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Pricing the Commons

A market mechanism for non-scarce goods, with a deterministic pricing function and a charter-bound minimal executor

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ABSTRACT

Markets price scarcity. Open systems — software, hardware designs, datasets, scientific knowledge — produce value *without* scarcity, leaving their producers without a market-driven income stream. Existing responses either reconstruct scarcity (patents, source-available licenses), depend on voluntary contribution (donations, sponsorship), or introduce speculative governance assets (DAO tokens) that empirically collapse into plutocracies.

This paper proposes a fourth path: a deterministic pricing function that converts commercial use of an open work into a proportional contribution obligation, with capital and labour fully substitutable through in-kind return, modulated by a time-decaying behavioural index. The function is fixed at protocol release and operated by a minimal executor whose charter prohibits its modification; evolution proceeds through forks, not through governance.

The proposal is positioned as a *market mechanism for non-scarce goods* rather than as a license, although a short license text makes it legally operative. The central claim is that commons-based production can be sustained through markets if the price is coupled to realised commercial value rather than to denied access.

1 Introduction

The production of non-scarce goods is a sustained achievement of the past three decades. Their pricing is not.

Open-source software, open hardware, open scientific data, open educational resources, free encyclopaedic content — the volume and quality of these resources is now sufficient to underwrite trillion-Euro industries. The producers of these resources, by and large, do not share in that value. The pattern has been documented repeatedly (Eghbal, 2016; Tidelift, 2020; Tidelift, 2023) and is sufficiently familiar that it requires no extensive elaboration here: maintainers underpaid, projects underfunded, infrastructure burdened beyond capacity.

The conventional framing of this problem is moral or organisational. It asks whether commercial actors *should* contribute and how voluntary contribution can be increased. This paper takes a different approach. The problem is treated as a *pricing failure*: classical markets have no mechanism for setting prices on goods that are not scarce, because price formation in classical markets is grounded in the exclusion of access. Open systems, by definition, do not exclude access. The market therefore finds no price, and producers receive no income from market activity — even when their output enables substantial commercial value.

This paper specifies a market mechanism for the case where access is not the price-bearing variable. The mechanism prices *commercial use* directly, on the basis of revenue attributable to the work, with three modulators: a progressive base rate, a discount for in-kind contribution, and a time-decaying behavioural index. The mechanism is deterministic, requires no governance discretion, and is operated by a minimal institution whose charter forbids its own amendment.

The contribution of the paper is fourfold. **First**, it formulates the open-source sustainability problem as a market-design question rather than a moral one (§ 2). **Second**, it specifies a closed-form pricing function and derives its formal properties (§ 3, § 4). **Third**, it argues that no governance discretion is needed for the mechanism to operate, and proposes a charter-bound minimal executor as the operational form (§ 5). **Fourth**, it examines failure modes that no formula eliminates and discusses what additional research and validation are required before the mechanism can be deployed at scale (§ 6, § 7).

2 The Pricing Problem for Non-Scarce Goods

2.1 What classical markets price

Standard microeconomic theory derives prices from the interaction of supply and demand under conditions of scarcity. A good is scarce if its consumption by one party reduces availability to others, or if access to it can be controlled. Classical markets price these conditions: the cost of bread reflects the alternative uses of the wheat; the cost of a manufactured object reflects the labour, materials, and capital required to produce it; the cost of access to a book reflects its reproduction and distribution.

When the good is itself non-rivalrous and non-excludable — a digital file, a shared knowledge structure, a publicly accessible algorithm — these mechanisms cease to operate. The marginal cost of an additional copy is zero. Access cannot be denied without active intervention. The price discovered by a classical market in this setting is, accordingly, zero.

2.2 Existing responses and their failure modes

Four families of response have been deployed against this gap, none of them satisfactory:

- **Reconstructed scarcity.** Patents, copyright maximalism, source-available licenses (BUSL, SSPL), and trade-secret protection re-introduce excludability. They produce income, but they destroy the openness that justified the open production mode in the first place. The cure is the disease (Lessig, 2001; Boyle, 2008).
- **Voluntary contribution.** OpenCollective, GitHub Sponsors, Patreon, foundation donations. Empirically, these mechanisms reach *fewer than 5 %* of commercial users (Tidelift, 2020) and produce gross volumes orders of magnitude below what would be required to sustain the dependency graphs they support.
- **Governance tokens and DAOs.** Token-based decentralised funding mechanisms have been deployed across multiple cycles (2017–2018, 2020–2022) and have empirically produced highly concentrated voting power, with a small number of addresses holding majority influence in major DAOs (Fritsch et al., 2024; Buterin, 2022).
- **Foundation funding.** Apache Software Foundation, Linux Foundation, Mozilla. These work at institutional scale but require sustained major-donor relationships. They are ongoing fundraising operations rather than market mechanisms; they do not solve the pricing problem, they bypass it.

What none of these solves is the *specific* question: *can a market operate inside an open system, without reconstructing scarcity, to direct value flows from commercial use back to producers?* The remainder of this paper proposes that it can, if the price is coupled to observable commercial value rather than to denied access.

2.3 Reframing the problem

The reframing is mathematical. In classical markets, the price-bearing variable is access (controlled by exclusion). In a market for non-scarce goods, the price-bearing variable must be *commercial value realised* by the user, expressed in revenue terms attributable to the use of the work. This is observable: commercial entities report revenue. It is bounded: a percentage of revenue cannot exceed revenue. And it is incentive-compatible in a specific sense: an entity that derives no commercial value pays nothing, while an entity that derives substantial commercial value pays in proportion. The market signal flows from observed commercial activity rather than from artificial supply restriction.

What follows is a specification of how such a price can be set deterministically, without discretion, and how it can be operated by an institution that lacks the authority to alter it.

3 The Pricing Function

A single equation. Four inputs. Deterministic output. The protocol is the formula; the rest is plumbing.

3.1 Definitions

For an entity using a work licensed under this protocol, in a fiscal year, the annual obligation is defined:

$$\textbf{AnnualObligation} = \max(0,\ \mathit{AttributableRevenue} \times \mathit{BaseRate} \times \mathit{ReturnDiscount} \times \mathit{HistoryMultiplier})$$

The four components are specified below. Each is computable from public data; the formula is therefore self-verifying — any third party can compute any entity's obligation given the necessary inputs.

3.2 AttributableRevenue

The portion of the entity's revenue that derives from productive use of the work. Operationally defined as the lesser of: (a) revenue from products or services where the work is a load-bearing component; (b) the proportional fallback *0.1 × total entity revenue* per work dependency. Entities self-declare which applies; declarations are public; competitors and analysts can challenge implausible declarations through public counter-analysis. The market — investors, customers, journalists — adjudicates plausibility.

3.3 BaseRate

A smooth, bounded, monotonically increasing function of attributable revenue. Below a floor U_0, no obligation arises. Above the floor, the rate rises asymptotically toward a maximum R_{max}:

$$\mathit{BaseRate}(U) = R_{max} \times (1 - e^{-k(U - U_0) / U_{scale}}) \text{ for } U > U_0;\ 0 \text{ otherwise}$$

Parameters fixed at v1.0 release: U_0 = 100,000 EUR; U_{scale} = 10,000,000 EUR; R_{max} = 0.015 (1.5 %); k = 1.0

Attributable Revenue (EUR)	*BaseRate*	*Pre-discount Obligation (EUR)*
50,000	0.00 %	0
100,000	0.00 %	0
250,000	0.02 %	54
500,000	0.06 %	293
1,000,000	0.13 %	1,285
5,000,000	0.57 %	28,600
10,000,000	0.95 %	94,900
50,000,000	1.49 %	745,000
100,000,000	1.50 %	1,498,000
1,000,000,000	1.50 %	14,999,000

Table 1. *BaseRate and pre-discount obligation across a range of revenue levels. The function is continuous (no step at the floor), monotonically increasing, and bounded above by 1.5 % regardless of revenue magnitude.*

3.4 ReturnDiscount

The mechanism by which in-kind return substitutes for financial payment. This is the central economic novelty: *capital and labour are made fully substitutable* in satisfying the obligation.

$$ReturnDiscount(E, B) = max(0, 1 - B / E)$$

where E = pre-discount expected obligation (= AttributableRevenue × BaseRate), B = market value of in-kind contributions during the period

An entity contributing in-kind value equal to E owes zero cash. An entity contributing nothing owes the full E. Intermediate ratios linearly reduce cash obligation. Excess contribution (B > E) accrues to the HistoryMultiplier (§ 3.5).

In-kind contributions are valued by a fixed price table, denominated in EUR with annual inflation adjustment via published index (Eurostat HICP). The table maps contribution categories — senior developer-hour, documentation-hour, data attestation, translation, formal review — to monetary values. Maintainers of recipient projects sign attestations confirming receipt; the protocol applies the table value mechanically. Attestation is the only act of human judgement in the system, and is constrained to accept/reject — never to set the price.

3.5 HistoryMultiplier

A behavioural index that rewards sustained over-contribution and penalises sustained under-contribution. Constructed as a tanh-bounded transformation of accumulated, time-decayed performance:

$$\mathit{Karma}(\mathit{entity}, t) = \Sigma\ (\mathit{overperf} - \mathit{underperf}) \times \mathit{decay}(\mathit{years\_ago})$$

$$\mathit{HistoryMultiplier}(K) = 1 - 0.5 \times \tanh(K / \mathit{KarmaScale})$$

overperf = max(0, B − E); underperf = max(0, unpaid_obligation); decay(n) = $0.5^{n/3}$ (3-year half-life); KarmaScale = 3 × average_annual_obligation; result range: HistoryMultiplier ∈ [0.5, 1.5]

The multiplier ranges from 0.5 (long-term over-contributor, permanent 50 % discount) to 1.5 (long-term extractor, permanent 50 % surcharge). The 3-year half-life means recent behaviour weighs more than ancient behaviour, but cumulative track record never fully decays. The multiplier is computable from the public Register and cannot be reset by changing legal entity — new entities start at neutral karma, which is worse than positive but no worse than starting state.

4 Formal Properties

Five properties follow mathematically from the pricing function. Each addresses a failure mode of prior systems.

Property 1 — Substitutability of capital and labour. An entity can satisfy the full obligation through cash, in-kind contribution, or any combination, with substitution at market-table prices. A skilled team contributing 100 % in-kind owes zero cash; a financially-flush firm without technical capacity pays 100 % cash. Both are fully compliant. This dissolves the binary distinction between "users" and "contributors" present in classical open-source licensing.

Property 2 — Long-term cooperation is a dominant strategy. Because karma has a 3-year half-life and the multiplier is tanh-bounded, the optimal long-horizon strategy is consistent slight over-contribution. A firm contributing 110 % of its obligation each year converges toward a steady-state karma yielding a permanent 30–40 % discount; a firm under-contributing 90 % converges to the opposite, paying 30–40 % more indefinitely. Over a ten-year window, the spread between the two paths is substantial — and the comparison is between two firms with identical revenue and identical access to the work.

Property 3 — Maximum-extraction is dominated. A firm taking maximum use and contributing nothing pays BaseRate × 1.5 (negative-karma surcharge). The rational response is to convert some cash to in-kind, since in-kind is valued at market-table rates while cash is valued at full nominal. Once converted, the in-kind contribution improves the work the firm depends on. The formula structurally prefers the cooperative outcome.

Property 4 — No discretion to capture. The formula contains no parameters that adapt at the discretion of any human actor. Revisions require a fork (a new protocol identifier, a new executor, a new charter); existing licensees continue under the version they adopted. This eliminates the capture vector that has dominated comparable systems' failure modes.

Property 5 — Self-verifiability. Any third party — auditor, journalist, competitor — can compute any entity's obligation from public data: declared attributable revenue, the published BaseRate function, public attestations in the Register, and computable karma. Disputes shift from "what does the entity owe" (mechanically determined) to "are the inputs honest" (an empirical question with public evidence).

5 Operational Form: The Charter-Bound Minimal Executor

A formula does not receive payments, operate registers, or appear in court. A legal person must. The protocol's institutional design is to make that legal person as constrained as possible.

An earlier draft of this work proposed "no governance, no institution." This was incomplete: a non-bodied formula cannot perform the operational acts the system requires. The corrected position is that an institution exists, but that *its discretionary scope is engineered to be near zero.*

The Executor — instantiated as a foundation, association, or comparable legal person — is bound to perform exactly five operational functions: (1) receive incoming contributions; (2) distribute funds by published split table computed from Register attestations; (3) operate the canonical Register instance; (4) pursue non-compliance through courts when standing is granted; (5) publish the inflation-adjusted price table per the protocol's published method. It is forbidden to: change the formula, refuse a formally valid declaration, set contribution values at discretion, grant waivers or exemptions, or interpret ambiguous clauses (which fall to courts).

Four mechanisms enforce this constraint, layered:

1. **Charter encoding.** The legal document establishing the Executor (statutes of foundation, articles of association) contains the Return Protocol formula as a substantive clause. Modification of the formula requires charter amendment, which under structured European entities (Austrian Privatstiftung, Dutch Stichting, Swiss Verein) is regulator-supervised.
2. **Express prohibition of core amendment.** A specific charter article prohibits modification of the formula, with the express requirement that change must take the form of establishing a successor entity under a new name. Under Austrian and German foundation law, such perpetuity clauses (Ewigkeitsklauseln) are binding on the entity's own organs.
3. **Multi-signature treasury.** Outbound payments above routine operational thresholds require 5-of-9 multi-signature authorisation across three independent signer groups (community-elected, board-appointed, external auditor), preventing unilateral misuse.
4. **Redundant Register mirrors.** The Register is not exclusively hosted by the Executor; mirrors with the same schema may be operated independently. If the canonical instance is corrupted, offline, or contradicts mirror data, the community migrates to the mirror set. The Executor occupies no privileged data position.

Five legal-form options have been examined for the Executor, with profiles summarised in Table 2.

Form	***Setup cost (EUR)***	***Annual cost (EUR)***	***Time to stand up***	***Principal advantage***	***Principal risk***
Hosted by existing steward (SFC, FSFE)	`~0`	`~0`	Weeks	Lowest barrier, fastest	Dependence on host's continuity
Dutch Stichting	`5–15k`	`3–8k`	2–4 months	EU-wide recognition, light oversight	"Lower-regulation" perception
Swiss Verein	`5–10k`	`2–5k`	2–3 months	Lightweight, internationally familiar	Reputational baggage from crypto-adjacent uses
Austrian Privatstiftung	`15–30k`	`10–20k`	4–8 months	Strongest perpetuity guarantees	Significant ongoing cost
Austrian/German Verein	`< 2k`	`1–3k`	1–2 months	Cheapest, most familiar in DACH	Member-assembly amendment risk requires careful drafting

Table 2. *Five legal-form options for the Executor, with cost and risk profiles. Phase 0–2: hosted is recommended; Phase 3+: Dutch Stichting or Swiss Verein once adoption justifies the institutional overhead; Phase 4+: Austrian Privatstiftung where maximum perpetuity is justified.*

6 Failure Modes and Limitations

Honest enumeration of weaknesses that no formula eliminates.

6.1 Attributable revenue is contestable. The protocol specifies the obligation given AttributableRevenue. It cannot prevent an entity from understating this figure. Detection depends on external evidence: competitor counter-analysis, journalistic investigation, whistleblower reports. This is a weakness shared with every existing reciprocal license; no mathematical mechanism fully addresses it.

6.2 Attestation collusion is possible. A maintainer and a licensee could collude on fraudulent attestations. The protocol's defence is the price-table bound on per-hour values; a fully corrupted maintainer could still sign fictional hours. The counter-mechanism is reputational: maintainers whose attestations are systematically anomalous lose downstream confidence — but this is community-mediated, not algorithmic.

6.3 Initial parameter choices may prove wrong. The values U_0 = 100,000 EUR, U_{scale} = 10,000,000 EUR, R_{max} = 1.5 %, decay half-life = 3 years are judgement calls at v1.0. They may need to be different. The response under Axiom 3 is not adjustment but fork: release of v1.1 under a new protocol identifier, with voluntary migration. This is slower than discretionary tuning but does not introduce a capture vector.

6.4 Enforcement still depends on courts. The formula determines the obligation; collecting it from an uncooperative licensee still requires civil action in a relevant jurisdiction. The determinism simplifies the litigation — quantum is not in dispute — but does not eliminate the judicial dependency.

6.5 Legal validation requires years. Whether the formula is enforceable as a contract in specific jurisdictions can only be confirmed through court decisions over time. Early adopters accept this risk knowingly.

6.6 Identity is presupposed. The protocol assumes that distinct entities can be identified for declarations, attestations, and karma calculation. Sybil attacks on the identity layer would corrupt karma. Existing proof-of-personhood and KYB frameworks are adequate at the entity level; individual-level karma is not part of the v0.2 protocol.

7 Discussion

7.1 Relation to prior work

The proposal sits at an intersection of several existing literatures. From *mechanism design* (Maskin, 2008; Hurwicz & Reiter, 2006), it inherits the focus on incentive-compatible rules with verifiable inputs and outputs. From *quadratic and retroactive public-goods funding* (Buterin et al., 2019; Optimism Foundation, 2022), it inherits the use of formula-driven distribution but rejects the dependence on speculative capital and discretionary funding rounds. From *commons-based peer production* (Benkler, 2006; Ostrom, 1990), it inherits the framing of collective production as productive in its own right rather than as a deviation from market norms. From *reciprocal licensing* (GPL, AGPL, CERN-OHL-S), it inherits the use of license terms to enforce copyleft obligations, but extends the obligation from a structural condition (must remain open) to a quantitative one (must contribute proportionally).

The proposal differs from each of these in a specific way: it is the first to specify the obligation as a closed-form deterministic function with substitutability between cash and labour and with an explicit behavioural-history term, embedded in a license that is operationally executed by a charter-bound minimal institution rather than by a governance body.

7.2 The market-design claim

The substantive claim is that markets can operate over non-scarce goods if the price is coupled to realised commercial value. This claim is empirically testable in two stages: (a) can the protocol be deployed without producing perverse incentives that the authors did not anticipate; (b) does the resulting flow of contributions, in aggregate, materially fund the producers it is designed to support.

Stage (a) is reachable through pilot adoption with three to five small projects in different domains (open hardware, open data, open educational resources). Stage (b) is reachable only at substantially greater adoption scale and would require multi-year observation. Until both stages have produced evidence, the proposal remains a design specification rather than a validated solution.

7.3 What this is not

The proposal is not anti-capitalist. It does not reject markets, prices, or commercial activity. It argues that market mechanisms are richer than the scarcity-pricing case usually associated with them, and that the case of non-scarce goods admits a different but still recognisably market-like mechanism. The protocol places non-scarce goods *inside* the market system rather than outside it.

Nor is the proposal a governance reform. It does not propose how foundations should be run, how OSS communities should make decisions, or how value should be redistributed across society. It specifies a single mechanism for a single class of value flow: from commercial users of open works to the producers of those works.

8 Conclusion

This paper has specified a market mechanism for non-scarce goods. The mechanism takes the form of a deterministic pricing function — AnnualObligation = max(0, AttributableRevenue × BaseRate × ReturnDiscount × HistoryMultiplier) — that converts commercial use of an open work into proportional contribution, with full substitutability between cash and in-kind labour, modulated by a time-decaying behavioural index. The function is fixed at protocol release; evolution proceeds through forks, not through governance discretion. Operational implementation is delegated to a minimal executor whose charter prohibits its own modification of the formula.

The central design move is to treat sustainable open production as a market-design problem rather than as a moral one. The market signal is reformulated: not from denied access (the classical case) but from observed commercial value. The price-bearing variable shifts from supply restriction to revenue attribution. This shift, properly specified, may admit market-driven sustainability for goods that classical pricing cannot reach.

Whether the proposal works in practice cannot be determined from specification alone. Legal review, pilot adoption, and empirical observation over multi-year windows are required. The specification is therefore released as an open draft, under CC BY 4.0, with a public invitation to critical review, legal scrutiny, and adoption by appropriate pilots. The most important contribution of the paper, if there is one, may be the reframing rather than the specification: the suggestion that the open-source funding problem is a pricing problem, not a moral problem, and that pricing problems are amenable to mechanism design.

> *Use is free. Return is priced. The market is the mechanism.*

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