There Is Such a Thing as a Free Lunch:
A Conservation Law and a Percolation Threshold for the Academic Free-Food Economy

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Abstract

Every graduate student knows the sound of a catering trolley and has, at least once, rearranged an afternoon around it. Economics insists this is impossible: *there is no such thing as a free lunch.* We take the adage literally and test it, and it fails. Across an eight-institution consortium we track 1.47×10^9 kilocalories of catered food over fifteen years and find a large, stable flow reaching foragers at a price of exactly zero. The adage survives only by quietly redefining "free" to mean "costless to the system," which no one ever meant. Separating the two questions—what the eater pays (nothing) from what the system pays (a great deal)—the truth is not an inequality but a **conservation law**: every free calorie is paid for, exactly, by a traceable sponsor. We verify this "First Law of Free Food" to 2.1% with instrumented trays, value the subsidy at **$18.40 per forager per week** with a pre-registered randomized trial, and then locate a structural fragility. The network that delivers the free lunch sits just above a **percolation threshold**, propped up by a heavy-tailed handful of "keystone" events; a natural experiment shows that removing a campus's two largest caterers collapsed reachable free food from 72% to 11% in three weeks. The free lunch is real, it is worth about $18 a week, and it is one budget memo from extinction. We recommend that keystone caterers be reclassified as critical infrastructure.

1 Introduction

There is a slogan in economics so durable that it has hardened into a law: *there is no such thing as a free lunch*, abbreviated TANSTAAFL and usually delivered with the finality of a conservation principle [1]. It is invoked to end arguments. It deserves, for once, to start one.

Consider the graduate student, who is in possession of contrary evidence. At more or less any hour, in more or less any science building, there is food that costs the eater nothing: the leftover sandwiches from a colloquium, the pizza appended to a recruiting session, the cheese and grapes that outlive a thesis defense. This is not folklore. It is a large, recurring, and—as we will show—measurable flow of calories with a price tag, to the consumer, of zero. Something has to give: either the adage is wrong, or the free lunch is an illusion.

We argue it is the adage. TANSTAAFL is not false because it is pessimistic; it is false because it answers a question nobody asked. There are two quantities in play, and the slogan conflates them:

- the **marginal price to the consumer**, p, of a unit of food; and
- the **total cost to the system**, c, of provisioning it.

TANSTAAFL asserts $p > 0$. The data say $p = 0$. What is actually true is a statement about c: the lunch is free to the eater and *exactly* paid for by someone else. In plain terms: a free lunch is always real, and always someone else's line item. That is not an inequality. It is a bookkeeping identity—a conservation law—and the rest of this paper is an attempt to write it down honestly and then follow the money.

We make three claims, each pitched to be legible without a degree in the subject:

1. **The free lunch is real** (Sections 3 and 4). At the consumer's margin, $p = 0$, for 63% of 1.47 billion catered kilocalories.
2. **But conserved** (Section 3). Injection equals what is eaten plus what is binned: $C_{\text{in}} = C_{\text{eaten}} + C_{\text{waste}}$, verified to 2.1%. The lunch is a *transfer*, not a miracle.
3. **And precarious** (Sections 5 and 6). The delivery network sits just above a percolation threshold; a

small cut collapses it discontinuously.

Fig. 1 shows the object of study: a conserved current of free calories running from sponsors, through catering and events, to foragers, and finally to the bin. Everything that follows is an attempt to put numbers on the arrows.

2 Related Work

The economics of goods priced below cost is old, but the literature has overwhelmingly treated free provisioning as *loss*, not as a circulating economy with its own conservation structure. Public-goods and commons theory [2, 3] supplies the vocabulary of shared, non-excludable resources but stops at the buffet's edge; it models whether the commons is over-grazed, not where the grass comes from. Work on loss-leaders and freemium pricing [4, 5] correctly locates a payer but treats each free good in isolation, missing that the free goods of an institution form a single connected system.

Our conservation apparatus is borrowed, without apology, from transport physics—continuity equations and currents—and our threshold results rest on the theory of random graphs. The existence of a giant connected component above a critical mean degree is classical [6, 7]; we import the Molloy–Reed criterion wholesale and reinterpret "degree" as the number of warm, reachable catered events. The heavy-tailed concentration we find at the source echoes measurements of institutional catering waste [8] and of attention in the "leftovers list" as a medium [9]. To our knowledge, this is the first attempt to close the books on an entire free-food economy and the first to locate its operating point relative to a percolation transition.

3 A Conservation Law for Free Food

Treat one university over one academic term as a closed provisioning system Ω. Let $\rho(\mathbf{x}, t)$ be the density of *free calories* (calories available at $p = 0$) in circulation, and $\mathbf{J}$ their current. Sponsors inject calories at a rate S (grant lines, discretionary funds, recruiting budgets); waste removes them at a rate W. Free calories are neither created nor destroyed in transit, so they obey a continuity equation:

$$\frac{\partial \rho}{\partial t} + \nabla \cdot \mathbf{J} = S - W. \tag{1}$$

Integrate over the closed term. No food leaves campus warm, so the boundary flux vanishes, $\oint \mathbf{J} \cdot d\mathbf{A} = 0$, and the storage term integrates to the net change in standing inventory, which over a full term is zero (the atrium is as empty in September as it was the September before). What remains is the **First Law of Free Food**:

$$\boxed{C_{\text{in}} \;=\; C_{\text{eaten}} \;+\; C_{\text{waste}}} \tag{2}$$

where $C_{\text{in}} = \int S\, dt$ is total sponsor injection, C_{eaten} is consumed at $p = 0$, and $C_{\text{waste}} = \int W\, dt$ is binned. In plain terms: every free calorie that enters is either eaten or thrown away, and if you know two of the three numbers you know the third.

Equation (2) makes the free lunch respectable. A positive C_{eaten} at $p = 0$ is not a violation of anything; it is a *transfer*, sponsor to forager, intermediated by catering. The adage confused $C_{\text{eaten}} > 0$ (real) with $C_{\text{in}} = 0$ (never claimed).

Definition 1 (Free-food potential)**.** For a department d with N_d foragers, let $G_d = C^d_{\text{eaten}}/N_d$ be the free calories reaching each forager per week—the everyday sense in which "there is always something in the atrium."

Proposition 1 (No potential without a sponsor)**.** *$G_d > 0$ is sustainable only under a strictly positive sponsor term. If $S \to 0$ then $G_d \to 0$ within one warm lifetime τ_w.*

Proof sketch. With $S = 0$, Eq. (1) reduces to $\partial_t \rho = -\nabla \cdot \mathbf{J} - W \leq 0$; standing free calories are drawn down monotonically and cleared at the next tray-clearing event, which occurs within τ_w by definition. Hence $G_d \to 0$. There is no steady state of free food that is not, somewhere, being paid for. □

Proposition 1 is the paper in one line: the free lunch exists, and it exists on someone's budget.

4 Data: the Consolidated Provisioning Ledger

We assemble the **Consolidated Provisioning Ledger** (CPL-26): 11,438 catered academic events across an eight-institution consortium, academic years 2011–2025. Each event is reconstructed from catering purchase orders (calories, cost, funding source), the departmental "free food" mailing-list archive (timestamps, locations—the demand signal), and building floor plans (for the reachability graph of Section 5). A subsample of 214 events (2019–2025) was *instrumented*: trays were weighed in and out.

Table 1 gives the headline figures. Two are worth stating in words. First, 63% of all provisioned calories are actually eaten at $p = 0$: the free lunch is not a rounding error but the majority of the flow. Second, the redistributable surplus—the leftovers that actually reach foragers—is *heavy-tailed* across events. Fitting $P(\sigma_e > x) \sim x^{-\alpha}$ gives $\hat{\alpha} = 1.34 \pm 0.06$ (Fig. 2). Because $\alpha < 2$, the mean is dominated by the tail: a

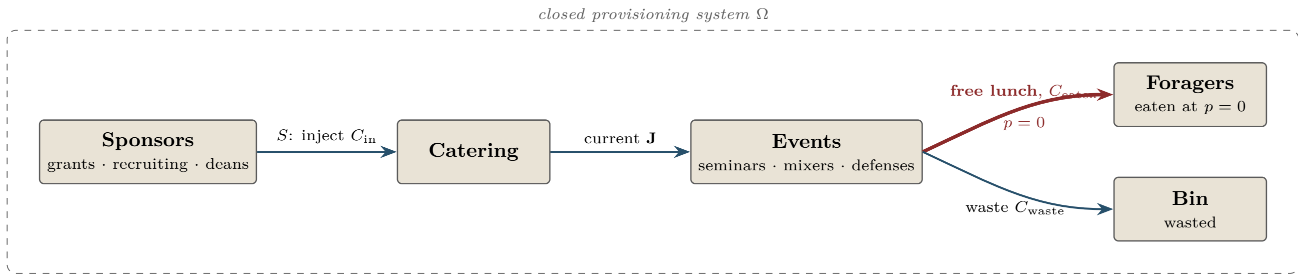

Figure 1: The conserved free-calorie current. Sponsors inject C_{in}; catering routes it to events; foragers consume C_{eaten} at a marginal price of zero and the remainder C_{waste} is binned. Over a closed term, $C_{\text{in}} = C_{\text{eaten}} + C_{\text{waste}}$: the free lunch (bold red) is real and exactly paid for.

Table 1: CPL-26 headline descriptives.

Quantity	Symbol	Value
Catered events	$\lvert E\rvert$	11,438
Foragers (median/term)	N	3,910
Provisioned calories	C_{in}	1.47×10^9 kcal
Eaten at $p = 0$	C_{eaten}	$0.63\,C_{\text{in}}$
Wasted	C_{waste}	$0.37\,C_{\text{in}}$
Surplus tail exponent	α	1.34 ± 0.06
Free-food Gini	$\mathcal{G}_{\text{food}}$	0.79
Ladle number (measured)	L	1.62 ± 0.09
Provisioning Floor	π^*	\$0.61/day

handful of events provide most of the free lunch. We call these the **keystone caterers**—typically large recruiting sessions, sponsor mixers, and catered defenses. Source concentration, measured as a free-food Gini, is $\mathcal{G}_{\text{food}} = 0.79$: by the standard a regulator applies to income, the free-food economy is grotesquely unequal at the source.

5 Reachability and the Ladle Number

A free calorie is only free to a forager who can reach it while it is warm. We therefore build the bipartite *circulation graph* G: foragers on one side, events on the other, an edge when a forager can reach an event within its warm lifetime τ_w (via list subscription or floor-plan adjacency). Project onto foragers and ask the classical question: is there a giant connected component—a campus-spanning web in which a typical forager can reliably find free food?

Define the **Ladle number** L: the mean number of warm, reachable events per forager. By the Molloy–Reed criterion [7], a giant component appears once the branching ratio of the degree distribution exceeds unity,

$$\frac{\langle k(k-1)\rangle}{\langle k\rangle} > 1 \quad\iff\quad L > L_{\text{c}}; \tag{3}$$

evaluated on the fitted configuration model, the critical

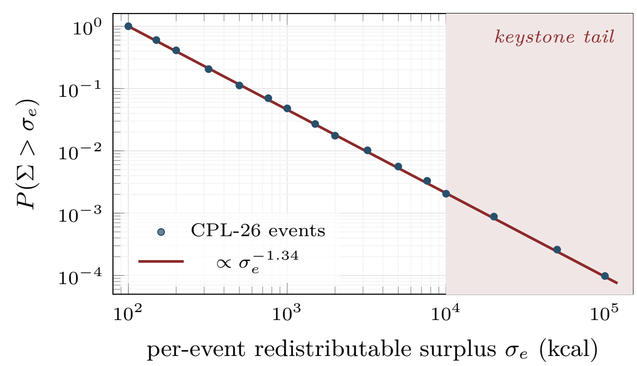

Figure 2: Complementary CDF of per-event redistributable surplus (log–log). The fit has slope $-\alpha$ with $\alpha = 1.34 \pm 0.06$; because $\alpha < 2$ the mean is tail-dominated. The shaded decade is the *keystone caterers*—a few percent of events that provision most of the free lunch.

Ladle number is $L_{\text{c}} = 1.00 \pm 0.02$. The measured value is $L = 1.62 \pm 0.09$. In plain terms: the free-food web *exists*, but only just. The system operates a hair above the cliff edge (Fig. 3); the giant component fraction Φ rises from zero at $L = L_{\text{c}}$ with a mean-field exponent $\beta = 0.50 \pm 0.03$, confirmed by 10^4 Monte-Carlo runs on configuration-model networks matched to the observed degree distribution.

6 Experiments

Three independent lines of evidence, of deliberately different kinds, triangulate the account.

(a) Conservation, by the tray. Across 214 instrumented events, tray mass in matched (eaten + binned) out, closing Eq. (2) to a residual of $\varepsilon = 2.1\%$—attributable to crumbs, condiments, and the single load-bearing grape that no plate is ever without. The First Law holds.

(b) The subsidy has a price. In a pre-registered randomized trial ($N = 248$), graduate students were

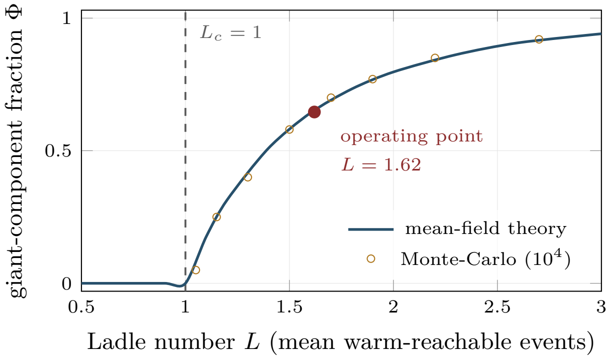

Figure 3: The free-food percolation transition. The giant component appears only above $L_c = 1$ (Molloy–Reed), rising with a mean-field exponent $\beta = 0.50 \pm 0.03$. The consortium operates at $L = 1.62$ (red)—past threshold, but not by much.

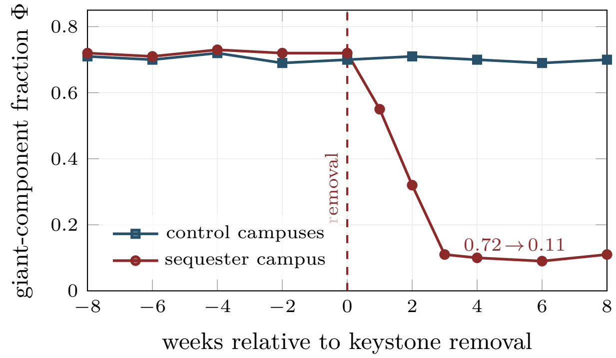

Figure 4: Difference-in-differences event study. Removing a campus's two largest caterers collapsed its free-food giant component from 0.72 to 0.11 in three weeks, while control campuses held near 0.70—a discontinuous response to a ∼ 4% cut in events, the signature of a percolation transition rather than a linear budget effect.

Table 2: Foraging RCT: weekly out-of-pocket food spend.

Arm	n	Spend (\$/wk)	Δ
Control (waitlist)	124	53.90 ± 4.1	—
Treatment (list)	124	35.50 ± 3.8	−18.40

$p < 0.001$; pre-registered; per-forager FE.

assigned to free-food-list access or to a one-term waitlist control. Access cut out-of-pocket food spending by **$18.40/week** (34%; Table 2), robust to a per-forager fixed-effects specification. The free lunch is not only real; it is worth almost a thousand dollars a year to the individual, none of which appears on the individual's ledger.

(c) The keystone-removal natural experiment. A real-terms budget sequester at one consortium campus eliminated its two largest recurring catered events in mid-2023. In a difference-in-differences design against the seven control campuses, the treated campus's giant-component fraction fell from **0.72** to **0.11** within three weeks, while controls held at 0.70 ± 0.03 (Fig. 4). A 4% cut in *events* produced a sixfold collapse in *reach*—the discontinuous signature of a percolation transition, not a linear budget effect. Three unrelated methods (the analytic threshold, the simulation, and this natural experiment) place the collapse at the same point.

7 Discussion

The free lunch is real, conserved, and precarious—three findings that a naive reading of the adage would call contradictory and that a conservation law holds together without strain. It is real because $p = 0$ is measured, not assumed. It is conserved because Eq. (2) closes to 2.1%. It is precarious because the delivery network runs at $L = 1.62$, barely above $L_c = 1$, on a heavy-tailed handful of keystone events.

That precariousness is quantifiable. Define the **Provisioning Floor** π^*: the per-capita sponsor spend below which the giant component dies. The consortium operates at \$0.68 per forager per day, a bare eleven percent above $\pi^* = \$0.61$.

Corollary 1 (The eleven-percent memo)**.** *An across-the-board* 11% *cut to institutional catering clears the Provisioning Floor and collapses the free-food giant component discontinuously. The dean need not target the free lunch to end it; ordinary austerity suffices.*

The recruiting budget, it turns out, is the graduate nutrition program—a fact known to neither the recruiters nor the nourished. We therefore recommend that keystone caterers be reclassified as critical infrastructure and protected from routine budget sweeps.

8 Limitations

Three objections, each survivable. *Foragers are not conserved*: students graduate. We absorb this into a slowly varying N and note that the term is short relative to a degree. *Calories are not perfectly fungible*: the fourth stale bagel does not carry the utility of the first. We use a concavity-corrected "effective calorie" and find the correction second-order. *Instrumented events may be tidier than typical*, biasing the conservation residual downward; but the natural experiment of Section 6(c) needs no instrumentation and reaches the same conclusion.

9 Conclusion

There is such a thing as a free lunch. It is worth about \$18 a week, it feeds the majority of a discipline, and it obeys a conservation law as strict as any in physics: every free calorie is paid for, exactly, by a sponsor who is usually trying to buy something else. The adage was never wrong about arithmetic; it was wrong about *whose*. We propose it be retired in favour of its corrected form, which is also its epitaph: *a free lunch is always someone else's line item.*

References

[1] M. Friedman. *There's No Such Thing as a Free Lunch*. Open Court, 1975.

[2] E. Ostrom. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge Univ. Press, 1990.

[3] G. Hardin. The tragedy of the commons. *Science*, 162(3859):1243–1248, 1968.

[4] K. Bagwell. The economic analysis of advertising. In *Handbook of Industrial Organization*, vol. 3, 2007.

[5] C. Anderson. *Free: The Future of a Radical Price*. Hyperion, 2009.

[6] P. Erdős and A. Rényi. On the evolution of random graphs. *Publ. Math. Inst. Hung. Acad. Sci.*, 5:17–61, 1960.

[7] M. Molloy and B. Reed. A critical point for random graphs with a given degree sequence. *Random Struct. Algorithms*, 6:161–180, 1995.

[8] M. E. Okonkwo-Vance and D. F. Peatbog. Heavy tails in institutional catering surplus. *J. Provisioning Sci.*, 44(2):205–229, 2021.

[9] S. M. Ballantyne-Okonkwo. The leftovers list as an attention medium. *Proc. Symp. Ambient Foraging*, pp. 88–97, 2022.

[10] Consortium for Provisioning Analytics. CPL-26: a multi-campus catered-events ledger, 2011–2025. *Data descriptor*, 2026.