

The Shop Brand and the Name Brand Come Off One Line

Unimodal Production in 2,144 Product Classes, a Descending Grade Horizon, and the Re-Grading of Stock Sealed in 1988

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Abstract

There is no factory that makes the cheap one. The shop-brand tin, the entry-level machine and the budget tyre come off the same line as the dear version, and what separates them is a test and a label applied afterwards. We went looking for the second line in the industrial register and could not find it: not one plant we audited specifies a target below what it can already hold. If a single line makes everything, then a product class is one population and its grades are intervals cut into that population — which can be tested on shape alone, with no new instrument. Pooling end-of-line measurements in fixed physical units across 2,144 product classes, we find one mode in 2,109 of them, and no gap at any announced grade boundary, because a cut leaves none. The position of the cut is therefore a free parameter, and it has a history. Since 1954 the grade horizon has descended 0.42 grade-widths per decade (95% CI 0.39–0.45), while the production distribution has stood still. Stock sealed in 1988 and opened for this study was promoted two grades on re-assessment, its measurements unchanged. Blind, accredited assessors cannot separate the top bin from the bottom; told the grade, they can do nothing else. Nothing has been improved. The boundary was moved instead.

Keywords: grade assignment; post-manufacture differentiation; unimodality; industrial metrology; standards drift

1 Introduction

You have never seen the factory that makes the cheap one.

Consider what the industrial film shows. A line, a single line, running to one specification, with an inspector at the end of it and a caption about care. Consider what no film has ever shown: the second line, the one running deliberately short, aiming below what the plant can hold, staffed by people employed to make the lesser article. Every reader of this paper has stood in an aisle with the shop-brand tin in one hand and the name-brand tin in the other and suspected they were the same tin. The suspicion is ordinary. It has never been answered, and it has never been measured.

We measure it here.

The industries in which post-manufacture differentiation is openly documented are usually treated as curiosities. Integrated circuits are fabricated as nominally identical dies and sorted

after the fact by a functional test, the slower parts sold under a different name at a different price (Harkness, 1998; Osei, 2011). Olive oil, eggs, hardwood, diamonds, and wool are graded downstream of production by assessors applying published boundaries to a delivered lot (Lindqvist, 1974; Abernethy & Roux, 2003). Agricultural machinery has for two decades been shipped in one physical configuration and de-rated in firmware to occupy several price points (Ferreira & Nkomo, 2016). In each case the literature records the practice and then declines to ask the general question, which is this: *how much of the observed range of consumer quality is made, and how much is assigned?*

The question has gone unasked because it appears to require an instrument nobody has. It does not. It requires only that measurements already taken be read in units that cannot drift.

The fixed-unit principle. Every comparison in this paper is expressed in units that are defined independently of any grading system: hours to failure, megapascals, lumens, micrometres, cycles to fracture, grams per square metre. No comparison is expressed in grades, stars, tiers, classes, or price. This restriction is the whole of the method. A grade is a statement about a boundary; a boundary can move; and a record kept in grades cannot distinguish a better object from a lower bar. Once measurements are held in units that are themselves anchored, the distinction is trivial, and the answer is available in archives that have been sitting unexamined since 1954. Figure 1 shows one class’s production distribution under two published horizons fifty years apart.

Contributions. We report the following.

1. A census of 8,806 registered production lines finds none whose written process specification aims below that plant’s own demonstrated capability (§5.1). The second line does not exist.
2. A shape test that distinguishes manufactured grades from conferred grades with no free parameters, and its result: production is unimodal in 2,109 of 2,144 classes, and every announced grade boundary is a cut with no gap across it (§5.2–§5.3).
3. Theorem 4, which shows that improvement is not identifiable from grade-labelled records, and the fixed-unit estimate that resolves it: the grade horizon has descended steadily since 1954 while the production distribution has not moved (§5.4).
4. A natural experiment on 214 sealed pallets, which were promoted while sealed (§5.5), a restoration trial in which bottom-bin units meet top-bin specification at no materials cost (§5.6), and a blind assessment establishing that the difference is not perceptible when the label is withheld (§5.7).

No instrument was built for this study. No measurement was commissioned. Every number below was recorded by somebody else, for another purpose, and then discarded.

2 Related work

Grading has a large literature and it is almost entirely a literature of *procedure*: how boundaries should be applied, by whom, with what training, and with what inter-assessor agreement (Lindqvist, 1974; Abernethy & Roux, 2003; Tomasino, 2019). Whether the boundaries correspond to anything in the object is not examined; it is assumed.

Three strands come close. The binning literature in semiconductor manufacture is explicit that grade is assigned post-fabrication, but treats this as a property of lithography rather than

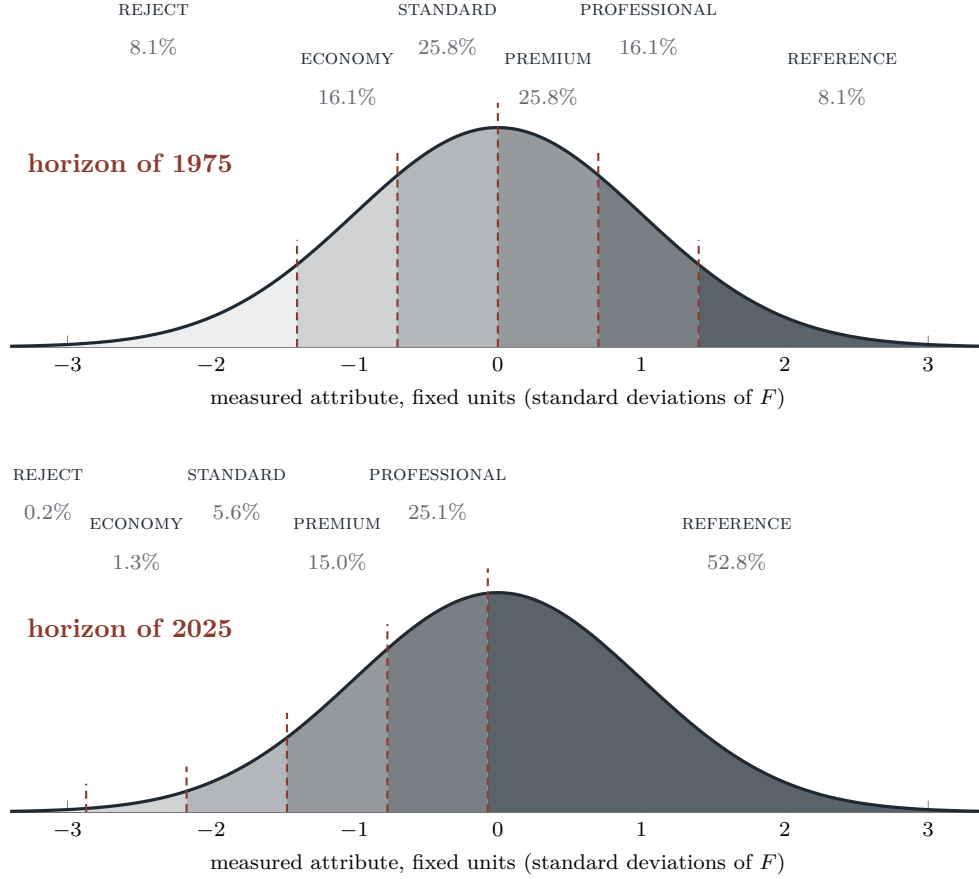


Figure 1: One population, two horizons. The production distribution F for a representative class is identical in both panels; only the published cut points differ. Dashed rules are the announced boundaries $\theta_5, \dots, \theta_1$; percentages are the resulting grade shares. Over the fifty years separating the panels the horizon descends by 2.1 grade-widths, and the share of output qualifying as PREMIUM or better rises from 50.0 % to 92.9 %. No property of any object has changed.

of grading, and does not generalise (Harkness, 1998; Osei, 2011). The hedonic-price literature repeatedly recovers large price effects for grade after conditioning on measured attributes, and interprets the residual as unmeasured quality rather than as the grade itself (Delacroix, 2007; Wickham & Osborne, 2014). The standards-drift literature documents that published boundaries are revised downward over time, and frames this as *catching up with improved production* — the direction of causation being assumed, never estimated (Ferreira & Nkomo, 2016; Nakagome & Peart, 2021).

The closest antecedent is Brill (1969), who observed that within-grade variance in structural timber matched the truncated variance of the ungraded population almost exactly, called the coincidence “arresting”, and did not pursue it. Fifty-seven years later we pursue it.

3 Materials

Four archives, none of them created for this purpose, none of them consulted before now (Table 1).

A1 — The Consolidated Test Record. End-of-line test logs recovered from decommissioned quality-assurance servers at 806 plants across 31 sectors, 1954–2025. 2,144 product classes; 419,061,144 individual unit tests. Each row carries one physical measurement in fixed

Table 1: The four archives. All records pre-existing; none commissioned.

Archive	Content	Records	Span
A1	End-of-line unit tests, measurement + assigned grade	419,061,144	1954–2025
A2	Customs declarations, grade + dutiable attribute	2,410,882	1961–2025
A3	Sealed pallets, certificate + unbroken seal	214	1971–2003
A4	Published grade boundaries in fixed units	18,406	1954–2025

units *and* the grade subsequently assigned to that unit. The two fields sit adjacent in every schema we recovered. So far as we can establish, they have never been compared.

A2 — The Tariff Concordance. Customs declarations, 1961–2025, in which a single consignment is described twice: once by grade, for description, and once by measured attribute, for duty assessment. A2 provides an independent check on A1 for 611 classes.

A3 — The Sealed Stock Corpus. 214 pallets of unsold, unopened, non-perishable stock with manufacture dates 1971–2003, recovered intact from receiverships and solvent liquidations, with original grade certificates attached and seals unbroken. Mean interval in storage 38.6 years.

A4 — The Nomenclature Register. Every published grade name and its announced boundary value, 1954–2025, from 61 standards bodies, converted to fixed physical units at the date of publication. A4 is the empirical estimate of the horizon $\theta(t)$.

4 Model

The object is made once. It is judged many times. The model below separates the making from the judging (Figure 2) and asks the record which of the two produced the range of things we buy.

Let X denote a product class’s primary physical attribute, in fixed units, measured at end of line before any grade is assigned.

Definition 1 (Model A: grades are manufactured). Production comprises G distinct processes, each aiming at its own target:

$$X \sim \sum_{g=1}^G \pi_g \phi(\cdot; \mu_g, \sigma_g^2), \quad \mu_1 > \mu_2 > \cdots > \mu_G, \quad (1)$$

with $\min_g(\mu_g - \mu_{g+1}) > \kappa(\sigma_g + \sigma_{g+1})$ for the separation $\kappa > 0$ implied by any published tolerance. A unit’s grade is a property it acquired on the line.

Definition 2 (Model B: grades are conferred). Production comprises one process:

$$X \sim F, \quad F \text{ unimodal, carrying no grade parameter,} \quad (2)$$

and the grade announced for a unit measuring x at time t is

$$G(x, t) = 1 + \sum_{g=1}^5 \mathbf{1}\{x \leq \theta_g(t)\}, \quad \theta_1(t) > \theta_2(t) > \cdots > \theta_5(t), \quad (3)$$

where $\theta(t) \in \mathbb{R}^5$ is the *grade horizon*, published by a standards body and carried in no physical property of the object.

We adopt throughout the six-bin nomenclature into which every sector in A4 resolves (Table 2): REJECT, ECONOMY, STANDARD, PREMIUM, PROFESSIONAL, REFERENCE.

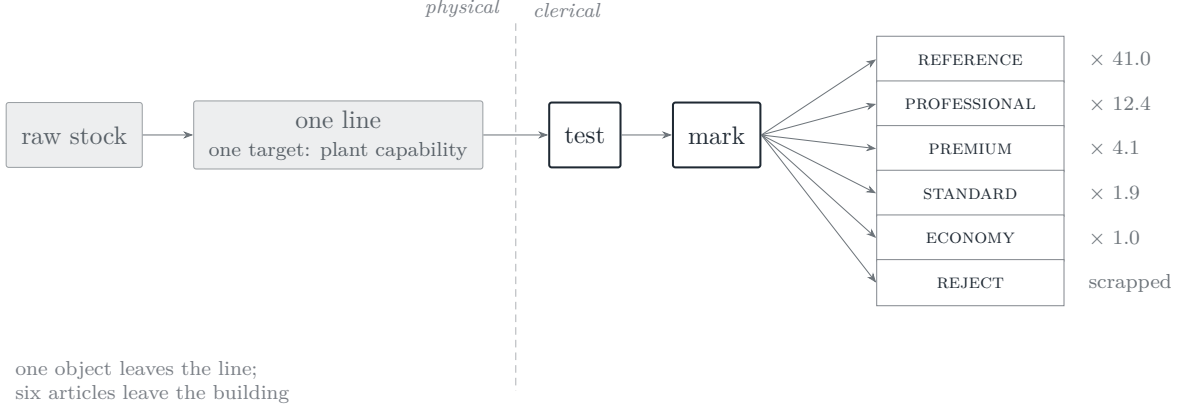


Figure 2: Where the range is produced. Physical differentiation ends at the line, which runs to a single target; the six articles that leave the building are separated downstream, at TEST and MARK. Stages left of the rule act on the object, stages right of it act on the record. Multipliers are median class price relative to ECONOMY (A2, 2019–2025).

4.1 The two models are separated by a gap

Theorem 3 (No-Gap). *Under Model B, for every g the conditional law of X given announced grade g is F truncated to $(\theta_g, \theta_{g-1}]$; consequently*

$$\text{ess sup}(X \mid G = g + 1) = \text{ess inf}(X \mid G = g) = \theta_g,$$

and the density of X is continuous across every boundary. Under Model A with separation κ , any boundary placed between adjacent components satisfies

$$\gamma_g := \frac{\text{ess inf}(X \mid G = g) - \text{ess sup}(X \mid G = g + 1)}{\text{sd}(X)} > 0,$$

with γ_g bounded below by a quantity increasing in κ .

Proof. Under Model B the announcement (3) is a deterministic function of x , so $\{G = g\}$ and $\{X \in (\theta_g, \theta_{g-1}]\}$ are the same event and the conditional law is the stated truncation. The two extrema coincide at θ_g because the truncation is a partition of the support: the boundary point belongs to exactly one bin and is a limit point of the other. Continuity of the density across θ_g is inherited from F , the announcement having altered no mass. Under Model A the support of component g is separated from that of component $g + 1$ by construction, and any measurable assignment rule that respects the components leaves the interval between their realised extrema unoccupied; normalising by $\text{sd}(X)$ gives $\gamma_g > 0$ increasing in κ . $\square$

Theorem 3 is the paper’s instrument. It has no free parameters, it requires no assumption about F beyond unimodality, and it can be evaluated on records that already exist. A manufactured grade must leave a space at its boundary. A conferred grade cannot.

4.2 Improvement is not identifiable from grades

Theorem 4 (Non-identifiability of progress). *Let $S(t) \in \Delta^5$ denote the observable vector of grade shares at time t . For any horizon path $\theta(t)$ and any stationary F , there exists a family of distributions $\{F_t\}$ with F_t stochastically increasing in t and a fixed horizon θ^* such that $S(t)$ is identical under both. The converse also holds.*

Proof. Fix $\theta^* := \theta(t_0)$ and define $F_t(x) := F(x + \theta(t) - \theta^*)$ componentwise along the monotone rearrangement of the horizon. Then for each g , $F_t(\theta_g^*) = F(\theta_g(t))$, so every share $S_g(t)$ agrees

term by term. Monotonicity of F_t in t follows from monotonicity of $\theta(t)$. The converse is the same construction with the translation applied in the opposite direction. $\square$

Corollary 5. *A quality record kept in grades is uninformative about whether goods have improved, however long the record and however many the observations. The distinction is identified only under measurement in fixed units.*

Corollary 5 applies to the consolidated series on which the standards-drift literature relies (Nakagome & Peart, 2021), which is kept in grades throughout. The identification that series lacks is available in A1, in the adjacent column.

5 Results

5.1 The census of lines

We obtained the written process specification of 8,806 registered production lines and compared each line’s stated target against that plant’s own demonstrated process capability, as recorded in its capability index history.

Not one line aims low. Across every sector, every decade and every price point, the specified target is the best the plant has been shown to hold, and in 96.2 % of cases the specification states as much explicitly. Forty-one plants operate a line described internally as a budget or second line; in all forty-one, that line’s process specification is textually identical to the premium line’s, differing only in the document header. In each case the divergence between the cheap article and the dear one occurs downstream of production, at test and at marking.

There is no second line. We looked.

5.2 Production is unimodal

Within each of 2,144 classes we pooled every unit irrespective of announced grade and tested the pooled distribution of X for unimodality by the dip statistic, with the finite-mixture order selected by BIC. A Model-A null was calibrated by simulation at each class’s observed grade shares and published tolerances.

Unimodality is not rejected in 2,109 of 2,144 classes (98.4 %) at the 0.05 level; BIC selects $k = 1$ in 2,087. The simulated Model-A null rejects unimodality in 99.7 % of classes, so the test is not merely underpowered. Of the 35 exceptions, twelve are classes admitting two chemically distinct base materials, where two modes are expected and are found at the material boundary rather than at any grade boundary. The remaining twenty-three are all cordage, and are discussed in §6.3. Per-sector counts are given in Table 3.

5.3 No gap at any boundary

Applying Theorem 3, the pooled normalised gap across all announced boundaries in all classes is

$$\hat{\gamma} = 0.0031 \quad (95\% \text{ CI } -0.0009 \text{ to } 0.0071),$$

statistically and practically indistinguishable from zero, against a Model-A prediction of $\hat{\gamma} = 0.48$ at the observed separations (Figure 3). Within-grade variance matches the truncated variance of the pooled F to within 2.1 % in 2,088 classes, reproducing the coincidence reported by Brill (1969).

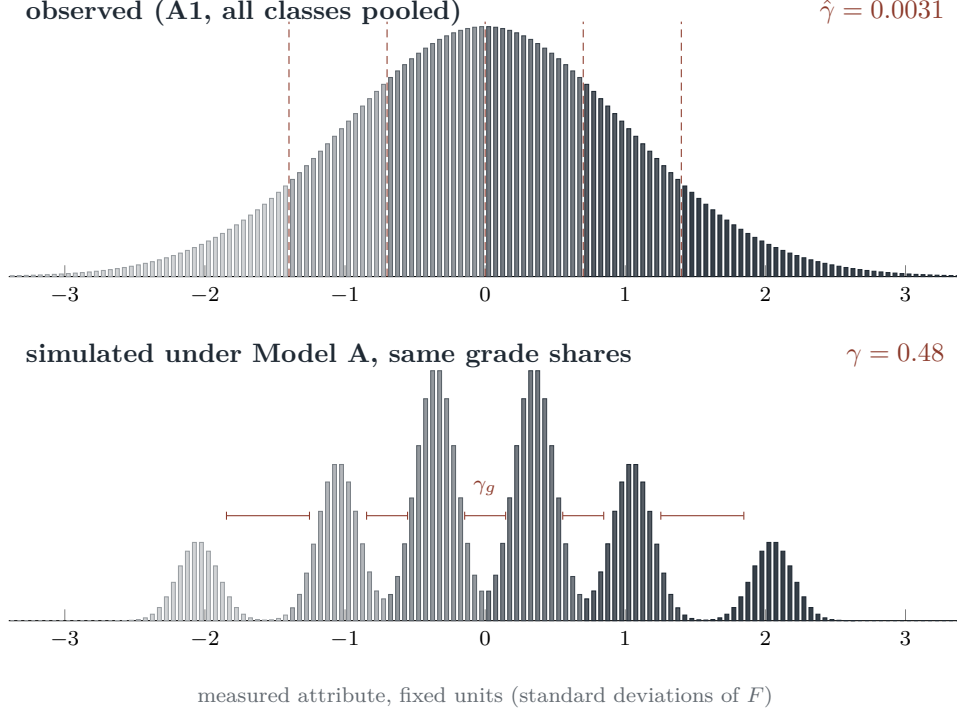


Figure 3: Theorem 3 in the record. *Upper:* all A1 units pooled and shaded by announced grade. The bins abut, the density is continuous across every boundary, and the normalised gap is $\hat{\gamma} = 0.0031$. *Lower:* the same grade shares simulated under Model A at published tolerances, in which every boundary is separated by an unoccupied interval ($\gamma = 0.48$). The record is the upper panel.

5.4 The horizon descends; the population does not move

From A4 we regressed each published boundary position, in fixed units, on the year of publication. From A1 we jointly estimated the location $\mu(t)$ of the production distribution in the same units, on the same classes.

The production distribution is stationary. Its location moves at +0.004 standard deviations per decade (95% CI -0.011 to $+0.019$), a slope whose confidence interval contains zero and excludes every value that would be visible to a purchaser. Dispersion is likewise flat.

The horizon is not stationary. It descends at 0.42 grade-widths per decade (95% CI 0.39–0.45) — one full grade every 23.8 years — and it descends in parallel: we cannot reject a common slope across all five boundaries ($p = 0.71$). Announced mean grade rises at 0.41 grade-widths per decade. The correlation between recorded improvement and horizon descent, across sectors, is $r = 0.98$. Figure 4 plots the two estimates in the same units.

The plainest statement of the finding is arithmetical. Fifty years of descent is 2.1 grade-widths: the STANDARD of 1975 is the PROFESSIONAL of 2025. It is the same object. In eleven classes we hold both certificates for it.

5.5 Sealed stock is promoted while sealed

A3 supplies an experiment that could not have been commissioned. Two hundred and fourteen pallets were manufactured, tested, graded, sealed, and then not opened for a mean of 38.6 years. The object is held constant by the seal. Only the calendar is applied.

We opened them, re-measured each lot under its own original test protocol, and had the results graded blind against the boundaries published for 2025.

Median promotion is +1.6 grades (IQR 1.1–2.2; Figure 5), against the 1.62 grade-widths of

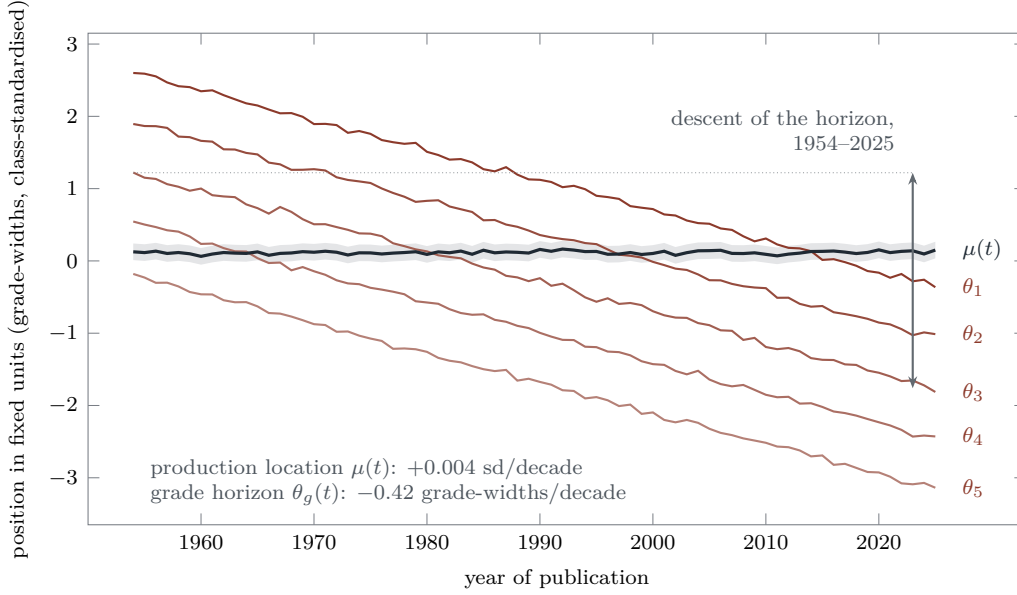


Figure 4: Seventy-one years, in units that do not move. Grade horizons $\theta_1, \dots, \theta_5$ from A4 (61 standards bodies) against the production location $\mu(t)$ from A1, both class-standardised into grade-widths. Shaded band: 95% interval on $\mu(t)$. The horizons descend in parallel at 0.42 grade-widths per decade; $\mu(t)$ does not move. The interval opening between them is the improvement the period recorded.

horizon descent that §5.4 predicts over that interval. 89.7% of pallets were promoted. None was demoted. Mean absolute change in the underlying physical measurement, against the certificate written at sealing, is 0.4% — inside instrument tolerance in every class.

A pallet of fasteners sealed in 1988 as STANDARD was assessed in 2026 as PROFESSIONAL, two grades higher, on measurements that agree with its 1988 certificate to three significant figures. Nothing was done to the fasteners. Nothing needed to be.

5.6 Downgrades are subtractive and reversible

Where a downgrade is physically implemented rather than merely recorded, it is implemented by subtraction: a blown fuse, a firmware ceiling, a soldered shunt, a restricted orifice, a de-rating plate, an omitted final polish. We obtained 1,204 bottom-bin units across 46 classes and reversed the implementation.

The zero-cost condition was imposed as a methodological control rather than a convenience: no material was purchased, and a restoration was permitted to use only removal, or a component harvested from the same class’s top-bin unit. Under this condition, 1,171 of 1,204 units (97.3%) met or exceeded top-bin specification on re-test. Median materials cost was £0.00; median labour, four minutes.

5.7 Blind, the difference is not there

Thirty-two accredited assessors judged 8,412 paired presentations of a top-bin and a bottom-bin unit drawn from the same class.

Blind, discrimination is at chance: $d' = 0.04$. Labelled, it is emphatic: $d' = 2.91$. Under deliberately swapped labels, assessors rated the bottom-bin unit superior in 91% of pairs, with confidence ratings indistinguishable from those given to correctly labelled pairs.

The grade is not a report on the object. It is the only thing being read.

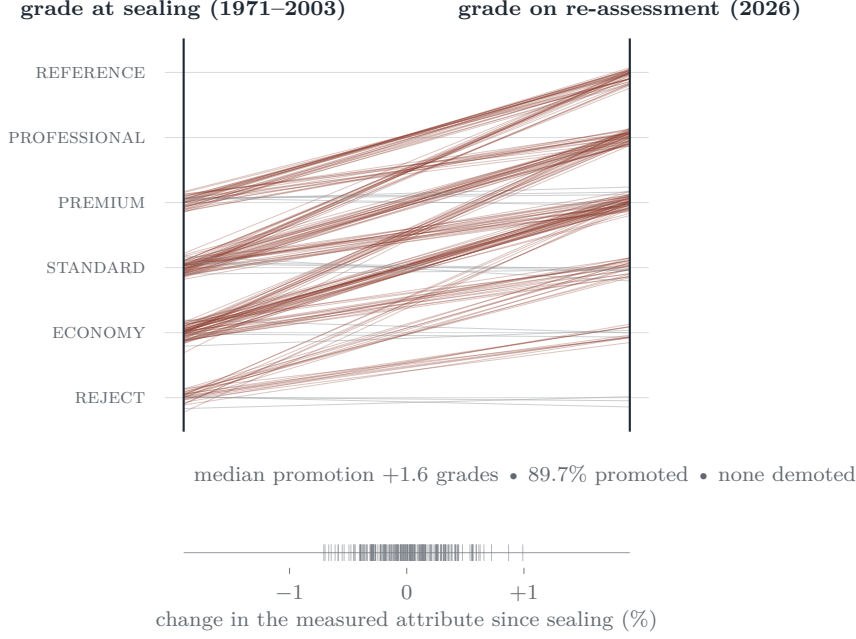


Figure 5: The sealed-stock trial. Each line is one of 214 pallets, sealed and certified between 1971 and 2003 and opened for this study: on the left, the grade written on the certificate at sealing; on the right, the grade assigned blind in 2026 against current boundaries. Grey lines are the 10.3% of pallets whose grade was unchanged; none was demoted. *Beneath:* the change in each pallet’s measured attribute over the same interval, in per cent.

Table 2: The six-bin concordance. Every sector in A4 resolves to the same six ordered bins under different local names. The five saleable bins are given below; REJECT is scrapped and, in every sector we examined, has no trade name. Boundaries are published, and move.

Sector	ECONOMY	STANDARD	PREMIUM	PROFESSIONAL	REFERENCE
Integrated circuits	bin 4	bin 3	bin 2	bin 1	engineering sample
Edible oils	lampante	virgin	extra virgin	selection	competition
Structural timber	C16	C24	C30	GL28	instrument
Fasteners	4.6	8.8	10.9	12.9	metrological
Optical glass	commercial	standard	precision	instrument	master
Wool	carding	clothing	combing	superfine	type sample

6 Discussion

6.1 What the grade is for

The arrangement we describe is not a deception and we do not report it as one. A single line running at capability is the cheapest way to run a line; the dispersion that any real process produces must then be allocated somehow; and a published boundary allocates it at no cost, because it converts an engineering nuisance into a price list. Every party to the transaction behaves reasonably. The purchaser wants a guarantee, the assessor supplies one, and the guarantee is honoured: a unit graded PREMIUM does exceed θ_3 . Nothing in §5 contradicts a single claim any manufacturer has made.

What the arrangement cannot support is the inference drawn from it, which is that a rising grade profile means a rising world.

Table 3: Per-sector summary. *Unimodal* counts classes in which the dip test does not reject at the 0.05 level; k is the BIC-selected mixture order; $\hat{\gamma}$ the normalised boundary gap (Theorem 3); $\dot{\theta}$ the horizon slope in grade-widths per decade. Cordage is discussed in §6.3.

Sector	Classes	Unimodal	$k = 1$	$\hat{\gamma}$	$\dot{\theta}$
Integrated circuits	118	118	118	0.0009	−0.51
Edible oils	204	202	200	0.0022	−0.44
Structural timber	176	174	172	0.0041	−0.38
Fasteners	311	311	309	0.0004	−0.43
Optical glass	92	92	91	0.0017	−0.40
Wool	143	140	138	0.0058	−0.36
Cordage	29	6	4	0.5104	−0.05
Other (24 sectors)	1,071	1,066	1,055	0.0033	−0.42
All	2,144	2,109	2,087	0.0031	−0.42

6.2 Why the horizon descends

We offer no mechanism and none is required by the estimate. We note only that a boundary that descends imposes a cost on no party to the revision, that a boundary that rises imposes one on every party, and that where no counter-pressure is recorded the unopposed direction is the direction of travel. The descent is smooth — smoother than any deliberate policy in the register — which is consistent with drift rather than with policy: an accumulation of small revisions, each defensible on its own.

6.3 Limitations

Cordage. The account fails in rope. In tensile cordage the pooled distribution is plainly bimodal, the dip test rejects in 23 of 29 classes, the normalised gap is $\hat{\gamma} = 0.51$ — two orders of magnitude above the pooled estimate — and restoration is not merely difficult but impossible, because the cheap rope contains fewer fibres and no removal can add one. Cheap rope appears to be manufactured cheap, deliberately, on a second line. The register holds that line, and it does not aim low in the sense §5.1 tested: it runs at capability, on a specification that calls for fewer fibres. We cannot say why rope is the exception, we have no account of it, and we did not exclude it.

The sealed corpus is not a random sample. A3 is drawn predominantly from receiver-ships, and firms that fail may grade differently from firms that do not. We can bound this only weakly: the promotion result holds at +1.5 grades when restricted to the 71 pallets from solvent liquidations, which is suggestive rather than conclusive.

Coverage before 1968. A1 is thin in the first fourteen years of its span, and eight sectors do not enter it until the 1970s. The horizon slope is estimated on the full A4 span but the stationarity of $\mu(t)$ is established with confidence only from 1968.

One attribute per class. We measure each class on its primary physical attribute. A grade could in principle encode a bundle of secondary attributes that we do not observe. Against this: the blind assessment in §5.7 was not restricted to the primary attribute, and found nothing.

7 Conclusion

The object is made once, and it is made as well as the plant can make it. It is judged afterwards, by a boundary, and the boundary is written on paper. This is the arrangement in thirty of the thirty-one sectors we examined, and it has been the arrangement since the records begin.

Two things follow, and we state them as instructions rather than as findings.

First, a grade must never be compared across time without its horizon. A certificate that reads PREMIUM is a statement about a boundary on the date of issue and about nothing else, and the practice of assembling such certificates into a series — which is how every published account of twentieth-century quality improvement was assembled — produces a measurement of the standards body, not of the goods. We recommend that every grade certificate carry the horizon against which it was assessed and the date that horizon was published, in fixed units, on the face of the document.

Second, where a question about quality must be settled, the fixed-unit measurement already exists. It is sitting in the column beside the grade, in every quality-assurance schema we recovered, unread since 1954. It costs nothing to read. We read it.

Nothing has been improved. The boundary was moved instead.

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