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(Almaty, Kazakhstan)**WHICH INEQUALITY STATISTICS SURVIVE AN ADMINISTRATIVE
BOUNDARY CHANGE? EVIDENCE FROM KAZAKHSTAN, 2010–2023**

Abstract: Kazakhstan changed its administrative map twice in five years: Shymkent separated from South Kazakhstan in 2018, and three new oblasts appeared in 2022. The published regional accounts mark neither change, so parent oblasts continue under unchanged names on smaller territory. Simulation studies disagree about which inequality measures survive such redistricting. This study tests the question against a real, dated change and against every way two of the sixteen pre-2018 regions could have been joined. Official gross regional product and population for 2010 to 2023 gave two panels of output per head: regions as published, and the same economy on a constant pre-2018 geography of sixteen units. Five measures were computed on both panels and then on all 120 single-pair recombinations. Three sign results are arithmetic identities, so only magnitudes are empirical. Across the actual reforms the population-weighted coefficient of variation, the Theil index and the Gini shift by at most 2.05 per cent and the finding of convergence holds, while the richest-to-poorest ratio is overstated by 18 to 56 per cent. That stability is not a property of the measures: 41 recombinations move the weighted coefficient of variation and 49 the Gini by more than the real reform did. Distortion arises only where a recombination touches an extreme, and one region dominates: of the 105 recombinations not involving Atyrau, none reaches the real change. No inequality statistic can be assumed to survive a boundary change; which ones do depends on whether the divided units sit at an extreme, and that is checkable in advance.

Keywords: regional inequality; Kazakhstan; administrative boundaries; modifiable areal unit problem; sigma convergence; gross regional product

Introduction. Kazakhstan is one of the most spatially unequal economies in Central Asia. Oil-producing western oblasts and the two largest cities produce output per head many times that of the southern agricultural regions, and the size of that gap is a standing subject of policy argument. Recent work finds the divide widening: Rodríguez-Pose, Bartalucci and Rau report that rapid aggregate growth has been accompanied by a widening territorial divide, with wealth concentrating in Almaty and Astana while southern regions lag [1], and a companion study drawing on Kazakhstan's first well-being survey documents wide disparities both between and within regions [2]. Turganbayev, studying sigma and beta convergence from 1993 to 2014, reports divergence over the full period but convergence from 2006 onward [3]. Tleuberdinova and colleagues observe that no methodological consensus exists for measuring territorial disparity [4].

Every such measure is computed across whatever territorial units a statistical agency happens to publish, and those units are not fixed by nature. Geographers have long recognised this as the modifiable areal unit problem: the result of a spatial analysis depends on how the

territory is carved up [6]. Work on the United States using nested Theil decomposition shows that measured inequality is sensitive to the geographical scale chosen [7], the decomposition machinery for separating within-group from between-group components is well established [10, 12], and convergence and inequality have been examined jointly across the regions of the European Union [11]. The problem becomes acute when the partition changes during the study period. He, Chung, Bayrak and Wang address exactly this for China, using a multi-scale decomposition of Guangdong to show how administrative boundary changes affect measurement, and note that the question has rarely been studied [5]. Related Chinese work finds that administrative borders shape economic outcomes at the county level [8] and that inequality patterns in western provinces follow their own trajectory [9].

Two papers frame the narrower question of which measures can be trusted. Portnov and Felsenstein tested how sensitive common inequality measures are to changes in the ranking, size and number of regions, using simulated distributions and permutation tests, and concluded that only the population-weighted coefficient of variation, known as Williamson's index, and the population-weighted Gini can be considered sufficiently reliable for countries with a small number of regions of varying population size [13]. Gluschenko raises a related but distinct objection: that population-weighted indices are conceptually inconsistent as measures of regional inequality, because what they estimate is interpersonal inequality across the national population [14]. His argument concerns interpretation rather than stability under redistricting, and because this study reports both weighted and unweighted measures, its central result does not depend on which side of the weighting dispute the reader takes. Portnov and Felsenstein establish their conclusion by simulation; the present study tests the same question against a real, dated, documented change in a real economy, which is the natural complement to their design.

For Kazakhstan since 2018, the assumption that a region means the same thing across a study period is false, and no published study appears to have quantified the consequence. Two changes occurred. In 2018 Shymkent, the country's third-largest city, was granted the status of a city of national significance and separated from South Kazakhstan oblast, whose remainder was renamed Turkistan. On 8 June 2022 a presidential decree created Abai from part of East Kazakhstan, Jetisu from part of Almaty oblast, and Ulytau from part of Karaganda. First-order units rose from sixteen to seventeen and then to twenty. In the published accounts the new units simply begin and the parent oblasts simply continue, under the same names, with unbroken series, on smaller territory. Nothing in the data files marks the change. East Kazakhstan's nominal gross regional product falls 25.4 per cent between the first half of 2021 and the first half of 2022, across a year of high inflation; read at face value this is a severe recession. Most of it is the departure of Abai.

Splitting one region into two changes measured dispersion even when no economic activity has changed, and whether it raises or lowers the measure depends on whether the split separates rich from poor. This study quantifies that effect for Kazakhstan, asks which statistics it damages and which it leaves usable, and then asks whether the damage is attributable to these decrees at all. The objective is deliberately narrow: not a new account of Kazakh regional development, nor a claim that existing findings are wrong, but a measurement result of the kind that is cheap to establish once and costly to leave unexamined. The study covers 2010 to 2023 at oblast level and treats output per head only; it does not address within-oblast inequality and does not attempt to explain the level of Kazakh regional inequality.

Materials and Methods. The design is a paired comparison. The same economic data are measured twice, once on the territorial units as published and once on units held constant, and the difference between the two is the quantity of interest. Because both panels are built from identical underlying figures, any divergence arises from the partition rather than from the economy. A paired comparison establishes that a difference exists; the falsification arm described below is what addresses what the difference should be attributed to.

Two official series published by the Bureau of National Statistics of the Republic of Kazakhstan were retrieved on 31 July 2026 and re-retrieved on 20 September 2026 from the national accounts and demography dynamic-table archives: gross regional product, cumulative by quarter with annual totals, 2008 to 2025, in million tenge (element 5923), and population by region, annual, 2000 to 2025, in persons (element 6584). All numbers reported below are from the September vintage; the Bureau marks its 2021 gross regional product column as revised, and the 2021 values differ from the July vintage used in an earlier draft. Three properties of the output file required correction, none documented in the file itself. First, values are labelled in millions of tenge but stored scaled by 10: the national figure for January to September 2024 appears as 84,962,626,099,999,997,952, which on division gives about 85 trillion tenge, consistent with a full-year nominal gross domestic product near 140 trillion. Second, each observation is a year-to-date cumulative total rather than a quarterly flow, so annual values were taken as the January-to-December observation. Third, complete annual totals end in 2023, which fixes the study period at fourteen years.

Output per head was computed as gross regional product divided by population rather than taken from the published per-capita series, because that series omits 2010 to 2013 and 2021, and 2021 falls immediately before the second boundary change. The 2023 population totals used are those of element 6584: national 19,766,807, Almaty city 2,161,902, Astana 1,354,556, Atyrau 693,079, Turkistan 2,119,226 and Abai 610,198. South Kazakhstan oblast's series terminates at a January-to-March 2018 cumulative figure; because annual values are taken from the December observation, that partial-year figure has no annual counterpart and the unit simply leaves the annual panel after 2017. Turkistan and Shymkent both begin in 2018 and both carry a December 2018 observation.

The naive panel uses regions as published: sixteen units for 2010 to 2017, seventeen for 2018 to 2021, and twenty for 2022 to 2023. The harmonised panel maps every year onto a constant pre-2018 geography of sixteen units: Turkistan and Shymkent are recombined into South Kazakhstan, Abai into East Kazakhstan, Jetisu into Almaty oblast, Ulytau into Karaganda, and twelve unaffected units are carried unchanged. Output and population are summed, and output per head is recomputed as summed output over summed population. Five measures were computed on output per head for each year and panel: the coefficient of variation, unweighted and population-weighted; the population-weighted Theil index; the population-weighted Gini coefficient across regions; and the ratio of maximum to minimum.

Four comparisons were specified in a plan written before any result was computed. C1 is the distortion, naive minus harmonised, for each measure and year. C2 is the discontinuity in that distortion at each break. C3 regresses each measure on year by ordinary least squares with Newey–West standard errors at two lags, separately on each panel, testing whether the sign or significance of the trend differs. C4 was a placebo applying the same merge arithmetic to three never-redrawn oblast pairs in every year. Because fourteen observations is a small sample for an asymptotic standard error, the trend estimates were additionally re-examined with a moving-block bootstrap, block length three, 10,000 replications, fixed seed. A classification rule was

fixed beforehand: support required distortion of at least 5 per cent on at least two of the five measures at a break year together with a differing C3 conclusion. The plan also fixed a failure condition: if the placebo reproduced the break-year jump, the effect was to be reported as aggregation arithmetic and the paper was to become a methods caution rather than an inequality finding.

C4 as planned cannot fail on the extremes ratio, and this was discovered only after it had been run. It applies the same merges in every year, so it contains no event at a break year and structurally cannot produce a break-year discontinuity. C4 was therefore replaced by a timed sham split. For a pair of regions A and B, a sham history is constructed in which A and B are a single unit until a sham split year T and two separate units from T onward; the sham naive panel merges them before T and separates them from T, the sham harmonised panel merges them in every year. Before T the sham distortion is exactly zero; from T it is not, so the break-year jump is measured on the same footing as the real one. The decision rule was fixed in the analysis script before the sham block was run: if a sham 2018 split of never-redrawn regions reproduces a max/min jump of the same order as the real one, the failure condition has been met. The test was run for four named pairs at 2018 and 2022, then exhaustively for all 66 pairs drawn from the twelve never-redrawn units, and for all 120 pairs drawn from all sixteen. The plan is therefore best described as a pre-specified plan with one disclosed post-hoc operationalisation: the failure condition was fixed in advance, but the sham design that operationalises it was designed after the original placebo's results were known.

One property of the restricted pool has to be stated before its results are read. The region holding the minimum in thirteen of fourteen years, South Kazakhstan, is itself a redrawn unit, so it cannot appear in a pool defined as never-redrawn; that pool can only produce shams acting on the maximum. The exhaustive 120-pair pool is reported alongside it because it restores the minimum side, and results are broken out by which extreme a pairing touches. The study uses aggregate official statistics published for public use; no human subjects or private data are involved, and no ethical approval was required.

Results. Between 2010 and 2017 no boundary change had occurred, and the two panels return identical values on all five measures in all eight years. This is weaker than it looks: in those years the harmonisation performs no merge at all, so the check confirms that the loader and the measure code are consistent, not that the harmonisation logic is correct. The planned reconciliation was also run and passes: for every year, summed regional gross regional product equals the published national row to within floating-point noise, against a tolerance of 1 per cent. That reconciliation sums the published regional rows and compares them with the published national row; it never touches the recombination map, so it cannot detect an error in it. A mutation suite makes the point concretely: deliberately double-counting Abai, deleting Jetisu, or omitting Shymkent from the South Kazakhstan recombination each leave the reconciliation passing at 0.0000 per cent while the reported numbers move (the 2022 Gini distortion rises from 1.45 to 2.50 and 3.12 per cent respectively, and omitting Shymkent reduces the 55.89 per cent headline to zero). Those three mutations violate the partition or the mass-conservation checks and are caught by them. A fourth mutation, misfiling a successor unit under the wrong parent, violates neither check and is caught only by comparison with the decree text from which the crosswalk was built; the crosswalk's parentage therefore rests on the decrees, not on an automatic test.

Before any result is read, three properties of the measures must be stated, because they are true by arithmetic and none is a finding about Kazakhstan. Proposition 1 (extremes

compression): recombining two units replaces their two values by a single population-weighted average, which cannot exceed the larger nor fall below the smaller, so the harmonised ratio of maximum to minimum can never exceed the published one. Corollary: because the ratio depends on exactly two units, a recombination changes it if and only if one of the recombined units holds the maximum or the minimum, which is why 91 of the 120 pairings in Table 3 move it by exactly zero. Proposition 2 (the Theil gap is the within-group term): by the standard between-and-within decomposition of the Theil index [10, 12], the published index equals the harmonised index plus the population-weighted within-group inequality of the recombined units, so the published Theil is always at least the harmonised Theil; verified numerically, the 2018 difference equals the within-group term, 0.00764702, on both sides. Read this way, the Theil distortion is not noise: it is exactly the inequality inside the merged units that the pre-2018 boundaries concealed. Proposition 3: the largest distortion a minimum-side repartition can produce is fixed by the two lowest values, and the largest a maximum-side one can produce by the two highest; for 2018 these ceilings are 4.7711, 87.0974 and 96.0239 per cent, and the exhaustive search attains each exactly. What remains empirical is therefore the magnitude of the distortions the actual reforms produced, how often counterfactual repartitions exceed them, the behaviour of the trends, and which units drive the effect.

Table 1 – Inequality measured on published against harmonised regions, 2010–2023.
 $\Delta\%$ is the distortion, naive minus harmonised, relative to the harmonised value.

Year	Units (naive / harm.)	CV unweighted $\Delta\%$	Gini $\Delta\%$	max/min naive $\rightarrow$ harm.	max/min $\Delta\%$
2010–2017	16 / 16	0.00	0.00	identical	0.00
2018	17 / 16	+1.83	+2.05	15.00 $\rightarrow$ 9.62	+55.89
2019	17 / 16	+2.15	+1.33	14.48 $\rightarrow$ 10.44	+38.71
2020	17 / 16	+2.25	+1.72	10.14 $\rightarrow$ 7.51	+35.04
2021	17 / 16	+2.03	+1.20	11.78 $\rightarrow$ 9.94	+18.43
2022	20 / 16	−0.57	+1.45	11.96 $\rightarrow$ 9.62	+24.42
2023	20 / 16	−1.67	+1.76	12.16 $\rightarrow$ 9.20	+32.14

Distribution-wide measures move little. The population-weighted Gini differs by at most 2.05 per cent and the unweighted coefficient of variation by at most 2.45 per cent, turning slightly negative in 2023. The ratio of richest to poorest region is overstated in every year after 2018, by between 18 and 56 per cent: for 2018 the published data imply that the richest region produced 15.0 times the output per head of the poorest, where constant geography gives 9.6. The sign of that column carries no information, as Proposition 1 states; only the magnitude is a result. The mechanism is visible in the arithmetic. Distribution-wide measures aggregate over sixteen or twenty units, so moving output between a parent and its offspring shifts them only at the margin. The extremes ratio depends on two units: separating Shymkent from South Kazakhstan left a lower-output rural remainder, Turkistan, at the bottom of the distribution, and

it is that fall in the minimum that drives the ratio. Atyrau holds the maximum in all fourteen years and is untouched by either reform (Figure 1).

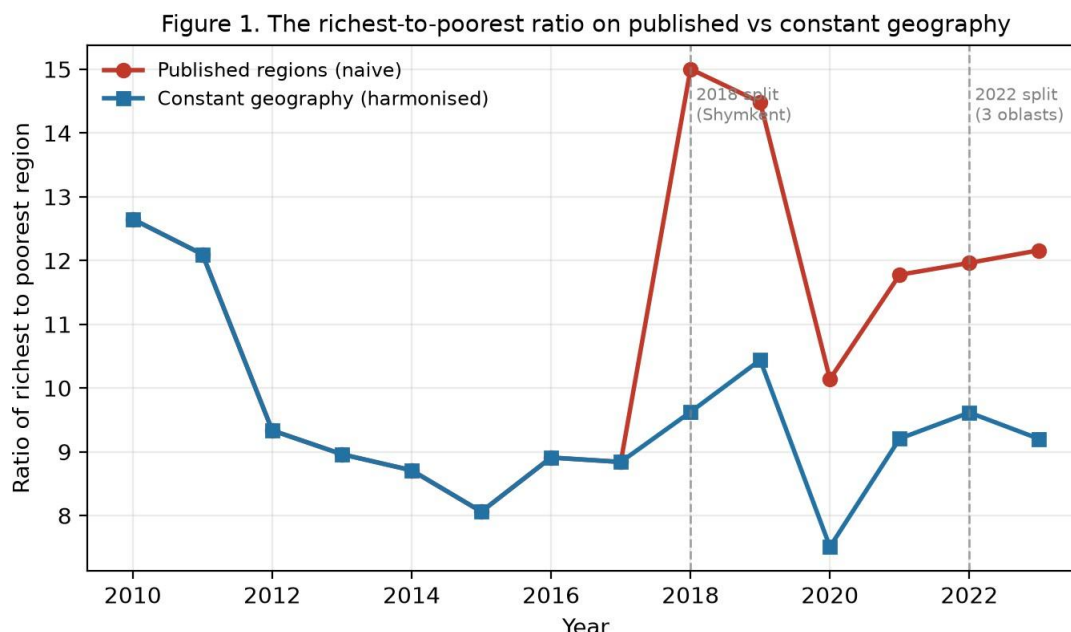


Figure 1 – The richest-to-poorest ratio on published against constant geography, 2010–2023. The two series coincide exactly before 2018.

Between 2017 and 2018 the distortion in the extremes ratio jumps by 55.89 percentage points, in the Theil index by 3.33 and in the Gini by 2.05. Between 2021 and 2022 the same jumps are +5.99, +0.53 and +0.25. The earlier change is far more consequential for measurement despite 2022 creating three new units against one in 2018, and the reason is not the number of units: Abai, Jetisu and Ulytau are middling regions and none of them, nor their parents, holds an extreme, whereas the 2018 change created a unit at the minimum.

Table 2 – Sigma convergence: ordinary least squares on year with Newey–West standard errors (two lags), $n = 14$, and moving-block bootstrap intervals on the residuals (block length 3, 10,000 replications, fixed seed).

Measure	Naive slope (p)	Harmonised slope (p)	Bootstrap 95% CI, naive	Bootstrap 95% CI, harmonised
CV unweighted	−0.00272 (0.229)	−0.00306 (0.210)	[−0.00664, +0.00169]	[−0.00677, +0.00101]
CV weighted	−0.00722 (<0.001)	−0.00754 (<0.001)	[−0.00995, −0.00426]	[−0.01034, −0.00459]
Theil	−0.00419 (<0.001)	−0.00465 (<0.001)	[−0.00579, −0.00249]	[−0.00630, −0.00297]
Gini	−0.00343 (<0.001)	−0.00399 (<0.001)	[−0.00485, −0.00196]	[−0.00549, −0.00250]
max/min	+0.15828 (0.242)	−0.13962 (0.205)	[−0.14754, +0.47637]	[−0.30770, +0.03641]

On the population-weighted coefficient of variation, the Theil index and the Gini, Kazakh regions converge across 2010 to 2023 on both panels, and harmonisation strengthens the estimated convergence slightly in each case, so the direction of Kazakh regional inequality does

not rest on the boundary artefact. The bootstrap intervals for the weighted coefficient of variation, the Theil index and the Gini exclude zero on both panels, so convergence on those measures is robust to serial correlation; the unweighted coefficient of variation is not distinguishable from zero on either panel. The extremes ratio behaves differently: its trend is positive on published units and negative on constant geography, but neither slope is distinguishable from zero and both bootstrap intervals are wide, so the reversal is inconclusive rather than established. All five measures are ratios and are unchanged by any deflator applied uniformly to regions within a year, which was verified numerically; region-specific price differences, which Kazakhstan does not publish at oblast level, are the one channel through which prices could enter.

The planned placebo, merging three never-redrawn pairs in every year, reads exactly 0.00 per cent on the extremes ratio in thirteen of fourteen years. Those zeros are an arithmetic necessity: neither Atyrau, which holds the maximum in all fourteen years, nor South Kazakhstan, which holds the minimum in thirteen, is in any placebo pair. In the single year where a pair member did touch an extreme, 2010, the placebo moved the ratio by -10.08 per cent, so a merge involving no boundary change at all can shift the ratio by double digits. The corrected timed sham splits are what the verdict rests on. A sham split of Atyrau from Mangistau at 2018, two regions that were never redrawn, distorts the extremes ratio by 38.85 percentage points, and the same sham at 2022 by 58.63, larger than the real 2018 figure of 55.89; a sham split of Almaty city from Almaty oblast, the closest structural twin of the Shymkent case, leaves the extremes ratio untouched while moving the Gini by 20.20 per cent. Across all 66 pairs of never-redrawn units the actual 2018 jump is unexceptional on every distribution-wide measure, sitting at or near the sham median with between 25 and 41 of the 66 repartitions moving those measures more, while on the extremes ratio the distribution is close to binary: 55 shams move it by exactly zero and the eleven that move it all involve Atyrau, seven of them by more than the real change.

Table 3 – All 120 sham pairings at split year 2018, classified by which extreme the pairing touches. The actual 2018 change gives +55.89 on max/min.

Pairing touches	Pairs	Pairs that move max/min	Magnitude range (pp)
The maximum (Atyrau)	15	15	38.85 – 96.02
The minimum (South Kazakhstan)	14	14	1.32 – 4.77
Neither extreme	91	0	exactly 0

The rule is exact rather than approximate: every one of the 29 pairings touching an extreme moves the ratio, every one of the 91 touching neither leaves it unchanged, and there are no intermediate cases. Magnitude is not symmetric: acting on the maximum moves the ratio by 38.85 to 96.02 percentage points, acting on the minimum by 1.32 to 4.77. The asymmetry matters because the 2018 decree acted on the minimum yet moved the ratio by 55.89 points, more than eleven times the largest minimum-side sham. A sham split returns two regions that already exist in the panel, so it can never produce a unit outside the observed range; the 2018 decree did. Turkistan's output per head in 2018 was 839,623 tenge against 1,308,920 for the undivided South Kazakhstan, 35.9 per cent below what had until then been the poorest region in the country. Under the decision rule fixed before the sham block was run, the failure condition

is nevertheless met: shams do reproduce and exceed the break-year jump. What the breakdown establishes is narrower and is reported as such: the reproduction comes entirely from repartitions acting on the maximum, and no repartition of existing regions acting on the minimum comes close.

Table 4 – Break-year distortion across all counterfactual single-pair repartitions, 2018. Percentages are absolute. The 2.05 per cent column asks how often a hypothetical repartition would have exceeded the largest distortion the actual reforms produced in any distribution-wide measure.

Measure	>2.05% (of 120)	>5% (of 120)	max % (120)	median % (120)	max % (66-pair)
CV unweighted	44	16	49.95	1.52	48.39
CV pop-weighted	41	24	50.16	0.78	32.31
Theil	60	42	96.81	2.05	47.21
Gini	49	24	38.44	1.23	17.53
max/min	28	15	96.02	0.00	87.10

Three things follow. The actual reform was gentle by comparison: between a third and a half of all single-pair recombinations of this economy would have moved the distribution-wide measures further than the real one did. The Theil index is the least reliable of the three population-weighted measures on every column. And the median tells the opposite story to the maximum for every measure: a typical repartition is nearly harmless, while an unlucky one is severe, which is why the question has to be asked case by case. The reference class rests on one region, and that must be said before Table 4 is used. Atyrau appears in 15 of the 120 recombinations, and removing it removes almost the entire effect: of the 105 recombinations not involving Atyrau, none moves the extremes ratio by as much as the real 2018 change, and the largest reaches 4.77 rather than 96.02. The three maxima of 50.16, 38.44 and 96.81 per cent are all produced by the same single recombination, Atyrau with South Kazakhstan; they are one fact about one pair of regions, not three independent results, and several of the largest values coincide because they saturate the closed-form ceilings of Proposition 3. Table 4 should therefore be read as a statement about how much influence a single extreme unit has in this economy, not as a survey of what redistricting does in general.

Two rules were fixed in advance and they point in different directions. Against the classification rule, only one of the five measures exceeds the 5 per cent threshold where the rule required two, although a C3 conclusion does differ; taken alone that would grade the result partially supported. Against the failure condition, the corrected placebo reproduces the break-year jump, and the plan states that in this event the paper becomes a methods caution rather than an inequality finding. The failure condition is the stricter rule and it governs; the claim that the effect is attributable to the boundary changes rather than to the act of merging units is withdrawn. Two qualifications are recorded rather than used to soften that reading. The shams that reproduce the real jump all act on the maximum while the 2018 decree acted on the minimum, so the reproduction is of the magnitude, not of the mechanism. And the failure condition fires because of one region: had Atyrau been absent from this economy, or had the reference class been built only from regions a redistricting could plausibly join, the condition would not have fired. Both qualifications are stated so that the reader can weigh the narrow base

on which the verdict rests: one region, in one recombination, inside a class that is a single-pair slice of the partition space rather than a survey of it.

Discussion. Two undocumented territorial discontinuities in Kazakhstan's regional accounts leave distribution-wide inequality measures and the finding of convergence substantially intact, and inflate the ratio of richest to poorest region by a quarter to a half. Neither effect is a property of the decrees. Both are properties of repartitioning, and their size is governed by which units the repartition touches. For extremes-based measures the governing rule is sharp: a repartition moves the ratio if and only if it creates or dissolves a unit at the maximum or the minimum, and otherwise moves it by exactly zero. For distribution-wide measures no such rule appears, and their apparent safety across the actual reforms does not generalise: every repartition moves them somewhat, and the real 2018 change happens to sit near the median. What the actual reforms demonstrate is that Kazakhstan divided units that happened to sit away from the tails, not that these statistics are safe to carry across a redistricting.

The practical implication is a diagnostic, and it is cheaper than the harmonisation it may render unnecessary. Before computing an inequality statistic across an administrative boundary change, an analyst should ask a single question: does any created, dissolved or shrunken unit sit at the maximum or minimum of the distribution? If none does, extremes-based measures are unaffected, not approximately but exactly, and in 91 of 120 Kazakh counterfactuals that is the answer. If one does, extremes-based measures are unusable without harmonisation, and the error can exceed 50 per cent. That question can be answered by inspection, before any panel is rebuilt. A second question follows for anyone who needs the size of the error: how unequal are the parts being separated, and which extreme do they sit at? Separating a rich city from a poor rural remainder at the bottom of the distribution, which is what 2018 did, moves the ratio far more than separating two ordinary neighbouring regions at the same end, and this second question needs the panel rebuilt. The diagnostic also explains the Kazakh case without recourse to anything Kazakh: 2018 looks dramatic and 2022 looks harmless, despite 2022 creating three times as many units, because 2018 created a unit at the minimum and 2022 did not.

This study does not reconcile with the existing literature as smoothly as an earlier draft claimed. Rodríguez-Pose and colleagues employ convergence analysis alongside two composite indices and conclude that Kazakhstan's territorial divide is widening [1]; the present study employs convergence analysis and finds that Kazakh regions converge on three of five measures, on both panels, across 2010 to 2023. These are the same method family reaching opposite conclusions, and harmonisation does not resolve the difference. One documented mechanism could account for part of it: Turganbayev reports divergence from 1993 to 2006 and convergence from 2006 onward [3], so a panel beginning in 2010 lies wholly inside the later, convergent regime. Whether that accounts for the difference cannot be determined here, because it would require matching study periods and measures directly. What this study adds is not a verdict on that dispute but a boundary on where the published units can be trusted, which is the same service He and colleagues performed for Guangdong [5] and which the modifiable areal unit literature predicts will be needed whenever a partition changes [6, 7].

On the narrower question of which measures withstand redistricting, the results qualify Portnov and Felsenstein rather than simply confirming them [13]. Across the actual reforms their two endorsed measures do hold: the population-weighted coefficient of variation and the Gini shift by at most 2.05 per cent, their convergence conclusions do not change, and the ratio of maximum to minimum moves by 24 to 56 per cent. Read alone, that corroborates them. It should not be read alone: the same 120-pairing exercise records what these measures do under

repartitions that did not happen, and there 41 recombinations move the weighted coefficient of variation and 49 the Gini by more than 2.05 per cent, with maxima of 50.16 and 38.44 per cent. The Theil index, which is not among the measures they endorse, is worse than both on every cut of the exhaustive pool: 60 of 120 repartitions exceed 2.05 per cent, 42 exceed 5 per cent, and its maximum is 96.81 per cent, which is a reason not to substitute it for them. What this adds to their result is therefore a boundary rather than an endorsement: their ranking survives, in that the extremes ratio fails far worse than anything else and their two measures are the best of the set, but it does not survive as a licence, because on real data a repartition can move even those two measures by tens of per cent. Gluschenko's objection to weighted indices [14] is about interpretation rather than stability and does not disturb the finding: the unweighted coefficient of variation, which is not subject to his criticism, is also displaced by at most 2.47 per cent, whereas the extremes ratio fails on either view, so readers on both sides of the weighting dispute are led to the same practical conclusion.

The objective was to quantify the distortion and to identify which statistics it damages. Both were met, and a third result arrived unbidden: the damage is predictable from the position of the affected units in the distribution, which makes it checkable in advance. The secondary hope, that harmonisation would overturn a published trend conclusion, was not met. Studies spanning an administrative boundary change should run the extreme-unit check before computing any extremes-based measure and should state which partition they use; where the check fails, units should be harmonised. Because roughly a third to a half of possible repartitions move the distribution-wide measures by more than Kazakhstan's real ones did, a stable Gini or coefficient of variation across a particular boundary change is evidence about that change, not a warrant for the next one. The check is worth running wherever administrative maps have changed during a study period, which is common across the post-Soviet region and beyond, and publishing agencies could remove the problem at source by flagging territorial discontinuities in the data files themselves.

Several limitations bound these results. The sham distribution is a calibration exercise over counterfactual partitions of one economy, not a sampling distribution; its exceedance proportions are not p-values. A sham split can never create a unit outside the observed range, whereas the 2018 decree placed Turkistan 35.9 per cent below the previously poorest region, so the sham distribution calibrates generic repartition arithmetic and does not bound the most extreme repartitions a government could enact. The reference class is a single-pair slice, a vanishing fraction of the roughly 10.5 billion ways sixteen units could be partitioned; it cannot contain the treatment it is compared against; and its members are not all enactable, since the recombination producing every quoted maximum joins Atyrau to South Kazakhstan, two oblasts roughly 1,800 km apart. The sham design was chosen after the original placebo's results were known, and a reader weighing the methods-caution scope should weigh that too; no sensitivity analysis over alternative sham designs was run, and the verdict rests on this one. The trend tests rest on fourteen annual observations with serially correlated errors; no formal stationarity or autocorrelation diagnostics beyond the Newey–West correction and the block bootstrap were run, and the regressions do not include a break dummy at 2018 or 2022. Units are harmonised backwards onto pre-2018 geography because a forward mapping would require sub-oblast output that the Bureau does not publish. Regional price differences are not observed, and the study treats output per head alone; inequality in well-being, services or opportunity may respond differently to the same boundary changes [2].

Deviations from the plan were recorded as they were made. The population source was changed before results, from the gapped per-capita series to population computed from element 6584. The planned placebo C4 was executed, found incapable of failing on the extremes ratio, retained with its limitation stated, and supplemented by the timed sham split, whose decision rule was fixed in the analysis script before the block was run once. The national reconciliation and the statement of the sign identities were specified in the plan but executed only in a later draft, and that lateness is recorded. The scope was changed by the failure condition from an inequality finding to a methods caution. And the sham results were broken out by extreme after an earlier draft had reported the never-redrawn pool as its headline distribution, a pool from which the minimum-holding region is excluded by construction.

Conclusion. Two administrative boundary changes that Kazakhstan's regional accounts do not mark inflate the published ratio of richest to poorest region by 24 to 56 per cent for every year from 2018, while the population-weighted coefficient of variation, the Theil index and the Gini move by at most 2.05 per cent and the finding of regional convergence survives on both partitions. The stability of the distribution-wide measures across these particular reforms is not a property of the measures: 41 of the 120 single-pair recombinations of the same economy move the weighted coefficient of variation, and 49 the Gini, by more than the real reform did, and the Theil index is the least stable of the three. What decides whether a statistic survives is whether the divided units sit at an extreme of the distribution, a condition that is exact for extremes-based measures and checkable by inspection before any panel is rebuilt. The falsification test fixed in advance was met, so the effect is reported as repartition arithmetic rather than as a property of these decrees, and that verdict rests on one region, Atyrau, in one recombination. A statistic can be arithmetically correct and still describe something that never happened: the twenty-five per cent fall in East Kazakhstan's output is real in the sense that the numbers say so, and imaginary in the sense that no factory closed. Keeping those two senses apart is most of what careful measurement means.

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