: thresholds, hysteresis, and far-from-equilibrium behaviour are untreated, and the gain-ceiling and Gramian results are near-equilibrium statements.

**4. The noise model is too polite.** Noise enters additively and independently across layers. Correlated noise — the shared misreading, the rumour that reaches every regional office in the same distorted form — interacts with the blind-spot geometry of §2.1 in ways the paper has not modelled, and the interaction plausibly matters: a homogenized chain's noise is correlated for the same reason its blind spots are.

**5. Depth is not randomly assigned.** Politics choose their chains, and may choose depth in response to the very task characteristics that drive fidelity — the central identification problem for the observational entries in Part VI's roster. The paper's defences are partial: the within-country design holds the directive fixed, the capacity covariate is coded rather than absorbed, and one roster entry is a genuine randomised depth manipulation. A full study needs a full identification strategy, and the paper does not pretend otherwise.

**6. The superadditivity conjecture is a conjecture.** §7.4's claim — that shortening both chains at one node buys more than the sum of shortening each — is registered, motivated, and unproved. The full simulation can test it; until then it is the paper's most consequential unverified sentence, and is labelled so here to keep it from hardening by repetition.

**7. The geometry axis lacks a field instrument.** Simulation B swept the blind-spot correlation between its poles; no method yet exists for measuring where a real chain sits on that axis, and the measurement is intrinsically harder than depth — it requires comparing repertoires, not counting layers. Until the instrument exists, §7.3's design map can be reasoned about but not audited, and the implementer-correlation parallel to Paper X remains a structural argument awaiting an estimator.

**8. The energy reading is a mapping, not a derivation.**  $E_{\min}$  is the summed squared control signal of a formal model. Its translation into political capital, administrative attention, and fiscal effort is an interpretive correspondence — tier in-principle, never rigorous — and the paper's empirical predictions are deliberately framed in fidelity and depth, which are codeable, rather than in energy, which is not yet.

One positioning statement belongs with the limitations because it is one. The paper's debt to organizational cybernetics is structural, not decorative: Beer established that vertical variety imbalance is an architectural property, named the attenuators and amplifiers, and identified the detachment pathology this series rediscovered as the Goodhart–Ashby synthesis. What this paper adds is the state-space grammar, the threshold and energy laws, the geometry axis, the discriminator, and the beginnings of measurement. If a reader concludes that Paper XI is Beer made falsifiable, the paper has been read as intended.

## 8.2 What the Paper Established

Five contributions, in the order the argument built them.

First, a formal grammar for steady-state actuation: the delegation chain as a cascaded sequence of translating, delaying, perturbing layers, completing the state-space treatment the series began on the observation side — and yielding, by composition alone, the recovery of Pressman and Wildavsky's clearance arithmetic as the scalar special case of a matrix law.

Second, the energy law and its limit: minimum control effort growing superlinearly — exponentially, in the baseline model — with delegation depth, so that deep chains price policy out before they rule it out; constitutional uncontrollability as the asymptote of the same curve, the exact dual of Paper III's constitutional unobservability; and reform exhaustion as the named, derived condition of a government paying a depth-priced amplification bill with linearly growing budgets.

Third, the blind-spot geometry result, found by the paper's own simulation falsifying its first draft: a deficient chain generically costs one cleanly transmitted dimension per layer, with the correlation of the layers' blind spots determining whether the cost is charged as impossibility, as price, or as a single shared invisibility —

implementer correlation as the actuation dual of Paper X's observer correlation.

Fourth, the decomposition M·II and its discriminator: architectural and adversarial attenuation formally separated, with the testable signature — adversarial attenuation is directive-dependent, structural attenuation is not — that lets data assign real implementation failures between this paper's mechanism and Paper IX's.

Fifth, the empirical apparatus delivered inside the paper rather than deferred beyond it: a coding protocol with frozen variables and a deviation log, a prototype simulation whose results are reported including the one that corrected the theory, a source-backed case roster centred on a within-country design with one randomised entry, and four predictions registered before coding. The paper ends with instruments, which is the series' definition of ending well.

### 8.3 The Arc, and the Close of the First Cycle

The Governance as Engineering series began with a simple observation: governance systems are feedback systems, and feedback systems have structural properties that determine their stability under disturbance. Papers I through IV established those properties across four domains and found one mechanism beneath them — aggregation destroys information, and destroyed information cannot be recovered downstream. Paper V showed the failures compound multiplicatively; Paper VI treated objective functions as observation architectures; Paper VII synthesised fifteen countries into an account of why reform disappoints; Paper VIII began measurement; Paper IX modelled transition as contested control; Paper X extended the analysis to the population of observers.

Every one of those papers, this paper included by inheritance, analysed how a governance system *sees*. This paper analysed how it *acts*, and with that, a specific arc closes. A controller has two channels to the world. The series has now treated both — their attenuation laws, their critical depths, their compounding, their measurement — and the classical state-space grammar that has carried the series since its first equation is, at the level of its primitives, complete. The completion is a stopping rule, not a triumph: it means the next paper in this lineage has no missing channel to formalise, and the series declines to invent one.

What follows is therefore not announced as Paper XII. The measurement framework exists in prototype. The empirical programme is specified — the observer-correlation test of Paper X, the transition-bandwidth coding of Paper IX, the depth–fidelity study whose protocol this paper ships. The registered predictions are falsifiable and the deviation log is empty. The next phase is not more theory. It is confrontation with data, and the series' standing argument — since Paper VIII made the variety gap measurable on purpose — is that a framework which cannot be confronted is not yet a contribution, and a framework which declines confrontation no longer deserves the name engineering.

## 8.4 Coda: Oakland, Priced

The programme that opened this paper had everything a policy is supposed to need: money appropriated, objectives agreed, actors aligned, no villain anywhere in the chain. What it lacked appeared in no assessment, carried no number, and had no name — and two honest observers who went looking for the missing variable found it, counted seventy of it, did the arithmetic, and were read for fifty years as the authors of a cautionary tale rather than the discoverers of a law.

The variable now has a name, a counting rule, a price schedule, and a protocol. Whether the price schedule is real — whether depth predicts what the model says it predicts — is, from this page forward, not a question for theory. It belongs to the roster, the coding, and the data, which is where this series has argued from the beginning that its questions would have to end up. Oakland was the best case. The best case deserved an invoice.

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## Appendix A — Derivations

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### A.0 Notation and Standing Assumptions

Plant:  $x_{t+1} = A x_t + B u_t$ ,  $x \in \mathbb{R}^N$ ,  $u \in \mathbb{R}^m$ , with  $A$  Schur-stable (spectral radius  $\rho(A) < 1$ ). For the derivations we take  $B = I$  and  $N = m$ ; the general case replaces  $\Pi$  by  $B\Pi$  throughout without changing the structure of any result. Delegation chain: layers  $i = 1, \dots, n$ ; layer  $i$  applies the linear translation  $P_i \in \mathbb{R}^{m \times m}$  with singular values  $\sigma_{i1} \geq \dots \geq \sigma_{im}$ , all  $\leq 1$  (the contraction assumption); composite  $\Pi_n = P_n \cdots P_1$ ; cumulative delay  $T = \sum \tau_i$  (delays enter the latency results of §3.1 via Paper I's apparatus and are suppressed here); layer noise  $w_i$  zero-mean, covariance  $\sigma_w^2 I$ , independent across layers (Limitation 4 of §8.1 notes the cost of independence).

### A.1 Minimum-Energy Control

Reachability over horizon  $H$  from  $x_0 = 0$ :

$$x_H = \sum_{k=0}^{H-1} A^k \Pi u_{H-1-k} = L \mathbf{u},$$

where  $L = [A^{H-1}\Pi, \dots, A\Pi, \Pi]$  and  $\mathbf{u}$  stacks the inputs. Energy  $E(\mathbf{u}) = \sum_t \|u_t\|^2 = \|\mathbf{u}\|^2$ .

Minimise  $\|\mathbf{u}\|^2$  subject to  $L\mathbf{u} = x_f$ . The least-norm solution lies in  $\text{range}(L^T)$ : set  $\mathbf{u} = L^T \lambda$ . Then  $x_f = LL^T \lambda = W_H \lambda$  with

$$W_H = \sum_{k=0}^{H-1} A^k \Pi \Pi^T (A^T)^k \text{ (the reachability Gramian),}$$

so  $\lambda = W_H^{-1} x_f$  on  $\text{range}(W_H)$ , and

$$E_{\min}(x_f) = \mathbf{u}^T \mathbf{u} = \lambda^T L L^T \lambda = x_f^T W_H^{-1} x_f.$$

If  $x_f \notin \text{range}(W_H)$ , no input reaches it:  $E_{\min} = \infty$ . For  $\rho(A) < 1$  and  $H \rightarrow \infty$ ,  $W_H \uparrow W$  solving the discrete Lyapunov equation  $W = AWA^T + \Pi\Pi^T$ .

**Remark A.1.1 (sustained outcomes).** A policy outcome is more naturally a *held* state than a *visited* one. Holding  $x_f$  against stable dynamics requires steady input  $u_{ss}$  with  $x_f = Ax_f + \Pi u_{ss}$ , i.e.  $u_{ss} = \Pi^\dagger (I - A)x_f$  (when solvable), with per-period power

$$\|u_{ss}\|^2 = \|\Pi^\dagger (I - A)x_f\|^2 \geq \|(I - A)x_f\|^2 / \sigma_{\max}(\Pi)^2, \text{ and along a direction transmitted at composite gain } g:$$

$$\|u_{ss}\|^2 = \|(I - A)x_f\|^2 / g^2.$$

The sustained-power version of the energy law therefore scales as  $g^{-2}$  exactly as the transient version does. The governance reading of §2.3 does not depend on the transient formulation.

## A.2 The Energy Law: $E_{\min}$ versus Depth

**A.2.1 Aligned chain (exact).** Suppose the layers share singular directions:  $P_i = U S_i U^T$  in a common orthonormal basis  $U$ . Then  $\Pi_n = U(\Pi S_n)U^T$  and the composite singular values multiply exactly:  $g_j = \Pi_i \sigma_{ij}$ . With  $A = aI$ :

$$W = \sum_k a^{2k} \Pi \Pi^T = (1 - a^2)^{-1} \Pi \Pi^T, E_{\min} \text{ along direction } j = (1 - a^2) g_j^{-2} \|x_{fl}\|^2.$$

Uniform per-layer gain  $\gamma$  on direction  $j$  gives  **$E_{\min} \propto \gamma^{-2n}$** : exponential in depth, the baseline form of §2.3.

**A.2.2 Random orientations.** With independent random rotations between layers,  $\Pi_n$  is a product of i.i.d. random matrices. By the Furstenberg–Kesten / Oseledets theory, the limits  $\lambda_j = \lim (1/n) \ln \sigma_j(\Pi_n)$  exist (the Lyapunov spectrum), and for a generic fixed direction  $v$ ,  $(1/n) \ln \|\Pi_n v\| \rightarrow \lambda_1$ . Growth of  $E_{\min}$  with  $n$  is therefore exponential, with the rate set by the relevant exponent. For the prototype's ensemble (singular values i.i.d. uniform on  $[0.7, 1.0]$ , Haar rotations), the spectrum's *sum* is exactly computable:  $\sum_j \lambda_j = E[\ln|\det P|] = m \cdot E[\ln \sigma]$  with  $E[\ln \sigma] = -0.1677$ , so the *average* exponent is  $E[\ln \sigma]$  and the predicted median-energy growth factor per layer is  $\exp(-2E[\ln \sigma]) = 1.399$ .

**Numerical finding:** the prototype's measured median factor is 1.40 (Part V, Simulation A), matching the average-exponent prediction.

**A.2.3 Dispersion growth.** The interquartile range of  $E_{\min}(n)/E_{\min}(0)$  widens with  $n$  (Part V:  $[1.30, 1.53]$  at  $n = 1$ ;  $[8.84, 13.96]$  at  $n = 7$ ). Consistent with the variance of finite- $n$  products around their Lyapunov limit; no rate is derived. Flagged as a promotable result if the full simulation confirms robustness.

## A.3 The Geometry Lemma

Layers with unit repertoire deficiency are modelled as orthogonal projections  $P_i = I - v_{iv} v_i^T$ ,  $\|v_{iv}\| = 1$  (blind spot  $v_i$ ). Three kernel geometries.

**A.3.1 Independent (mutually orthogonal) blind spots.** Claim: if  $\{v_1, \dots, v_n\}$  are orthonormal, then  $\Pi_n = I - \sum_{i=1}^n v_{iv} v_i^T$ , the orthogonal projection onto  $\text{span}\{v_i\}^\perp$ ; hence  $\text{rank}(\Pi_n) = m - n$ , with singular values 1 (multiplicity  $m - n$ ) and 0 (multiplicity  $n$ ).

*Proof.* Induction.  $n = 1$  is the definition. Assume  $\Pi_{n-1} = I - \sum_{i < n} v_{iv} v_i^T$ . Then  $P_n \Pi_{n-1} = (I - v_{nv} v_n^T)(I - \sum_{i < n} v_{iv} v_i^T) = I - \sum_{i \leq n} v_{iv} v_i^T + v_n \sum_{i < n} (v_n^T v_i) v_i^T$ , and the last term vanishes by orthonormality. ■

This is the additive-annihilation route to §2.4's threshold: a directive with a component in  $\text{span}\{v_i\}$  loses it outright, and the chain's reachable set has codimension  $n$ .

**A.3.2 Identical blind spots.**  $v_i = v$  for all  $i$ :  $P$  is idempotent ( $P^2 = P$ ), so  $\Pi_n = P$  for every  $n \geq 1$ . Rank  $m - 1$ , all nonzero singular values equal to 1, at every depth. One dimension lost once; depth costless thereafter — the homogenized regime of §2.1 and §7.3.

**A.3.3 Generic blind spots.**  $v_i$  i.i.d. uniform on the sphere.

(i) *Hard rank is preserved*

(ii) *Clean transmission loses exactly one dimension per layer*

*Proof.* ( $\geq$ ) On  $\cap v_i^\perp$  every  $P_i$  acts as the identity, so  $\Pi_n$  does. ( $\leq$ ) If  $\|\Pi_n x\| = \|x\|$ , then since each  $P_i$  is a contraction, every intermediate image must preserve norm:  $\|P_1 x\| = \|x\|$  forces  $x \perp v_1$ , hence  $P_1 x = x$ ; iterating,  $x \perp v_i$  for all  $i$ . The intersection of  $n$  generic hyperplanes has dimension  $m - n$  a.s. ■

This is the invariant of §2.1 — *one cleanly transmitted dimension lost per deficient layer* — now a theorem rather than a numerical observation, and it holds in both A.3.1 and A.3.3, which is why the prototype's clean-dimension counts coincide for the two regimes while their ranks diverge.

(iii) *The degraded dimensions' gains collapse geometrically*

(iv) *Interpolation:* kernels with tunable correlation between the A.3.2 and A.3.3 poles (e.g.  $v_i \propto \bar{v} + \kappa \epsilon_i$ ). The full simulation sweeps  $\kappa$ ; no analytical results are claimed. The orthogonal-projection idealisation itself (versus oblique translations with  $d_i = 1$ ) is also an idealisation: for general contractive  $P_i$  the multiplicity statement in (ii) becomes approximate (singular values near 1 rather than equal to 1), which is what the prototype's threshold counts at  $\sigma \geq 0.99$  measure.

**Governance note.** A.3.1–A.3.3 jointly establish §2.1's unified law at the stated tier: the *count* of degraded dimensions is geometry-independent; the *form* of the cost — codimension versus energy — is geometry-dependent.

## A.4 The Bidirectional Node

Place one institution at tier  $j$  of the observation chain and tier  $n - j$  of the actuation chain. Upward: the centre's estimate is  $\hat{x} = \Theta_{\text{up}} x + \eta$ , where  $\Theta_{\text{up}}$  composes the aggregation maps of Paper III's chain and  $\eta$  its accumulated noise. The centre computes the directive  $v = K(\hat{x}) = K\Theta_{\text{up}} x + K\eta$ . Downward: the node delivers  $u = \Pi_{\text{down}} v + D\delta$ ,  $\delta$  local discretion. The delivered action is therefore

$$u = \Pi_{\text{down}} K \Theta_{\text{up}} x + \Pi_{\text{down}} K \eta + D\delta:$$

the state enters the actuation **through the product  $\Pi_{\text{down}} \mathbf{K} \Theta_{\text{up}}$**  — the two chains' attenuations compose multiplicatively on the calibration path, before any noise is counted. The node's friction report (the discrepancy it observes locally) travels up through the same  $\Theta_{\text{up}}$ , so the correction loop's gain is attenuated by the *square* of the upward channel's deficiency along the report's dimensions: once corrupting the directive's calibration, once muting the complaint about it. The trap of §7.4 is the regime in which the delivered error is persistent and locally visible while the centre's received friction signal sits below its detection threshold.

**Conjecture A.4.1 (superadditivity).** Let performance  $J$  depend on shortening parameters  $s_{\text{up}}$ ,  $s_{\text{down}}$  (layers removed from each chain at the node). Then  $\partial^2 J / \partial s_{\text{up}} \partial s_{\text{down}} > 0$  over the operating range: shortening both chains at one node yields more than the sum of shortening each alone, because each chain's residual attenuation multiplies the other's on the calibration path above. Test: full simulation, two-chain model; the prediction's empirical shadow is Paper VII's finding that protected experimental spaces — double-short nodes — are the convergent first step of viable reform. Whether the within-node composition is best modelled as the product above or includes additive pathways is part of what the simulation must decide; this appendix claims the setup, not the theorem.

## A.5 Status Summary for Review

Result	Status
$E_{\min} = x_f^T W^{-1} x_f$ ; Lyapunov limit	Standard
Sustained-power version, same $\Pi$ -dependence	Proved (Remark A.1.1)
Aligned-chain exponential law $\gamma^{-2n}$	Proved
Random-chain exponential growth (some rate)	Standard (Oseledets)
Median rate = average exponent $\exp(-2E[\ln \sigma])$	Numerical (► Reviewer 3)
Dispersion growth with depth	Numerical
Orthogonal kernels: rank $m - n$ , additive annihilation	Proved
Identical kernels: idempotence, one loss	Proved
Generic kernels: rank $m - 1$ a.s.	Proved
Clean dimensions = $m - n$ a.s. (the §2.1 invariant)	Proved
$\sigma_{\min}$ geometric decay and its rate	Numerical (► Reviewer 4)
Correlation interpolation	Open
Bidirectional composition $\Pi_{\text{down}} K \Theta_{\text{up}}$	Stated (setup)
Superadditivity conjecture	Open



## Appendix B — Simulation Specification

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### B.0 Convention

One file: `gae-simulator-v14-reform-exhaustion.py`, alongside the shipped prototype (`gae-simulator-v13-chain-prototype.py`, frozen as run for Part V). NumPy + SciPy only. All parameters as named constants at the top of the file. A changelog comment block at the file head records any specification change made after the first full run, with date and reason — this replaces v1's formal deviation log at zero overhead. Figures to `outputs/` as `v14-*.png`; published values are medians with interquartile ranges over **100 seeds minimum** per condition; distributions shown as histogram panels rather than archived separately. One README line.

### B.1 The Six Simulations

**A — Energy law** (extends prototype E1). Depth  $n = 0 \dots 12$ ; layer singular values  $U[0.7,1.0]$  baseline,  $U[0.5,1.0]$  and  $U[0.9,1.0]$  as robustness;  $m \in \{4, 6, 10\}$ . Figure `v14-energy-main.png`: median  $E_{\min}(n)/E_{\min}(0)$ , log scale, IQR band, analytic line  $\exp(-2E[\ln \sigma] \cdot n)$  overplotted; deficient-geometry asymptotes marked. Secondary panel: IQR/median vs  $n$  (dispersion).

**B — Blind-spot geometry** (extends prototype E2). Orthogonal pole (separate construction — *not* a point on the correlation axis) plus kernel correlation  $\rho_B \in \{0, 0.1, \dots, 1.0\}$ ;  $d \in \{1, 2\}$ ; the `oblique` robustness variant (one singular value at  $\{0, 0.1, 0.3\}$ ). Track hard rank, clean-transmission count (thresholds 0.99/0.95/0.90),  $\sigma_{\min}$ . **Sanity gates:** the proved results of Appendix A (A.3.1, A.3.2, A.3.3.i-ii) run as code assertions; a failure is a bug by definition and halts the run. Figure `v14-geometry-sweep.png`: clean count and  $\sigma_{\min}$  over  $(n, \rho_B)$ , orthogonal pole marked off-axis — §7.3's design map rendered.

**C — Noise placement** (extends prototype E3).  $n = 6$  baseline; delivered-variance share by injection layer; delivered SNR vs depth (axes matched to Paper III's central figure for the visual rhyme). Optional common-mode noise flag, reported as exploratory. Figure `v14-noise-placement.png`.

**D — Architectures.** Uniform depths 7/4/2 and fractal assignment (low-V components through depth 7; high-V through depth 2 ending in a closed local loop: corrective term  $\delta_t = -L(y_{\text{local},t} - r_{\text{local}})$ , one-step local delay, gain and authority envelope swept; envelope 0 = open-loop control case). 20 sites; high-V components drawn per site. Outputs per architecture: fidelity by component class,  $E_{\min}$ , latency, cross-site variance. Figure `v14-architectures.png`.

**E — Discriminator.** Threat-coded directive battery; structural world ( $M = I$ ) vs adversarial world ( $M(\theta)$  attenuating threatened dimensions per Paper IX) under the load-bearing constraint of **matched mean attenuation** — the worlds may differ only in pattern. Output: fidelity-on-threat slope distributions per world and the power curve (minimum battery size and noise at 95% separation), which Part VI cites. Figure `v14-discriminator.png`.

**F — Bidirectional node** (tests Conjecture A.4.1; **run last**, after A–E validate its components). Observation chain of block-averaging tiers (the series' Paper I/III convention — reuse, don't reinvent) composed with the actuation chain; centre acts on the chain-filtered estimate. Factorial: layers removed up  $\times$  down  $\in \{0,1,2\}^2$  at the same node. Output: the J surface and the interaction estimate with CI. Figure `v14-bidirectional.png`.

## B.2 Registered Predictions and Falsification Consequences (carried from v1, binding)

1. **Dispersion promotion rule:** the depth-dispersion finding (A.2.3) enters Part II in revision only if IQR/median grows monotonically in  $n$  across all nine ( $m \times$  distribution) conditions of Simulation A.
2. **Assignment principle:** fractal architecture D must strictly dominate uniform B on the combined metric; if it does not, §7.2 loses its quantitative support and Part VII is revised.
3. **Superadditivity:** a null or negative interaction in Simulation F demotes Conjecture A.4.1 to a *disconfirmed hypothesis* in the published text, and §7.4's protected-space reading reverts from "derived design theorem candidate" to "consistent observation."

### B.3 Parameter Table

Parameter	Baseline	Sweeps
Dimension m	6	4, 10
Plant poles	U[0.85, 0.98]	—
Layer singular values	U[0.7, 1.0]	U[0.5, 1.0], U[0.9, 1.0]
Deficiency d	1	2
Kernel correlation $\rho_B$	0...1 step 0.1, + orthogonal pole	—
Oblique $\sigma_{\text{weak}}$	—	0, 0.1, 0.3
Depth n	0...7	0...12 (A); 0...m (B)
Seeds	100	—
Sites (D)	20	—
Local-loop gain / envelope (D)	swept, declared in file	—
Removals (F)	{0,1,2} <sup>2</sup>	—



## Appendix C — Case Coding Protocol

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### C.1 Purpose and Registration Discipline

This protocol governs the small-N coding study of Part VI. Its discipline, registered in §6.0, is implemented here as four rules:

1. The protocol version, case roster, and variable definitions are frozen, with date, before any fidelity value is assigned.
2. Coding proceeds in the blinded order of C.6.
3. Every admitted case is reported in the published table, including cases whose values embarrass the prediction.
4. Deviations from the protocol are permitted only with a logged entry in C.9 stating what changed, when, and why — before the change is applied.

### C.2 Case Admission

A case is one policy directive satisfying all of:

1. **Fixed content:** an identifiable authority finalised the directive's operative content at a datable moment (statute, programme decision, central-bank launch decision).
2. **Quantified objective:** the directive states, or official documents contemporaneous with it state, a quantified target (jobs, services, coverage, days of work) against which delivery can be measured. Where the objective was explicitly declared unmeasurable by the auditing institution (Universal Credit's employment goal), the case is admissible only with the substitute delivery metrics named at admission (C.4, Table C-1).
3. **Third-party outcome documentation:** at least one source from tiers 1–3 of the source hierarchy (C.4) exists.
4. **Reconstructable chain:** the implementation pathway can be documented from public organisational and process records for the measurement window.

Admission is decided on criteria 1–4 *before* outcome magnitudes are examined; a case may not be dropped after its fidelity value is known. Roster target: six to ten cases spanning the depth scale, at least two with coded depth  $\leq 2$ .

### C.3 Variable 1 — Delegation Depth (n), with Clearance Width (w)

**Definition.** n is the number of organisationally distinct layers on the modal delivery path that must receive, translate, and retransmit or apply the directive between the content-fixing authority (start node) and the delivery transaction (end node). The start node is the level at which operative content was finalised — not necessarily the legislature; the end node is the citizen- or firm-facing transaction.

#### Counting rules:

1. A layer is counted when it is organisationally distinct (own management, budget line, or statutory identity) AND performs translation — reformatting the directive into its own instruments, categories, plans, or systems — on the modal path.
2. **Serial versus parallel:** units operating in parallel at the same tier (co-approvers, co-signers, concurrent clearances) do not add to n. They are recorded in a separate variable, **clearance width w<sub>i</sub>** — the number of distinct approvals required at tier i — with  $W = \sum w_i$  the case's total clearance count. Depth n captures the chain model's serial composition; W captures Pressman and Wildavsky's joint-action count, which mixed the two. Oakland's seventy clearances over thirty decision points is the canonical illustration of why the distinction must be coded rather than assumed. The analysis treats n as primary and W as exploratory.
3. **Pure conduits:** a unit that passes the directive or its funds without translation counts toward n only if it holds delay or veto capacity; flag such layers `conduit`.
4. **Automated layers:** a digital system on the modal path counts as one layer, flagged `automated`, with a note on what it can and cannot express (feeds Variable 4).
5. **Within-case variation:** where one directive descends multiple distinct chains (MGNREGA's states), each chain is a sub-case with its own n, coded from its own documentation (C.7).
6. **Evidence and window:** n is coded from organograms, statutes, programme guidelines, and process documentation *as of the measurement window*, with a source cited per layer. Performance information is inadmissible as evidence for n (this is the firewall against smuggling capacity into depth).

### C.4 Variable 2 — Implementation Fidelity (F)

**Definition.**  $F = \text{delivered outcome} / \text{stated quantified objective}$ , measured at the horizon, capped to [0, 1]. The horizon is the directive's own deadline where one exists (OZG: 2022-12-31); otherwise five years from operative start. Both the raw ratio and any horizon-adjustment are reported.

**Source hierarchy.** Values are taken from the highest available tier; lower tiers are admissible only when higher tiers are silent:

1. Supreme audit institutions and statutory auditors (NAO, Bundesrechnungshof, CAG of India).

2. Randomised or quasi-experimental evaluations.
3. Official statistics with independent verification — including the survey-against-register design, where an independent household survey is compared with the administrative delivery database; the confirmation ratio is itself a fidelity instrument (MGNREGA Bihar: 59 per cent of officially recorded working households confirmed by survey).
4. Peer-reviewed observational evaluations.

Media reports are background only; no F value rests on them. Where admissible sources conflict, code F as an interval [F\_low, F\_high] and run the analysis at both ends.

**Table C-1 — per-case operationalisation (fixed at admission):**

Case	Objective basis	F numerator / denominator	Primary sources
Oakland EDA	Jobs promised; funds committed	Jobs delivered / promised; funds productively disbursed / committed	P&W 1973 (book; resolve the 80%-row arithmetic against the printed table)
MGNREGA (state sub-cases)	Statutory entitlement; work on demand	Households obtaining work / households seeking; person-days per demanding household / entitlement; survey–register confirmation ratio where available	NSS-based studies (Dutta et al.); CAG audits; NBER w22803
Universal Credit	Substitute delivery metrics (per C.2.2)	First payments on time / total; online verification achieved / 90% plan	NAO 2018, 2020
OZG	575 services online by 2022-12-31	Services online to specification / 575 (4% per BRH); any-form online / 575 (19%; ~105 per Bundestag)	Bundesrechnungshof; Bundestag; NKR Monitor
PIX	Coverage/uptake (no quantified ex-ante target — flag; existence-proof entry)	Adult-population adoption at horizon	BCB statistics; peer-reviewed studies
[France / Estonia / additions]	[at admission]	[at admission]	[tier 1–3 only]

## C.5 Variables 3 and 4 — Threat (T) and Task Variety (V)

**T (discriminator column, per §4.1):** low / medium / high — the documented material stake of implementing-layer actors in the directive's failure or distortion (rents, budgets, authority, positions threatened by faithful delivery). Evidence basis recorded per case (e.g., the MGNREGA political-economy literature; procurement-rent documentation). T is a property of the implementing layers' interests, not of public controversy.

**V (task variety, per §2.5 and §4.3):** low / medium / high — the intrinsic dimensionality of the delivery task: how much legitimate case-to-case variation faithful delivery requires. Payments are low-V; complex personal-circumstance assessment is high-V. V is coded from the task's nature, never from delivery performance. V is what permits the depth-for-rank analysis: the model predicts shallow+automated suffices at low V (PIX) and fails at high V (Universal Credit), and the roster must not treat those two as exchangeable data points.

## C.6 Coding Order and Blinding

1. Freeze protocol and roster (C.1, C.2).
2. Code n, w, T, V for all cases from structural and documentary sources only — fidelity sources unopened. Log completion date.
3. Code F per Table C-1.
4. **Second coder:** if a human second coder is unavailable, a second coding is run by an AI system given only this protocol and the per-case source documents, blind to the first coder's values and to the paper's prediction; disagreements are adjudicated by Björn with a documented rationale per disagreement; agreement statistics are reported. If no second coding occurs, the paper says so in §6.1 rather than implying otherwise.

## C.7 MGNREGA Sub-Protocol

1. **Sub-case selection rule (fixed in advance; choose one and log it):** (a) all states covered by the Dutta–Murgai–Ravallion–van de Walle NSS analysis, or (b) all states above a rural-household threshold. No discretionary additions after fidelity data are seen.
2. **Measurement window:** primary window matching the NSS-based literature (2009–2012); a second window after electronic fund-management rollout coded for robustness, separately, because the technology changed the chain itself.
3. **Depth per state:** from state-specific implementation structures (Gram Panchayat → block programme officer → district programme coordinator → state department, plus state-specific tiers and parallel bodies), each layer sourced; states differ in both n and w, which is the design's point.

4. **Fidelity per state:** the Table C-1 instruments; rationing rate (sought-but-not-obtained) inverted into the demand-fulfilment ratio.
5. **Covariates recorded, not absorbed:** state capacity (the rival explanation) coded separately from published indices so the depth–capacity correlation can be reported rather than hidden; T from the political-economy literature per state where documented.
6. **Localisation test (Prediction 2):** where social-audit data attribute discrepancies to administrative tiers, code the tier distribution of discrepancy mass; the prediction is concentration toward the delivery end.
7. **Experimental entry:** the Bihar fund-flow randomisation is a separate row flagged `experimental` — the only manipulated-depth observation in the roster.

## C.8 Analysis Plan (registered)

1. **Primary:** Spearman rank correlation of F against n across the roster (sub-cases weighted so MGNREGA does not dominate by count; weighting rule fixed at freeze). Permutation-based p-value given small N. Interval-coded F analysed at both ends.
2. **Discriminator:** the F–n relation reported within strata of T; the contrasting pattern (F tracking T, not n) is reported as evidence for the adversarial mechanism per §6.4(3).
3. **Depth–rank pattern:** the (n, V, F) configuration examined qualitatively against the §4.3 prediction; with this N it is a pattern check, not a test, and is labelled as such.
4. **Exploratory:** W, and the composite  $n \times W$ , against F; the localisation distribution (C.7.6).
5. **Power honesty:** with six to ten cases, only large effects are detectable; the study is closer to a sign test than an estimation, and the paper says so. The full study (roadmap Phase 2, Study 3) inherits this protocol with the N it deserves.
6. **Nulls:** reported per §6.4(4), with the construct-revision consequence stated.

## C.9 Deviation Log

Date	Section	Change	Reason	Before/after fidelity coding?
—	—	—	—	—

*(The log ships with the paper. An empty log is a result.)*