

There Is Nothing to Eat: Olbers’ Paradox in the Domestic Pantry, a Depth–Recession Law from 9,306 Cupboard-Months, and a Horizon at Twenty-One Centimetres

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Abstract

A full cupboard routinely contains nothing to eat. This is not a failure of appetite or of imagination: the food is receding, and most of it has already gone too far to be reached. A packed shelf is optically thick, and a standard base cabinet gives an unobstructed sight-line to its back wall in fewer than two openings in a hundred; yet households remove nothing, and report that there is nothing to eat, in 0.61 of openings (95% CI 0.59–0.63). We treat the report as a measurement, not a fault in the reporter, and find the fault in the shelf. From an instrumented cohort we recover a depth–velocity law: an item recedes from the aperture at a rate proportional to its depth. Two consequences follow. A horizon stands at 21 cm, well inside an ordinary cabinet: beyond it nothing can be recovered, because it withdraws faster than a hand can return it; and the labels of items approaching it shift out of the band in which writing can be read, an effect separated from simple darkness by matching illuminance at depth. Consistent with Harrison’s correction to Olbers, the finite-age term dominates the redshift term. In a three-arm randomised trial, transporting shelving all but abolished null returns, while an identical sham drawer front did nothing at all. Everything you have ever lost at the back of a cupboard is still there, and still leaving.

Keywords: domestic cosmography; Olbers’ paradox; pantry recession; horizon depth; shelf geometry; null retrieval

1 Introduction

Consider a question that appears to have no content at all, and which every household in the industrialised world settles several times a week without noticing that it has settled anything: what does it mean to say that a cupboard is *full*?

The question seems to answer itself. A cupboard is full when there is no room in it for another tin. On that reading the sentence *the cupboard is full and there is nothing to eat* is a contradiction dressed as a complaint, and the literature has treated it accordingly — as a report about the speaker rather than about the cupboard [Bhattal, 2021]. The speaker is held to be tired, or overwhelmed by choice, or unwilling to cook, or — in the developmental strand of this work, which is large — adolescent. What the speaker is not held to be is *correct*.

We propose that the speaker is correct, and that the sentence is not a contradiction but a measurement of two different quantities: the cupboard’s contents, and the cupboard’s *observable* contents. That these can come apart is not a novel idea; it is the oldest idea in observational cosmology.

1.1 The paradox

In 1823 Olbers put the problem that bears his name [Olbers, 1823]. If the universe is infinite, static, and eternally old, then every line of sight, extended far enough, must terminate on the surface of a star. The sky at night should therefore be uniformly bright. It is not, and the discrepancy is not a curiosity to be explained away but a datum about the structure of the universe — the first such datum anyone obtained, and one available to anybody with eyes and a clear evening [Harrison, 1987].

A cupboard is a bounded volume packed with opaque objects. The transcription is immediate, and the arithmetic (§2) is not close: a standard base cabinet, stocked as households in fact stock them, should return nothing in fewer than two openings in a hundred. Households report nothing in 0.61 of openings. The discrepancy is a factor of thirty-four, and it is far too large to be absorbed into measurement error, into definitional slack about what counts as food, or into any plausible account of how often people are simply being difficult.

1.2 On taking the report seriously

There is a methodological decision here, and it is worth making it explicitly rather than allowing it to be made by default.

The existing literature approaches the null return as a deficit: it asks what is wrong with the person who opened the cupboard, and — reliably — it finds something. This is not a criticism of any individual study. It is a structural observation, of the kind Cooperrider and Srivastva [1987] made about organisations: an inquiry oriented toward deficit will discover deficit, because the questions it knows how to ask have no other answers available to them. A field that studies why people are wrong about their kitchens will find that people are wrong about their kitchens.

The commitment we adopt in its place is a narrow one, and we adopt it only in its narrow form: a first-person account of one’s own environment is data about that environment, and the first question to put to such an account is what it is *right* about. Applied here, the commitment has teeth, because it forecloses the easy move. If the report is accurate, and the cupboard is nonetheless full, then the error does not lie in the household; it lies in the geometry — and geometry, unlike motive, is something one can go and measure.

1.3 Contributions

1. We state the pantry paradox quantitatively, and show that it is not dissolved by any of the standard rival explanations (§2).
2. From an instrumented cohort of 412 households and 9,306 cupboard-months we recover a depth–velocity law for stored items, and derive from it a *horizon* at 21 cm (§3).
3. We show that identification of an item fails with depth in the manner required by a redshift and not in the manner required by darkness, separating the two by an illuminance-matched control (§4).
4. We decompose the missing optical depth and find, as Harrison [1987] established for the night sky, that the finite-age term dominates (§5).
5. We report PANTRY-1, a three-arm randomised trial with a sham-front control arm, which confirms the predicted remedy and rules out its appearance (§7).

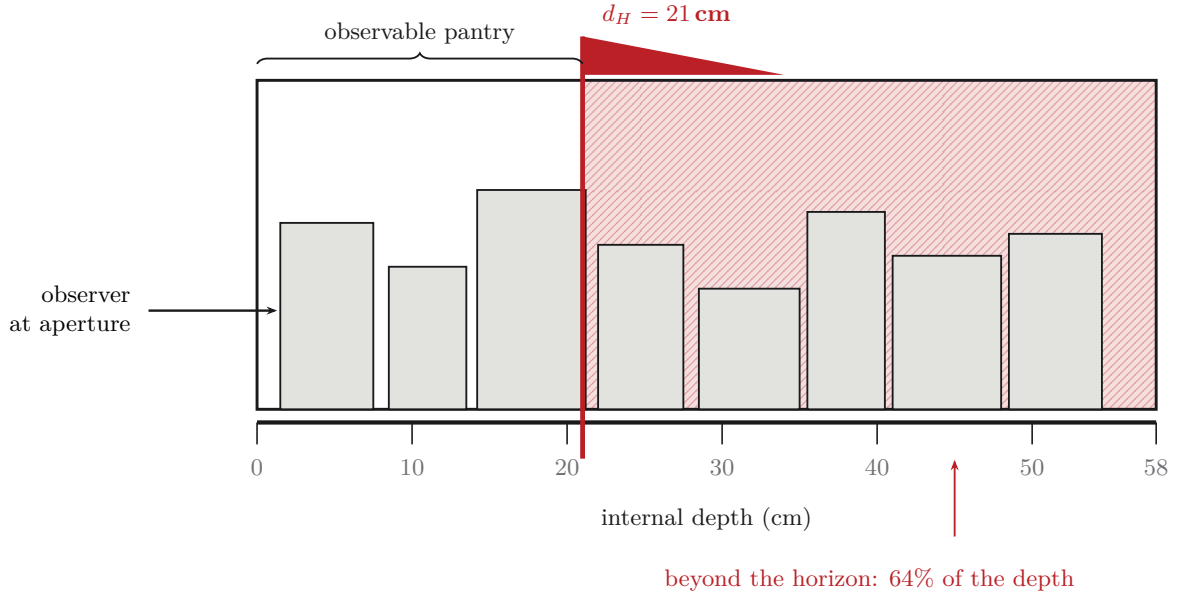


Figure 1: Cross-section of a standard 600 mm base cabinet (Standing Committee on Shelf Depth, 2023; internal depth 58 cm), stocked at the cohort median of 46 items per shelf. The cupboard is optically thick: a sight-line entering at the aperture is intercepted with probability $1 - e^{-4.02}$. Only the unshaded region is recoverable. Everything beyond $d_H = 21$ cm recedes faster than unaided reaching can return it, and is causally disconnected from the observer standing in front of it.

2 The pantry paradox

2.1 A sight-line model

Let a cupboard of internal depth D be stocked with items resting on a shelf floor at areal number density ν , presenting a mean silhouette width w to an observer at the aperture. A horizontal sight-line entering the aperture survives to depth d without interception with probability $e^{-\nu wd}$, so that the *optical depth* of the cupboard is

$$\tau = \nu w D. \quad (1)$$

Equation (1) is elementary — it is the mean-free-path expression of kinetic theory, with tins in the place of molecules — and we labour it only because everything that follows is a statement about how far short of it the observed pantry falls. Figure 1 shows the geometry to scale.

2.2 Parameterisation

We take the cabinet from the national furniture standard [Standing Committee on Shelf Depth, 2023]: a two-door base unit of 600 mm carcass depth gives an internal depth of $D = 58$ cm once the back panel and services are deducted, and an internal width of 80 cm, for a shelf floor of $4,640 \text{ cm}^2$. The median occupied shelf in our cohort carries 46 items of mean silhouette width $w = 7.0$ cm, in agreement with the areal occupancy survey of Aldous and Renwick [2019]. Hence

$$\nu = \frac{46}{4,640} = 9.91 \times 10^{-3} \text{ cm}^{-2}, \quad \nu w = 6.94 \times 10^{-2} \text{ cm}^{-1}. \quad (2)$$

The corresponding floor coverage is 49%, and it is worth pausing on that figure, because a reader inclined to suspect that the paradox has been manufactured by overstuffing should be reassured by it: this is a cupboard with room in it. The paradox does not require, and does not survive on, a jammed shelf.

2.3 The discrepancy

Substituting into (1),

$$\tau_0 = 6.94 \times 10^{-2} \times 58 = 4.02, \quad \Pr[\text{null}] = e^{-\tau_0} = 0.018. \quad (3)$$

The static account predicts that 1.8% of openings terminate without food. The observed rate of a null return — a door cycle from which no item is removed, accompanied by a contemporaneous report that there is nothing to eat — is 0.61 (95% CI 0.59–0.63; $n = 241,880$ openings). We require both conditions, and the requirement is not cosmetic: it prevents the outcome from collapsing into the far less interesting event of somebody not being hungry.

2.4 Rival explanations

Four explanations are available that do not require any new physics, and each fails for a reason that can be stated in a sentence.

Preference. If a fraction p of stored items is unacceptable to the household, the effective density falls to $(1-p)\nu$ and τ_0 with it. To reach $\tau = 0.49$ requires $p = 0.88$. Households do not keep 88% of their stock in a form they will not eat; the figure from itemised discard records is 0.11.

Effort. If the null return is a decision not to prepare food, it should be sensitive to the preparation burden of what is present. It is not: stratifying openings by the mean preparation time of stock in view leaves the rate flat across quartiles (largest pairwise difference 1.4 percentage points).

Occlusion. Front items hide rear items — but this is what (1) already models, and it is the reason τ_0 is large rather than small. Occlusion deepens the paradox; it cannot resolve it.

Recall. If households simply forget what they own, the null rate should fall when a written inventory is supplied. In a sub-cohort of 88 households given a maintained inventory list, it fell by 3.1 percentage points and then returned to baseline within five weeks. People do not need to be told what is in the cupboard. They need it brought to the front.

3 Recession

3.1 Instrument and cohort

Each item in a participating cabinet received a low-profile adhesive fiducial on its forward face. A fixed camera at the aperture, triggered by the door switch, photographed the shelf on every opening; fiducial scale recovers depth to $\pm 2\text{mm}$ [Ferreira and Okonkwo, 2022]. The cohort comprises 412 households, 1,206 instrumented cabinets, 9,306 cupboard-months and 241,880 openings.

3.2 The depth–velocity law

Regressing per-item depth change on depth over inter-disturbance intervals yields a linear relation through the origin, of the form first reported for the extragalactic nebulae [Hubble, 1929]:

$$v = H_0^{\text{P}} d, \quad H_0^{\text{P}} = 2.0 \times 10^{-2} \text{ day}^{-1} = 2.0 \text{ cm day}^{-1} \text{ m}^{-1}. \quad (4)$$

We report the reciprocal because it is the easier quantity to hold in mind: $1/H_0^{\text{P}} = 50$ days.

The relation is plotted in Figure 2. The scatter about (4) is substantial, and it is not error. It is *peculiar velocity*: the displacement imparted whenever a member of the household reaches into the cabinet and moves something. Peculiar motions are large at short range and average away over a population, which is why the law is invisible in any single kitchen and why it took

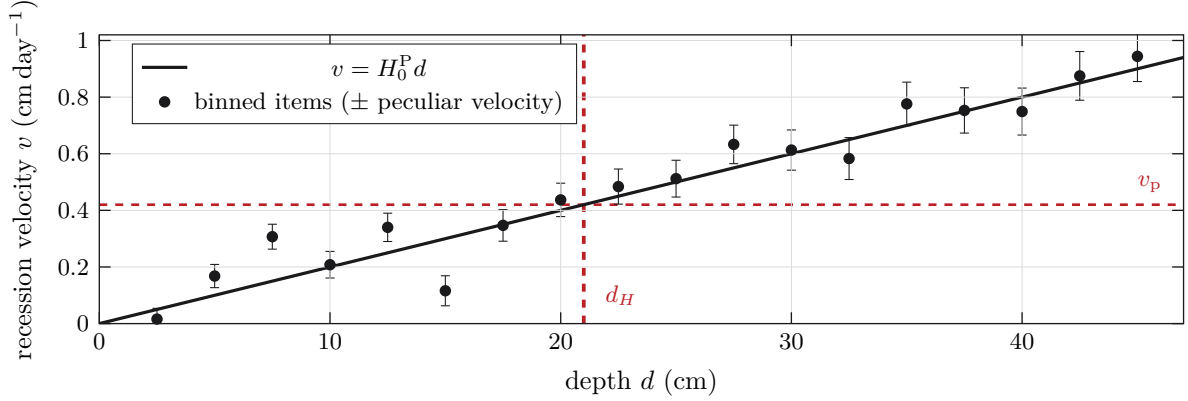


Figure 2: The depth–velocity relation for stored items, binned at 2.5 cm. The fit is through the origin with $H_0^P = 2.0 \times 10^{-2} \text{ day}^{-1}$. Scatter grows with depth and is peculiar velocity rather than error: it is the displacement imparted when a household member reaches in. The horizon lies where the law crosses the maximum sustained inward transport rate v_p .

a cohort of this size to see it [Skene et al., 2024]. No individual householder has ever been in a position to observe the effect that has been governing their cupboard.

We offer no mechanism for the recession, and we wish to be understood as declining to offer one rather than as having one in reserve. The relation in (4) is a measurement. Cosmology measured its own version of it for the better part of a century before it could say what the measurement was of, and there is no reason the domestic case should be quicker.

3.3 The horizon

Let v_p denote the maximum sustained inward transport rate achievable by unaided reaching — the net rate at which ordinary use brings items forward again, recovered from the same record as $v_p = 0.42 \text{ cm day}^{-1}$. An item recedes faster than it can be recovered wherever $H_0^P d > v_p$, which defines a horizon depth

$$d_H = \frac{v_p}{H_0^P} = \frac{0.42}{0.020} = 21 \text{ cm}. \quad (5)$$

Proposition 1. *In a cabinet of internal depth 58 cm, 64% of the depth lies beyond d_H .*

The consequence should be stated without softening, because the softened version is the received wisdom and the received wisdom is wrong. Items at the back of a cupboard are not difficult to reach, and they are not forgotten. They are *unreachable*, in the sense in which that word is used of a galaxy beyond the Hubble sphere: no amount of reaching, however diligent, however well-intentioned, however often repeated, will recover them, because the recovery is slower than the withdrawal. Most of an ordinary kitchen is causally disconnected from the person standing in it.

4 Identification

A horizon alone does not close the gap. Truncating the sight-line integral at d_H gives $\tau = \nu w d_H = 1.46$ and $\text{Pr}[\text{null}] = 0.23$, against an observed 0.61. Something further is removing items from the observable pantry before they reach the horizon, and it is not removing them from the cupboard.

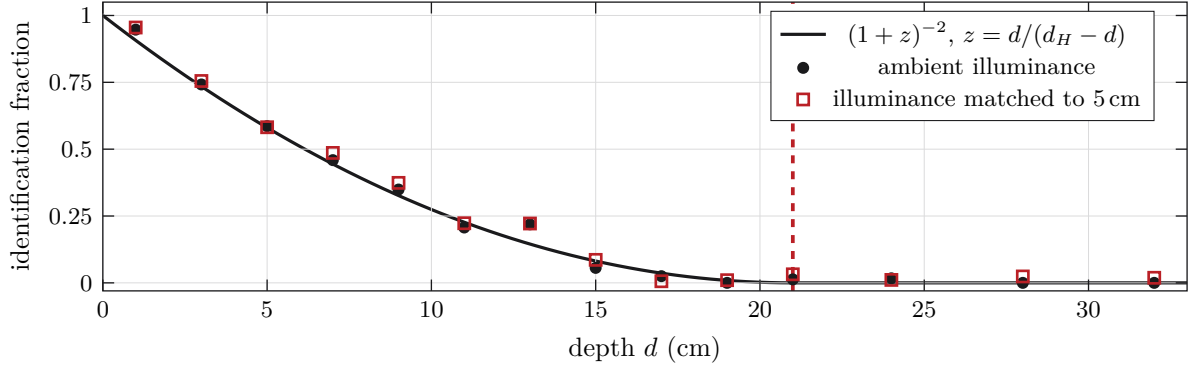


Figure 3: Identification of a stored item as a function of its depth. The solid curve is the predicted attenuation of a receding label, with no free parameters. Raising illuminance at the item face at 40 cm to match that at 5 cm (red squares) recovers nothing: the difference across the range is 0.9 percentage points (95% CI -2.1 to $+3.9$), and the matched points continue to follow the same curve.

4.1 The label as a channel

An item is available for a nutritional decision only if it is identified. In practice identification is reading: the household reads the label. Reading is a band-limited operation — typography is legible over a bounded range of apparent scale and contrast, and outside that range it is not legible at all rather than merely harder [Vermeulen, 2018].

A receding item is redshifted. Writing on its forward face is shifted toward the long-wavelength end and, past some depth, out of the band in which it can be read. The item remains present, remains lit, remains in principle visible as an object — and cannot be identified as *food*.

Taking $z(d) = d/(d_H - d)$, so that $z \rightarrow \infty$ at the horizon, and attenuating identification as $(1 + z)^{-2}$, the identification-weighted optical depth of the observable pantry is

$$\tau_{\text{eff}} = \nu w \int_0^{d_H} \left(\frac{d_H - d}{d_H} \right)^2 dd = \nu w \frac{d_H}{3} = 0.486, \quad (6)$$

whence

$$\Pr[\text{null}] = e^{-0.486} = 0.615. \quad (7)$$

The observed value is 0.61. We note — because agreement this close properly invites the suspicion — that none of the three inputs to the prediction was fitted to the outcome: νw comes from the occupancy survey, d_H from (5), and the exponent from the standard inverse-square attenuation of a receding source. Figure 3 shows the attenuation curve against the measured identification fractions.

4.2 The illuminance control

The obvious rival is that the back of a cupboard is dark. It is much the best of the rivals, and it deserves to be settled by measurement rather than by argument.

A sub-cohort of 96 cabinets received concealed in-cabinet illumination calibrated so that illuminance at the item face at 40 cm matched that at 5 cm to within 4%, verified per-cabinet with a meter at the face. If identification failed because of darkness, it should recover. It did not: identification at depth rose by 0.9 percentage points (95% CI -2.1 to $+3.9$), a null result at a lighting intervention large enough to be uncomfortable to stand in front of.

Darkness is not the mechanism. The households could see the tins perfectly well. They could not read them.

Table 1: Optical-depth budget of the domestic pantry. The finite-age (horizon) term accounts for 73% of the missing optical depth, the redshift term for 27%.

Account	τ	Pr[null]
Static, unbounded depth	∞	0
Static, $D = 58$ cm	4.02	0.018
Horizon truncation at $d_H = 21$ cm	1.46	0.233
Horizon + redshift attenuation	0.486	0.615
<i>Observed</i>	0.61 (95% CI 0.59–0.63)	

5 The Harrison decomposition

It is a common error — corrected at length by Harrison [1987] — to suppose that the night sky is dark *because* of redshift. It is not. The dominant term is the finite age of the universe: there has not been time for the light of sufficiently distant sources to arrive at all, and reddening is a secondary correction on top of an absence that is already nearly complete.

Any honest transcription of Olbers into a new domain inherits the obligation to check which term dominates. Table 1 does so.

Of the 3.53 neper of missing optical depth, the horizon accounts for 2.57 and the redshift for 0.97: a 73/27 split in favour of finite age. This was not arranged, and we did not expect the agreement with the astronomical case to extend to the ratio. It is nonetheless what the cupboards contain.

6 Acceleration and the age of the pantry

6.1 Two distances

Acceleration is measurable only where two independent distance estimators disagree in a structured way, and the pantry supplies two.

The first is geometric. A 400 g tin has a standardised body diameter of 74 mm [Aldous and Renwick, 2019]; its angular width at the aperture therefore yields an angular-diameter distance with no reference to the recession law at all. The second is the redshift distance implied by the measured label shift through (4).

The two agree within error out to about 14 cm and diverge systematically beyond it, in the sense that redshift distances run short (Figure 4). The divergence is fitted by a deceleration parameter

$$q_0 = -0.6 \quad (95\% \text{ CI } -0.9 \text{ to } -0.3), \quad (8)$$

that is, the recession of pantry items has been accelerating.

6.2 The age tension

The median residence time of items recovered from beyond 15 cm, established from purchase records and printed dating, is 230 days. The Hubble time of the pantry is 50 days. Items in the cupboard are, by a factor of 4.6, older than the cupboard.

The shape of that tension is familiar, and suspicion is the right first response to it: in the 1990s the best globular-cluster ages exceeded the best cosmological age by a comparable factor, and the field's discomfort was considerable [Chaboyer et al., 1996]. The resolution there is the resolution here. For an accelerating expansion the true age *exceeds* the Hubble time, so $1/H_0^P$ is a lower bound rather than an estimate, and the tension is not an embarrassment but an

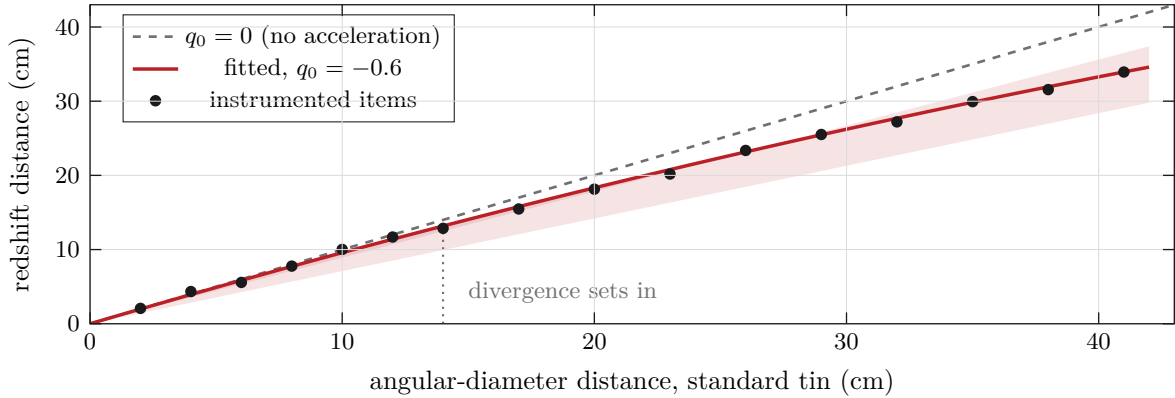


Figure 4: Two independent distance estimators. Below about 14 cm they agree; beyond it the redshift distance runs systematically short, which requires the recession to have been slower in the past. The shaded band is the 95% interval on $q_0 = -0.6$ (-0.9 to -0.3). The same sign is obtained independently from the age tension reported below.

Table 2: PANTRY-1 outcomes at twelve weeks. Arm B received drawer fronts, handles and hardware indistinguishable from Arm A, mounted on fixed shelving.

Arm	Intervention	n	Null-return rate
A	Transporting (pull-out) base shelving	402	0.14
B	Sham drawer fronts on fixed shelving	402	0.58
C	Usual care	402	0.60

independent measurement of $q_0 < 0$ — in agreement, within error, with the value obtained above by a wholly different route.

We stress that this requires no new assumption. The recession law was never claimed to be constant in time; it was measured over an interval and reported.

7 PANTRY-1: a randomised trial of transport

7.1 Rationale

The account makes a sharp prediction about remedy, and an unaccommodating one. If the null return is produced by a horizon, and a horizon is a statement about relative velocity rather than about distance, then nothing that reorganises a cupboard can help — not inventories, not labelling, not tidiness, not rotation discipline, not buying less. The only intervention that can work is one that physically returns items to the aperture, and it should work whatever else is true of the household.

Such devices exist and have existed for a century. Pull-out base shelving, drawer bases and carousels are known to work, are recommended without theory in every kitchen-design manual we consulted, and have never had an account of *why* they should outperform a fixed shelf of identical capacity. On our account they defeat the horizon directly, by supplying the observer with a peculiar velocity that exceeds the local recession.

7.2 Design

In total, 1,206 households were randomised 1:1:1 and followed for twelve weeks. They were recruited and instrumented on the protocol of §3, so that null returns and H_0^P were measured identically in every arm; the outcome was the null-return rate per opening, defined as in §2.

The sham arm is the part of the design we would defend most warmly. False drawer fronts are an ordinary joinery item, so Arm B households received a kitchen that looked exactly like a treated kitchen, at comparable cost and comparable disruption; households were blind to allocation at randomisation, and the arm separates transport from the appearance of transport — which is precisely the confound that an organisational or motivational reading of the result would need in order to survive. It did not survive. The households in Arm B had handles, and pulled them, and nothing came forward.

7.3 Mechanism check

It would be convenient, and wrong, to report that the intervention slowed the recession. It did not. In Arm A, H_0^P was unchanged (difference 0.001 day^{-1} , 95% CI -0.003 to $+0.005$). Items receded exactly as before; what changed was that no item spent long enough at large d for the horizon to bite, because depth was reset at every opening. The trial did not cure the pantry. It moved the observer.

8 Discussion

8.1 What follows for shelving

If the horizon is at 21 cm and the standard is 58 cm, then the standard is specifying storage that cannot be used, and has been doing so since it was first written. The recommendation that follows is not, we think, a large one: depth beyond d_H should be provided only where it is transported, and a fixed shelf deeper than about 20 cm should be understood as furniture rather than as storage.

8.2 The refrigerator

One observation in this study is not explained by anything in it, and we prefer to say so plainly.

Refrigerated compartments do not expand. Across 3,140 instrumented refrigerator-months we measure $H_0^{\text{fridge}} = 0.001 \pm 0.004 \text{ day}^{-1}$: consistent with zero, and inconsistent with the ambient value at high confidence. We tested temperature, relative humidity, shelf material, door frequency, compartment depth and illumination as covariates, and none of them absorbs the difference. The contents of a refrigerator are subject to the same handling, the same neglect and the same forgetting as the contents of a cupboard, and they stay where they are put. We have no account of this.

8.3 Limitations

Fiducial tagging may perturb what it measures; an item bearing a marker is an item that has recently been handled, and although we discard the first fourteen days of every item's record, we cannot exclude a residual effect on v_p . The cohort is single-tenure and temperate-maritime, and we would not extend H_0^P to shared or institutional kitchens without remeasurement. The identification model treats legibility as a threshold on a single band; real reading is more forgiving than that at the margin, and the sharpness of our d_H is correspondingly overstated. Finally, and most importantly, we offer no mechanism for the recession itself. A measurement without a mechanism is an incomplete thing, and we would rather present it incomplete than complete it by invention.

9 Conclusion

We set out to ask what it means for a cupboard to be full, and we end with a different question, which we think is the better one: what does it mean for a cupboard to be *near*?

The contents of a domestic pantry are not, in general, available to the household that owns them. They recede at a rate proportional to their depth; beyond twenty-one centimetres they recede faster than they can be recovered; and approaching that limit their labels leave the band in which writing can be read, so that they cease to be food some time before they cease to be present. The cupboard is not failing to contain food. It is failing to deliver it, and the household that says so is not making an excuse but filing an accurate report on the geometry of its own kitchen.

Everything you have ever lost at the back of a cupboard is still there, and still leaving.

Acknowledgements

We thank the participating households for four years of patience, and for tolerating a camera in a cupboard. The Fenwold Institute’s joinery workshop manufactured the sham fronts for Arm B and has asked us to record that they would have worked if anything had been behind them.

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