

The geography of intergenerational mobility in Denmark: source-faithful replication registration

Bolero

Abstract

Registered research design and conditional interpretation policy; no outcomes observed.

Keywords: Pre-registration, research design

The geography of intergenerational mobility in Denmark: source-faithful replication registration

Replication pre-registration: the source paper's results are known; no new replication outcomes have been observed.

Research question

How does intergenerational income mobility vary across Danish childhood municipalities, compare with the paper's international benchmarks, and correlate with municipal characteristics?

Scope

Source 1973–1977 birth cohorts, 2010–2015 child income, 1980-to-child-endpoint parental income (main 18; source appendix 15/18/20), source municipal rank/log/quintile variants and original municipal correlations. Descriptive only. Exact unresolved targets have no-estimate dispositions; all 531 FSV tables are permitted for planning but none validated.

Graph overview

Dependency edges summarize the graph, not unconditional activation. Exact logical conditions and all local outcomes follow below; the separate graph atlas shows each Atom's branches.

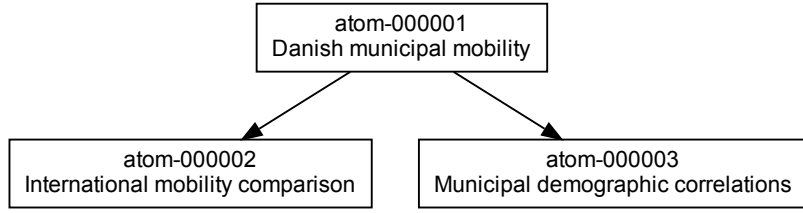


Fig. 1 Registered Atom dependencies

Registered storyline

Follow the published narrative, preserving the three contributions. Begin with Table 1’s sample and measurement description within atom-000001, then its municipal rank-persistence and absolute-upward-mobility maps. Next report atom-000002’s Danish distribution summaries beside explicitly published international reference targets. Then report atom-000003’s complete original Figure 2 row order and four-series correlations. Finally describe the online appendix’s related income/geography/age/elasticity/quintile targets within atom-000001, including every unsupported or conflicted target. No supplementary specification replaces the main specification. Every result and evidence-dependent conclusion is pending; source boundaries remain explicit in the manuscript and figures.

Source and live-search record

This search recovered and checked the fixed paper’s materials. It is not a novelty search, independent review or a new scientific design. Searches were run live on 2026-09-05 UTC. Primary source identities and hashes are in `replication/source-provenance.yaml` (unchanged supplied record) and `replication/retrieved-source-hashes.yaml`. Exact HTTP requests, timestamps, status codes and hashes are retained in `replication/retrieval-ledger.jsonl`; the separate OpenAlex ledger records its access failure. Temporary originals and extraction caches remain outside the World in `conversion/source-inspection/`.

Material actually inspected

1. **P: published article**, Jesper Eriksen and Martin D. Munk (2020), *The geography of intergenerational mobility — Danish evidence*, Economics Letters 189, 109024, [DOI](#). All four supplied PDF pages were read. Pages 2 and 3 were also inspected as images to verify Table 1, both map panels, all Figure 2 row labels and caption. The supplied Markdown was read as a text aid and checked against the PDF; it

has an affiliation extraction error and is not authority over the PDF. Both supplied hashes match. No source results were treated as newly observed.

2. **Author preprint**, January 16, 2020, six PDF pages including title page, [author-hosted file](#). Complete text read. It corroborates the main methods/order, but is not a correction or authority to override the specified published version.
3. **R: appendix Readme.pdf**, three pages, [file DOI](#). Retrieved successfully through the Dataverse file API and read completely. It adds exact income fields, supplemental endpoint ages, variables and historical suppression rules. It does not contain an empirical program.
4. **D1 and D2: original public appendix files**, [earlier wide file](#) and [replacement long file](#). Both downloaded. Only headers and distinct identifying specification/variable labels were inspected, not outcome values or calculated outcome summaries. D2's labels enumerate 72 specifications: two geographic systems $\times$ three endpoint ages $\times$ six rank pairs plus six log pairs. The DataCite record identifies dataset version 2.0, updated July 22, 2020, with D2 and R as parts. The published file schema is not evidence that an identical microdata analysis is executable here.
5. **Official definitions**, live Danish HKV pages for PERINDKIALT and PERINDKIALT_13, and live Danish FSV CPST variable list. Full definition sections read. Narrow FSV register/variable pages were read for IND, BEF, CPST, FAIN, BEFBOP, BEFADR, RAS, AKM, IDAP, UDDA, IEPE, FTBARN, FTFORAEL, FTDB, FODT, KRAN, KRAF and FLYT. These support candidate fields and metadata limits, not observed coverage or a source-authorized choice among candidate records. No unrelated table rows were read.

Searches and access levels

The following are exact live web queries. Search result counts denote returned pages only where visible; the web tool did not expose total index counts. Inclusion required this article, its author-hosted material, correction/version record, or the precise source data definition. Unrelated papers were screened out; their methods were not imported.

Query/channel	Retrieval result and access level
"The geography of intergenerational mobility" "Eriksen" appendix code	Author research page and institutional publication/data records; HTML read; author page led to preprint and Dataverse.
"10.1016/j.econlet.2020.109024" supplementary data code corrigendum	Article and replication data identities; no verified corrigendum returned.
"YIS2QY" code; "Eriksen" "Munk" "mobility" "github"	Dataverse Readme/file DOI records and author sites. The GitHub link for Eriksen–Etzerodt is a different paper and was excluded.

Query/channel	Retrieval result and access level
"The geography of intergenerational mobility" "corrigendum"	Unrelated publications/correction boilerplate; none established a correction to this article.
"Eriksen" "Munk" "IG_Geo_DK" code R; "IG_Geo_DK" ".R"; "Jesper Eriksen" "Munk" "replication code"	No relevant empirical source program retrieved.
"The geography of intergenerational mobility" "Danish" "correction"; "Eriksen" "Munk" "109024" supplement	Institutional copies and paper metadata; no source-backed resolution of specification gaps. RePEc's generic Corrections heading is not a corrigendum.
site.dst.dk "PERINDKIALT_13" "1980"	Live official income definitions and FSV list; read definition text. Later papers using the field were excluded as scientific authority for the target.
"YIS2QY" "R"	Dataset metadata lists R as technical information; this is not a retrieved R program.
site.dst.dk "Ulighedsmål" "Gini-koefficient" "2017"	No precise archived municipal 1987–1993 source input identified. Other Gini series were excluded as substitutes.
"Danish rural development programme 2007" "2011" municipalities classification	Secondary reports described the classification; no original 2011 municipal mapping file recovered. The source short link redirected to the agency home page. Secondary typologies were not implemented.
site.jespereriksen.com "Geography" "code"	Author page identifies preprint and supplementary data, no empirical code link.

OpenAlex DOI resolution was attempted with the supplied skill client. The exact DOI request returned HTTP 429, zero remaining budget, with an explicit insufficient-budget response. The error is preserved; no OpenAlex metadata, abstract or citation network was invented. Author/publisher/Crossref/DataCite/Dataverse/web channels continued the search. Broad citation expansion would not resolve this conversion's missing program and is not used to generate extra analyses. PMC skill was read; this income-mobility study has no biomedical question requiring a PMC search. No claim of PMC coverage is made.

Additional direct retrievals: author research page returned 200; GitHub API account repositories and relevant website trees returned 200; no matching empirical program appeared in those inspected listings. An initially guessed **jespereriksen** GitHub account was not used as author evidence; the author-page link resolved the

EriksenJ account. Crossref DOI record returned 200 with no update-to or relation entry. DataCite dataset and file records returned 200. Dataverse dataset-title search returned one matching dataset; file searches returned zero; one attempted filtered search returned 400. Native dataset/version/export routes repeatedly returned 403, so their contents were not claimed as retrieved. The persistent-file routes succeeded for R, D1 and D2. ScienceDirect page retrieval returned 403; the supplied published PDF provided full article access. The source’s original TIMES URLs returned 404; official HKV successor definitions were recovered.

The final author-code/correction search round added no relevant program or correction. This is a bounded recovery limit, not proof that no code or correction exists. No historical replication manual, earlier generated preregistration, Atom list or review was consulted as scientific evidence. Missing original material stays missing throughout the package.

Prior-work positioning, restricted to the source

P positions its municipality analysis alongside Chetty et al. (2014, 2020) and Connolly, Corak and HaecK (2019). It distinguishes Swedish hierarchical and Italian surname-information estimates as not directly comparable. It cites lifecycle work to motivate income windows and mentions later causal uses of descriptive spatial estimates. These are statements of P’s positioning, not claims that this conversion independently read or validated all cited studies. The replication manuscript uses those citations only to describe the original argument; it adds no theory, causal test or external empirical analysis.

Exact references reproduced bibliographically from P where used: Chetty, Hendren, Kline and Saez (2014), *Where is the land of opportunity?*, Quarterly Journal of Economics 129(4), 1553–1623; Chetty, Hendren, Jones and Porter (2020), *Race and economic opportunity in the United States: An intergenerational perspective*, QJE (forthcoming in P); Connolly, Corak and HaecK (2019), *Intergenerational mobility between and within Canada and the United States*, NBER Working Paper 25735. No published number from these papers is represented as a fresh estimate.

Data contract: source definitions and schema candidates

Only the 531 tables in the unchanged [data-boundary.yaml](#) are permitted for microdata planning. Its asserted state is user-assumed availability for planning, and `validated_tables` is empty. No person records, runtime table counts, computed confidential summaries or join results have been inspected. Public source appendix files are published reference material; only their column/specification labels were extracted. Neither their values nor the article’s numbers are replication observations.

All resource paths below are relative to `/home/shaoerzhuo/Bolero-denmark`. The curated FSV snapshot is dated 2026-08-30; official pages were checked 2026-09-05 where noted. Catalog observation counts are not empirical evidence for this project. The evidence ladder remains documented → `listed_for_pilot` →

included_in_approved_upload_list → mounted_and_readable → validated. The last two states are not asserted here.

Supported scientific construction

P §2: children born 1973–1977, linked to registered parent(s), with at least one administrative observation in 2010–2015; parent(s) appear at least once from 1980 through the year the child turns 18. The unit of the municipal regression is a linked child. Total pre-tax child income includes the components described in P; family income is the time average of annual child-plus-registered-spouse sums. Parental income is the time average of annual registered mother-plus-father sums. R p.3 identifies IND.PERINDKIALT for parents and IND.PERINDKIALT_13 for children. A spouse belongs to the child’s income construction, but the source does not independently name a spouse field/version: the same total-income concept is intended and the physical mapping needs verification. Annual incomes are CPI deflated before time averaging and expressed in 2015 USD. R adds endpoint ages 15 and 20 as supplementary specifications. No parental age restriction, native-born restriction, balanced panel, additional control or later follow-up is specified.

The supported symbolic definition is

$$I_{iy}^{real} = I_{iy}^{nominal} CPI_{2015}/CPI_y,$$

followed by the source’s annual component sum, time mean and DKK-to-2015-USD conversion. This identity does not select the CPI series, conversion factor, annual component missingness or denominator. G01–G07 stop unresolved quantities before a calculation can alter the scientific sample.

Exact candidate fields and coverage

These are documentary candidates, not a claim that the authors used each table or that competing records can be spliced interchangeably. The distinction is consequential for the historical periods.

Construct	Exact table/fields	Row/reference/key and documented coverage	Source locator and unresolved mapping
Parent/child annual total income	IND.PNR, PERINDKIALT, PERINDKIALT_13; ALDER_ULT_INK is an age candidate	Person-income-year; PNR person-key class; annual flow in DKK/øre. PERINDKIALT 1980–2013; PERINDKIALT_13 listed 1980–2024; income-year comes from documented annual delivery index, not an invented YEAR field.	fsv/labour-income-and-wealth/IND.md, Variables, relative to resources/schema/data-registry-bolero/; R p.3 explicitly identifies the two measures. Live HKV definitions below confirm differing concepts.
Early-year residence, registered parents, spouse	CPST.PNR, MOR_ID, FAR_ID, AEGTEFAELLE_ID, KOM, BOPIKOM, OPGIKOM, ADRDATO, CIVST, STATUS	Person/status date, annual December snapshots; 1975–2006 overall; parent IDs from 1978. PNR/parent/spouse keys; municipality/address keys.	fsv/population-and-elections/CPST.md, Variables; live Danish FSV page checked. Covers a documented candidate for 1980–1984 despite absence from the historical upload list. Does not settle source snapshot/link choice.
Early family and co-residence	FAIN.PNR, MOR_ID, FAR_ID, AEGTEFAELLE_ID, ALDER, KOEN, KOM, BOPIKOM, A_FAMILIE_ID, A_TYPE, A_STATUS, C_FAMILIE_ID, C_TYPE, C_STATUS, D_FAMILIE_ID, D_TYPE, CIVST	Person with household/family status; annual 1980–2007 catalog, latest reference 2006-12-31; precise delivery reference requires confirmation. Multiple historical family classifications are not equivalent.	fsv/population-and-elections/FAIN.md, Variables. No family-type code, co-residence definition or A/C/D priority is selected.

Construct	Exact table/fields	Row/reference/key and documented coverage	Source locator and unresolved mapping
Later demographic status, birth, spouse	BEF.PNR, FOED_DAG, ALDER, KOEN, AEGTE_ID, MOR_ID, FAR_ID, CIVST, KOM, ADRESSE_ID, FAMILIE_ID, FAMILIE_TYPE, IE_TYPE, OPR_LAND, REFERENCETID	Person-reference date; quarterly/December status; documented 1985-12 through 2026-06. FOED_DAG is a date, ALDER age on the reference date.	fsv/population-and-elections/BEF.md, Variables. An adult record can document birth date but is not authorization to select an adult-only birth-cohort universe or fix parent identity at adulthood.
Residence-history candidate, not substitute time convention	BEFBOP.PNR, ADRESSE_ID, BOP_VFRA, BOP_VTIL; BEFADR.ADRESSE_ID, KOM, ADR_VFRA, ADR_VTIL	Person/address spells (BEFBOP 1986-2025); address geography histories (BEFADR 1971-2026), current snapshot contains history. Keys require date-valid address joins.	fsv/population-and-elections/{BEFBOP, BEFADR}.md, Address history alone is not evidence for the child's full 1980 history. No days-based replacement for P's years rule.
Employment/outside labour market and student status	RAS.PNR, ALDER_RAS, ARBSTIL; IDAP.PNR, PSTILL, ALDERNOV; AKM.PNR, BESKST, SOCIO; UDDA.PNR, UDD, IG_VFRA	RAS status on last working day of November, person/year; ARBSTIL 1980-1993; IDAP person/year 1980-2024, PSTILL 1980-2007; AKM annual income/employment classification.	fsv/labour-income-and-wealth/{RAS, IDAP}.md, fsv/education-and-culture/UDDA.md. These are different reference concepts; exact source labour/student codes and bridging over 1993/1994 are unresolved. Annual income status is not automatically employment in November.

Construct	Exact table/fields	Row/reference/key and documented coverage	Source locator and unresolved mapping
University and vocational education	UDDA.PNR, HFAUDD, HF_VFRA, HF_KILDE	Person/attainment snapshot; catalog 1980-12-2025-09; source target 1981-1995. Historical Danish education codes and classification vintage are required.	fsv/education-and-culture/UDDA.md, Variables. No DISCED/ISCED crosswalk or bachelor/vocational code boundary chosen by extractor.
Immigrants and descendants	IEPE.PNR, IE_TYPE, OPR_LAND, GENERATION; later BEF equivalents	IEPE catalog 1979-2025, current cumulative snapshot fields labeled 2025. Person class and country-of-origin keys; historical validity not demonstrated by overall coverage.	fsv/population-and-elections/IEPE.md; neither citizenship nor country of birth alone replaces P's first-/second-generation non-western construct. Source classification year/code list missing.
Teen births	FTBARN.PNR, FOED_DAG, FOEDAAR, MOR1, MOR2, MOR_ALDER, MOR_ALDER_ULT, LEVENDE_ELLER_DOEDT, FTFORAEEL.FORAEELDER.PNR, PNR, FOED_DAG, MOR_FAR	Fertility event histories, 1973-2023, in 2023 cumulative snapshots. FTFORAEEL.PNR parent keys; FTFORAEEL.PNR equal age at event versus year-end are distinct.	fsv/population-and-elections/{FTBARN,FTFORAEEL,FTFORAEELDER}.md; Source birth-event versus mother unit, teen age range, live/stillbirth inclusion, municipality date and per-capita denominator unresolved. FODT starts 2005 in this catalog and is not a historical substitute.

Construct	Exact table/fields	Row/reference/key and documented coverage	Source locator and unresolved mapping
Criminal offences	KRAN.JOURNR, ANM_GER7, ANM_KOMKOD, ANM_REGDATO, ANM_STARTDTO, ANM_SLUTDATO, ANM_ANMMOPTKO; alternative decision-record candidates KRAF.PNR, AFG_AFGOEDTO, AFG_GER7	KRAN report/case records, 1990– 2025; municipality of offence and case-key class. KRAF decisions 1980–2025 are a different unit. Source window 1990–1997.	fsv/living-conditions/{KRAN,KRAF}.md. All are permitted by full boundary. Exact offence scope, recorded versus committed versus adjudicated event, duplicate case rule, denominator and geographic translation unresolved. No conviction proxy.

AKM.SOCIO is a candidate only for its documented historical period, not a claimed harmonized 1980–1995 measure. The source’s unspecified classifications cannot be repaired by selecting a convenient modern variable.

Official income definition evidence

The README’s two TIMES URLs return 404. Their live [PERINDKIALT](#) and [PERINDKIALT_13](#) HKV successors were retrieved and read in Danish. Both exclude imputed owner-occupied housing rent. The newer definition changes business-interest and transfer components; it is not an interchangeable spelling of the older measure. Preserve the source’s generational distinction. No harmonization estimator is added.

The old definition documents 1980–2013; the newer HKV validity label begins 1987, while FSV lists backfilled years from 1980. The child’s 2010–2015 window is within both descriptions. Early parental years use the old measure as R specifies. Documented changes include additions to transfers in 1984, incomplete stock-income recording in parts of 1991–2000, 1994 benefit grossing-up and later income-definition revisions. They are measurement limitations, not authority to change cohorts or add robustness estimates. Official schema definitions cannot establish that the delivered vintage matches the authors’ inputs.

Join and integrity contract

For any supported branch, resolve person-key classes through the governed dictionary, never by parsing anonymized identifiers. Income lookup has at most one source-authorized row per person/income-year; each chosen annual demographic observation has at most one row per person/reference date. Parent/spouse lookup is many children to one referenced adult-year, not a many-to-many expansion. Assert these cardinalities before each join. On unexpected duplicates: stop the affected output and log the

failed key class; do not retain first/last records or average duplicates. A missing physical table/field is an evidenced data boundary only after a governed runtime check; an inaccessible service is an operational failure.

Do not assert that all parents must match, all years must be present or every municipality must reach an invented minimum N. The source explicitly allows some observation gaps, but leaves their computation unresolved. Integrity logs describe failed prerequisites without treating linkage percentages, sample sizes or coverage as scientific success scores. Every consuming Atom keeps these checks internally.

External CPI, currency, cartography, rural classification and original Statistics Denmark Gini inputs are named source dependencies. Their identification/recovery is incomplete; no microdata table outside the boundary is added and no replacement series is chosen. US/Canadian values are source comparison context only, with no external-country empirical program authorized here.

Descriptive identification and claim limits

The fixed question is how intergenerational income rank mobility varies across Danish childhood municipalities, how the Danish distribution compares with the paper's US/Canadian benchmarks, and how municipal characteristics correlate with mobility. P explicitly describes the within-country literature as descriptive. There is no intervention, instrument, natural experiment, treatment assignment or causal identification strategy to extract.

P Eq. (1) relates child-family rank to parental rank separately by municipality. Its slope describes rank persistence; alpha plus beta times a specified parental rank describes the fitted child rank. A smaller slope is less persistence in that equation. The conversion neither reciprocates beta nor claims that places cause the slope. The article's conflicting verbal relative-mobility wording is retained as G08.

Childhood residence is selected rather than randomly assigned. Family composition, parental resources and sorting may contribute to geographic patterns; the paper does not estimate their causal decomposition. Municipal demographic correlations are ecological associations. Correlated employment or family structure is not a treatment effect, mediator estimate, policy ranking or individual-level relationship. The income periods were selected by the original authors to limit lifecycle bias; the conversion reports that rationale, not a verified absence of bias. The cohort-age arithmetic discrepancy remains visible.

The source does not prescribe a causal DAG. `diagrams/study-dag.dot` is therefore explicitly a descriptive data-flow diagram. It is separate from the canonical completion/activation graph. No conditioning set is derived from either diagram.

No new power analysis, equivalence region, significance hurdle, negative control, sensitivity battery, clustering scheme, multiple-testing adjustment or omitted-variable control is registered. Confidence intervals appear only in source-supported targets, with exact unresolved inference details preserved. A future numerical difference from a published value is descriptive comparison, not a pass/fail verdict. The paper supplies no replication agreement band.

Governance, states and handoff

This is Stage 1 of a two-stage replica conversion. Published outcomes were known before registration. This package is a source extraction and prepared report, with no empirical execution and no independent scientific reviewer. The second stage may format and compile; it may not add science, select defaults, repair source conflicts, split/merge modules or change final IDs. The manifest remains draft for the Stage 1 handoff. Buildability does not establish statistical executability or successful replication.

Atom registrations own protocols, activation and local states. Molecule membership owns the complete roster of three source-contribution modules, including every pending member. The Molecule registration owns interpretation. Shared definitions are explicitly incorporated by the Atoms. Manuals, figures, PDFs and graph indexes are derived views. Retain exact `eriksen-munk-2020-source-faithful-retry` slug.

All Atoms currently have `atom_result: prereg`, null strength/shape and no evidence paths or registered state. No published number enters a replication-result slot. Future outputs use `origin=replication` only after governed execution; reference constants use `origin=published_reference` in separate files and are rejected by plotting templates as empirical inputs.

At execution, evaluate operational termination separately from scientific local states. An incomplete program or missing permission is `no_result` operationally and does not satisfy `done`. After a completed prerequisite audit, explicit unresolved source decisions or verified absent data can give a boundary/no-estimate disposition and satisfy `done`; this never licenses downstream estimates without their inputs. A completed module can be partial, with precisely enumerated computable and blocked siblings. All unrun/unactivated targets remain in the inventory. `otherwise` is a residual unresolved state, not a statistical null.

Within each module, evaluate the registered states in written first-match order. Output-local restrictions take precedence over completion labels. Numeric scientific outcomes do not choose activation, local completion state or a replication score. Directional statements use the actual reported statistic and any source-supported uncertainty without an added threshold. Any unfitted target, missing CI, suppressed result, source conflict or nonactivation is stated in Results and Discussion.

The compatibility schema requires prospective ordinal ratings and a Molecule letter. The entries here are inert format metadata, explicitly uncalibrated for a replica; they are not evidence ratings, acceptance criteria, a novelty competition, power, expected significance or scoring bands. Null observed scores remain null. No rating controls execution or interpretation.

All confidential computation would remain inside the separately governed runtime. Only approved aggregate evidence may leave it. The README's original release rules (fewer than 25 matched children; quintile groups below five) are preserved as historical publication restrictions with their ambiguity, not represented as sufficient current disclosure approval. No actual counts, flags or confidential logs are created by this conversion.

Source ambiguities and unavailable inputs have explicit STOP dispositions in `replication/deviations.md`. They are not executor TODOs. New clarifications

require a new source-backed version, never quiet overwrite. An actual conflict with future author code must preserve both locators and block the affected target rather than preferring paper or code. Published files are read-only reference material; no empirical author code was executed. No repository resources, earlier plans, controller state or external systems were modified.

The authoritative science remains unchanged when derived registration/manuscript PDFs are built for inspection. The later Transcriber/host controls final acceptance, sealing and any archive outside this Stage 1 output path. This handoff does not claim those later actions have occurred.

Registered interpretation rules

Restrictions take precedence over permissions; residual reporting does not invent a finding.

1. restriction

Condition: (state(atom-000001) == "source_boundary") OR (state(atom-000001) == "input_boundary") OR (state(atom-000001) == "otherwise")

atom-000001: report the exact unavailable scope and source/input reason. No empirical conclusion from blocked targets is permitted; no boundary implies zero mobility, zero association or agreement.

```
kind: restriction
condition: (state(atom-000001) == "source_boundary") OR (state(atom-000001)
== "input_boundary") OR (state(atom-000001) == "otherwise")
says: 'atom-000001: report the exact unavailable scope and source/input
↪ reason.
No empirical conclusion from blocked targets is permitted; no boundary
↪ implies
zero mobility, zero association or agreement.'
```

2. restriction

Condition: (state(atom-000002) == "source_boundary") OR (state(atom-000002) == "input_boundary") OR (state(atom-000002) == "otherwise")

atom-000002: report the exact unavailable scope and source/input reason. No empirical conclusion from blocked targets is permitted; no boundary implies zero mobility, zero association or agreement.

```
kind: restriction
condition: (state(atom-000002) == "source_boundary") OR (state(atom-000002)
== "input_boundary") OR (state(atom-000002) == "otherwise")
says: 'atom-000002: report the exact unavailable scope and source/input
↪ reason.
No empirical conclusion from blocked targets is permitted; no boundary
↪ implies
zero mobility, zero association or agreement.'
```

3. restriction

Condition: (state(atom-000003) == "source_boundary") OR (state(atom-000003) == "input_boundary") OR (state(atom-000003) == "otherwise")

atom-000003: report the exact unavailable scope and source/input reason. No empirical conclusion from blocked targets is permitted; no boundary implies zero mobility, zero association or agreement.

```
kind: restriction
condition: (state(atom-000003) == "source_boundary") OR (state(atom-000003)
== "input_boundary") OR (state(atom-000003) == "otherwise")
says: 'atom-000003: report the exact unavailable scope and source/input
↪ reason.
    No empirical conclusion from blocked targets is permitted; no boundary
    ↪ implies
    zero mobility, zero association or agreement.'
```

4. restriction

Condition: state(atom-000001) == "partial"

Inspect individual target statuses before downstream use. Unavailable core municipal estimates block their international summaries and demographic correlations. Available supplementary estimates never substitute for core estimates.

```
kind: restriction
condition: state(atom-000001) == "partial"
says: Inspect individual target statuses before downstream use. Unavailable
    core municipal estimates block their international summaries and demographic
    correlations. Available supplementary estimates never substitute for core
    estimates.
```

5. primary

Condition: (state(atom-000001) == "complete") OR (state(atom-000001) == "partial")

atom-000001: describe actual completed danish municipal mobility quantities in their registered units and source order, with required intervals and explicit missing scope. This permission composes only after restrictions, is descriptive and does not classify replication success.

```
kind: primary
condition: (state(atom-000001) == "complete") OR (state(atom-000001) ==
↪ "partial")
says: 'atom-000001: describe actual completed danish municipal mobility
↪ quantities
    in their registered units and source order, with required intervals and
    explicit missing scope. This permission composes only after restrictions,
    is descriptive and does not classify replication success.'
```

6. primary

Condition: (state(atom-000002) == “complete”) OR (state(atom-000002) == “partial”)

atom-000002: describe actual completed international mobility comparison quantities in their registered units and source order, with required intervals and explicit missing scope. This permission composes only after restrictions, is descriptive and does not classify replication success.

```
kind: primary
condition: (state(atom-000002) == "complete") OR (state(atom-000002) ==
↪ "partial")
says: 'atom-000002: describe actual completed international mobility
↪ comparison
quantities in their registered units and source order, with required
↪ intervals
and explicit missing scope. This permission composes only after
↪ restrictions,
is descriptive and does not classify replication success.'
```

7. primary

Condition: (state(atom-000003) == “complete”) OR (state(atom-000003) == “partial”)

atom-000003: describe actual completed municipal demographic correlations quantities in their registered units and source order, with required intervals and explicit missing scope. This permission composes only after restrictions, is descriptive and does not classify replication success.

```
kind: primary
condition: (state(atom-000003) == "complete") OR (state(atom-000003) ==
↪ "partial")
says: 'atom-000003: describe actual completed municipal demographic
↪ correlations
quantities in their registered units and source order, with required
↪ intervals
and explicit missing scope. This permission composes only after
↪ restrictions,
is descriptive and does not classify replication success.'
```

8. supplementary

Condition: (state(atom-000001) == “complete”) OR (state(atom-000001) == “partial”)

Appendix age, income, geography, elasticity and quintile targets may be described only where their own statuses are completed. Conflicts and legacy targets stay visible; they neither establish robustness nor resolve a blocked main target.

```
kind: supplementary
condition: (state(atom-000001) == "complete") OR (state(atom-000001) ==
↪ "partial")
says: Appendix age, income, geography, elasticity and quintile targets may
be described only where their own statuses are completed. Conflicts and
```

legacy targets stay visible; they neither establish robustness nor resolve a blocked main target.

9. residual

Condition: TRUE

Report all remaining pending, unactivated, operationally failed, suppressed, conflicted and unavailable targets. All Atoms start pending. Cross-country benchmarks are published context; no causal claim, numerical success band or independent review is licensed. Residual reporting never overrides a specific restriction.

```
kind: residual
condition: 'TRUE'
says: Report all remaining pending, unactivated, operationally failed,
↪ suppressed,
    conflicted and unavailable targets. All Atoms start pending. Cross-country
    benchmarks are published context; no causal claim, numerical success band
    or independent review is licensed. Residual reporting never overrides a
    specific restriction.
```

Preregistered epistemic graph

Each Atom is an interpretable question or diagnostic judgment. Local result states determine registered activation.

atom-000001

How does intergenerational income mobility vary across Danish childhood municipalities under the source's main and supplementary specifications?

Activation: TRUE

- **complete:** First: a completed audit exists, every rebuildable target in this module has a source-supported estimate and required uncertainty/release disposition, and all inventory context/not-rebuilt targets are explicitly accounted for; no unresolved scientific prerequisite remains for any rebuildable target. — Describe only the completed registered quantities; contextual or explicitly not-rebuilt targets are not replicated findings. Completion does not mean numerical agreement or independent validation.
- **partial:** Second: completed audit, at least one substantive registered target estimated faithfully, at least one other required target has a documented source/input/data/uncertainty boundary; not complete. — Report exactly the estimated targets and preserve all blocked siblings. No substitute specification stands in for an unavailable target.
- **source_boundary:** Third: completed audit, no substantive target estimated, and at least one necessary source decision remains unresolved or conflicting. This takes precedence over concurrent input gaps. — No estimate is licensed for the affected module under the extracted source specification. Report exact source gaps; this is not a null effect.

- **input_boundary:** Fourth: completed audit, no substantive target estimated, no unresolved scientific source decision is the binding cause, and an original input or required governed field is demonstrably unavailable. — The registered target cannot be estimated with the documented inputs. Report the missing input, not a negative scientific finding.
- **otherwise:** otherwise — Report unresolved scientific scope explicitly. Operational failures and unrun work remain unrealized and are never assigned a scientific null.

atom-000002

How does the distribution of the source’s Danish municipal mobility measures compare descriptively with its published US and Canadian benchmarks?

Activation: `done(atom-000001)`

- **complete:** First: a completed audit exists, every rebuildable target in this module has a source-supported estimate and required uncertainty/release disposition, and all inventory context/not-rebuilt targets are explicitly accounted for; no unresolved scientific prerequisite remains for any rebuildable target. — Describe only the completed registered quantities; contextual or explicitly not-rebuilt targets are not replicated findings. Completion does not mean numerical agreement or independent validation.
- **partial:** Second: completed audit, at least one substantive registered target estimated faithfully, at least one other required target has a documented source/input/data/uncertainty boundary; not complete. — Report exactly the estimated targets and preserve all blocked siblings. No substitute specification stands in for an unavailable target.
- **source_boundary:** Third: completed audit, no substantive target estimated, and at least one necessary source decision remains unresolved or conflicting. This takes precedence over concurrent input gaps. — No estimate is licensed for the affected module under the extracted source specification. Report exact source gaps; this is not a null effect.
- **input_boundary:** Fourth: completed audit, no substantive target estimated, no unresolved scientific source decision is the binding cause, and an original input or required governed field is demonstrably unavailable. — The registered target cannot be estimated with the documented inputs. Report the missing input, not a negative scientific finding.
- **otherwise:** otherwise — Report unresolved scientific scope explicitly. Operational failures and unrun work remain unrealized and are never assigned a scientific null.

atom-000003

How do the source-defined municipal characteristics correlate with the four source mobility measures?

Activation: `done(atom-000001)`

- **complete:** First: a completed audit exists, every rebuildable target in this module has a source-supported estimate and required uncertainty/release disposition,

and all inventory context/not-rebuilt targets are explicitly accounted for; no unresolved scientific prerequisite remains for any rebuildable target. — Describe only the completed registered quantities; contextual or explicitly not-rebuilt targets are not replicated findings. Completion does not mean numerical agreement or independent validation.

- **partial:** Second: completed audit, at least one substantive registered target estimated faithfully, at least one other required target has a documented source/input/data/uncertainty boundary; not complete. — Report exactly the estimated targets and preserve all blocked siblings. No substitute specification stands in for an unavailable target.
- **source_boundary:** Third: completed audit, no substantive target estimated, and at least one necessary source decision remains unresolved or conflicting. This takes precedence over concurrent input gaps. — No estimate is licensed for the affected module under the extracted source specification. Report exact source gaps; this is not a null effect.
- **input_boundary:** Fourth: completed audit, no substantive target estimated, no unresolved scientific source decision is the binding cause, and an original input or required governed field is demonstrably unavailable. — The registered target cannot be estimated with the documented inputs. Report the missing input, not a negative scientific finding.
- **otherwise:** otherwise — Report unresolved scientific scope explicitly. Operational failures and unrun work remain unrealized and are never assigned a scientific null.

Conversion handoff (no independent scientific review)

- Verdict: `ready_for_transcription`

Paper-to-protocol conversion, not an independent scientific acceptance. Published results are reference targets; no replication has been executed. Native manifest acceptance means the package was compiled and frozen for execution only.

Checks

- `artifact_contract`: `pass`

Issues

Independent checks

No independent scientific reviewer is part of this two-stage lane. The converter's self-audit is in `docs/replication/conversion-audit.md`.

Source-fidelity self-check

This is the converter's own check, not an independent scientific review. No empirical estimate, runtime data validation or author-code execution occurred. Stage 1 supplies a native World for the two-stage replica lane. Compiled reports do not resolve underdetermined source science.

Check	Finding
Supplied sources read and identified	Complete published four-page PDF and supplied Markdown read; both SHA-256 values match the unchanged provenance record. PDF page images verified Table 1 and Figures 1–2 layout.
Supplement recovery	Complete three-page original README and both public appendix versions retrieved; preprint read completely. Public file headers/specification labels were inspected without extracting val/N into current results or calculating outcome summaries.
Available author code/corrections	Live author-site/GitHub, DOI, publisher and repository searches performed. No empirical author program or resolving correction located. Dataset search identifies released V2 with two files; primary files/README obtained. Inaccessible metadata routes and search scope are disclosed, not treated as proof of nonexistent code.
Fresh extraction	No earlier generated plan, historical Atom list, old deck, source-code reconstruction or prior review was used as scientific evidence.
Fixed question and source order	Three original contributions preserved: municipality analysis, international comparison, demographic correlations. Table 1 remains with its consuming analysis; appendix discussed in its source location.
Analysis grouping	Three final Atoms correspond to the three stated contributions, not a requested count. Main and supplementary municipal income/geography/outcome variants stay together. Source-map explains the two between-contribution separations.

Check	Finding
Target coverage	All 15 Table 1 rows $\times$ six statistics; municipal model/predictions; both maps; prose population/geographic/international comparisons; all 12 $\times$ four correlation targets/intervals; appendix 72 tuples/720 var labels; N/release metadata; D1-only legacy fields; log-percentile ambiguity; conclusion targets retained. No unavailable target is silently removed.
Full data boundary	Unchanged all-FSV boundary used. Early CPST/FAIN and crime KРАН candidates were retained despite historical upload-list omissions. No inference of universal early-data absence from BEF alone. No table outside the boundary is used for microdata planning.
Exact schema versus runtime	Field names/units/key classes/reference periods and candidate gaps documented. No observed join/cardinality, missingness, population count or identifying variation is claimed.
Missing science	G01–G20 explicitly identify the decision, affected output and STOP/no-estimate disposition. Cohort ranks/ties, municipality ties, family observation rules, missingness, CPI/FX, municipal fitting/inference, demographic definitions and quintile/log conflicts are not filled.
Primary-source conflicts	Paper relative-mobility wording and age arithmetic, README variable descriptions, log percentile labels and publication schema differences preserved. No unseen paper-code conflict is fabricated, and code agreement is not asserted.

Check	Finding
Extensions/defaults removed or avoided	No new OLS weighting assumption for municipal fits, rank/quantile type, missing-income zero rule, CPI/FX rate, normal/t critical value, uniform parent/child log floor, demographic proxy, causal DAG, subgroup test, power analysis, multiplicity adjustment, significance score, effect band or replication success threshold.
Engineering translation	Output names, fractional prediction algebra, exact source-label inventory, documented key candidates, duplicate-detection stops, plotting API, vector exports and layout choices only. No engineering label is used to authorize a scientific repair.
Native ownership	Atom registrations own science/activation/local states; Molecule owns all membership and composable interpretation; manifest indexes the same three IDs. Canonical dependencies use completion only. All result fields remain prereg/null/empty.
Complete prepared paper	Study-specific introduction, measurement, methods, Results, conditional Discussion, access limits and conclusion authored. Fifty-three named result slots bind to exact Atom output columns and statuses. No replication sample size, coefficient, interval or conclusion is populated from a publication.
Implemented figures	Both original figures have implemented Python renderers and explicit interfaces. They read no microdata, perform no model fit, reject published-reference origins and unresolved required inputs, preserve source row/series order and retain missing-target dispositions. Original PDFs/screenshots/caches are outside the World.

Check	Finding
Structural checks	Native package validation with the full allowed-table set passed; figure syntax checks passed; result-slot set equals binding set; provenance copy is byte-identical; World root contains exactly atoms/, molecules/, prereg/. Final build checks are recorded below after compilation.
Review/acceptance claims	No independent reviewer, scientific acceptance, causal validation or successful replication is claimed. Manifest remains draft at this Stage 1 handoff. Transcriber may format/build only and must preserve all unresolved science.

The native format requires inert prospective ratings; these are explicitly marked uncalibrated compatibility fields, not substantive science ratings or empirical scoring bands. They never govern an analysis or interpretation. No active Atom’s current state is set to a boundary merely because this extraction has documented a source gap.

Any later source recovery may support a separately versioned clarification. Neither elapsed time, a build success nor executor convenience supplies that clarification. All currently binding stops remain in the Atom protocols, Molecule restrictions, manuscript and figure interfaces.

Build and interface verification

Both drafter-class LaTeX reports compiled successfully with shell escape disabled. The manuscript PDF contains the authored abstract, result placeholders, full methods and two empty source-figure shells. The registration PDF includes the source audit, all shared materials, complete Molecule and complete Atom protocols/states. Visual inspection caught an oversized derived graph and clipped code/table text; graph sizing, block-scalar display, line wrapping and mathematical rendering of the age inequality were corrected without changing parsed scientific payloads. Typesetting suppresses duplicate automatic section numbering. The final source PDFs, page images and build logs remain outside the World.

Native validation, exact result-slot bindings, figure Python syntax and missing-input refusal were checked. Both renderers refuse an empty interface and write no substitute image. No empirical data or simulated result was used to populate a manuscript figure. No current result file was produced. Parsed Atom/Molecule digests were compared before and after typesetting serialization and were identical. This is engineering verification and converter self-check, not empirical testing or independent review.

Source gaps and dispositions

This is a gap ledger, not authorization for alternative analyses. The frozen package does not resolve a scientific choice by choosing a software default. `STOP_UNRESOLVED_SOURCE` produces an affected-target record with no estimate. A later clarification needs a separately versioned registration before computation; the executor and Transcriber cannot supply it. No current Atom has a realized result.

Source abbreviations: P = supplied published PDF, pp. 1–4; R = retrieved Data-verse Readme.pdf, pp. 1–3; D1 = earlier wide appendix file CMLMMY; D2 = long appendix file 2NH3WW associated with dataset version 2.0. C = retrieved author code: **none located**. Consequently, paper–code agreement has not been verified, and no paper–code conflict is claimed on unseen evidence.

ID	Exact unresolved decision or conflict	Affected outputs	Frozen disposition
G01	P §2 specifies linked children born 1973–1977, at least one adult observation and at least one parental observation, but not the date at which mother/father identities are fixed, how changes in legal parenthood are handled, or whether annual residence records or another observation unit determine eligibility. R repeats the population without resolving these choices.	Entire analytical sample; all three Atoms	Do not select an annual snapshot, fixed parent date, biological-only link, citizenship restriction or complete-case cohort. Preserve cohort years; stop sample-dependent estimation.

ID	Exact unresolved decision or conflict	Affected outputs	Frozen disposition
G02	P/R specify annual family sums followed by time averages. They do not settle absent spouse versus missing spouse income, one missing parent component, income-record absence versus zero, nonresident years, exact annual spouse-link date, or denominators for partially observed sums/individual means.	All income statistics, ranks, logs and their downstream outputs	No zero filling, available-case average, balanced-panel requirement, imputation, trimming or censoring convention is added. Stop each dependent quantity. No common-support restriction across supplementary specifications.
G03	P says Danish CPI deflation and conversion to 2015 USD, without naming the CPI vintage/series, within-year aggregation, exchange-rate source or averaging convention. R confirms CPI adjustment but does not give series values.	USD Table 1 cells; time-weighted incomes, ranks and elasticity	Symbolic deflation is retained; no rate or series is chosen. A common positive currency factor cancels from ranks algebraically, but that does not resolve the unknown year-specific deflator or missingness.

ID	Exact unresolved decision or conflict	Affected outputs	Frozen disposition
G04	P says rank within cohorts; R defines names and fractional prediction points but does not settle tied ranks, endpoint normalization, exact ranking universe, treatment of zero/negative ranks, or whether individual parental ranks use the same population as combined parental ranks.	All rank specifications; quintile membership; main maps/comparison/conditions	Do not apply average ranks, $(\text{rank}-1)/(\text{n}-1)$, packages or minimum-income exclusions. Stop affected ranks; retain known prediction formula only.

ID	Exact unresolved decision or conflict	Affected outputs	Frozen disposition
G05	P assigns the municipality with most observed childhood years, 1980 through age 18. Annual reference date, equal-duration municipality ties, within-year moves and person-specific post-2007 crosswalk for split historical municipalities are not specified. R gives old/new boundaries but no allocation file. For ages 15/20 it does not say whether geographic assignment changes with the income window.	Municipality assignment, Table 1 moves/time shares, every municipal estimate, Figure 1 geometry linkage	No earliest/latest/lowest-code tie-break, days-based assignment, population crosswalk, adult residence substitution, or shortened childhood window. FAIN/CPST document early-year candidates, so do not label 1980–1984 universally unavailable. Assignment remains unresolved.
G06	Table 1 does not fully define the marriage indicator across 2010–2015, move count event unit, annual co-residence test for each parent, denominator when addresses are missing, sample-versus population-SD or quantile algorithm.	All 15 Table 1 rows, with scope depending on the unresolved operation	Preserve each row and its six statistics. Simple counts/means may only use independently resolved inputs; SD/quantile cells stop where their convention is not supported. Do not turn the table into a new diagnostic experiment.

ID	Exact unresolved decision or conflict	Affected outputs	Frozen disposition
G07	P Eq. (1) specifies a linear regression; R supplies coefficients and their SE labels, but neither retrieved source states the fitting criterion/weights or covariance estimator for the municipal regressions. P's explicit OLS-SE statement concerns Figure 2, not necessarily Eq. (1).	Municipal alpha/beta, SEs and predictions, all related modules	Preserve the regression equation. Do not silently assume unweighted OLS or transfer Figure 2's SE rule to every municipal regression. Municipal fitting and uncertainty remain stopped pending source support.
G08	P §2 calls beta the inverse of persistence/relative mobility, its abstract says mobility is larger than in the US, and its conclusion says less; §3 reports a smaller Danish slope. Eq. (1) and Figure 2 legend identify beta as the slope.	Relative-mobility wording and international conclusion	Display beta as rank persistence when available, with lower beta corresponding to less persistence in that equation. Do not calculate $1/\text{beta}$ or $1-\text{beta}$; retain the source's verbal inconsistency. No generic larger/smaller mobility claim substitutes for the actual statistic.

ID	Exact unresolved decision or conflict	Affected outputs	Frozen disposition
G09	P footnote 3 says the youngest cohort turns 34 in 2010; the stated 1977 cohort turns 33.	Age motivation, not permission to change the cohort	Record the arithmetic discrepancy. Preserve 1973–1977 and 2010–2015. No age-34 exclusion or shifted income window.
G10	P’s international paragraph does not identify the exact US/Canadian extraction files/versions, weights, missing-estimate policy or dispersion denominator. Exclusions of the largest 30 US counties/10 Canadian districts are stated for population-size context, not clearly for mobility summaries. Geography is described inconsistently as tracts in the introduction and districts in the findings.	Atom 2 international empirical reconstruction and some Danish summary cells	External published values remain labeled comparison targets. No new US/Canadian data analysis under the FSV boundary; no exclusion transfer to mobility estimates, weighting convention or new country test. Danish formula summaries stop if required aggregation conventions remain unresolved.

ID	Exact unresolved decision or conflict	Affected outputs	Frozen disposition
G11	Figure 2 and §3 give age windows and exceptions, but not complete annual denominators, missing municipality-years, demographic coding, national/local income-decile universe or thresholds, student codes, marriage/single-parent family type, non-western classification vintage, or age-at-reference convention.	All 12 characteristics $\times$ four mobility measures, with row-specific gaps listed in Atom 3	No proxy or ad hoc recoding. Preserve each row; stop affected inputs and all correlations relying on them. No controls or extra subgroups.
G12	Figure 2 calls intervals 95% CIs based on OLS SEs, without specifying regression direction, standardization/weighting, covariance implementation, critical-value distribution or degrees of freedom.	48 Figure 2 intervals and, where fitting is needed to define the reported correlation, point estimates	State the source's OLS-SE requirement. Do not choose normal 1.96, Student t, Fisher transformation, bootstrap, robust/cluster SEs or a regression direction. Stop unresolved points/intervals. No significance decision rule.

ID	Exact unresolved decision or conflict	Affected outputs	Frozen disposition
G13	Statistics Denmark (2017) Gini citation lacks an exact archived series or extraction. Figure 2 specifies 1987–1993. Current definitions/other Gini series do not identify the original data.	Four Gini correlations	Original numeric input unavailable; no microdata Gini replacement or newer series.
G14	Figure 1 geography file, projection and map-to-municipality identity file were not recovered. P footnote 4's 2011 rural classification short link now redirects to the agency home page.	Figure 1 exact geographic rendering; rural/urban descriptive labels	Require verified geometry/identity and classification before their use. Renderer accepts preprojected geometry with audited Bornholm relocation, not invented polygons. No new rural score or statistical group contrast.
G15	R p.1 specifies resetting child/family income below zero to 1000 DKK before logs. It does not specify zero handling, treatment of parental nonpositive income, timing of replacement relative to deflation/averaging, or log base.	All 36 log specifications and their coefficient/SE targets	Do not extend the child rule to parents, replace zeros, add one, trim or discard observations. Preserve the supported negative-child rule text but stop log construction.

ID	Exact unresolved decision or conflict	Affected outputs	Frozen disposition
G16	R describes r_75 as the 25th percentile while giving $\alpha + \beta \times 0.75$; P Eq. (1) explicitly gives the 75th target. R calls x_q5_N first-quintile observations, and repeats first-to-first descriptions for q1q5/q5q1/q5q5. Dataset metadata lists the four distinct transitions.	Supplementary labels/denominators and appendix-specific target fidelity	Main P-defined r75 formula remains supported. Appendix r_75 label conflict is disclosed; no silent correction. All quintile denominator/transition semantics remain stopped where descriptions conflict; labels alone do not authorize a repair.
G17	D2 contains r_25/r_50/r_75 labels for log specifications; R's percentile formula does not explain how a value of .25/.50/.75 on a log-income RHS represents a parental percentile.	108 log-specification prediction labels	Retain as explicit not-rebuilt targets. Do not evaluate log-income regressions at fractional ranks, exponentiate ad hoc or supply log income quantiles.

ID	Exact unresolved decision or conflict	Affected outputs	Frozen disposition
G18	R says municipal estimates with fewer than 25 child-parent matches are removed and quintile information is removed when any observed quintile group has fewer than five observations. It does not completely define which joint/marginal groups are in “any,” and D1/D2 expose different publication schemas.	Appendix release mask, quintile cells; main-vs-appendix comparison	Preserve the explicit N<25 release rule; it is not a new scientific exclusion or an achieved privacy guarantee. Stop quintile release if group scope is unresolved. Do not infer a numerical suppression mask from published missing values. Governed release approval still controls publication.
G19	D1 is wide and includes joint-count columns and rank_rank; D2 is long, includes 13 var labels, and does not expose the joint-count columns. R describes long format. DataCite v2.0 points to D2 and R; index-native version history was inaccessible.	Supplementary version/coverage claims	Keep both identities/hashes. Use D2 for the current label inventory, D1-only columns as retained legacy targets; do not claim numerical agreement, correction intent or reproduce undocumented deletions.

ID	Exact unresolved decision or conflict	Affected outputs	Frozen disposition
G20	No empirical author program was located via author sites/GitHub trees, indexed repository metadata, searches or supplied files. Publisher and native Dataverse metadata routes partly failed.	Code-specific rules/conflict adjudication	Code is unavailable in this conversion, not proven nonexistent. No historical generated plan is used to fill the gap. No empirical source program was executed.

Operational errors (failed mounts, timeouts, broken builds) are not statistical nulls and do not satisfy **done**. A documented source boundary can be adjudicated as a completed boundary at execution, with no estimate; this preregistration does not pre-populate that runtime state. The only retained numeric thresholds are source definitions (cohorts, windows, percentiles, nominal 95% CIs and appendix release cutoffs). Power, additional diagnostics, negative controls, multiplicity corrections, equivalence bands and replication success thresholds: not specified in source; not added.

Post-extraction display check

2026-09-05. This is an operator engineering check, not an independent scientific review or empirical replication. The original two-stage retry is retained.

Nine synthetic-only checks exercised the two authored figure interfaces: complete and partial correlation displays; refusal of all-unestimated, published-reference, duplicate-target and missing-target correlation inputs; complete synthetic map display; refusal of published-reference map values and missing geography. Synthetic plots were written outside the World and are not included in the manuscript, package or ZIP.

All interface assertions passed. Visual inspection nevertheless found that long missing-result explanations overlapped at the right of the correlation plot. The source-level layout repair uses numbered markers and a separately sized, wrapped explanation area. It preserves every explanation, input row, point estimate, interval, series order and input refusal. It adds no scientific calculation, outcome, threshold, test, imputation or source convention.

The repaired renderer passed the same nine checks and its partial-input PDF was visually inspected. Atom registrations, Molecule membership/interpretation, scientific shared documents and authored manuscript remain unchanged. The repaired source is

handed to Transcriber for exact preservation; Transcriber does not make the scientific or display-design amendment itself.

The lane’s instructions now explicitly reserve full LaTeX/PDF compilation for the final stage/host. Stage 1 owns protocol and manuscript/figure source files, source-fidelity checks and source/interface tests, not hand-edited generated LaTeX which a later host build would replace.

Published reference targets — not replication results

These values were read from P, with Table 1 and Figure 2 layout inspected as PDF images. They are known public comparison targets only. Do not load this file as empirical input to an Atom or figure. No numerical agreement band is registered. The manuscript’s replication table/results remain unfilled.

Table 1 (P p.2)

Source row	N	Mean	SD	p25	Median	p75
Observations in adulthood	339,969	5.92	.52	6	6	6
Female	339,969	.43	.5	0	0	1
Married between 2010–2015	339,969	.62	.48	0	1	1
Child mean income	339,969	60,724	89,008	42,600	54,720	69,110
Family mean income	339,969	95,677	113,142	52,715	86,864	122,009
Parents’ mean income	339,969	93,843	59,063	71,194	86,683	105,848
Mother’s mean income	338,874	34,352	17,039	25,684	33,590	41,825
Father’s mean income	334,136	61,450	55,220	43,110	53,024	68,316
Mother’s age in 1980	338,854	31.57	4.93	28	31	34
Father’s age in 1980	333,988	34.37	5.79	31	34	37
Moves by age 18	339,969	.47	.92	0	0	1
In assigned municipality	339,969	.93	.15	.93	1	1
Living with both parents	339,969	.75	.38	.54	1	1
Living with mother	339,969	.19	.38	0	0	.2
Living with father	339,969	.03	.14	0	0	0

The father’s-age mean is printed 34,37; preserve that typography in the reference transcription. A decimal-comma normalization for comparison would be disclosed as formatting, never a new result. Dollar entries are source 2015 USD. The source’s average assigned-childhood share is 92.6% in prose versus .93 in the rounded table.

Population context and international mobility (P p.2)

Source quantity	Published reference	Status
Danish municipality population mean / median in 2015	57,751 / 42,812	Population context, not analytic cohort size
US county population mean, 2010, excluding 30 largest	75,609	Foreign published context, not rebuilt
Canadian district population mean, 2011, excluding 10 largest	69,694	Foreign published context, not rebuilt
Denmark and Canada average beta	approximately .242	Source wording; no equivalence threshold
US average beta	.33	Source published reference
US r25 mean (SD)	.427 (.065)	Fractional rank
US r50 mean (SD)	.51 (.059)	Fractional rank
US r75 mean (SD)	.591 (.062)	Fractional rank
Denmark r25 mean (SD)	.441 (.023)	Fractional rank
Denmark r50 mean (SD)	.502 (.019)	Fractional rank
Denmark r75 mean (SD)	.562 (.019)	Fractional rank
Mean r75 minus mean r25, US / Denmark	16.4 / 12.1	Percentile points, source arithmetic

No source correlation coefficient or confidence limit is inferred from pixel positions. Figures 1 and 2 supply display structure and source interpretations only. D1/D2 numerical values were not extracted into this World, and no new summary of their outcome values was computed.

Source-to-Atom audit and grouping

The source paper fixes one question and explicitly names three contributions (P p.1, introduction). Those contributions determine the three final Atoms. No Atom corresponds merely to a figure, panel, coefficient, join or convenience step. The source's sample table is kept inside its municipal analysis, and its appendix's related outcomes/specifications stay there too. There is no Atom-count target and no discarded candidate hand.

Final Atom	Source purpose and locations	Grouping rationale	Downstream meaning
atom-000001	Danish within-country municipal mobility; P §2, Table 1, Eq. (1), §3 first paragraph, Figure 1, p.4 footnote 6; R all three pages and D1/D2 specification labels	The same linked-child income/geography analysis produces its sample description, main rank coefficients/predictions, maps, individual-income specifications, endpoint ages, old boundaries, elasticity and quintile targets. Keeping these related variants together preserves the first contribution. Neither two map panels nor 72 specifications are independent research questions.	Supplies only completed core age-18 family-on-parents municipal quantities to the other contributions. Keeps all supplementary boundaries without substituting supplementary results for main results.
atom-000002	P §3 second paragraph, international area-distribution comparison and population context	A separate source contribution compares distributions of local estimates rather than estimating child-level relations. Foreign benchmarks remain known reference targets; no external-country experiment is invented.	Descriptive comparisons of completed Danish summaries only; source cross-country measurement limits remain binding.

Final Atom	Source purpose and locations	Grouping rationale	Downstream meaning
atom-000003	P §3 third paragraph through p.4; Figure 2, its caption and footnote 5	The source treats correlations with 12 characteristics and four mobility measures as one analysis. All 48 targets, special windows and demographic interpretation stay in this module. No row is split into a diagnostic Atom.	Ecological correlations only; no causal driver or policy ranking. Missing definitions/intervals remain explicit.

Canonical schedule: atom-000001 is initially active; atom-000002 and atom-000003 use `done(atom-000001)`. Completion includes a documented scientific boundary, but an operational failure does not satisfy `done`. Downstream protocols inspect their required target-level core inputs even after completion. They cannot consume a bare completion label as an estimate. Atom 2 and Atom 3 have no scientific dependency on each other; their narrative order remains the source order.

Consequential rule map

Rule	Evidence and class	Implementation ceiling
Birth cohorts, child window, at-least-once observations	P pp.1–2 §2; R pp.2–3, S	1973–1977; child 2010–2015; parent 1980 to endpoint. No fixed parent-link date, residence-date convention or complete-case rule is added.
Income fields	R p.3 explicitly names PERIND-KIALT/PERINDKIALT_13; S; current IND field identification verified, E	Preserve generational income definitions. Unknown spouse/missing-component/date rules stop affected targets.

Rule	Evidence and class	Implementation ceiling
Childhood parent/residence linkage candidates	CPST/FAIN/BEF FSV Variables; live CPST page; E only for candidate key meanings	CPST and FAIN document early years. Their mere existence does not establish authors' table choice, join success or interchangeable snapshots. G01/G05 remain.
Income sum, deflation, time means	P p.2 §2 and R p.3, S; CPI-ratio identity E	No CPI vintage, exchange rate, missing-value rule or nonlinear correction selected.
Cohort ranks	P p.2 §2, S	Fractional prediction points are corroborated by R. Rank/tie/universe implementation unresolved; no guessed rank function.
Main regression/predictions	P Eq. (1), S; $\alpha + \beta \times p$ also R p.2	Formula retained; municipal fitting weights/criterion and covariance remain unresolved. Source Figure 2 OLS uncertainty is not automatically transferred to Eq. (1).
Most-years municipality	P p.2 §2, S	Preserve 1980–18 rule; tie handling, within-year record and post-reform split mapping not chosen. Source 98 municipalities is a geographic scope, not an observed successful match count.
Related supplementary variants	P footnote 6; R pp.1–3; D2 identifying labels, S	Only the 72 source tuples, no rank/log cross-types or extra sensitivity models. All log percentile and transition ambiguities retained.

Rule	Evidence and class	Implementation ceiling
Appendix release restrictions	R p.3, S	N<25 and group N<5 are historical release rules, not statistical decision thresholds. Ambiguous quintile group scope blocks release.
International summaries	P p.2 §3, S; span identity E	Exact published values separate from replication slots; source weights/SD/missing policy remain unresolved; no new external-country estimation.
Demographic rows/windows/exceptions	P Figure 2 image/caption, §3 and footnote 5, S	Original 12 rows × four measures, source age windows and student exclusion. Schema candidates do not choose source-silent codes or denominators.
Figure 2 intervals	P Figure 2 caption, S	95% and OLS-SE requirement retained. Direction/standardization/critical value/df unresolved; no implementation default.
Figure form	P Figure 1 image/caption and Figure 2 image, S; Python layout/API/output paths E	Maps and ordered correlation intervals only. No invented figures, estimates, bands or empirical arrays. Missing inputs have explicit refusals/boundary marks.
Relative-mobility prose, age arithmetic, appendix descriptions	P abstract/§2/§3/conclusion, R p.2, C	Exact conflicts preserved in G08/G09/G16/G17; no silent scientific correction.
Empirical author code	Search record, A	No empirical program retrieved. No claim of paper-code agreement or fabricated source-code locator.

S = source-explicit; E = meaning-preserving engineering; U = unresolved source choice; C = source conflict; A = unavailable original. U/C/A produce no-estimate or not-rebuilt dispositions. Source-provenance and retrieved hashes distinguish exactly which materials were supplied, retrieved, metadata-only, or inaccessible. Full source text/screenshots are not shipped in this World.

Schema evidence map

All exact candidate fields, coverage, row units, key classes and breaks are in [data-contract.md](#), incorporated by each Atom. P/R identify the income variables; other table choices are documentary candidates. Relevant FSV locators are [resources/schema/data-registry-bolero/fsv/labour-income-and-wealth/{IND,RAS,IDAP,AKM}.md](#), [population-and-elections/{CPST,FAIN,BEF,BEFBOP,BEFADR,IEPE,FTBARN,FTFORAEL}.md](#), [education-and-culture/UDDA.md](#), and [living-conditions/{KRAN,KRAF}.md](#). Planning permission covers all these, including CPST and KRAN absent from old upload lists. No historical smaller boundary is inherited.

Manuscript and figure bindings

Table 1 and municipal/map/supplement Results bind to atom-000001. International prose/table binds to atom-000002. The 48 Figure 2 rows and corresponding Results bind to atom-000003. [docs/paper/results-map.md](#) names every slot, exact output column and conditional reporting disposition. [figures.yaml](#) binds the two implemented Python renderers to those outputs. Neither prose nor code estimates, imputes, reweights, reclassifies or fills unknown results from source values.

Original-order source target inventory

This inventory includes source targets even when no faithful estimator can currently be determined. All replication result slots are empty. Target IDs below are audit labels, not separate experimental nodes. The complete Atom roster is in the Molecule. Public numeric references are isolated in [published-reference-targets.md](#).

1. Data/sample context and Table 1 (P §§1–2, pp.1–2)

P's stated 339,969 matched sample is a reference N, never an inclusion target or stopping threshold. Source time windows and parent-age motivation remain with atom-000001. The contradictory youngest-age footnote is G09.

Each following row retains **all six** source statistics: N, mean, SD, p25, median, p75. Every cell maps to atom-000001/table1.csv with its row_id/statistic. Source choice gaps G01/G02/G03/G06 block affected cells; none are dropped.

Row ID	Source row, in printed order	Unit	Disposition
adult_observations	Observations in adulthood	count	Retained; unresolved inputs/statistical conventions; no estimate.
female	Female	indicator	Retained; unresolved inputs/statistical conventions; no estimate.
married	Married between 2010–2015	indicator	Retained; unresolved inputs/statistical conventions; no estimate.
child_income	Child mean income	2015 USD	Retained; unresolved inputs/statistical conventions; no estimate.
family_income	Family mean income	2015 USD	Retained; unresolved inputs/statistical conventions; no estimate.
parent_income	Parents' mean income	2015 USD	Retained; unresolved inputs/statistical conventions; no estimate.
mother_income	Mother's mean income	2015 USD	Retained; unresolved inputs/statistical conventions; no estimate.
father_income	Father's mean income	2015 USD	Retained; unresolved inputs/statistical conventions; no estimate.

Row ID	Source row, in printed order	Unit	Disposition
mother_age	Mother's age in 1980	years	Retained; unresolved inputs/statistical conventions; no estimate.
father_age	Father's age in 1980	years	Retained; unresolved inputs/statistical conventions; no estimate.
moves	Moves by age 18	count	Retained; unresolved inputs/statistical conventions; no estimate.
assigned_share	In assigned municipality	share	Retained; unresolved inputs/statistical conventions; no estimate.
both_share	Living with both parents	share	Retained; unresolved inputs/statistical conventions; no estimate.
mother_share	Living with mother	share	Retained; unresolved inputs/statistical conventions; no estimate.
father_share	Living with father	share	Retained; unresolved inputs/statistical conventions; no estimate.

P §2 also gives mean/median Danish municipal population in 2015 and average childhood time in assigned municipality (92.6%, more precise than Table 1). Municipal population belongs to atom-000002's comparison context and is not rebuilt under an invented population reference date; childhood residence belongs to atom-000001 and G05/G06. These prose-only targets are retained separately from table rounding.

2. Eq. (1), municipal findings and Figure 1 (P pp.2–3)

Source target	Atom/output	Frozen disposition
Municipal alpha and beta; expected ranks r25, r50, r75	atom-000001/municipal-estimates.csv, core age18/fam_rank/parent_rank/pos12007	Retained; G01–G07 stop unresolved source rank/pos12007 not use a supplementary tuple as replacement.
Figure 1a relative mobility (beta)	atom-000001/core-map.csv.beta; figure1.py left	Retained; no inverse transform. Missing estimates/geometry produce explicit no-display boundary.
Figure 1b absolute upward mobility (r25)	atom-000001/core-map.csv.r25; figure1.py right	Retained; darker for smaller fitted child rank.
Four cities, Bornholm relocation; rural/urban/Western Jutland/Lolland–Falster descriptive narrative	atom-000001, map-geometry/city-labels and geographic prose	Presentation retained; no new subgroup test or rural score. Exact geometry/classification gaps G05/G14.

3. International comparison (P §3 second paragraph, p.2)

Source target in narrative order	Atom/output	Disposition
US 2010 population mean after top-30 county removal; Canadian 2011 mean after top-10 district removal; Danish 2015 mean/median context	atom-000002/country-summary.csv	Published context retained, no new external analysis; precise Danish population date unavailable. Exclusions not copied into mobility analysis.
Canada/Denmark average beta versus US average beta	atom-000002/country-summary.csv, beta_mean	Foreign reference only; Danish aggregation has G10 plus upstream gaps. Source verbal conflict G08 retained.
US means and SDs of r25, r50, r75	atom-000002 reference context	Original-order three pairs retained; not independently rebuilt.

Source target in narrative order	Atom/output	Disposition
Danish means and SDs of r25, r50, r75	atom-000002/country-summary.csv	All three pairs retained; no weighting/SD convention invented.
“About three times” US dispersion; span between mean r75 and mean r25 (US 16.4, Denmark 12.1 percentile points)	atom-000002/country-summary.csv.span_pp and comparison.csv	Span identity retained; no new variance test or agreement score. Published numbers do not fill rebuilt fields.
Similarity to Canadian/US comparison and prior national mobility findings	atom-000002 narrative	Source context only, not a new national mobility estimate.

4. Figure 2 and demographic interpretation (P pp.2–4)

Each row below retains beta, r25, r50 and r75, each with a point estimate and source 95%-CI target, totaling 48 point/interval pairs. All map to atom-000003/correlations.csv and figure2.py. No numeric values are digitized from the figure. The unknown interval specification remains G12, in addition to row-specific construction gaps.

Row ID	Printed characteristic, in top-to-bottom order	Window/exception	Disposition
bottom_decile	Share from bottom income decile	1980–1995; ages 25	Retained; G11/G12 and upstream gaps; no estimate.
top_decile	Share from top income decile	1980–1995; ages 25	Retained; G11/G12 and upstream gaps; no estimate.
gini	Gini coefficient	1987–1993	Retained; G11/G12/G13 and upstream gaps; no estimate.
outside_labor	Share outside labor market	1980–1995; students excluded	Retained; G11/G12 and upstream gaps; no estimate.

Row ID	Printed characteristic, in top-to-bottom order	Window/exception	Disposition
employed	Share employed	1980–1995; students excluded	Retained; G11/G12 and upstream gaps; no estimate.
married	Share of married individuals	1980–1995	Retained; G11/G12 and upstream gaps; no estimate.
single_parents	Share of single parents	1980–1995	Retained; G11/G12 and upstream gaps; no estimate.
teen_births	Teen births per capita	1980–1995	Retained; G11/G12 and upstream gaps; no estimate.
nonwestern	Share of non-western immigrants	1980–1995; first and second generation	Retained; G11/G12 and upstream gaps; no estimate.
university	Share university educated	1981–1995	Retained; G11/G12 and upstream gaps; no estimate.
vocational	Share vocationally educated	1981–1995	Retained; G11/G12 and upstream gaps; no estimate.
crime	Criminal offences per capita	1990–1997	Retained; G11/G12 and upstream gaps; no estimate.

The following prose-only interpretation targets are also retained with atom-000003: the employment/marriage association; single-parent/non-western association; teen-birth/outside-labour-force association; the suggested geographic pattern across urban municipalities, Western Jutland and Lolland–Falster. They are conditional descriptions of the registered correlations, not separately fitted mechanisms or subgroup contrasts. Future causal-use suggestions on p.4 are context only, explicitly not rebuilt.

5. Online appendix named at footnote 6 (P p.4; R; D1/D2)

The source appendix is actually retrieved, not merely cited. R is three pages; D2 is the long-format file identified by current dataset version 2.0 metadata. `appendix-specifications.yaml` exhaustively enumerates the **72 observed source specification labels**, without N/val. This is target coverage, not a scientific cohort count. All map to atom-000001. No output value from D1/D2 is in an Atom result.

Two geography flags (pre-/post-2007), three endpoint ages (15/18/20), and the exact income pairs below are source-supported labels. The product is corroborated by the retrieved file labels, not invented as a robustness battery.

Specification family	Exact pairs	Retained output labels	Disposition
36 rank tuples	y=c_rank or fam_rank; x=parent_rank, mom_rank or dad_rank; both geographies and all three ages	alpha, alpha_se, beta, beta_se, r_25, r_50, r_75, x_q1_N, x_q5_N, q1q1, q1q5, q5q1, q5q5	468 labels retained; shared construction/fitting gaps. Main-compatible predictions retain P's formula; quintile label/denominator conflicts G16 and ties G04 stop transitions.
36 log tuples	y=c_inc_log or fam_inc_log; x=parent_inc_log, mom_inc_log or dad_inc_log; both geographies and all three ages	alpha, alpha_se, beta, beta_se	144 coefficient/SE labels retained; G15 nonpositive/log-transform rules unresolved, plus sample/geography/fitting gaps.
Log percentile-labelled outputs	Same 36 log tuples	r_25, r_50, r_75	108 labels retained as not-rebuilt-unresolved (G17). No log prediction at a fractional rank or invented back-transform.

Specification family	Exact pairs	Retained output labels	Disposition
N metadata per tuple/municipality	Both rank and log families	N	Retained as source appendix sample/release metadata, not a target value to force; G01/G02/G18.
D1-only legacy fields	Earlier wide-file source labels; applicable meaning not inferred from values	q1q1_N, q1q5_N, q5q1_N, q5q5_N, rank_rank	Retained as legacy/unresolved targets (G19/G16). D2 omission is not interpreted as a correction or authorization to drop them silently.
Appendix publication mask	R p.3	N<25 municipality omission; quintile-group N<5 information suppression	Explicit source release rules retained; G18 group scope unresolved. No privacy guarantee or scientific success threshold.

The source target dimensions, including 15-year endpoints omitted from the general dataset description but present in R and file labels, are preserved. Negative child/family income replacement at 1000 DKK is recorded without extending it to zeros/parents or selecting its operation order.

6. Conclusion and non-analysis material

P §4 repeats the three contributions in their original order. Replication conclusion slots bind to those three modules, with source conflicts and boundaries carried forward. No new conclusion-level test, pooled score or preferred specification is added. References, acknowledgments and statements that the original aggregate release is nonconfidential are source context, not experimental nodes. No target is removed because the needed original material or scientific decision was unavailable.

Execution supplement

Frozen Danish income-mobility execution

This implements the executable, source-supported parts of the existing canonical registration. **Every empirical estimation path in this particular frozen version has an explicit source stop.** The CLI executes a complete target audit and emits those boundaries. It does not fit an invented municipal OLS regression, choose ranks, construct a guessed cohort, or manufacture Figure 2 intervals. It cannot produce an empirical replication from this registration as it stands.

The authority is the three Atom registrations and shared documents, especially [deviations.md](#). The common protocol says a later source clarification requires a new registration version. Nonempty runtime source-resolution metadata is therefore rejected, even if it claims a locator. This engineering bundle does not amend those instructions.

The implementation includes executable arithmetic, calendar predicates, complete annual component sums, the CPI-ratio identity, currency conversion, count/mean calculations, unique-most-years residence selection with a tie stop, the supported negative-child-income clause, rank prediction identities, span/comparison arithmetic, the source $N < 25$ release rule, and cardinality-preserving joins. [kernels.py](#) operates on already-defined operands in memory; it does not authorize their empirical construction. Independently testable operations remain usable even when a different operation is blocked. The CLI cannot accept precomputed ranks, coefficients, correlations, or a purported resolved cohort as a shortcut past G01–G20.

Running and environment

Use the supplied controller Python. No environment was installed or changed. Versions are in [requirements-tested.txt](#). Rscript is available but unused; Stata is not installed and is not required. SciPy 1.15.2 is present but no inference method from it is used. The tested Python is 3.12.4.

For this author workspace, set these explicit locations (the World and code may subsequently be relocated independently):

```
STUDY_PY=/home/shaoerzhuo/anaconda3/bin/python
STUDY_WORLD=/home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-reference-co_
↪ de-20260906/income-mobility/v003/world
STUDY_CODE="$STUDY_WORLD/docs/execution"
STUDY_SCRATCH=/home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-reference-
↪ code-20260906/income-mobility/scratch/r03/author
STUDY_INPUTS="$STUDY_CODE/input-example.json"
"$STUDY_PY" "$STUDY_CODE/run.py" --help
"$STUDY_PY" "$STUDY_CODE/run_tests.py" --output "$STUDY_SCRATCH/test-results"
```

Each run creates `--output/atom-NNNNNN/`. Supply a new output root for repeated runs; existing Atom directories are never overwritten. Outputs must be outside the World. The CLI never writes Atom bodies, registered states, manuscripts, manifest, figures, or controller state. A writable copied execution directory can run against a

separate read-only World. Tests accept optional `--world PATH` when the test code itself has also been copied.

Exit code 0 means an execution disposition was written, including a source boundary or an unactivated run. It does not mean a successful empirical study. Exit 2 indicates operational failure/refusal. With validated inputs and a broken predecessor, the receipt has `terminal=no_result` and no scientific state. Invalid World/manifest/setup input is refused before a scientific receipt can be issued.

atom-000001 — Danish municipal mobility

Exact command:

```
"$STUDY_PY" "$STUDY_CODE/run.py" --atom atom-000001 --world "$STUDY_WORLD"  
↪ --inputs "$STUDY_INPUTS" --output "$STUDY_SCRATCH/atom1-audit"  
↪ --dispatch-policy activation_respecting
```

Implementation: `run.execute` → `analysis.atom_000001`; operand calculations and integrity assertions in `kernels.py`. Reads all 72 source tuples and their 720 labels directly from the frozen appendix inventory. Retains 90 Table 1 cells; core alpha/beta/r25/r50/r75 and alpha/beta SE labels; all appendix labels; 72 N-metadata targets; release scope; five D1 legacy labels; maps and prose scope.

Required empirical inputs, if a future source-backed version licenses them: IND.PNR, PERINDKIALT for parents and PERINDKIALT_13 for children, with the delivery's income-year index; source-selected parent/residence links among CPST/FAIN and later BEF; verified historical geography among CPST/FAIN/BEFBOP/BEFADR candidates; original CPI/FX and geographic assets. Exact field meanings and locators are in [schema-candidates.json](#) and [data-contract.md](#). CPST.AEGTEFAELLE_ID and BEF.AEGTE_ID are separate documentary candidates, not interchangeable snapshot rules. All candidate tables are inside the existing 531-table boundary; none is validated for access. The current CLI stops before opening any declared microdata path.

Outputs and units:

- **table1.csv**: row_id/statistic/value/unit/status/reason/origin, all 15 rows × N/mean/sd/p25/median/p75; N in linked children, other units in the frozen labels.
- **municipal-estimates.csv**: municipality_id/name, muni_post2007reform, age_child, yvar/xvar, measure/estimate/unit/status/reason/origin. There are 795 scope rows while municipality identities are unresolved: 720 appendix labels, 72 N labels, and three additional core prediction spellings. Four core coefficient/SE labels coincide with appendix cells and are emitted once, with both source targets accounted for in the audit. No duplicate runtime records are coalesced. Rank quantities are fractional; beta is a slope; counts are counts; unresolved log and transition units are explicitly labelled.
- **core-map.csv**: one scope-level empty-key row with beta/r25 and separate statuses/reasons; no invented municipality roster or successful sample count.
- **map-geometry.csv**, **city-labels.csv**: header-only original interfaces while G14 inputs are unavailable. No surrogate geography is put in study outputs.

- **appendix-release.csv**: specification_key/measure/status/reason, 792 rows. G17 log predictions remain NOT_REBUILT_UNRESOLVED. The source count release kernel does not resolve G18's ambiguous quintile group mask.
- **target-status.csv**: 975 source-target dispositions, including context and source release accounting. This is an evidence audit, not 975 experiments.

Tests: calendar endpoints, eligibility predicates, negative/zero incomes, independent arithmetic oracles, partial count/mean versus stopped SD/quantiles, most-years ties, duplicate/missing links, empty/singleton inputs, release at 24/25, appendix tuple/label coverage, and Figure 1 complete/partial/refused input. Remaining binding source gaps: G01–G07, G14–G19; G08/G09/G20 are also retained as interpretive/source context. In this frozen World the executable audit's state is source_boundary, with no empirical estimates.

Quintile count/transition targets carry their construction/ranking/definition/release gaps, without G07 (municipal regression fitting). The exact sets for all 792 appendix labels including N are regression tested.

atom-000002 — International mobility comparison

Exact command (direct dispatch is explicitly selected here to exercise the registered audit without predecessor evidence):

```
"$STUDY_PY" "$STUDY_CODE/run.py" --atom atom-000002 --world "$STUDY_WORLD"
↪ --inputs "$STUDY_INPUTS" --output "$STUDY_SCRATCH/atom2-audit"
↪ --dispatch-policy direct
```

Implementation: `analysis.atom_000002`; arithmetic in `kernels.span_pp` and `comparison_difference`. Its default policy is still `activation_respecting`, requiring valid Atom 1 evidence for native `done(atom-000001)`. A completed source boundary satisfies `done` but supplies no core estimates. Direct bypasses only outer activation. Neither policy retries a predecessor marked `no_result`.

Required empirical input: compatible completed core post2007/18/fam_rank/parent_rank municipal outputs from Atom 1 plus source-defined aggregation rules; CPST/BEF.PNR and KOM with a source-defined 2015 population date for Danish population context. G10 and the unresolved population date prevent aggregation. US/Canada are published references only; no foreign microdata are accepted.

Outputs: **country-summary.csv** has country/geography/statistic/estimate/unit/status/reason/origin for exactly 21 registered combinations. Foreign rows use `reference_only_not_rebuilt`, with empty estimate. There are no Canadian percentile summaries. **comparison.csv** has the 10 Danish targets, `rebuilt_value`, `published_reference`, `difference`, `unit`, `published_precision`, `status/reason/origin`; `rebuilt/difference` are empty. **published-reference.csv** isolates the 21 matching reference transcriptions with `origin=published_reference`. **target-status.csv** has 23 rows including two prose context dispositions. Units are people, slope, fractional ranks, or percentile points. The known references never initialize rebuilt fields. No comparison band, equality test, or foreign reconstruction is implemented or registered.

Tests: hand-computable $100 \times (\text{high} - \text{low})$ span and same-unit comparison difference; country/statistic inventory; strict published/synthetic origin separation; absent, valid boundary, corrupt, wrong-input and no_result predecessor receipts; both policies. G10 plus upstream core gaps leave all Danish estimates stopped.

The eight Danish mobility targets first check the exact required core measures; span requires both r75 and r25. Their CSV status/reason/source_locator propagate the failed prerequisite before local G10 aggregation is reached. Population context remains independent of the linked-child core fit. Each reason also names G10 as unevaluated and still blocking that target; upstream gap_ids are preserved exactly. Operational/unrun prerequisites retain those statuses and leave the consumer without a scientific state, including under direct dispatch.

atom-000003 — Municipal demographic correlations

Exact command:

```
"$STUDY_PY" "$STUDY_CODE/run.py" --atom atom-000003 --world "$STUDY_WORLD"
↪ --inputs "$STUDY_INPUTS" --output "$STUDY_SCRATCH/atom3-audit"
↪ --dispatch-policy direct
```

Implementation: `analysis.atom_000003`; exact figure loading and column checks in `interfaces.py`. Default activation is native done(atom-000001), with the same evidence requirements as Atom 2. All 12 characteristics $\times$ beta/r25/r50/r75 remain explicit, including their point/95%-interval slots.

Required empirical inputs: core same-municipality measures from Atom 1; IND/CPST/FAIN/BEF demographic-income candidates; RAS.ARBSTIL/ALDER_RAS, IDAP.PSTILL/ALDERNOV or AKM.BESKST/SOCIO with source-defined employment/student codes; UDDA.HFAUDD/HF_VFRA and UDD/IG_VFRA with historical education definitions; IEPE.IE_TYPE/OPR_LAND with a source country-list vintage; FTBARN/FTFORAEL birth and parent events; KRAN case/offence municipality/date fields. KRAF is only the frozen alternative decision-record candidate, never a substitute conviction outcome. The original Statistics Denmark Gini series is an unavailable external input. Neither classification codes nor annual denominators are guessed.

Outputs: `characteristics.csv` has 12 scope rows with municipality_id, characteristic, window_start/end, value/unit/status/reason/origin. The default window is 1980–1995; Gini 1987–1993, education 1981–1995, crime 1990–1997. `correlations.csv` has exactly 48 ordered pairs and columns characteristic, measure, estimate/lower/upper/n_municipalities, status/reason/origin. All numeric fields remain empty at a frozen source boundary. `target-status.csv` has 65 rows: 12 construction, 48 correlation, four conditional interpretation and one future-use context target. G11/G12 and row-specific G13 remain binding. No confidence interval, clustering, weighting, standardization or regression direction is implemented without source support.

Tests: exact row/measure/window inventory; distinct demographic/event clocks; source-stopped fitting and uncertainty; no loss of siblings; complete and point-only/partial synthetic figure interfaces; missing/all-unestimated, duplicate, wrong-origin and invalid-interval refusals. These figure tests are not numerical validation of a correlation estimator.

Characteristic construction remains explicit even when a core measure is absent. The Gini construction row is unavailable__original for the unrecovered G13 series, while retaining G11's still-unresolved averaging definitions in its reason. Each correlation first checks its own core measure and propagates its exact failure. Only a completed prerequisite reaches local G11/G12/G13 checks. No completed core prerequisite can be produced under this frozen source version. Every correlation reason still names its deferred G11/G12, and G13 for Gini, after the exact upstream failure. This discloses remaining requirements without claiming that the later checks ran. Operational/unrun upstream statuses propagate to all affected correlations while characteristic rows remain explicit.

Input manifest and evidence portability

[input-example.json](#) is a runnable, clearly synthetic source-audit manifest with no empirical inputs. JSON keys are strict; unknown scientific settings are rejected.

- **format:** danish-mobility-inputs-v1.
- **purpose:** synthetic or governed. Synthetic receipts cannot supply governed activation evidence. Purpose never bypasses source validity.
- **dataset_id:** stable non-path delivery identifier, not a mount name.
- **material_identity:** the frozen material identity shown in the example and returned by `authority.verify_world`.
- **tables:** optional list of descriptors with exactly table, path, sha256, fields, delivery_index, dictionary_id. Table names/fields must be frozen documentary candidates. Path must be supplied explicitly and absolute. sha256 is the supplied delivery content digest. fields maps documented names to physical column names; two distinct source fields cannot map to the same physical column. delivery_index is either empty or contains column and a logical source_locator, for the delivery's annual index (not an assumed YEAR).
- **dictionaries:** list of id/path/sha256 descriptors. Table dictionary_id must resolve to an entry. A dictionary's scientific rules are not loaded or adopted through this plumbing. Under current frozen stops neither dictionary bytes nor microdata bytes are opened; availability remains unverified.
- **evidence:** map from Atom ID to exactly path and sha256, naming a previously produced result.json and its expected digest. Use the same purpose, dataset_id and complete table/dictionary descriptor set for all three Atoms in a run. Add evidence without changing that input identity. Output CSV/artifact digests, source and sealed implementation identities, all CSV contents, full target audit and registered state are verified. audit_complete must be a JSON Boolean; missing, null, numeric and string values are refused. Supplying a bare state, a published table, or an unbound numeric estimate is insufficient.

- **source_resolutions**: omitted or empty only. The frozen common contract gives no permission to resolve G01–G20 at runtime. No seed or source-silent scientific parameter is accepted. Tests use deterministic explicit synthetic operands.

To activate Atom 2/3 by default, copy the example into scratch, retain its input identity fields, and add Atom 1’s `result.json` absolute path and SHA-256 under `evidence.atom-000001`. Pass that manifest with `activation_respecting`. Evidence paths and input physical paths are not scientific identities. Relocating them with identical contents and descriptors preserves identity.

A downstream receipt includes `upstream.targets`, a lossless projection of the four core target-status rows, plus `receipt_sha256` when there was a validated predecessor. Supply the same Atom 1 evidence descriptor when revalidating that downstream receipt; the validator reloads and checks that prerequisite instead of trusting the embedded projection. There are no absolute paths in the projection. With absent evidence its kind is `local_source_audit`: a local reading of frozen prerequisites, with `accepted_predecessor=false`. With no `result` the actual operational rows are preserved and the predecessor is never retried. `UPSTREAM_BOUNDARY` is a reason prefix; CSV statuses use existing registered tokens. An operational `failure` or `unrun` core prerequisite keeps its own status; it does not demonstrate data absence. With direct dispatch the consumer’s audit can complete while `registered_state` and `terminal` both remain null. Its own execution did not fail, but essential scientific scope remains unrealized and does not satisfy `done`. The slot dispositions say so and retain the exact target reasons. Default nonactivation still has `audit_complete=false` and `unrun` targets. An operational prerequisite also prevents a scientific state when the span’s other prerequisite carries a source boundary. No predecessor is retried.

`frozen-material.json` pins the original native registration digests and material checksums; it is an engineering integrity record, not a new scientific registry. The original Atom/Molecule bytes are untouched. At runtime their `body/result` fields can change while their registration and membership stay fixed. Result bodies and current Molecule interpretation are excluded from evidence matching; a separate realization fingerprint is diagnostic only. Altered protocols or shared source documents fail validation. Native digest and strong Kleene activation functions were meaning-preservingly vendored from `tools/prereg-lane/src/prereg_lane/native.py`; no Python eval is used.

`implementation-seal.json` pins the eight runtime Python/JSON files by relative name and content digest. `verify_implementation` checks the deployed World files and the action copy against that roster before target execution. It also rejects unlisted Python source/bytecode/native modules and all child directories, including packages without `init.py`, in both execution directories. Keep caches and operator helper modules outside the copied execution directory. Both entrypoints disable bytecode writes; callers importing the modules directly must use Python `-B` or an equivalent setting. The action seal must equal the seal delivered with the World; merely recomputing an altered action copy’s seal fails. Receipts must have the same sealed implementation identity. Tests and documentation do not enter this runtime identity. `run_tests.py` is explicitly allowlisted, because the runtime import graph does not import it; non-importable operator notes may also coexist. This checks the directory inventory after

imports, so it is not sandboxing: a shadow module can execute import-time code before the check rejects it. The guarantee assumes a trusted interpreter/import environment and deployment, and does not claim protection against arbitrary hostile import-time code. Receipts from earlier implementation identities are refused; legitimate Atom/Molecule result-body changes with this implementation remain valid. Deploy the reviewed World and its seal together as trusted read-only material. Checksums do not authenticate a replaced deployment/seal or a malicious Python environment, and are not digital signatures. Runtime cannot authorize code changes by resealing itself. The original manifest and CHECKSUMS.sha256 stay unchanged; controller packaging remains separate.

Each execution also writes result.json, integrity-log.json, figure-dispositions.json and slot-dispositions.json. The receipt includes scientific state versus operational terminal, dispatch policy, input/material/registration/code identities, CSV/artifact digests and upstream scope. It contains no raw person records. The integrity log contains only safe operation-level facts, no person identifiers. Slot dispositions bind all applicable members of the fixed 53-slot results map; they never write text into paper.md or a canonical Atom.

Round-3 regressions reproduce the three round-2 findings on inherited code and check their repairs: extra module/package/bytecode/native/namespace entries in both directories; 12 downstream dispatch/operational-receipt combinations; mixed operational/source span prerequisites; and deferred citations on all 8 Danish mobility targets and 48 correlations, against the source inventory.

Figures and limitations

The unchanged Figure 1 and Figure 2 templates are loaded through their declared DataFrame API at 130.7 mm. Figure 1 refuses partial core maps; Figure 2 preserves partial/point-only targets but refuses an entirely unestimated figure. The CLI records these refusals in figure-dispositions.json and leaves existing manuscript shells unchanged. No substitute chart is created.

For Figure 2 use `interfaces.call_template(world, "figure2", tables, output)` (where `world` is returned by `authority.verify_world`) or the CLI's adapter. It parses numeric-string estimate/bound columns and requires completed and `point_only` estimates in `[-1,1]`. It preserves OLS/Wald bounds beyond that domain and checks the fixed template's interval-order rules. This is input validation, not clipping, estimation or a changed correlation definition. The immutable standalone `figure2.py` still lacks the domain check and mishandles some numeric strings; direct invocation of that template bypasses this correction. The controller/visualizer must retain the adapter when copying action code.

CLI synthetic CSVs have `origin=synthetic`. The old templates require the literal `origin=replication`; the adapter creates only an in-memory synthetic test view for that interface, while receipts/CSV files retain their synthetic origin. Rendering fixtures are explicitly named `SYNTHETIC` and remain outside the World. They cannot be used as empirical evidence. Real source maps and real correlation inference have not been validated. The local tests use `DejaVu Sans`; the required runtime `Helvetica Neue` files were not found in the available resources, so their actual font binding remains untested.

No runtime-figure-interface.md or runtime-execution-interface.md was present in the supplied package/resources.

Tests exercise source-supported kernels and the actual CLI for every Atom. Causal time zero, treatment timing, competing risks, survival censoring, matching, clustered uncertainty, heterogeneity regressions and modern DiD/RD are not registered here. No such experiments were added merely for test coverage. Death/emigration handling is explicitly unresolved in G01/G02. Rank-deficient or tied synthetic inputs do not license a fit or a default tie convention.

See [implementation-report.md](#) for exact coverage, source boundaries, test runs and review status. Synthetic success is not empirical replication, causal validation, or proof of runtime data access.

Engineering supplement

Implementation report — author, round 3

Date: 2026-09-06. Scope: the frozen income-mobility World, exact roster atom-000001, atom-000002, atom-000003. This is implementation of the existing source-faithful replica, not a new study, amendment, or independent review.

Outcome: all source-supported operand calculations, source-first target execution, native dispatch/evidence validation, fixed output interfaces and synthetic tests are implemented. The frozen source specification still prevents all empirical estimation paths. The implemented CLI honestly reports those source boundaries; it is not a numerically complete empirical replication pipeline, and this report does not call it one. Filling the missing estimators or definitions would violate the frozen protocols.

The final round-3 test run passed **36 tests**, with zero failures/errors and no warnings, in 40.277 seconds. The inherited round-2 run passed 32 tests but missed the defects described below. Exact commands and artifacts are recorded below, including the failing run before this round's fixes. Tests ran actual computations for the supported arithmetic and integrity kernels, actual CLI dispatch for all three Atoms, and both unchanged figure templates on synthetic interfaces. No confidential Danish/APTO data, old empirical session, measured outcome file, or remote QGPU was accessed. No existing manuscript slot or canonical Atom was populated. No environment was installed, no agent was spawned, and no commit/push/release occurred.

Responses to every round-2 finding

Read the complete [reviews/r02/opus.md](#) and both round-1 reports. No round-2 Codex report was supplied in the review directory. The round-1 response table below remains part of this report; its fixes are retained and rerun.

Round-2 Opus finding	Implemented response	Regression evidence
1, moderate: the eight-file seal allowed extra importable modules in the action directory	authority.verify_implementation now checks both action and deployed execution directories for unlisted importable entries, as well as checking every sealed byte. It refuses Python source, bytecode, native-extension suffixes and all child directories, including namespace packages with no <code>__init__.py</code> . <code>run_tests.py</code> remains explicitly allowlisted because production does not import it. Non-importable operator notes are allowed.	Before repair, both <code>yaml.py</code> and <code>yaml/init.py</code> shadow loaders emitted only 18 of 90 Table 1 cells while all eight sealed digests still matched. The repaired CLI refuses all ten cases (five entry forms in each directory) with exit 2 and no output directory; a clean copy plus a <code>.txt</code> note emits all 975 targets and 90 cells. Existing <code>tampered-file/action-reseal/producer-identity</code> and read-only relocation tests still pass.
2, minor: operational_failure/unrun prerequisites were relabelled data_boundary	analysis.upstream_boundary preserves operational_failure/unrun and gives operational incompleteness precedence if a span needs two differently disposed core inputs. Existing adjudication therefore leaves the consumer's <code>registered_state</code> null. Under direct dispatch the consumer audit completes and terminal stays null: its own execution succeeded, but its essential scientific prerequisites did not. Default nonactivation remains <code>audit_complete=false</code> with unrun targets.	Twelve actual CLI cases: three operational/unrun predecessor receipt classes $\times$ two downstream Atoms $\times$ both policies. The exact predecessor projection is checked against CSVs read from disk; all 8 Danish mobility rows or 48 correlation rows keep the relevant status. All downstream receipts round-trip through validation. Four mixed r25/r75 branch cases also preserve the operational status and independent population/beta siblings. The inherited <code>no_result</code> test now expects no scientific state under either policy.

Round-2 Opus finding	Implemented response	Regression evidence
3, minor: upstream-first reasons dropped still-binding target-local gaps	The upstream boundary still comes first and its gap_ids/source locators remain lossless. A required deferred argument appends the exact local gaps to reason as unevaluated and still stopping the target: G10 for each Danish mobility summary; G11/G12 for every correlation and G13 additionally for Gini. No new column or gap adjudication was introduced.	A test reads the frozen target-inventory.md as its local-gap oracle, separately from analysis helpers, then checks every affected output reason under local-source and validated-predecessor dispatch. It verifies 8 Danish targets and 48 correlations, all four Gini targets, exact upstream gap_ids, and propagation into the country-summary/correlations interfaces.

One associated reporting repair was needed for finding 2: a direct consumer with an audited operational prerequisite is no longer described as entirely “Not run” in slot-dispositions.json. interfaces.slot_dispositions uses the audit flag to report unresolved scientific scope and point to exact target statuses. This implements the existing results-map residual/operational reporting rules; it does not assign the scientific **otherwise** key or fill any manuscript slot.

The round-2 sentence “Only a byte-identical action copy matches the deployment seal” overstated the check and is corrected here and in README. The check requires the eight sealed files to match and rejects extra importable entries; documentation and the allowlisted test file need not match. It checks the inventory after Python imports have run. Thus this is not a sandbox, and arbitrary hostile import-time code or replacement of the interpreter/trusted deployment is outside the guarantee. The shadowing fixture is rejected before target execution/output, not necessarily before import-time code executes. Keep helper modules/caches outside the action execution directory and deploy the reviewed seal with the read-only World.

Only the four runtime files analysis.py, authority.py, interfaces.py and run.py changed, along with tests/documentation and their implementation seal. The new implementation identity is bcdcc3adaad6c1c96e6e07be2f17b726f874adc692e5767f7cdb5a56f2a1fedd. The material identity remains 3e91dbf5b8d91f0cb63197e408601adf0c20cc58291073ee59f299c47cce2ad1; every registration digest is unchanged. Earlier implementation receipts are not accepted as current-code evidence. Within this implementation, changing only realized Atom bodies/Molecule interpretation still preserves faithful evidence.

Executed round-3 checks

The two complete suite runs used the required controller Python:

```
/home/shaoerzhuo/anaconda3/bin/python -B
↪ /home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-reference-code-20260
↪ 906/income-mobility/v003/world/prereg/execution/run_tests.py --output
↪ /home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-reference-code-20260
↪ 906/income-mobility/scratch/r03/author/before-fix-tests
/home/shaoerzhuo/anaconda3/bin/python -B
↪ /home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-reference-code-20260
↪ 906/income-mobility/v003/world/prereg/execution/run_tests.py --output
↪ /home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-reference-code-20260
↪ 906/income-mobility/scratch/r03/author/test-results
```

Artifact directory, relative to scratch/r03/author	Actual result
before-fix-tests/synthetic-tests- 2_0734lp	Inherited runtime plus three new regression tests: 35 tests, 17 failed assertions/subtests across those three tests, zero errors; 45.806 seconds. All original 32 tests passed. This independently reproduced all three findings, including the working YAML inventory corruption.
test-results/synthetic-tests-h12l4ktu	Final: 36 tests passed , zero failures/errors/warnings; 40.277 seconds. Includes the repairs, corrected inherited no_result expectation, and an additional mixed-prerequisite span test.

Each directory contains tests.log, test-summary.json, SYNTHETIC-ONLY.txt and per-case outputs. Final tests executed the supported numerical kernels, every Atom, both dispatch policies, 12 operational-predecessor combinations, eight copied-CLI/read-only-World cases, source and receipt tampering checks, all source inventories, 53 paper-slot bindings, and both figure interfaces. These are engineering tests; inference_validated=false and empirical_data_accessed=false.

CLI equivalents of the three updated README examples ran separately with the shipped input-example.json and scratch/cli-smoke output root. Each exited 0, purpose=synthetic, state=source_boundary, terminal=null. Exact argv/stdout/exit records are in scratch/r03/author/cli-smoke/commands.json, with per-Atom evidence beside it. Software availability was checked in cli-smoke/engines.json: Rscript 4.1.2 is available and unused; Stata is absent. No environment was modified.

Visually inspected the final suite's complete Figure 1 and complete/partial Figure 2 raster previews from the vector PDFs. At 130.7 mm, long characteristic labels and wrapped boundary notes fit; the partial figure keeps its hollow point-only marker, missing-series callouts and nearby endpoints. Source map shading orientation and

the four labels remain intact on deliberately synthetic boxes. PDF page width, fonts and Figure 2 text bounds passed automated checks. The generated CLI boundary tables were also sent through the unchanged figure interfaces and correctly refused without substitute plots. Original Danish geometry, inference and Helvetica Neue binding remain unvalidated.

The round-3 preservation record is `scratch/r03/author/preservation-check.json`: all 69 immutable-source files remain byte-identical, no originals are missing, and additions remain confined to execution/engineering. No World bytecode or test outputs were created. The current local FSV candidate definitions were re-read; no table/field, classification, scientific choice or gap was added. The existing boundary still contains 531 allowed tables and no validated table. No live source search or source clarification was undertaken in round 3.

Responses to all round-1 engineering findings

Read both complete round-1 reports under the task's `reviews/r01/` directory. These reviews concern engineering and source fidelity, not empirical acceptance. No measured Danish outcome or old empirical session informed this revision.

Reviewer finding	Response and implementation	Regression evidence
Opus finding 1: malformed audit_complete bypassed full no_result content validation	Fixed in authority.load_evidence: audit_complete must be exactly a JSON Boolean, and the unexecuted content guard uses is not True . Full output re-derivation remains mandatory. The old report's unconditional integrity guarantee was too broad; the scoped guarantee below replaces it.	Forged receipts with absent/null/0/1/string/Boolean/list/object fields and an injected published N are refused, including when CSV and receipt digests are recomputed. Genuine boundary, unrun and no_result receipts round-trip.

Reviewer finding	Response and implementation	Regression evidence
Opus finding 2: Gini construction status ambiguous	Adopted the row-specific original-input disposition: characteristic:gini is unavailable__original for G13. Its reason and gap_ids retain G11 because recovery alone would not settle annual averaging. No Gini input is constructed from IND.	Exact Gini status/reason assertion, 12 construction rows and 48 correlation pairs retained; Atom 3 still source_boundary.
Codex F01: recorded implementation identity not enforced	Added execution/implementation-rank_predictions r25 seal.json: relative filename/content digest roster for all eight runtime Python/JSON files. author-ity.verify_implementation verifies both the deployed World and action copy against the deployed seal. load_evidence requires that sealed identity. An altered action seal is not accepted in place of the deployed one.	A copied rank_predictions r25 sign change refuses before output. Recomputing only the action seal also refuses. Both downstream Atoms under both policies reject a receipt with unchanged boundary CSVs but altered producer identity. Byte-identical copied code works against a relocated read-only World.

Reviewer finding	Response and implementation	Regression evidence
Codex F02: missing first upstream-boundary branch	run passes a validated, lossless four-row core target-status projection to downstream builders. Every Danish mobility summary and every characteristic/measure correlation first checks its particular core prerequisite; span checks r75 and r25. CSV status/reason/source_locator preserve exact upstream failure before local aggregation/fitting. Characteristic construction and Danish population context keep their independent scopes.	Tests compare projected records with actual validated predecessor CSV rows, inspect downstream reasons/locators, reject projection forgery, round-trip dependent receipts, and exercise a synthetic completed-beta branch while retaining blocked r25 siblings. Absent/direct uses local_source_audit, never accepted predecessor evidence; no_result is projected without retry.
Codex F03: G07 on quintile targets	Removed the municipal-fitting gap from all 216 quintile count/transition targets; actual construction/G04/G16/G18 gaps remain. No new quintile computation is licensed.	Per-family exact gap-set assertions across all 792 appendix labels including N; all 72 tuples/720 original variable labels retained. The round-2 reviewer additionally verified this against the ledger independently; the author test itself parallels the implementation and is not an independent numerical oracle.

Reviewer finding	Response and implementation	Regression evidence
Codex F04: out-of-domain Figure 2 points accepted	Added numeric parsing and [-1,1] point validation in <code>interfaces.call__template</code> , within the permitted execution tree. Completed and point_only points are checked; supplied OLS/Wald interval bounds remain unchanged even beyond [-1,1]. The immutable template bytes are untouched.	Tests reject ± 1.2 and immediately-outside endpoints, accept ± 1 and immediately-inside points, and exercise numeric-string/blank-bound DataFrames, negative numeric ordering, invalid strings and intervals extending beyond the parameter domain.
Opus optional FSV-locator check	Added a World-internal comparison of documentary paths (including brace lists) with <code>schema-candidates.json</code> . It explicitly records the known UDDA <code>education-and-culture</code> $\rightarrow$ <code>education-and-knowledge</code> erratum in the two frozen shared documents. The scientific source files remain unchanged.	A regression test asserts precisely that documented exception, writing the erratum list only to synthetic scratch. The current local FSV field definitions for all 15 candidates were also re-read.

F04 is repaired at the authorized execution interface. Calling the frozen `prereg/paper/figures/figure2.py` directly still bypasses the new domain/parser guard. README explicitly requires the adapter for a copied runtime/visualizer; this limitation is not hidden as a repaired template. No fixed plot is redesigned.

The implementation seal is a deployment integrity anchor, not a signature or protection against replacement of both the trusted World and its seal, or a malicious interpreter. It must be delivered with the reviewed World. Runtime does not reseal code. Round-1 receipts from the older implementation are refused; changes only to realized Atom bodies/Molecule interpretation still preserve receipt validity within this sealed implementation. Scientific material identity and registration digests are unchanged.

Authority and inspected material

Read the complete `tools/prereg-lane/AGENTS.md` and the `predata-engineering`, `preregistration-package`, `paper-to-replication` and `canonical-preregistration` skills; also the full `package-contract`, `atom-granularity` and `paper-scaffold` references. Read all three full `protocols/verdict` regions, full Molecule membership and registration, shared `data/identification/governance/boundary` documents, source mapping, gap ledger, source/formatting/conversion audits, source provenance and hash records, appendix tuples/labels, paper manuscript, all 53 result bindings, figure roster, both figure implementations and `plot_style.py`. The immutable package has no `prereg/code` tree or empirical author program. G20 remains an unavailable-program finding from the frozen source audit, not proof that no author program exists.

The local public-paper Markdown was read completely as a text aid. Public published values remain reference-only. The frozen audit's PDF/README locators are used without changing their scientific extraction. No new live web search was performed in this author round; consequently there are no new web queries, URLs or retrieval-success claims to add. Earlier source searches and HTTP access limits remain exactly as documented in `prereg/literature.md` and the immutable replication provenance/ledger files. No fresh source clarification was adopted.

Read the relevant variable definitions in the local FSV pages for IND, CPST, FAIN, BEF, BEFBOP, BEFADR, RAS, IDAP, AKM, UDDA, IEPE, FTBARN, FTFORAEL, KRAN and KRAF. The engineering `schema-candidates.json` records only the candidate fields named in the frozen data contract, with their actual local labels/coverage. The existing 531-table boundary was not replaced with an older upload whitelist or newer table roster. Documentation is not runtime access evidence.

A stale documentation path was found: the frozen contract names `fsv/education-and-culture/UDDA.md`, while the available local file is `resources/schema/data-registry-bolero/fsv/education-and-knowledge/UDDA.md`. HFAUDD is highest completed education; HF_VFRA is its completion time. This is a locator correction in the engineering metadata only. It selects no education codes, vintage, snapshot or source construction rule, and the frozen shared contract remains untouched. The source distinction PERINDKIALT versus PERINDKIALT_13, November labour status versus year-end age, earliest/latest mother versus chosen parent identity, birth-event age versus year-end maternal age, and offence occurrence versus registration/decision dates remain explicit.

Protocol-to-code coverage

The exact per-Atom commands, inputs, field provenance, output columns/units and limits are in [execution/README.md](#). No reverse entry-point links were added to the frozen Atom files because the user's write scope explicitly prohibits changing their bytes.

Source/protocol target	Executable implementation and validation	Remaining boundary
P §2 cohort years, source windows and at-least-once predicates	kernels.source_windows and observation_predicates; independent 1973/1977 × 15/18/20 endpoint oracles, years just inside/outside 1980 and 2010–2015, empty histories	This is calendar arithmetic on defined observations, not a chosen eligibility snapshot or parent linkage; G01/G02 remain. No age-34 exclusion from the conflicting footnote.
Annual sums, real-income identity, time mean and USD conversion	complete_component_sum, deflate_annual, count_mean, convert_2015_usd; exact arithmetic including negative/zero operands, empty/singleton vectors and nonfinite rejection	CPI/FX series, component membership under missingness and time denominators are not chosen (G02/G03).
Shared person/year and lookup cardinalities	require_unique and join_many_to_one; preserves row order and duplicate left index labels; duplicate/null/blank right keys stop; unmatched links remain explicit	No parent/spouse identity, annual reference date, crosswalk or missing-income meaning is inferred (G01/G02/G05).
P most-observed-years geography	most_observed_years on a previously defined annual vector; unique winner is computed, equal-year tie stops, duplicate/empty input fails	This does not choose the annual observations, post-reform crosswalk, reference date or age-15/20 geography window (G05).
All 15 Table 1 rows × six cells	analysis.atom_000001 emits 90 cell-local dispositions in source order; count_mean computes only independently defined N/mean operands	G01 and row-specific G02/G03/G05/G06; SD/quantile algorithms and missingness remain stopped, never a ddof or percentile-package default.

Source/protocol target	Executable implementation and validation	Remaining boundary
Core municipality model and alpha/beta SE labels	Core targets explicit in municipal-estimates and target-status; rank_predictions calculates P's three fractional prediction identities from defined alpha/beta	G04/G07 forbid rank construction and municipal fitting/inference. No OLS transfer from the Figure 2 caption, covariance invention or prediction CI from marginal SEs.
72 appendix specifications, 720 labels, 72 N targets	Read directly from immutable appendix-specifications.yaml. All related rank/log, individual/family/parent, old/new geography and endpoint variants dispatched within Atom 1	Construction/fit gaps retained per target. No rank/log cross-type models, subgroups or replacement of the main fit.
R negative-child/family clause	negative_child_log_clause applies strictly negative → 1000 DKK; zeros/positive values remain untouched at this clause; parental invocation stops	No log is taken. Zero/parent treatment, log base and operation order remain G15.
Log percentile labels and D1 legacy fields	All 108 log percentile labels and five legacy labels remain explicit NOT_REBUILT_UNRESOLVED; no fractional-log evaluation or back-transform	G16/G17/G19; no silent author-definition repair.
Appendix release	appendix_count_release executes strict N<25 status, tested at 0/24/25/26; per-specification release dispositions remain explicit	N must itself be source-defined. G18's unknown relevant quintile group set prevents the N<5 mask, including at synthetic group values 4 and 5. Release is not cohort selection or a privacy guarantee.

Source/protocol target	Executable implementation and validation	Remaining boundary
Atom 2 population and international summary targets	21 exact country/statistic combinations; 10 empty Danish comparison rows; isolated printed references, including approximate .242 wording; span_pp and comparison_difference tested by hand	Source population date, weights/missingness/SD and upstream core inputs unresolved (G10 plus Atom 1). Foreign values are reference-only, not rebuilt; no Canadian percentile targets or country tests.
Atom 3 characteristics and correlations	All 12 construction scopes and 48 row/measure point/CI slots; exact education/Gini/crime windows; four conditional narrative targets	G11/G12, G13 for Gini and upstream inputs. No numerator/denominator, classification, correlation direction, standardization, weight, covariance, critical-value or df default.
Figure 1	Exact fixed mobility/geography/cities columns; complete synthetic render; partial/missing/duplicate/origin inputs refuse	All empirical maps remain blocked. Synthetic boxes do not establish Danish cartographic validity or Bornholm's original transform.
Figure 2	All 48 keys; complete and partial/point-only synthetic renders, explicit long missing reasons, nearby interval endpoints, rejection of missing/duplicate/reference/invalid-interval inputs	Hand-supplied synthetic intervals test the renderer only. No correlation inference was estimated or validated.
Result slots and interpretation	interfaces.result_slot_bindings checks exact 53-slot equality with paper.md; slot-dispositions outside World; native state adjudication respects first-match order and context is excluded from substantive completion	No observed prose or numerical slot is filled; no source boundary is a null or replication success.

All source-inventoried output interfaces exist. While municipality identity is unresolved, municipal tables contain explicit scope rows with empty municipality keys, not 98 fabricated municipalities. Geometry/city tables are header-only. Four coefficient/SE labels are shared between the core and its identical appendix tuple; their output cells appear once, while both source targets remain audited. This produces 795 municipal scope rows (720 appendix labels + 72 N + three core prediction spellings) and 792 appendix-release rows. It is explicit alias handling at code construction, not deduplication of runtime observations.

Atom 1 has 975 target-audit rows, Atom 2 has 23, and Atom 3 has 65. These are within-Atom output/source dispositions; the roster remains exactly three Atoms. Source G08/G09/G20 and external-country context can be accounted for without being counted as substantive estimates or resolving the scientific gaps.

Exact frozen gap treatment

The executable Audit class reads the exact G01–G20 decisions from [deviations.md](#) and attaches the original source locator and target-specific subset to each consuming output. No string such as “missing data” replaces these decisions.

Gap	Exact affected implementation targets and locator
G01	All Table 1/core/appendix sample-dependent quantities; P §2 and R pp.2–3. Calendar predicates do not fix parent identity or observation unit.
G02	Income/time-average/rank/log and N paths; P/R annual-family definitions. Missing components are never zero-filled or averaged away.
G03	USD cells and year-deflated income paths; P §2, R p.3. Operand-level CPI/FX identities do not select a series.
G04	All rank/quintile core and supplementary paths; P cohort ranks, R fractional prediction points. No tie/universe/normalization function is chosen.
G05	Municipality assignment, residence cells, municipal/figure/geographic scope; P §2 and R old/new labels. No within-year/split-crosswalk tie repair.
G06	Table 1 cell-specific statistics and residence/marriage constructs; P Table 1. Independently defined N/mean kernels do not settle SD/quantiles.

Gap	Exact affected implementation targets and locator
G07	Municipal fit and SE/prediction operands; P Eq.(1), R coefficient labels. No default fit/weight/covariance.
G08	Slope/relative-mobility prose; P abstract/§2/§3/conclusion. No reciprocal/complement or sign-flipped output.
G09	Youngest-age motivation; P footnote 3. Preserves source 1973–1977, not an age-34 sample.
G10	Danish aggregation/population-context and foreign reconstruction scope; P §3 second paragraph. Foreign context remains isolated, no 30/10 exclusion transfer to mobility.
G11	All 12 demographic constructions and 48 consuming points/intervals; P §3/Figure 2/footnote 5. Every row remains present.
G12	Correlation fitting and all 48 intervals; P Figure 2 caption. No normal/t/Fisher/robust/cluster/bootstrap method is substituted.
G13	Gini input and four Gini correlations; source Statistics Denmark (2017), 1987–1993 window. No modern series or IND-based replacement.
G14	Figure 1 geometry/city identities and geographic prose; P Figure 1 caption/footnote 4. No invented geographic result.
G15	All log-model derived quantities; R p.1. The negative-child clause is preserved separately from the blocked complete transformation.
G16	Appendix r_75 description conflict, quintile labels/counts/denominators; R p.2, D1/D2. P’s core r75 identity is retained without silently repairing appendix descriptions.
G17	All 108 log r_25/r_50/r_75 labels in D2. Explicit not-rebuilt target, no numerical evaluation.

Gap	Exact affected implementation targets and locator
G18	Appendix publication scope and quintile mask; R p.3. N<25 arithmetic is implemented; relevant group definitions remain unknown.
G19	D1-only q1q1__N/q1q5__N/q5q1__N/q5q5__N/rank__rank; earlier wide versus D2 long schema. No tuple applicability or correction intent inferred.
G20	Author-code availability; immutable source/retrieval audit. No source program was fabricated, no easier replacement model added.

The common Atom protocol explicitly says, “A later source clarification requires a new registration version; this protocol contains no permission to resolve it.” The CLI accordingly refuses nonempty source_resolutions and unknown scientific parameters. This is the existing source boundary, not a request for additional user confirmation. No approval question is pending.

Native dispatch, evidence and portability

Vendored only the portable read/digest/condition-parser/evaluator portion of local prereg_lane/native.py; omitted its write and unrelated validation/build helpers. Native digest serialization and strong Kleene evaluation are preserved. Tests include unknown NOT, AND/OR absorbing constants, absent predecessor, boundary-done and explicit no_result. Only the canonical activation selected by the package is used for these Atoms.

The default root executes its source audit. Default Atom 2/3 without evidence remain unrun with activation=unknown, empty numeric fields and no scientific state. A faithful Atom 1 boundary receipt satisfies done, after which each consumer separately retains its core-input/source boundaries. Explicit direct bypasses only this outer activation condition. A missing predecessor gives local source-prerequisite audit scope, never an accepted predecessor Atom or a locally fabricated empirical fit. An explicit no_result is never retried, even under direct dispatch. Evidence irrelevant to the selected Atom/dependencies is not opened, preserving independence of siblings.

Input metadata names explicit runtime paths, dictionary identities, documented field-to-column bindings and a stable dataset identifier. No mount is guessed. No declared register/dictionary is opened in this version, because frozen source stops precede empirical input consumption. Hash declarations are delivery bindings, not proof of actual mounted availability. Source-selected scientific parameters are not invented. Runtime path relocation leaves input identity unchanged.

Receipt validation uses pinned immutable registration/material identities, explicit expected receipt hashes, exact Atom/input/purpose binding, output and artifact checksums, sealed implementation identity, full CSV target/content checks and coherent scientific/operational states. For this source-blocked version, all CSVs are independently re-derived from the frozen source audit; altered numerical cells are rejected even when checksums are recomputed. Malformed audit_complete fields are refused before state adjudication. These checks cover the tested receipt classes and counterexamples; they are not a claim of authenticity for an attacker-replaced deployment. Provenance artifacts are checksum-checked, not independently authenticated external observations. Tests reject missing files, wrong state, corrupt tables/artifacts, wrong input binding and mixed synthetic/governed evidence. Expected hashes must come from trusted governed orchestration; checksums are integrity mechanisms, not a digital signature or a proof of external input authenticity.

Atom result/body fields and Molecule current interpretation are not scientific identity inputs. A test mutates those fields in a copied World, sets that World read-only, copies the code to a different writable action directory, and executes the CLI in a subprocess with output outside the World. Faithful predecessor receipts remain valid. The test asserts identical World bytes before/after execution, then demonstrates that protocol tampering fails. A realization hash is recorded only diagnostically; changes to it do not invalidate evidence. No absolute runtime World/code/input/output path is used as a scientific identity.

Generated result.json contains no raw observations, identifiers or confidential rows. It binds aggregate/disposition outputs only. Table/figure status files retain component missingness; operational failures have no local scientific state and are never converted to statistical nulls. Original manifest/checksum files were not edited to add the execution/engineering directory, because their bytes are outside the author write scope. The engineering pins verify existing original material while permitting these authorized additions; any later controller packaging/resealing is outside this role.

Historical executed tests and actual results — round 2

The following command ran the full supported implementation and synthetic interface suite, using the required controller Python:

```
/home/shaoerzhuo/anaconda3/bin/python -B
↪ /home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-reference-code-20260
↪ 906/income-mobility/v002/world/prereg/execution/run_tests.py --output
↪ /home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-reference-code-20260
↪ 906/income-mobility/scratch/r02/author/test-results
```

Round-2 run under author scratch/test-results	Actual result
synthetic-tests-lu7vbey2	31 tests passed, no failures/errors/warnings; 27.021 seconds. All six reviewer findings exercised.
synthetic-tests-lyzf19tw	Final: 32 tests passed, no failures/errors/warnings; 27.261 seconds. Adds the optional frozen-locator erratum regression.

The final `tests.log` and `test-summary.json` are in `scratch/r02/author/test-results/synthetic-tests-lyzf19tw/` relative to the task workspace. They record numerical package versions, synthetic-only status and `inference_validated=false`. Every synthetic output remains outside the World.

The suite now includes eight copied-CLI runs against a separate `chmod 555/444 World`: every `Atom ×` both policies with absent evidence, and both downstream `Atoms` with validated `Atom 1` evidence. Outputs are outside that World; all its file hashes match before/after; realized body changes preserve material identity; protocol tampering fails. Tampered producer code and independently altered receipt claims failed separately. This round-2 suite did not reject extra importable files and did not preserve operational status at the consuming target level; the round-3 corrections and tests above supersede those earlier guarantees.

The synthetic completed-core branch fixture exercises local-source continuation only. It cannot pass receipt validation or yield a numerical result under this frozen registration. No invented estimator or confidence interval was used to test that branch. The earlier arithmetic oracles and figure checks below remain part of the final suite.

The three current README entry commands also ran with the shipped `input-example.json`: `Atom 1` `activation_respecting` and `Atoms 2/3` `direct`. All exited 0 with `purpose=synthetic`, `state=source_boundary` and `terminal=null`. Their exact `argv/stdout/exit` records are in `scratch/r02/author/cli-smoke/commands.json`, with per-`Atom` evidence beside it. This confirms the runnable example, not data access.

Historical round-1 test trail

The inherited author report recorded these earlier runs with this command:

```
/home/shaoerzhuo/anaconda3/bin/python
↪ /home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-reference-code-20260
↪ 906/income-mobility/v001/world/prereg/execution/run_tests.py --output
↪ /home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-reference-code-20260
↪ 906/income-mobility/scratch/r01/author/test-results
```

All output directories below are relative to that author scratch test-results root, never final-World outputs:

Run	Result and response
synthetic-tests-yaf8qz3b	23 tests, five failures and one error. Test helper eagerly evaluated a default and overwrote explicitly supplied manifests; cloned source files retained read-only mode before intended mutation. Fixed the test helper and permissions only in scratch clones. These failures were not presented as successful evidence validation.
synthetic-tests-5q2lq_no	23 tests, zero failures/errors, no warnings; 10.004 seconds. Full initial CLI/evidence suite and fixed figure renders passed.
synthetic-tests-1jmi_46c	24 tests, zero failures/errors; 10.025 seconds. Added source-supported FX/negative-child clause/most-years kernels and explicit tie/threshold tests.
synthetic-tests-9pi60yxt	Final: 25 tests, zero failures/errors, no warnings; 10.650 seconds. Added unrelated-sibling isolation and semantic validation of unrun/no_result content.

Historical final log: round-1 author scratch `test-results/synthetic-tests-9pi60yxt/tests.log`; machine-readable versions, results and warning record: `test-summary.json` in the same directory. The SYNTHETIC-ONLY.txt marker describes their nonempirical status. Tests generate fresh per-case scratch paths and may be rerun with the required absolute `-output`.

Round-1 CLI smoke checks also ran `run.py` as a subprocess for each Atom using the shipped `input-example.json`: Atom 1 with `activation_respecting`, Atoms 2/3 with `explicit direct`. All exited 0 with `source_boundary`, `terminal=null` and `purpose=synthetic`. Their outputs are under author scratch `cli-smoke/atom-NNNNNN/`. The default unactivated downstream path is separately exercised by the tests.

Independent numerical oracles include: annual sum $-100+300=200$; deflation $-80 \times 100/80 = -100$; a row vector $[-3, 3, 6]$ has $N=3$ and $\text{mean}=2$; $\alpha=.125$ and $\beta=.5$ give $r_{25}=.25$, $r_{50}=.375$, $r_{75}=.5$; a $.75-.25$ mean span is 50 percentile points; comparison arithmetic is checked against `fractions.Fraction`; 600 DKK at six DKK/USD is 100 USD; strictly negative child income triggers exactly 1000 DKK, zero does not; and a two-to-one observed-year residence majority wins while a one-to-one tie stops. None uses the implementation's numerical output as its own expected answer.

Tests also cover missing/blank/duplicate identifiers, unmatched joins, nonstandard/duplicate DataFrame indices, empty/singleton vectors, negative/zero operands, rank ties and a constant rank RHS fixture, missing definitions, calendar endpoint

boundaries, distinct recording/event/index clocks, all registered target combinations, incomplete siblings, both dispatch policies, absent/no_result predecessors, corrupt/wrong-bound evidence, relocated read-only Worlds, body mutation, protocol tampering, source-resolution override rejection, unknown table/field rejection and output-write containment/nonoverwrite.

No numeric municipal regression, log elasticity, quintile probability, country aggregation, correlation or confidence interval was estimated. None is validated by passing these tests. Tests deliberately assert source stops rather than fitting empty/singleton/rank-deficient groups with a substitute procedure. Clustered uncertainty, matching, treatment timing, competing risks and survival censoring are not source-registered analyses in this descriptive paper; they were not invented to satisfy a generic test list. Death/emigration semantics remain G01/G02.

Figure and manuscript interface inspection

Actual synthetic Figure 1 complete, Figure 2 complete and Figure 2 partial PDF renders were produced outside the World. Their page widths were independently read from the PDFs as 130.7 mm, font objects were present, and Figure 2 word bounding boxes stayed within the page. Raster previews from those PDFs were visually inspected at the manuscript width. The partial Figure 2 retained an open point for unavailable uncertainty, numbered missing-series notes, long reasons in the allocated notes area and nearby interval endpoints without clipping or overlap. Figure 1 had the correct two-panel orientation, four city labels and separately framed synthetic island. Boxes were deliberately synthetic geometry, not purported Danish municipal polygons.

The templates themselves were not changed. Generated CLI outputs were passed through the exact fixed DataFrame interfaces: all-unestimated Figure 2 and unresolved Figure 1 correctly refused rendering, and their dispositions were written instead of replacement plots. Tests separately covered partially unavailable Figure 1 refusal and all 48 required Figure 2 pairs. The fixed 53-result-slot binding was verified against the manuscript; no placeholders were replaced.

The inherited origin adapter handles the old templates, which accept only literal `origin=replication`. Synthetic CLI outputs instead remain labelled `origin=synthetic`, so `interfaces.py` creates a disposable in-memory view solely for synthetic interface testing. Original CSVs, receipt identities and files remain synthetic; governed receipt validation rejects them. This does not convert a synthetic estimate into evidence or alter a figure's numerical content.

Round 2 adds the numeric parser/domain guard described in response F04 above. Both complete and partial synthetic Figure 2 previews and the complete Figure 1 preview from `synthetic-tests-lu7vbey2` were visually inspected again at manuscript width. Points, four-series labels and wrapped long notes remain inside the page; synthetic map shading retains larger-beta/smaller-r25 darkness. The final suite rerendered the same fixtures and checked 130.7-mm PDF widths and text bounds. No original cartographic validity or inference is established by these previews.

No supplied `runtime-figure-interface.md/runtime-execution-interface.md` or required HelveticaNeue font assets were found in the `package/resources`. Tests used

the unchanged template's documented DejaVu Sans local-test fallback. Actual run-time Helvetica binding and original Danish geographic assets remain untested. No unchanged manuscript/registration PDFs were rerendered or edited.

Software, preservation and review status

Tested: Python 3.12.4 from /home/shaoerzhuo/anaconda3/bin/python; NumPy 1.26.4; pandas 2.2.3; PyYAML 6.0.2; Matplotlib 3.10.0; Shapely 2.0.6; PyMuPDF 1.24.9. SciPy 1.15.2 was present but no inference function was used. Rscript 4.1.2 was available and version-checked but not used; Stata was absent and unnecessary. No scientific seed was specified or added; fixtures use explicit deterministic values. No software engine availability is offered as validation of unspecified inference.

A byte comparison against all 69 files in the immutable controller source found zero changed originals, zero missing originals and zero extra files outside the authorized execution/engineering directories. All tests and previews are in the authorized author scratch tree. Scientific Atom/Molecule payloads, source audits, manifest, paper prose and figure templates remain unchanged. The machine-readable preservation record is `scratch/r02/author/preservation-check.json`; no World bytecode was created.

All supplied prior findings are answered in the round-3 and round-1 response tables above. This invocation is the author role and explicitly prohibits spawning agents. **New round-3 adversarial Opus and Codex Sol xhigh reviews have not been run or claimed here; they remain the controller's subsequent independent checks.** The author's synthetic verification is not an independent scientific review.

The runnable boundary audit and supported kernels are ready for those checks. The frozen gaps remain substantive limitations. Passing synthetic tests is not empirical replication, causal validation, or proof of Danish data availability.

Reference implementation review

Engineering status: REVIEW INCOMPLETE. Review rounds: 3. Revision slots used: 2 (initial draft excluded).

User-directed bounded handoff: no more than two author revisions. Proceeding to formatting is not reviewer acceptance. Failed/missing reviewer calls have no scientific verdict; original records remain available below.

This augmentation used schemas, documentation and synthetic fixtures only. Code review and package compilation do not establish scientific validity, empirical replication, data availability or independent acceptance of the original science. Original registrations, manuscript sources and scientific review remain unchanged. Unresolved source definitions remain unresolved; runnable components and blocked targets must be distinguished in `prereg/execution/README.md`.

The host checks prose Atom coverage, Python syntax and synthetic commands. These are engineering checks, not a scientific verdict.

Controller checks and review dispositions

```
{  
  "round": 3,
```

```

"accepted": false,
"host": {
  "status": "pass",
  "findings": [],
  "processes": [
    {
      "label": "r03-host-run",
      "command": [
        "/home/shaoerzhuo/anaconda3/bin/python",
        "/home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-reference-cod
        ↪ e-20260906/income-mobility/scratch/r03/host/attempt-01/world/pr
        ↪ ereg/execution/run.py",
        "--help"
      ],
      "model": null,
      "cwd": "/home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-referenc
        ↪ e-code-20260906/income-mobility/scratch/r03/host/attempt-01",
      "log": "/home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-referenc
        ↪ e-code-20260906/income-mobility/logs/r03-host-run-a01.log",
      "created_at": "2026-09-06T07:45:30.748011+00:00",
      "status": "finished",
      "pid": 2323324,
      "start_ticks": "81880566",
      "state": "R",
      "started_at": "2026-09-06T07:45:30.755795+00:00",
      "returncode": 0,
      "completed_at": "2026-09-06T07:45:30.826032+00:00"
    },
    {
      "label": "r03-host-run_tests",
      "command": [
        "/home/shaoerzhuo/anaconda3/bin/python",
        "/home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-reference-cod
        ↪ e-20260906/income-mobility/scratch/r03/host/attempt-01/world/pr
        ↪ ereg/execution/run_tests.py",
        "--output",
        "/home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-reference-cod
        ↪ e-20260906/income-mobility/scratch/r03/host/attempt-01/output"
      ],
      "model": null,
      "cwd": "/home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-referenc
        ↪ e-code-20260906/income-mobility/scratch/r03/host/attempt-01",
      "log": "/home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-referenc
        ↪ e-code-20260906/income-mobility/logs/r03-host-run_tests-a01.log",
      "created_at": "2026-09-06T07:45:30.833896+00:00",
      "status": "finished",
      "pid": 2323326,
      "start_ticks": "81880575",
      "state": "R",
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      "returncode": 0,
      "completed_at": "2026-09-06T07:46:11.287481+00:00"
    }
  ],
  "completed_at": "2026-09-06T07:46:11.302579+00:00",
  "scope": "Structural coverage, syntax and synthetic execution; not
    ↪ scientific validation."
},
"reviews": {
  "opus": {

```

```

    "status": "complete",
    "verdict": "accept",
    "report": "/home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-referen
    ↪ ce-code-20260906/income-mobility/reviews/r03/opus.yaml"
  },
  "codex": {
    "status": "failed",
    "verdict": null,
    "error": "FileNotFoundError: [Errno 2] No such file or directory:
    ↪ '/home/shaoerzhuo/Bolero-denmark/.prereg-runs/denmark-reference-cod
    ↪ e-20260906/income-mobility/reviews/r03/codex.yaml'"
  }
},
"review_status": "incomplete",
"revision_slots_used": 2,
"continuation": "package_current_draft_with_unresolved_findings"
}

```

r01 / codex.md

Codex independent adversarial review — round 1

Verdict: **revise**. Coverage: atom-000001, atom-000002, atom-000003—all and only the requested roster.

This is an engineering/source-fidelity judgment on the frozen canonical replica. It is not approval of the original science, evidence that the Danish results were reproduced, or a request for new experiments. The package is right to leave unavailable scientific decisions unresolved. The revision request concerns integrity and exact implementation of already-frozen branches.

Bottom line

The implementation does substantial honest work despite the absence of a lawful empirical estimator in this frozen version. From a copied execution directory I reran the complete advertised suite: all 25 tests passed. The code retained 90 Table-1 cells, 72 unique appendix tuples and 720 appendix variable labels, 21 country/statistic rows, all 48 Figure-2 pairs, all 53 paper slots, native unknown semantics, both dispatch modes, receipt corruption tests, copied-layout execution, and complete/partial/refused figure interfaces. I visually inspected the complete and partial Figure-2 previews and the synthetic Figure-1 preview; labels and long boundary notes were inside the page at 130.7 mm. No synthetic value entered the World or a manuscript slot.

That pass is not sufficient for acceptance. A reviewer-authored counterexample changed the supported r25 kernel from $\alpha + .25\beta$ to $\alpha - .25\beta$ in a scratch copy. The modified producer emitted a different `implementation_identity`, but the untouched activation-respecting Atom-2 consumer accepted the receipt, treated it as validated predecessor evidence, and satisfied `done(atom-000001)`. The execution code is not covered by the World manifest/checksum seal, and receipt validation never compares its advertised implementation identity. Two downstream builders also omit their registered first upstream-boundary branch at target level. These defects require narrow fixes and regression tests.

Findings

F01 — execution-code identity is recorded but not enforced (major; all Atoms)

The accepted manifest’s file index spans [manifest.yaml lines 18–80](#), and the 68-line `CHECKSUMS.sha256` ends with template assets; neither has an `execution/` or `engineering/` entry. `authority.verify_world` checks the pinned registrations and original material at `prereg/execution/authority.py:42–66`. `run.execute` computes and records an implementation identity at `run.py:94–105`. But `authority.load_evidence` at `authority.py:164–214` never inspects `implementation_identity`.

The counterexample is preserved only in this reviewer’s scratch:

- `tampered-execution/kernels.py` changes `rank_predictions`’s `r25` sign.
- The tampered Atom-1 producer wrote identity `0db834ba...b1330` and a `source_boundary` receipt.
- The untouched consumer’s reviewed identity was `a6280e79...e355f`.
- `review-execution-copy/run.py`, under `activation_respecting`, accepted the tampered predecessor and returned Atom 2 with `activation=true`, `registered_state=source_boundary`, `terminal=null`, and `upstream.kind=validated_evidence`.

The current all-boundary output re-derivation prevents that altered dormant kernel from inserting a number. It does not prove that reviewed code produced the predecessor, and it permits actual code tampering to satisfy canonical completion. The narrow fix is to seal a path-independent checksum roster for the reviewed runtime files, verify the action copy before execution, and require predecessor receipts to bind to that reviewed identity. A self-asserted receipt string alone is not enough. The regression must modify a runtime scientific function while preserving boundary CSVs and prove both Atom-2 and Atom-3 consumers refuse it; a byte-identical relocated copy must continue to pass.

F02 — Atom 2/3 omit the registered first upstream-boundary disposition (moderate)

The Atom-2 protocol says to read Atom-1 core statuses and, first, emit an upstream boundary if the needed estimates are not completed (`atoms/atom-000002.md:103–109`). Atom 3 gives the same ordering for each characteristic/measure (`atoms/atom-000003.md:129–134`).

The builders at `analysis.py:190–245` receive only `world` and `origin`, not validated predecessor content. `run.py:51` builds their outputs independently of receipts and adds only a receipt-level generic summary at `run.py:67–77`. In the advertised activated-boundary fixture:

- Atom-2 target `country:Denmark:r25_mean` reported only G10.
- Atom-3 target `correlation:bottom_decile:beta` reported only G11,G12.

Neither target carried the corresponding Atom-1 core target's exact G01–G07 boundary, despite the protocol's ordered branch and the result map's requirement for exact reasons. Local gaps independently stop every estimate today, so this does not change a number. It does make the evidence path and manuscript disposition unfaithful. Pass a lossless validated predecessor target-status projection to the downstream builders, propagate the exact core prerequisite failure first, and evaluate local G10/G11/G12 only after that prerequisite is completed. Direct dispatch may bypass the outer activation test, not this internal prerequisite.

F03 — G07 is attached to every quintile target (minor; Atom 1)

`prereg/replication/deviations.md:15` scopes G07 to municipal regression coefficients, SEs and predictions. Quintile counts/transitions are separately defined at `atoms/atom-000001.md:198–205`. Yet `analysis.py:111` adds G07 to the common appendix gap list before the quintile-specific logic at lines 112–124.

My independent inventory test found all 216 marginal count/transition targets (`x_q1_N`, `x_q5_N`, `q1q1`, `q1q5`, `q5q1`, `q5q5` across 36 rank tuples) carrying irrelevant G07. Their genuine G04/G16/G18 and construction gaps still block them, so no new calculation is licensed. Build exact gap sets by operation and add a per-family exact-set regression test.

F04 — Figure 2 accepts a completed point outside the correlation domain (minor; Atom 3)

The Atom-3 interface defines point and interval fields in correlation units (`atoms/atom-000003.md:149–160`). `figure2.py:53–64` checks finiteness and interval order, but not the completed point's $[-1,1]$ domain. With all 48 rows present, my synthetic fixture set one completed point to 1.2 and ordered bounds to 1.1, 1.3; the renderer wrote a 22,300-byte PDF.

Reject completed and point-only point estimates outside $[-1,1]$, after explicit numeric parsing. Do not clip OLS/Wald interval bounds; they can extend past the parameter domain. Add boundary and just-outside cases, including numeric-string DataFrames.

Per-Atom coverage

atom-000001 — Danish municipal mobility

Reviewed the full verdict order and protocol; Table 1, cohort/calendar windows, income fields and generational distinction, annual sums/means, CPI/FX symbolic operations, parent/spouse/residence boundaries, rank and municipal-fit stops, all map interfaces, all appendix tuples/labels, log/quintile conflicts, release rules, legacy fields and downstream consequences. Executed hand-calculable arithmetic, endpoint boundaries for ages 15/18/20, zero/negative/nonfinite operands, unique-most-years/tie/duplicate cases, many-to-one link preservation and release at 24/25. The suite retained every output row and no empirical value. Findings F01 and F03 apply.

atom-000002 — international mobility comparison

Reviewed the full country/statistic inventory, fixed Danish core input, foreign-reference isolation, mean/SD aggregation boundary, span identity and comparison-difference units. Both dispatch policies and absent, valid-boundary, corrupt, wrong-input and no-result predecessors ran in the advertised suite. Published references never entered rebuilt/difference fields. Findings F01 and F02 apply.

atom-000003 — municipal demographic correlations

Reviewed all 12 source rows, their separate clocks/windows and candidate schemas, all 48 beta/r25/r50/r75 pairs, point-only semantics, OLS-SE source limit, ecological claim ceiling and Figure-2 binding. Complete, partial, all-unavailable, duplicate, wrong-origin and malformed-interval figure fixtures ran; preview text was readable. Findings F01, F02 and F04 apply.

Source-limit verification

I retrieved the exact public [Dataverse Readme](#) into scratch. Its SHA-256, `6ea24bb...ed4`, matched the frozen ledger. It confirms the released label definitions, child/parent windows, PERINDKIALT versus PERINDKIALT_13, negative-child/family log clause, and $N < 25$ / quintile-group- $N < 5$ release text. It does not provide a complete cohort/estimator program. Current [Dataverse dataset metadata](#) listed only `IG_Geo_DK.tab` and `Readme.pdf` in released version 2. This supports the narrow statement that no code is in the current deposit, not a claim that author code never existed.

Accordingly, G01–G20 remain real limits unless separately source-resolved in a new version. No numerical Danish mobility estimate, rebuilt country summary, or municipal-characteristic correlation is available from this frozen code. Source boundaries are not nulls or equivalence. The appendix inventory check read labels only—72 unique specifications, 720 variable labels, 36 rank and 36 log tuples—and did not read its published outcome values.

Tests and limitations

Reviewer-executed commands and exact outcomes are in the sibling YAML. The author's `prereg/engineering/implementation-report.md` reports its own final 25-test pass; I treated that as author-confirmed evidence and reran the suite independently.

No confidential rows, old empirical session, QGPU, commit, release or other reviewer's round-1 output was accessed. Real governed joins, disclosure checks and empirical estimators were unavailable and were not imitated with synthetic science. The original geometry, historical Gini input, CPI/FX series and rural classification remain unavailable. Helvetica Neue font files and both runtime interface documents were absent, so governed font binding remains untested; local previews used DejaVu Sans. Stata was not installed and is not required here; Rscript was available but

unused. RD, DiD, matching, survival and clustering are outside this descriptive frozen study and were correctly not invented.

r01 / opus.md

Independent adversarial reference-code review — Opus, round 1

Target: v001/world (Danish income-mobility replica-lane World, native canonical mode, roster atom-000001 / atom-000002 / atom-000003). Verdict: **revise** — one confirmed defect and one plausible fidelity item, each with a one-line fix and a regression test that I applied and tested in scratch. Everything else I attacked held.

This is an engineering/source-fidelity review. It is not scientific acceptance of the frozen protocol, not a replication, and not a claim that any Danish number was observed. I did not read the other reviewer.

1. What I actually did

I read all three Atom protocols and verdict regions in full, the whole Molecule policy, data-contract.md, data-boundary.yaml, identification.md, governance.md, the complete G01-G20 ledger, source-map.md, conversion-audit.md, published-reference-targets.md, appendix-specifications.yaml, display-labels.yaml, results-map.md, paper.md, figures.yaml, both figure templates, plot_style.py, all seven shipped Python modules and the 306-line implementation report, plus tools/prereg-lane/AGENTS.md and the upstream native.py.

Then I ran the advertised suite, the three README commands verbatim, and **twelve reviewer-authored verification scripts totalling 257 of my own checks**. Every one is a named, rerunnable file under scratch/r01/opus/work/ with absolute paths, so round 2 can re-verify all of them against the fixed code:

Script	Checks	Covers
t_pins.py	19	provenance vs the immutable package, pin coverage, no dropped sibling
t_inventory.py	16	independent appendix/label inventory arithmetic
t_dispositions.py	19	emitted dispositions, units, gap coverage, origin isolation

Script	Checks	Covers
<code>t_vendoring.py</code>	14	vendored native semantics vs upstream native.py
<code>t_locators.py</code>	19	FSV locator resolution and boundary containment
<code>t_manuscript.py</code>	10	53 slots, no smuggled published values, slot dispositions
<code>t_no_estimators.py</code>	29	tokenized estimator/inference scan, declared versions
<code>t_tamper.py</code>	25	registration identity: tampering vs legitimate realization
<code>t_adjudicate.py</code>	20	state machine vs the five registered verdict regions
<code>t_evidence.py</code>	23	receipt forgeries and dispatch policy (22/23 — finding 1)
<code>t_oracles.py</code>	32	independent arithmetic oracles for every supported kernel
<code>t_figures.py</code>	31	figure counterexamples + the pixel darkness oracle

Plus `t_gap_probe.py` (characterises finding 1 across five variants) and `t_genuine.py` (genuine-receipt round-trip before and after the fix). All eleven non-`t_evidence` scripts exit 0; `t_evidence.py` exits 1 by design because it *is* the finding. Nothing outside my scratch was written; I verified this by hashing every file in the World before and after every run.

2. The two findings

Finding 1 — CONFIRMED, moderate. `authority.py:215` gates on `is False`

`load_evidence` runs its full unexecuted-receipt content comparison only when `r.get("audit_complete")` is `False`. A receipt whose `audit_complete` is **absent**, **null**, 0, or **"false"** takes the `elif` at `authority.py:207`, which checks only that

`target-status.csv` statuses are all `unrun/operational_failure`, and then **skips the content check for every other output CSV**.

I forged a receipt from a real `run.py` output: `terminal="no_result"`, `registered_state=null`, `audit_complete` deleted, all `target-status.csv` statuses set to `unrun`, and `table1.csv` row 0 given the published sample size 339969 with status `completed`, both checksums recomputed. `load_evidence` **accepts it**. The literal boolean `False` control is correctly rejected — and that is precisely the only variant the author’s own regression test (`run_tests.py:313`) exercises, because it starts from a receipt that `run.py` emitted rather than a forged field.

This falsifies two stated guarantees:

- `execution/README.md:220` — “Output CSV/artifact digests, source identity, **full target audit** and registered state are verified.”
- `implementation-report.md:171` — “**Corrupt numeric values cannot be smuggled into** `completed`, `unrun` or `no_result` **evidence** by editing a receipt and recomputing an output checksum.”

Scientific impact is **contained, not absent**. `run.py:47-48` promotes only a non-null `registered_state` into `states`, so `evaluate` returns `done()==False` and the fabricated number is never consumed as an estimate. The exposure is that a forged receipt is recorded as a *validated* predecessor, indistinguishable from a genuine one, in a package whose entire value proposition is that its evidence chain is checkable. I am reporting it for that reason, not because a fake estimate can reach a result slot.

Pre-empting the obvious response. The report already says “Expected hashes must come from trusted governed orchestration; checksums are integrity mechanisms, not a digital signature”, so one could answer that the forgery presupposes an operator who supplies the forged hash. That does not dispose of it. The package deliberately does *not* rely on hash provenance alone: `load_evidence` rebuilds `expected = build_outputs(...)` locally and compares receipt content against it (`authority.py:178`, 201-204, 230-233) precisely because a supplied digest is not sufficient authority. **That independent content verification, not the hash chain, is what has the hole.** The hash chain behaves exactly as designed.

The fix is cheap, not obstructive. `frozen-material.json` pins 63 files and `prereg/execution/*` is deliberately not among them (`t_pins.py`). So changing `authority.py:215` alters **only** `implementation_identity` in the emitted receipt — not `material_identity`, not any registration digest, not `manifest.yaml`, not `CHECKSUMS.sha256`. No repackaging or re-sealing, no Atom or Molecule byte touched, no protocol amended, and receipts already produced under the frozen material still validate. The same holds for the finding 2 fix.

Fix (verified): `authority.py:215` → `if r.get("audit_complete") is not True:`. All five forgery variants are then rejected; all three genuine receipt classes (`audit_complete` true boundary, false operational `no_result`, false unactivated) still validate; downstream activation of Atoms 2 and 3 from a genuine Atom 1 boundary receipt is unchanged; all 25 advertised tests still pass. The README and report wording must be corrected alongside, or made true by the fix.

Finding 2 — PLAUSIBLE, minor. Gini status token, `analysis.py:227`

`characteristic:gini` is emitted with `status=unresolved_source` and a `STOP_UNRESOLVED_SOURCE.` prefix, although the frozen registration classifies the Gini input as *unavailable*, not *unresolved*: G13’s disposition reads “Original numeric input unavailable”; Atom 3’s gini row is the only one of twelve naming no unresolved decision (“Original series unavailable (G13)”); the common contract says “If a source-defined original input is not retrieved, emit `unavailable_original`”; and `analysis.py:100-102` already codes the exactly parallel G14 geometry case that way.

I record the counter-argument honestly: G11’s own affected-outputs column says “All 12 characteristics × four mobility measures”, its decision list includes “missing municipality-years” which could bind a 1987–1993 municipal average, and the contract states the unresolved-source test before the unavailable-input test. Under that reading the author is right. The four `correlation:gini:*` children carry G12, a genuine unresolved decision, so their status is correct either way, and the CSV already discloses G13’s full reason text — only the status token and prefix are imprecise.

Fix (verified): pass `status="unavailable_original"` for the gini characteristic row, keeping `gap_ids` G11,G13. State-neutral: 65/12/48 rows unchanged, all numeric fields still empty, `adjudicate` still returns `source_boundary` (the registered precedence clause keeps it binding via G11/G12 on the other rows), Atoms 1 and 2 unchanged, 25/25 tests still pass. If the author prefers the G11-binds-gini reading, making that precedence explicit in the report is an equally acceptable remedy — the defect is that it is currently implicit.

3. Per-Atom coverage

atom-000001 — Danish municipal mobility

Inventory verified independently, not by rerunning the author’s assertions.

I parsed `appendix-specifications.yaml` myself: 72 tuples with 72 unique keys, factorising exactly as 2 geographies × 3 ages × 2 outcome types × 6 y/x pairs; 720 variable labels; 36 log and 36 rank specifications; 108 log `r_` labels; **zero rank/log cross-type combinations**, as the protocol forbids. `display-labels.yaml` carries the 15 Table 1 rows and 12 Figure 2 rows in the exact printed order.

I then re-derived the emitted counts arithmetically: 720 + 72 N – 4 core aliases + 7 core-fit = **795** municipal rows; 792 release rows; 90 + 7 + 2 + 4 + 792 + 72 + 5 + 3 = **975** status rows. All match the CLI output. Appendix target IDs equal the source order exactly. I reproduced the unit assignment with an independent rule — **0 mismatches** across 795 rows. 113 `NOT_REBUILT_UNRESOLVED` rows = 108 log percentile labels + 5 D1 legacy labels.

I checked the two hard-coded lists at `analysis.py:77-78` against the YAML rather than trusting them: exactly five row IDs end in `_income`, and the five geography-dependent IDs match the list character for character. A mismatch there would silently under-declare G02/G03/G05/G06; there is none.

Supported components are really implemented. This is the crux of the review, so I verified each against my own oracles rather than the author’s expected values (`work/t_oracles.py`, 32/32):

Protocol clause	Implementation	My independent check
P §2 calendar endpoints	<code>kernels.py:39</code>	exhaustive 1970–1980 $\times$ {15,18,20}; endpoints 1991–1995 / 1988–1992 / 1993–1997 confirmed
at-least-once predicates	<code>kernels.py:49</code>	brute-forced 98 combinations against independent set logic
annual component sums	<code>kernels.py:62</code>	<code>fsum: [1e16,1,-1e16]</code> $\rightarrow$ exactly 1.0
CPI deflation identity	<code>kernels.py:70</code>	40-digit <code>Decimal</code> oracle; <code>deflate(x,c,c)==x</code> ; order preserved
DKK $\rightarrow$ 2015 USD	<code>kernels.py:78</code>	exact <code>Fraction</code>
negative-child 1000-DKK clause	<code>kernels.py:86</code>	strictly negative only; 0 and -0.0 untouched; refused for parent/mother/father/''/None
most-years municipality	<code>kernels.py:99</code>	exhaustive over 270 assignments: unique argmax or G05 tie stop, never a tie-break
Table 1 N and mean	<code>kernels.py:123</code>	<code>statistics.fmean; [1e16,1,-1e16] $\rightarrow$ 1/3</code> not 0.0; empty $\rightarrow$ N=0, mean None
P Eq.(1) predictions	<code>kernels.py:135</code>	exact <code>Fraction</code> +p for p { .25,.50,.75 }
R p.3 N<25 release join cardinality	<code>kernels.py:154</code> <code>kernels.py:162,173</code>	exhaustive n = 0...59 order/index/length preservation with duplicate index labels; duplicate right key stops; unmatched stays <code>left_only</code> , never zero-filled
the 17 frozen stops	<code>kernels.py:200</code>	each raises exactly the registered gap tuple; unknown operation refused

None of these is a stub. The independently computable siblings stay live while their blocked relatives stop, which is exactly the behaviour the protocol demands.

Figure 1. I wrote 14 counterexamples beyond the advertised suite; all refused correctly and none wrote a file: synthetic origin, zero *or* two Bornholm rows, unverified `mapping_status`, blank provenance, self-intersecting polygon, `LINestring`, estimate/polygon set mismatch, three or wrong city labels, nonfinite coordinates, nonfinite estimate, non-completed core status, and the frozen empty core/geometry.

I also built an **independent pixel oracle** for the source’s `[S]` shading rule. Rendering the synthetic map and measuring mean luminance: panel (a) falls $162.1 \rightarrow 103.3$ as `beta` rises, panel (b) rises $10.3 \rightarrow 220.1$ as `r25` rises. That is “darker at larger `beta` and smaller `r25`”, exactly as P’s caption requires — the `Greys / Greys_r` pairing at `figure1.py:71` is right, verified by measurement rather than by reading the code.

atom-000002 — International comparison

All **21** country/statistic combinations present; Canada carries only `population_mean` and `beta_mean`, matching the protocol’s prohibition on Canadian percentile means and SDs. All **10** Danish comparison rows have empty `rebuilt_value` and `difference`.

I cross-checked every one of the 21 transcribed values and its `published_precision` string against the frozen `published-reference-targets.md`: all trace literally. I hand-verified the span identities that the protocol registers as `[E]: 100×(.591-.427) = 16.4` and $100 \times (.562 - .441) = 12.1$, and confirmed `kernels.span_pp` reproduces both. Published values live only in `published-reference.csv` with `origin=published_reference` and never touch `estimate`, `rebuilt_value` or `difference`.

Direct dispatch here bypasses **only** outer activation: the local audit still runs and still returns `source_boundary` with `core_estimates_available: false` and an explicit `upstream.reason`. It does not fabricate a predecessor.

atom-000003 — Municipal demographic correlations

Exactly **48** ordered pairs and 12 characteristic rows; the four special windows (Gini 1987–1993, education 1981–1995, crime 1990–1997, default 1980–1995) all correct. G11/G12 and row-specific G13 bind; no direction, standardization, weighting, covariance, critical value or `df` is chosen anywhere — I grepped the whole shipped tree for `scipy`, `statsmodels`, `sklearn`, `polyfit`, `lstsq`, `linregress`, `.corr()`, `.std()`, `np.percentile`, `rankdata`, `.rank()`, `OLS`, `norm.ppf`, `bootstrap`, Fisher and a literal 1.96, and found **nothing** but prose and comments.

Figure 2: 11 of my counterexamples refused (unknown status, interval excluding the point, inverted interval, a 49th pair, renamed characteristic, invented measure, blank reason on a boundary row, `point_only` retaining bounds, `suppressed` retaining numbers, missing column, frozen all-blocked audit) and 3 legitimate partial states rendered (all-48 `point_only`, half-blocked, zero-width intervals). It preserves every unavailable row with a numbered note and never draws a missing value at zero.

4. Cross-cutting checks

Provenance. `diff -r` against `.controller/source` is clean: originals byte-identical, none dropped, and exactly two authorized additions (`prereg/execution/`, `prereg/engineering/`). No executable sibling was lost. `frozen-material.json` pins 63 files identical to `manifest.files`, all hashes match, and **every file the audit reads** is pinned — I enumerated them rather than assuming.

Registration identity (25/25, `work/t_tamper.py`). Rejected: Atom activation (twice), a verdict region, a protocol window, the registered tables list, Molecule membership/interpretation/scope/storyline, `deviations.md`, `display-labels.yaml`, `appendix-specifications.yaml`, `published-reference-targets.md`, `data-boundary.yaml`, `data-contract.md`, `results-map.md`, `paper.md`, `figures.yaml`, an estimator smuggled into `figure2.py`, and manifest mode/roster/digest. Accepted: realized Atom bodies and result fields, changed Molecule current interpretation, and mutable front-matter (`atom_strength`, `evidence_paths`, `molecule_mode`, `draft`). Identity survives legitimate realization and rejects real tampering — both directions tested.

The frontier block sits outside the registration digest. I checked this against `tools/prereg-lane/src/prereg_lane/native.py:311-312` before judging it: the vendored digest field selection is *identical* to upstream, so this is faithful, not a deviation. In fact `digest`, `parse_condition`, `references`, `evaluate`, `read_document` and all six constants are **byte-identical** to upstream — the “meaning-preservingly vendored” claim is literally exact.

State machine (20/20, `work/t_adjudicate.py`). All five registered regions reproduce, including `source_boundary` taking precedence over concurrent input gaps, `context:/legacy:/NOT_REBUILT_UNRESOLVED` targets excluded from substantive completion, and `operational_failure/unrun` yielding no state at all. I specifically probed the asymmetry where `characteristic:` rows are rebuildable but not “substantive”: 12 completed characteristics with 48 blocked correlations gives `source_boundary`, which is correct, because the Atom registers the 48 correlations as its targets. Not a defect.

Dispatch and evidence (22/23). Eight forgeries rejected (claimed complete state, one flipped `gap_ids` cell, an injected numeric beta, wrong `registration_digest`, wrong `material_identity`, an extra output file, a corrupt artifact digest, a checksum mismatch). `no_result` never retried under either policy, including an Atom’s own. All eight malformed `source_resolutions` variants refused; only `{}` accepted. Unactivated runs produce `unrun` with **no** scientific state — Kleene-unknown is preserved, never negated. The single failure is finding 1.

Portability. Copied CLI against a `chmod 555/444` relocated World: all three Atoms $\times$ both policies exit 0, the relocated World’s bytes are identical before and after, and no `.pyc` is written. `run_tests.py --world <copied>` gives 25/25. Path-after-copy identity holds; runtime paths never enter scientific identity.

Manuscript. 53 unique `[[RESULT:...]]` placeholders, exactly equal to the 53 binding rows. I scanned every numeric token in the prose: no published constant appears anywhere — no 339,969, no .242, no 16.4/12.1, no 57,751, no .441/.427. All 57 slot dispositions carry `fills_manuscript: false`.

Software. Every declared version matches the environment. SciPy 1.15.2 is present and unused; Rscript 4.1.2 present and unused; Stata absent — all exactly as reported. All 15 FSV schema locators resolve on disk and lie inside the 531-table boundary.

Censoring, leakage, immortal time, ties and longitudinal dependencies — checked, no finding

The brief names these explicitly, so I state the result rather than leaving it inferable.

No survival, event-time or treatment-timing construct exists in the code, and none should. Nothing of that kind is registered in any of the three Atoms, and Atom 1 says so outright: “*No causal time zero exists; 1980 is the source’s childhood observation start.*” There is consequently no index date, risk set, censoring rule or competing-risk handling to get wrong.

The source’s own design *does* contain a **look-ahead sample restriction**: a child must be observed at least once in 2010–2015, which is after the 1980-to-age-18 parental exposure window, so cohort membership depends on future survival and residence in Denmark. That is a property of the frozen published design, not of this implementation. `kernels.observation_predicates` (`kernels.py:49`) evaluates the at-least-once criteria exactly as P §2 states them and neither adds nor removes the restriction — I brute-forced it over 98 window combinations against independent set logic — and its docstring correctly notes this is *not* cohort construction, because G01 must first settle what an observation and a linked parent are. Consistently, G01/G02 leave death, emigration and nonresident-year handling explicitly unresolved, and `kernels.py` introduces no censoring, exclusion, trimming, balanced-panel or complete-case convention anywhere. **Preserving the source’s look-ahead criterion rather than silently correcting it is the faithful behaviour for a replica**; correcting it would be an unregistered design change. A future execution should still report it as a limitation of the replicated design.

Ties, duplicate joins, units, longitudinal dependencies likewise hold: equal-year municipality ties stop under G05 rather than taking any tie-break (exhaustive over 270 assignments); duplicate documented keys stop with no keep-first or averaging; many-to-one lookups cannot multiply child records and unmatched links stay explicitly `left_only` rather than being read as zero income; units are carried per target and reproduced by an independent rule over all 795 municipal rows with zero mismatches; and `done(atom-000001)` is enforced through the native Kleene evaluator, with downstream Atoms required to inspect target-level statuses rather than consume a bare completion label.

5. What remains unavailable, and why

No numerical result is produced by this reference code, and none can be. Not one Table 1 cell, municipal / /r25/r50/r75, appendix coefficient or SE, quintile

transition, Danish or international summary, span, municipal characteristic, or any of the 48 correlations or their intervals. All three Atoms adjudicate to `source_boundary`.

The causes are the frozen G01–G20, and I checked they are genuine and narrowly scoped rather than a blanket refusal: **every one of the twenty is actually cited** in at least one target-status row, none is unused, and the citations track each gap’s declared affected outputs. These are documented source boundaries — not statistical nulls, not equivalence, not negative findings — and the code refuses to convert them into any of those. Missing Danish microdata is *not* what I am reporting as a blocker; the honest boundary reporting is the deliverable.

Untested by necessity: any empirical estimate (no microdata or dictionary byte was opened); the estimators that correctly do not exist; the Helvetica Neue binding (assets absent, disclosed by the author); real Danish geometry and the Bornholm transform; and the controller’s own repackaging, since `manifest.yaml` and `CHECKSUMS.sha256` cannot index the new code tree from the author role.

One disclosed erratum that is **not** a finding: `data-contract.md` and `source-map.md` cite `fsv/education-and-culture/UDDA.md`, which does not exist — the real page is `fsv/education-and-knowledge/UDDA.md`. The executable `schema-candidates.json` already carries the correct resolvable path, and the engineer disclosed the discrepancy at `implementation-report.md:51–56` without editing the frozen contract. That is the right scoping. A World-internal regression test asserting that every `fsv/<section>/<TABLE>.md` string in the shared documents agrees with `schema-candidates.json` would let the next repackage correct the prose.

6. Why revise rather than accept

The package is strong: faithful, genuinely implemented where the source supports computation, honestly blocked where it does not, and hostile to exactly the shortcuts a replication is tempted to take. Finding 2 alone would not move me off **accept**.

Finding 1 does, for one reason: it is a reproducible hole in the evidence-validation layer, and the package **asserts in two places that the hole does not exist**. An engineering acceptance that leaves a false integrity guarantee standing is not faithful reporting. The remedy is one token plus one parameterised regression test, both already written and verified in my scratch, and it costs the author nothing scientific — no protocol change, no new research question, no new experiment.

Requested for round 2, and nothing more:

1. `authority.py:215` → `is not True`, plus the parameterised forged-receipt regression test; correct the `README.md:220` and `implementation-report.md:171` wording.
2. Either emit `unavailable_original` for `characteristic:gini` with its regression test, or state explicitly why G11 takes precedence for that row.

Optionally, the World-internal FSV-locator consistency test.

accept on the fixed package would mean: faithful, tested engineering within explicitly stated limitations — never observed science, never approval of the original protocol, and never a replication.

Artifacts: `scratch/r01/opus/work/` — the twelve named rerunnable scripts listed in §1 (257 checks) plus `t_gap_probe.py` and `t_genuine.py`, and the output trees `advertised-suite/`, `fixed-suite/`, `fixed-suite2/`, `ro-suite/`, `atom{1,2,3}-audit/`, `ro-world/`, `code/` and `code-fixed/`. Literal commands with absolute paths are in the YAML’s `test_commands`. The reviewed World, the immutable package, controller files and repository resources were never modified. `apply_patch` is unavailable in this harness; the two candidate fixes were applied with the harness Edit tool to `work/code-fixed/` only.

r02 / opus.md

Round-2 independent engineering review — Opus

Verdict: revise (one moderate + two minor findings, all with narrow verified fixes)

World reviewed: `v002/world` (replica lane, canonical native mode, roster `atom-000001`, `atom-000002`, `atom-000003`). Scratch: `scratch/r02/opus/work`. Nothing in the World, the immutable package, the other reviewer’s outputs, controller files or repository resources was modified.

This is an engineering / source-fidelity review. **revise** here means “apply three narrow code fixes and their regression tests”, not “the science is wrong” and not “the frozen protocol should change”.

1. What I did differently from the author’s own tests

The author’s round-2 regression tests largely mirror the implementation: `test_exact_appendix_operation_gaps_and_gini_input_disposition` transcribes `analysis.py:111-123`’s branch structure into assertions, and `test_upstream_projection_is_lossless...` uses `core_prerequisites` itself to build its expected value. Per predata-engineering (“A test that duplicates the implementation’s formula is not independent semantic verification”) I re-derived each fix from a source outside the code:

Fix	My independent oracle
Codex F03 (G07 on quintiles)	Gap sets rebuilt from <code>deviations.md</code> ’s own “Affected outputs” column plus the Atom-1 protocol, then compared to the emitted CSV.

Fix	My independent oracle
Codex F02 (upstream branch)	The predecessor's <code>target-status.csv</code> read off disk and compared field by field to <code>receipt["upstream"]["targets"]</code> .
Codex F04 (Figure 2 domain)	The complete round-1 refusal set replayed through both the adapter and the frozen template, so a weakening would show as a divergence.
Opus 1 (<code>audit_complete</code>)	12 forged variants each carrying the published N 339969.
Opus 2 (Gini)	<code>deviations.md</code> G13 disposition text and Atom 3's row table.
Codex F01 (code identity)	Nine seal counterexamples including cases the author did not test.

2. Provenance and unchanged material

- `diff -rq .controller/source v002/world` → only the two authorized additions (`prereg/execution/`, `prereg/engineering/`). All 69 original files byte-identical, none dropped.
- All 83 v002 file hashes identical before and after everything I ran; zero `__pycache__/.pyc` files created.
- `kernels.py`, `native_semantics.py`, `input-example.json`, `schema-candidates.json`, `frozen-material.json`, `requirements-tested.txt` are byte-identical v001 → v002. `native_semantics.py` is still byte-identical to `tools/prereg-lane/src/prereg_lane/native.py` for `digest`, `parse_condition`, `references`, `evaluate`, `read_document` and every constant (AST-level comparison). Round-1's 32 arithmetic oracles and vendoring checks therefore carry forward as **verified-unchanged**, not silently reused.
- Advertised suite: **32/32, 27.6 s**, reproduced independently.

3. Per-Atom coverage

atom-000001 — Danish municipal mobility

Ran the exact README command (`--dispatch-policy activation_respecting`):
`exit 0, state=source_boundary, terminal=None`. Emitted 975 targets, 90 Table 1 cells, 795 municipal scope rows, 792 release rows, header-only geometry/city interfaces — all matching the README, every numeric column empty.

F03 verified independently (19/19, `t_gaps.py`). The oracle is built from the ledger, not the code:

- `startswith("q")/startswith("x_q")` selects **exactly** the six quintile labels `{q1q1,q1q5,q5q1,q5q5,x_q1_N,x_q5_N}` and nothing else; the remaining seven

labels are exactly the coefficient/SE/prediction family. The partition is exhaustive and disjoint, so no stray label can fall into the wrong branch.

- **No log specification carries a quintile label** (0 of 36). This is the interaction that would have broken the author’s 216 assertion and the G15 if log else G04 branch; it holds.
- 0/792 gap-set mismatches against the oracle. G07 removed from 216/216 quintile targets; **retained** on 288/288 alpha/beta/SE and 108/108 non-log prediction targets, matching G07’s own “Municipal alpha/beta, SEs and predictions” scope. 108 log predictions remain G17-only and NOT_REBUILT_UNRESOLVED. `core-fit:*` and `release:*` gap sets unchanged.

Registration identity: 31/31 (`t_tamper.py`) over 30 scratch World copies. New in v002 and previously accepted by v001: tampering `kernels.py`, an `analysis.py` gap list or `schema-candidates.json` now refuses with exit 2. Realized Atom bodies, `atom_result`, mutable front matter, changed Molecule interpretation and rating are still accepted.

atom-000002 — International mobility comparison

Ran the exact README command (`--dispatch-policy direct`): 23 targets, 21 country/statistic combinations, 10 empty Danish comparison rows, 21 isolated published references. Published values never populate `estimate`, `rebuilt_value` or `difference`; Canada carries only two references.

F02 verified from disk (part of 276/276, `t_upstream.py`). The four `core-fit:{beta,r25,r50,r75}` projection rows are byte-equal to the predecessor’s CSV, in registered order, bound to the exact receipt digest, with no absolute path. All 8 Danish mobility targets emit `UPSTREAM_BOUNDARY first`, name their exact required core rows (`span_pp` names both `r75` and `r25`), reproduce the upstream reason and locator verbatim, and do not reach G10 — exactly the registered branch order IF needed core estimates not completed ... ELSE IF G10 Population context stays independent of the core fit. `alpha` and the SEs are correctly not projected: nothing downstream needs them.

Forgery matrix 24/24 (`t_forgery.py`). Refused: nulled/bogus `receipt_sha256`, downgraded `kind`, forged `core_estimates_available` and `accepted_predecessor`, a projected row flipped to `completed`, an edited `gap_ids` cell, a truncated or reordered projection, a removed or non-mapping `upstream`, an edited `implementation_identity`, a validated projection presented with a `no_result` predecessor — and a **fully self-consistent** downstream receipt whose CSVs were rebuilt from a forged `completed-core` upstream with every checksum recomputed. All six malformed `source_resolutions` refused.

atom-000003 — Municipal demographic correlations

Ran the exact README command: 65 targets, 12 characteristics, 48 correlations, `figure2` not_rendered with a reason.

Opus round-1 finding 2 fixed and verified: `characteristic:gini` is `unavailable_original` with G13 and G11 in `gap_ids`, its reason no longer carries

the `STOP_UNRESOLVED_SOURCE.` prefix, its four correlation children are retained, and Atom 3 still adjudicates `source_boundary` — it did **not** flip to `input_boundary`.

F04 verified with a 44/44 accept/refuse matrix (`t_figure2.py`). Every case ran through both `interfaces.call_template` and the frozen `figure2.py` directly. The new float pre-parse weakens nothing: all twelve round-1 refusals still refuse. The four domain violations refuse through the adapter and **render** through the frozen template, confirming the fix lives in the adapter exactly as the README discloses. ± 1.0 exactly and unclipped Wald bounds around an in-domain point still render. Numeric-string handling is strictly stronger than before (negative lexicographic ordering, blank `point_only` bounds and whitespace-only boundary cells now work where the frozen template raised). No refused case wrote a file.

I inspected a synthetic **partial** Figure 2 preview at manuscript width (`t_preview.py`): 130.7 mm exact, 0 out-of-page text blocks, long wrapped boundary notes contained in the numbered note area, unavailable rows annotated in the margin and never drawn at zero, `point_only` hollow markers, and a 1.4 upper bound extending past the domain without clipping.

4. Findings

Finding 1 — moderate, CONFIRMED. The implementation seal pins eight files but not the action directory

`authority.py:60-64` hashes the eight sealed names in both the deployed and the action directory, but never requires those directories to contain nothing else. `run.py` is executed as a script, so **its directory is `sys.path[0]`**.

I copied `prereg/execution/` verbatim (all eight files hash clean, action seal byte-equal to the deployed seal) and added one file, `yaml.py`, re-exporting real PyYAML but truncating `display-labels.yaml`'s `table1` list. Result: exit 0, and a receipt with

```
registered_state      = "source_boundary"
audit_complete        = true
implementation_identity =
↳ b41e78f9701329dbb20b9ca7d107a693adcbabfb3e98fc77911e0e368e18642f ← the
↳ reviewed identity
```

while `target-status.csv` held **903 of 975** rows and `table1.csv` **18 of 90** cells. That falsifies `implementation-report.md:251` — “*Only a byte-identical action copy matches the deployment seal*” — and narrows `README.md:272-277`.

This is **not** the disclosed “malicious interpreter” or “replaced deployment/seal” caveat: interpreter, World, deployed seal and all eight sealed files are untouched, and predata-engineering explicitly expects the registered code to be copied into a **writable** action workspace — precisely the surface the seal is meant to bind.

Containment is real but version-specific and I say so: an untouched consumer refused that producer’s receipt as `terminal=no_result` under **both** policies, because `load_evidence` re-derives every output from the frozen World. That works only

because this frozen version computes its outputs entirely from World bytes; it would not survive a version whose outputs depend on data — which is why Codex F01 asked to verify the running copy rather than trust a self-asserted receipt field.

Also confirmed working, so the seal is not being dismissed: tampered action `kernels.py` refused, self-resealed action copy refused, tampered deployed code refused, mismatched deployed seal refused, missing action seal refused cleanly with exit 2 and no traceback, a round-1 receipt (`a6280e79fce6`) refused by the sealed round-2 consumer, and a byte-identical relocated copy accepted against a `chmod 555/444` World that was unchanged afterwards with no bytecode written.

Fix (applied with `apply_patch` to `scratch/r02/opus/work/code-fixed/authority.py:65-71`, verified 6/6):

```
for entry in Path(directory).iterdir():
    importable = entry.name.endswith(".py") or (entry.is_dir() and
    ↪ (entry/"__init__.py").exists())
    if importable and entry.name not in RUNTIME_FILES | {"run_tests.py"}:
        raise ValueError("Unsealed importable module in runtime directory:
        ↪ "+entry.name)
```

Shadowing module and shadowing package directory both refuse with exit 2 before any output; a clean copy still emits all 975 targets; a non-importable extra file is still allowed. **The full 32-test suite passes with the fix deployed and resealed.**

Two things to say in the report alongside the fix. First, `run_tests.py` is allowlisted rather than sealed on purpose: nothing in `run.py`'s import graph imports it, so it cannot shadow a runtime dependency, and sealing it would widen the seal contract further than this defect requires — adding it to `RUNTIME_FILES` is the equally acceptable alternative. Second, this makes the roster exhaustive; it is not sandboxing, since an unsealed module still executes at import time before verification runs.

Identity cost: only `authority.py`'s digest and the emitted `implementation_identity` change. No registration digest, `material_identity`, `manifest.yaml` or `CHECKSUMS.sha256` entry is touched.

Finding 2 — minor, CONFIRMED. Upstream operational_failure/unrun relabelled data_boundary

`analysis.py:234-236` maps every non-completed core row that is neither `unresolved_source` nor `unavailable_original` to `data_boundary`. Both a `no_result` and an `unrun` predecessor land there. The registered common contract defines `data_boundary` as “*a resolved dependency is demonstrated absent in governed runtime*” and routes the other case explicitly: “*If access fails without establishing absence, report operational failure and leave the Atom unrealized.*” The relabel also defeats `adjudicate`'s first guard, which exists precisely to keep operational rows out of a scientific state.

Measured (`t_upstream.py`, `t_opfailure.py`): under `direct` with a `no_result` predecessor, `atom-000002` emits 8 and `atom-000003` emits 48 `data_boundary` rows whose own reason quotes `atom-000001/core-fit:beta [operational_failure]`.

Current impact is nil, and I verified that rather than assuming it. The emitted state is `source_boundary` for every predecessor class under `direct` — identical to the absent-evidence baseline, because G10/G11 independently stop the rest. Under the default `activation_respecting` policy a `no_result` or `unrun` predecessor correctly gives `state=null`, `audit_complete=false` and all-`unrun` rows.

The forward exposure is concrete: with the same emitted operational rows and the local gaps resolved in a later registration, `adjudicate` returns `input_boundary` (Atom 3) and `partial` (Atom 2) — a scientific state from a purely operational failure. Propagating the predecessor’s own status returns `None` in every case.

`README.md:259-260` documents the choice and the reason string discloses the true upstream status, which is why this is minor.

Fix — applied with `apply_patch` to `code-fixed/analysis.py:234-240` and executed (67/67), not just reasoned about. Extend the status ladder so a failed row whose status is `operational_failure/unrun` propagates verbatim. Under the fixed, resealed code the 8 Danish and 48 correlation rows carry the predecessor’s own status, no `data_boundary` relabel remains, `registered_state` is null in all four cases, and all 12 downstream receipts still round-trip through `load_evidence`. Baselines are unchanged.

Intended semantics, stated so the author implements what I tested: terminal stays null. This Atom’s own execution did not fail, so it emits `audit_complete=true` with no scientific state — the registered `otherwise` region. I confirmed that receipt class is legal rather than assuming it: with `audit_complete=true` the validator compares `registered_state` against `adjudicate(expected)`, which is also `None`.

This fix is not drop-in. Exactly one advertised test fails with it — `run_tests.py:429` in `test_no_result_never_retried_even_direct`, whose `assertEqual(r["registered_state"], "source_boundary" if policy=="direct" else None)` is the encoding of the disputed semantics and must become `None` for both policies. Every other assertion in that test still passes, and the other 31 tests pass.

Finding 3 — minor, CONFIRMED. The upstream-first branch drops target-local gap citations

F02 **replaced** rather than supplemented the local gap citations. All 48 correlation rows and all 8 Danish mobility rows now carry `gap_ids = "G01,G02,G03,G04,G05,G07"` only. G10 no longer appears on any Danish mobility target; G11/G12/G13 no longer appear on any correlation target — though those gaps still block exactly those targets. The trailing reason is the generic *“Local target operations not reached; source choices remain frozen”*, naming none of them.

Whole-ledger coverage is intact — I verified **all 20 of G01–G20 are still cited by at least one emitted target** — so this is lost target-local precision, not a lost gap. It matters because `results-map.md` binds these rows to the manuscript’s correlation and comparison slots: a reader of `correlations.csv` would conclude that settling the municipal fit unlocks the correlations. The claim is about **disclosure**, not about `gap_ids`.

Recorded in the author’s favour: the branch **order** is faithful — Atom 2’s pseudocode is unambiguous, and Atom 3’s measure loop likewise puts the upstream requirement before G12. Atom 3’s characteristic-level clause “*emit explicit boundary for that row’s 4 targets*” is the only text reading the other way. The defect is the silent omission, not the ordering.

Fix — applied with `apply_patch` and executed (67/67). Give `upstream_boundary` a `deferred` keyword and end the reason with “*Local target checks not reached; G11,G12 remain unevaluated and still stop this target.*” All 8 Danish rows now name G10, all 48 correlation rows name G11,G12 and the four gini rows name G11,G13,G12, while `UPSTREAM_BOUNDARY` still comes first. This fix alone leaves the suite at 32/32.

`gap_ids` is deliberately **not** widened. Codex F02 asked for the exact upstream gaps to be propagated, the author implemented that, and `run_tests.py` asserts `row.gap_ids == source.gap_ids`; widening it would reverse an accepted round-1 fix on a judgement call. `target-status.csv`’s columns are fixed by the Atom protocols, so a new column is not available either — which leaves **reason** as the only in-contract place.

5. Explicitly checked, no finding

- **No estimator or inference API anywhere.** Tokenized scan with `STRING` and `COMMENT` tokens blanked (so docstrings cannot mask a hit) across the six runtime modules and the three figure templates: no `scipy`, `statsmodels`, `sklearn`, `polyfit`, `lstsq`, `linregress`, `rankdata`, `OLS`, `norm.ppf`, `bootstrap`, `fisher`, `1.96`, `.corr()`, `.std()`, `.rank()`, `percentile/quantile` or `cov()`. Two scanner hits were false positives verified by `grep` (`ttest` inside `unittest`, from `run import execute`).
- **RD / staggered DiD / matching / clustered SEs / survival risk sets / competing risks** appear nowhere and correctly should not — none is registered in any of the three descriptive Atoms. Adding one to manufacture review coverage would itself be an unregistered design change.
- **Censoring, leakage, immortal time, index date vs time zero, ties, duplicate joins, units.** `kernels.py` is byte-identical to v001 and adds no censoring, trimming, balanced-panel or complete-case convention. The source’s own look-ahead restriction (observed at least once in 2010–2015, after the parental window) is a property of the frozen published design; preserving it is the faithful replica behaviour, and any future execution should still report it as a limitation.
- **Copied-layout CLI, complete.** All three Atoms $\times$ both dispatch policies run from a copied action directory against a relocated `chmod 555/444 World` — on the reviewed code and again on the fixed bundle. Six runs each, all exit 0, Atom 1 `source_boundary` under both policies, Atoms 2/3 `unrun` under `activation_respecting` and `source_boundary` under `direct`, the read-only World byte-identical afterwards, no bytecode written.

- **Missing optional inputs.** Manifests omitting `tables`, `dictionaries`, `evidence` and `source_resolutions` individually and all four together are all accepted and yield `source_boundary`.
- **Manuscript isolation.** 53 unfilled `[[RESULT:...]]` placeholders equal to the 53 bindings; none of 16 published constants in the prose; no slot has `fills_manuscript=true`; all integrity logs record `microdata_opened=false`.
- **audit_complete (Opus round-1 finding 1).** 12/12 forged variants — absent, `null`, `0`, `1`, `"false"`, `"true"`, `"False"`, `False`, `True`, `[]`, `{}` — carrying the published N 339969 are refused, with checksums recomputed.
- **FSV locator erratum.** The author added exactly the World-internal regression test I suggested in round 1, pinning that one erratum without editing frozen prose. Correct scoping; the documents still need correction at the next repackaging.

6. Limits stated plainly, not as blockers

- Codex F01 asked for the runtime roster to enter the **final package seal**. It does not: `manifest.yaml/CHECKSUMS.sha256` still pin 63 files, none under `prereg/execution/`, so `implementation-seal.json`'s own integrity rests on the World being delivered as trusted read-only material. That is the documented author/controller split (`implementation-report.md:216–224`), stated openly. Replacing deployed code + deployed seal + action copy together is accepted by design; I confirmed it and it matches the author's own caveat.
- **No numerical result is available from this reference code**, and none should be: no Table 1 cell, no municipal `/r25/r50/r75`, no appendix coefficient or SE, no quintile transition, no Danish or international summary, no span, no municipal characteristic, none of the 48 correlations or their intervals. All three Atoms adjudicate to `source_boundary`. This is a documented source boundary, not a statistical null, not equivalence, not a negative finding.
- Helvetica Neue assets and both runtime interface documents are absent, so the governed font binding is untested; renders used the documented DejaVu Sans fallback. Rscript is present and Stata absent, exactly as reported — with no registered executable estimator there is nothing to cross-implement.
- I did not report any missing real dataset as an engineering blocker, and I did not accept any missing implementation on the grounds that data is unavailable: findings 1–3 are all about shipped code paths that execute today on synthetic inputs.

`accept` would mean tested engineering within explicit limitations. This package is close to that — the four round-1 fixes are real and survive adversarial retesting — but finding 1 falsifies a written guarantee about the very mechanism round 1 asked for, so the verdict is **revise** for three narrow fixes and their regression tests. Nothing here is scientific acceptance, observed science, approval of the original protocol, or a replication.

Round-3 independent engineering review — Opus

Verdict: **accept**, with two narrow engineering items (one minor code fix, one controller packaging obligation) and one machine-readability observation.

accept here means: the delivered reference code is a faithful, tested implementation of the frozen replica registration, within explicitly stated limits. It is **not** scientific acceptance of the frozen protocol, **not** approval of the original Eriksen & Munk (2020) design, and **not** a replication. No empirical estimate exists in this World and none can be produced under the frozen source gaps. I did not re-open the converter's gap determinations; I checked that they are genuine, narrowly applied, and faithfully implemented.

Reviewed snapshot: v003/world, roster atom-000001, atom-000002, atom-000003, mode canonical, replica lane.

1. What I did differently from the author

The author's own suite (36 tests) passes, but the task forbids treating author-derived expectations as oracles. So I:

- wrote **gap oracles outside the implementation** for all 792 appendix targets and all 90 Table 1 cells and compared them row by row with the emitted CSV. To make sure the Table 1 oracle was not just a transcription of `analysis.py`'s branch logic, I re-derived it a second time using only the *Affected outputs* column of the G01/G02/G03/G05/G06 ledger rows; both converge exactly;
- verified every published constant, the whole Table 1 reference transcription and the G07/G08/G09/G10/G13 gap claims **verbatim against the retrieved source article**, whose SHA-256 matches `source-provenance.yaml`;
- hand-computed oracles for every kernel, including both published spans;
- built my own falsifying fixtures for the risky branches — receipt forgery, corrupt and *working* shadow modules, out-of-domain figure inputs, and the completed-core continuation the CLI can never reach.

Everything I wrote lives in `scratch/r03/opus/adversarial_{1..7}.py` with outputs under `scratch/r03/opus/out/`. The reviewed World was not modified: its 83-file tree digest and file count are unchanged after all runs, and no `__pycache__` was created.

2. Per-Atom coverage

atom-000001 — Danish municipal mobility

Inventory reproduced exactly. 90 Table 1 cells (15 rows $\times$ 6 statistics), 7 core coefficient/prediction/SE targets, 792 appendix labels (72 tuples $\times$ 13 or 7 variables + N), 792 release rows, 795 municipal scope rows (795 = 7 core + 792 - 4 core/appendix aliases), 5 legacy D1 labels, 3 context targets, **975 target dispositions**. All match the README’s stated counts and `target-inventory.md`.

Gap sets reproduced from outside the implementation. The appendix oracle (written from the Atom protocol’s stated structure) matched all 792 appendix gap sets; two separately written Table 1 oracles — one from the protocol, one derived only from the ledger’s *Affected outputs* column — both matched all 90 cells. In particular:

- the round-1 F03 repair holds: **none of the 216 quintile targets cites G07**;
- exactly **108 log r_25/r_50/r_75 labels** are G17-only and NOT_REBUILT_UNRESOLVED, matching G17’s own stated count;
- the appendix `r_75` label conflict is disclosed with G16 and the P-defined core `r75` is kept separately supported.

Supported science is really implemented, and correct. Every [S]/[E] operation is present in `kernels.py` and passed hand oracles:

Kernel	Check I ran	Result
<code>source_windows</code>	1977/18 $\rightarrow$ parent_end 1995; 1973 at 15/20 $\rightarrow$ 1988/1993; 1972 ineligible; age 17 refused	correct
<code>observation_predicates</code>	adult 2009 excluded; parent 1993 in, 1994 out	correct
<code>deflate_annual</code>	100 nominal, CPI 50 $\rightarrow$ 2015 CPI 100 = 200	correct
<code>convert_2015_usd</code>	700 DKK $\div$ 7 = 100; zero rate refused	correct
<code>count_mean</code>	N/mean exact; empty $\rightarrow$ N=0, mean absent (not 0); NaN refused, no available-case	correct
<code>negative_child_log_clause</code>	5 $\rightarrow$ 1000; 0 stays 0 ; <code>income_role="parent"</code> $\rightarrow$ G15	correct
<code>most_observed_years</code>	argmax correct; 2-way tie $\rightarrow$ G05; duplicate year $\rightarrow$ DataBoundary; blank geography $\rightarrow$ G05	correct
<code>rank_predictions</code>	+ .25 /.50 /.75	correct

Kernel	Check I ran	Result
<code>appendix_count_release</code>	24 → suppressed, 25 → passes; bool/non-integer/negative refused	correct
<code>join_many_to_one</code>	duplicate right key refused; left cardinality preserved with explicit unmatched status; null left key → G01/G02	correct

These are unreachable from the CLI only because every empirical path has a frozen upstream stop — that is the registered disposition, not a missing implementation. This is not a wrapper that reports missing inputs: it is a complete audit plus a real, tested arithmetic layer that the protocol forbids feeding.

Cohort / timing / leakage (task item 2). Verified against the paper text: births 1973–1977; child observed at least once 2010–2015; parents at least once 1980 through the child’s age-18 year. The parent window closes before the adult income window opens, so there is no future-information leakage; municipality assignment uses 1980–age 18 only, never adult location. There is no causal time zero, no censoring rule and no survival restriction — correctly, since none is registered. Ties (`most_observed_years`), duplicate joins (`require_unique`, `validate="many_to_one"`) and units (the CSV `unit` column) all stop rather than resolve.

Figure 1. Refuses the frozen boundary outputs with a `STOP_` reason and writes no PDF; no surrogate geography is emitted. `map-geometry.csv` and `city-labels.csv` are header-only, `geography:*` targets are `unavailable_original` under G14.

atom-000002 — International mobility comparison

21 country/statistic combinations, 10 Danish comparison rows, 21 isolated published-reference rows, 23 targets. Foreign rows are `reference_only_not_rebuilt` with empty estimates; published values never touch `rebuilt_value` or `difference`.

The transcription is exact and internally coherent. All 21 constants match the retrieved article verbatim (57,751 / 42,812; 75,609; 69,694; .242 and .33; US .427(.065)/.51(.059)/.591(.062); Denmark .441(.023)/.502(.019)/.562(.019); 16.4 and 12.1). Independently, `kernels.span_pp` applied to the transcribed means reproduces **both** published spans exactly: $100 \times (.591 - .427) = 16.4$ and $100 \times (.562 - .441) = 12.1$. That is a single check that validates the formula and the transcription together, from outside the package.

I forced the unreachable branch in which all four core measures are complete: all 10 Danish targets still stop, the span is still not computed, and the state is still `source_boundary`. With only `beta` forced complete, the `beta_mean` target reaches its own local G10 while `span_pp` correctly reports **both** `r25` and `r75` as failed prerequisites.

atom-000003 — Municipal demographic correlations

12 characteristic rows with the registered windows (default 1980–1995; Gini 1987–1993; education 1981–1995; crime 1990–1997 — all confirmed against the paper and the Figure 2 caption), 48 ordered correlation pairs, 65 targets. `characteristic:gini` is `unavailable_original` with `G11,G13` — the round-1 Opus finding 2 repair, which I confirmed is now correct in both status token and reason prefix.

Figure 2 through the adapter: ± 1.0 accepted, 1.000001 and ± 1.2 refused with no file created, Wald bounds beyond $[-1,1]$ preserved unclipped, reversed intervals / numbers on boundary rows / an entirely unestimated figure / `origin=published_reference` / a dropped pair / non-numeric text / duplicate keys all refused. `figure2.py` is hashed in `manifest.yaml` and `frozen-material.json`, so the adapter is the only legal place for that check — which closes round-1 F04.

3. Challenging the three round-2 fixes

I tested each with cases the author’s suite does not use.

Fix 1 — import surface. The repair is real. I compiled a *working* shadow `yaml` module to `yaml.pyc`, planted it in a writable action copy with all eight sealed digests intact, and the CLI refused with exit 2 and `Unsealed importable module in runtime directory`. Also refused: extra `.py`, a `yaml/` package, a bare namespace directory, a symlink named `yaml.py`, `__pycache__`, `sitecustomize.py`, an extra module planted in the **deployed** World directory, and a self-resealed action copy carrying an altered `rank_predictions` sign. A non-importable `.txt` operator note is correctly allowed. **One gap:** a corrupt `yaml.pyc` or `yaml.so` fails at import before the inventory check and escapes `run.main`’s handler → exit 1 with a machine-path traceback instead of the documented exit 2. Fail-safe (no output, no receipt, no state) but off-contract — this is finding **F01**.

Fix 2 — operational/unrun prerequisites. Correct. A `no_result` predecessor under direct dispatch leaves all 48 correlations at `operational_failure`, not `data_boundary`; `adjudicate` returns no scientific state; `terminal` stays null because the consumer’s own execution did not fail; the new `slot-dispositions.json` branch reports unresolved scope without assigning the `otherwise` key or filling a manuscript slot. Under `activation_respecting` the same predecessor correctly yields `unrun` instead. The predecessor is never retried under either policy.

Fix 3 — deferred gaps. Every affected reason now names its still-binding local gaps: `G10` on all 8 Danish mobility targets, `G11/G12` on all 48 correlations, plus `G13` on the four Gini rows. The `gap_ids` column still carries upstream gaps only — disclosed in the README and not required to be exhaustive by the Atom output contract, so I record it as informational (**F03**), not a blocker. I confirmed the reachable continuation does emit the local `gap_ids` (`G10`; `G11,G12`; `G11,G13,G12`), so nothing is lost.

4. Evidence, dispatch and registration identity

Nothing I tried turned a stop into a result:

- a predecessor receipt with the four `core-fit:*` rows flipped to `completed` and all hashes recomputed — refused by the content re-derivation in `load_evidence`, under both policies;
- an injected numeric `beta` in a predecessor CSV with recomputed hashes — refused;
- `audit_complete` as 1, "true", null, 0 — all refused (round-1 Opus finding 1 repair holds);
- runtime `source_resolutions`, unknown manifest fields, wrong material identity, a path-like `dataset_id`, evidence for an unregistered Atom, a relative evidence path, a symlinked predecessor artifact — all refused;
- a synthetic receipt cannot activate a governed run.

Strong Kleene semantics are correct: `done()` with no evidence is unknown, **NOT unknown stays unknown**, and the grammar rejects eval-like input.

Registration identity behaves as item 6 requires: an in-place realized Atom body/result change and Molecule interpretation edit preserve `material_identity` and all registration digests (only the diagnostic realization hash moves), and a receipt produced against that World still validates elsewhere — while a one-token activation edit is refused. All 69 immutable original package files are byte-identical; the only additions are the 14 execution/engineering files. Reading against a `chmod-read-only` relocated World leaves it byte-identical with no file added; outputs inside the World, relative output roots and directory overwrites are refused.

The 15 `schema-candidates.json` locators all resolve under `resources/schema/data-registry-bolero/` and every declared field appears in the cited document. The UDDA `education-and-culture` → `education-and-knowledge` erratum in the frozen `data-contract.md` is real and is correctly disclosed rather than silently corrected in frozen material.

All 53 `[[RESULT:]]` manuscript slots are covered by the union of the three Atoms' slot dispositions, with `fills_manuscript=false` everywhere and the manuscript untouched.

5. Findings

#	Severity	What	Owner
F01	minor	<code>ImportError</code> escapes <code>run.main</code>'s handler → exit 1 and a machine-path traceback instead of the documented exit-2 refusal, when an unloadable module shadows an imported dependency. Fail-safe; no output, receipt or state. Fix: add <code>ImportError</code> to <code>run.py:107</code>; regression test with a corrupt <code>yaml.pyc</code> and <code>yaml.so</code>.	author

#	Severity	What	Owner
F02	minor	<code>manifest.yaml</code> and <code>CHECKSUMS.sha256</code> still cover only the 63 original files; the 14 added execution/engineering files are outside both, so <code>read_bundle(..., verify=True)</code> fails and <code>archive_package</code> would refuse the sibling ZIP. The author documents this as outside their write scope, which matches <code>package-contract.md</code> line 246. Fix: controller reseal.	controller
F03	informational	Deferred gaps (<code>G10</code>; <code>G11/G12/G13</code>) appear only in <code>reason</code>, not in the machine-readable <code>gap_ids</code> column, on the 8 Danish and 48 correlation upstream rows. Disclosed; no disposition affected.	optional

#	Severity	What	Owner
F04	informational	analysis.py:338 omits characteristic: from the substantive- estimate prefix set, so 12 completed characteristics with all correlations blocked would adjudicate to source_boundary (“no substantive target estimated”) rather than partial. Unreachable under G11/G12, and defensible as treating a construction as an input rather than a finding.	optional

F04 came from probing a partition my main adjudication battery had missed: **characteristic:** rows are counted as required (they can block **complete**) but never as estimates. Since G11 blocks all 12 constructions and G11/G12 block all 48 correlations, the divergent branch cannot occur in this World, and the exclusion is consistent with how **geography:** and **release:** are deliberately kept out of the empirical set. I record it as an ambiguity with a one-tuple fix, not a defect.

F02 is the only item I would call a real gap in the delivered snapshot, and it is a packaging step the author cannot perform. It does not affect execution or any scientific disposition, and the added code is independently pinned by **implementation-seal.json** (identity **bcdcc3ad...**, all eight digests verified) and the 63 original files by **frozen-material.json** (all verified). It therefore does not drive the verdict.

6. What remains unavailable, and why

Plainly: **no numerical result from this study is available, and none can be.** All three Atoms adjudicate to **source_boundary**.

- **Atom 1** — all 90 Table 1 cells, 7 core targets, 792 appendix labels and both Figure 1 panels blocked by G01–G07; 108 log prediction labels not rebuilt (G17); 5 D1 legacy labels not rebuilt (G16/G19); Figure 1 geometry and city labels unavailable (G14).
- **Atom 2** — 2 population-context cells unavailable (no source 2015 count date or extraction); 8 mobility summaries blocked upstream with G10 additionally binding; 11 foreign rows are published context by registration, never rebuilt.
- **Atom 3** — 12 characteristic constructions blocked by G11, with Gini additionally `unavailable_original` under G13; all 48 correlations blocked upstream with G11/G12 (and G13 for Gini) deferred; Figure 2 refused.
- No author program was located (G20), so no paper–code disagreement is claimed on unseen evidence.

Not tested / not testable here: no real register data were read (`microdata_opened=false`, `runtime_access_validated=false` on every run), so actual FSV access, real join cardinality and real geometry remain unvalidated. No inference procedure exists to validate — no fit, rank, SD, quantile, correlation or CI. RD, staggered DiD, matching, clustered SEs, survival and competing risks are not registered here and, I confirmed, were not added for coverage. Figure rendering used DejaVu Sans because Helvetica Neue is absent. Original source PDFs are excluded from the World by contract, so constants were checked against the hash-matched retrieved article Markdown rather than publisher bytes, and D1/D2 were not re-retrieved. Stata is not installed (not required); Rscript 4.1.2 is present and unused; SciPy is installed and, as intended, unused for inference. The implementation seal is an integrity record against a trusted deployment, not a signature.

Complete registered Molecule

```
id: molecule-000001
molecule_mode: prereg
molecule_shape: convergent
topic: Danish mobility geography
rating: C
draft: false
membership:
- atom: atom-000001
  role: primary
  description: 'First stated contribution in P: one municipal mobility
↪ analysis
  with related outcomes, sample description and appendix specifications;
  no panel or linkage split.'
- atom: atom-000002
  role: primary
  description: 'Second stated contribution in P: distinct area-distribution
  comparison with source foreign values retained as external references,
  not new external experiments.'
- atom: atom-000003
  role: primary
  description: 'Third stated contribution in P: all related characteristic
  rows and four outcome series remain one ecological correlation analysis.'
literature: []
frontier:
```

```

rule: How does intergenerational income mobility vary across Danish
  ↳ childhood
    municipalities, compare with the paper's international benchmarks, and
    correlate with municipal characteristics?
avoid: No redesigned question, extra empirical analysis, causal attribution,
  guessed source convention, significance-based success score or
  ↳ historical-plan
  inheritance.
directions: []
preregistration:
mode: canonical
question: How does intergenerational income mobility vary across Danish
  childhood municipalities, compare with the paper's international
  ↳ benchmarks,
  and correlate with municipal characteristics?
scope: Source 1973-1977 birth cohorts, 2010-2015 child income,
  ↳ 1980-to-child-endpoint
  parental income (main 18; source appendix 15/18/20), source municipal
  rank/log/quintile variants and original municipal correlations.
  ↳ Descriptive
  only. Exact unresolved targets have no-estimate dispositions; all 531
  FSV tables are permitted for planning but none validated.
storyline: Follow the published narrative, preserving the three
  ↳ contributions.
  Begin with Table 1's sample and measurement description within
  ↳ atom-000001,
  then its municipal rank-persistence and absolute-upward-mobility maps.
  Next report atom-000002's Danish distribution summaries beside explicitly
  published international reference targets. Then report atom-000003's
  ↳ complete
  original Figure 2 row order and four-series correlations. Finally describe
  the online appendix's related income/geography/age/elasticity/quintile
  targets within atom-000001, including every unsupported or conflicted
  target. No supplementary specification replaces the main specification.
  Every result and evidence-dependent conclusion is pending; source
  ↳ boundaries
  remain explicit in the manuscript and figures.
interpretation:
- kind: restriction
  condition: (state(atom-000001) == "source_boundary") OR
  ↳ (state(atom-000001)
    == "input_boundary") OR (state(atom-000001) == "otherwise")
  says: 'atom-000001: report the exact unavailable scope and source/input
    reason. No empirical conclusion from blocked targets is permitted; no
    boundary implies zero mobility, zero association or agreement.'
- kind: restriction
  condition: (state(atom-000002) == "source_boundary") OR
  ↳ (state(atom-000002)
    == "input_boundary") OR (state(atom-000002) == "otherwise")
  says: 'atom-000002: report the exact unavailable scope and source/input
    reason. No empirical conclusion from blocked targets is permitted; no
    boundary implies zero mobility, zero association or agreement.'
- kind: restriction
  condition: (state(atom-000003) == "source_boundary") OR
  ↳ (state(atom-000003)
    == "input_boundary") OR (state(atom-000003) == "otherwise")
  says: 'atom-000003: report the exact unavailable scope and source/input
    reason. No empirical conclusion from blocked targets is permitted; no
    boundary implies zero mobility, zero association or agreement.'
- kind: restriction

```

```

condition: state(atom-000001) == "partial"
says: Inspect individual target statuses before downstream use.
↳ Unavailable
    core municipal estimates block their international summaries and
    ↳ demographic
    correlations. Available supplementary estimates never substitute for
    core estimates.
- kind: primary
condition: (state(atom-000001) == "complete") OR (state(atom-000001) ==
"partial")
says: 'atom-000001: describe actual completed danish municipal mobility
quantities in their registered units and source order, with required
intervals and explicit missing scope. This permission composes only
after restrictions, is descriptive and does not classify replication
success.'
- kind: primary
condition: (state(atom-000002) == "complete") OR (state(atom-000002) ==
"partial")
says: 'atom-000002: describe actual completed international mobility
↳ comparison
    quantities in their registered units and source order, with required
    intervals and explicit missing scope. This permission composes only
    after restrictions, is descriptive and does not classify replication
    success.'
- kind: primary
condition: (state(atom-000003) == "complete") OR (state(atom-000003) ==
"partial")
says: 'atom-000003: describe actual completed municipal demographic
↳ correlations
    quantities in their registered units and source order, with required
    intervals and explicit missing scope. This permission composes only
    after restrictions, is descriptive and does not classify replication
    success.'
- kind: supplementary
condition: (state(atom-000001) == "complete") OR (state(atom-000001) ==
"partial")
says: Appendix age, income, geography, elasticity and quintile targets
may be described only where their own statuses are completed. Conflicts
and legacy targets stay visible; they neither establish robustness nor
resolve a blocked main target.
- kind: residual
condition: 'TRUE'
says: Report all remaining pending, unactivated, operationally failed,
suppressed, conflicted and unavailable targets. All Atoms start pending.
Cross-country benchmarks are published context; no causal claim,
↳ numerical
    success band or independent review is licensed. Residual reporting never
    overrides a specific restriction.

```

Registration authority is the payload above and member Atom registrations. The entire source-target inventory is retained. Restrictions compose before compatible claims.

Current interpretation

All three Atoms are registered and pending. No experimental findings or realized boundaries exist yet. Published source values are comparison targets only. The letter C is uncalibrated compatibility metadata, not a scientific evaluation.

atom-000001: Danish municipal mobility

Danish municipal mobility, including the source's related specifications

Question, narrative role and target set

[S] P introduction's first contribution: describe intergenerational income mobility across Danish childhood municipalities. Table 1 supplies the sample description; Eq. (1) supplies the regression family; Figure 1 displays beta and r25. The online appendix extends the same analysis with individual incomes, old boundaries, parental endpoint ages 15/18/20, log-income elasticities and quintile transitions. These related specifications stay in this one Atom. No sex subgroup regression, place treatment effect or separate linkage Atom is added.

The core rank specification is post-2007 municipalities, endpoint age 18, yvar=fam_rank, xvar=parent_rank. All 72 supplemental specification tuples and their 720 var-label targets are enumerated without values in prereg/replication/appendix-specifications.yaml. D1-only joint quintile counts, rank_rank flag and publication-schema differences are retained in the target inventory as unresolved legacy targets, not silently discarded.

Cohort, time and measurement

[S] P §2: children born 1973–1977; child observed at least once in 2010–2015; matched parent(s) observed at least once from 1980 through the year the child turns 18. Calendar year of birth plus endpoint age defines the stated final year (main 1991–1995 across cohorts; supplemental ages 15 and 20 give 1988–1992 and 1993–1997). This arithmetic does not define within-year timing. No causal time zero exists; 1980 is the source's childhood observation start.

[S] R p.3: parent total = IND.PERINDKIALT; child total = IND.PERINDKIALT_13. [E] Annual person-income keys are PNR plus the delivery's income-year index. Candidate CPST/FAIN parent/residence links cover the early period; BEF documents the adult spouse and later demographic fields. See shared contract for exact fields. Do not treat these candidates as interchangeable. [U] G01/G02 block parent identity, annual snapshot, spouse timing and incomplete annual component rules. Death/emigration/nonresident observation handling is not specified beyond the source's at-least-once inclusion rules; no censoring or survival restriction is added.

[S] Form annual child-plus-any-registered-spouse income sums, and annual registered mother-plus-father sums. Deflate annual values using Danish CPI, then take

source time averages and convert to 2015 USD (P §2). Individual child/mother/father means are included by R. [U] G03 stops unspecified CPI/FX and G02 stops the missing-component/denominator decisions. Negative income is not automatically dropped from ranks or descriptive statistics.

[S] Rank child family and parental income within child birth cohorts (P §2). The R formulas establish fractional parental prediction points .25, .50, .75. [U] G04 stops rank universe/tie/normalization details. No implementation rank function is selected. R names separate individual-income rank measures; their precise ranking populations also remain unresolved.

[S] Assign childhood municipality as the one occupied for the most years observed from 1980 to age 18; main analysis uses 98 post-reform municipalities. [U] G05 stops equal-year ties, reference dates, split-area crosswalks and the geographic window for age-15/20 specifications. No population weighting or adult-location assignment replaces childhood residence.

Ordered executable pseudocode

```
REGISTER all Table 1 cells; core municipal alpha/beta/r25/r50/r75;
    every appendix tuple/var; map labels/geometry and legacy targets.
FOR target IN original-order target inventory:
    READ only its registered source locators, gap IDs and input schema.
    IF unresolved scientific prerequisite: STOP_UNRESOLVED_SOURCE(target,
        ↪ gaps).
    ELSE IF original input unavailable: STOP_UNAVAILABLE_ORIGINAL(target).
    ELSE:
        RESOLVE documented person-key classes and source-defined annual dates.
        ASSERT one record per authorized person/date and person/income-year.
        JOIN child -> registered parent(s)/spouse -> annual income by ID/year;
            require many-to-one lookups, no multiplication of child records.
        ON duplicate/ambiguous mapping: STOP_DATA_BOUNDARY for consuming
            ↪ targets.
        SELECT birth cohorts and at-least-once criteria exactly as P/R
            ↪ specify;
            never modify them to reproduce a published N.
        APPLY annual sums, CPI adjustment, averaging and ranks only when each
            source rule is settled; otherwise STOP before the first
            ↪ operation.
        ASSIGN source childhood municipality only when G05 is settled.
        DISPATCH Table 1 / rank regression / log regression / quintile target.
```

This is literal guarded pseudocode: with the frozen gaps, the unresolved branch is the disposition. The code path is not an instruction to invent the missing preconditions. Supported algebra below is retained so a source-supported sibling is not lost merely because another target is blocked.

Table 1

[S] Preserve this row order: observations in adulthood; female; married between 2010–2015; child mean income; family mean income; parents’ mean income; mother’s mean income; father’s mean income; mother’s age in 1980; father’s age in 1980; moves by age 18; share in assigned municipality; share living with both parents; share living with mother; share living with father. Report N, mean, SD, 25th percentile, median, 75th

percentile for each. Income units are 2015 USD, ages years, adulthood observations and moves counts, and other rows indicators/shares.

[E] Given a source-defined row vector z , N is the number of source-eligible observations and $\text{mean} = \text{sum}(z)/N$. [U] G06: source-defined missingness, SD and quantile functions are not supplied, so do not choose ddof or a percentile type. No empirical “balance test” or test against the printed values is added.

Municipal regression family

[S] For each source municipality c , preserve

$$R_i^{child} = \alpha_c + \beta_c R_i^{parent} + \epsilon_i.$$

[U] G07: fitting/weight and covariance specifications for this municipal model are not explicitly settled by the retrieved P/R. Stop fitting; do not infer unweighted OLS from the separate Figure 2 caption. [E] If alpha/beta are lawfully available from this registered fit, compute exactly $r25 = \alpha + 0.25\beta$, $r50 = \alpha + 0.50\beta$, $r75 = \alpha + 0.75\beta$. These are fractional child-rank units. A display in percentile points multiplies the estimate by 100 and labels that change; it does not rerank anything. Preserve α_se/β_se appendix targets, but do not add CIs or compute prediction uncertainty from marginal SEs without covariance/source support.

[S] Supplementary rank pairs are c_rank/fam_rank crossed with $parent_rank/mom_rank/dad_rank$. Related log pairs are c_inc_log/fam_inc_log crossed with $parent_inc_log/mom_inc_log/dad_inc_log$, at ages 15/18/20 and both geographic systems as the retrieved labels document. Do not create cross-type rank/log combinations. [S] R resets child/family incomes below zero to 1000 DKK for logs. [U] G15 leaves zeros, parental nonpositives, log base and transformation order unresolved: STOP all log-derived estimands rather than repair them. Retain alpha/beta/SE labels; log beta is the source elasticity target, not a rank-persistence measure. [C] G17: $r25/r50/r75$ labels exist for log models, but their percentile interpretation is unsupported. These 108 targets are NOT_REBUILT_UNRESOLVED, no fractional-log evaluation or back-transformation.

Quintile transitions and appendix release

[S] D2/R retain x_q1_N , x_q5_N and $q1q1/q1q5/q5q1/q5q5$ for rank pairs. Dataset metadata names transitions between extreme quintiles. [C] R’s repeated descriptions conflict with the destination labels; [U] quintile ties and ranking/denominator rules are unresolved. STOP transition and marginal-count targets (G04/G16); do not choose a presumed conditional-probability formula. D1’s $q1q1_N/q1q5_N/q5q1_N/q5q5_N$ and $rank_rank$ flag remain legacy labels without a reconstructed definition. These do not become new analyses.

[S] R p.3 removes municipal appendix records with $N < 25$ and suppresses quintile information when any relevant observed quintile group has $N < 5$. [E] $N < 25$ can be applied only to a resolved, lawfully generated source appendix match count; do not truncate the scientific analysis cohort to achieve a publication N . [U] G18 stops the ambiguous quintile mask. Suppression is a release status, not zero, failure of mobility, or an empirical result threshold.

Maps and geographic prose

[S] Figure 1 has beta left, r25 right; darker indicates less mobility, meaning darker at larger beta and smaller r25. Label Aalborg, Aarhus, Odense and Copenhagen, and frame/move Bornholm northwest as in P caption. [E] The implemented renderer consumes estimates and verified projected polygons; continuous grey scales, layout and text positions are presentation choices, not new bins or mobility classes. [A/U] G14/G05 block missing original geometry and geographic identities. No rural/urban contrast is fitted. Rural labels require the cited original classification; no score or cutoff is invented.

Evidence interfaces

All filenames below are under outputs/atom-000001/. In addition to target-status.csv and a private integrity log (no person IDs exported), write:

- table1.csv: row_id, statistic [N/mean/sd/p25/median/p75], value, unit, status, reason, origin. Explicitly blocked cells have empty value.
- municipal-estimates.csv: municipality_id, municipality_name, muni_post2007reform, age_child, yvar, xvar, measure, estimate, unit, status, reason, origin. Measures are exactly the registered appendix labels/core quantities; no inferred columns become new outcomes.
- core-map.csv: municipality_id, municipality_name, beta, r25, status_beta, status_r25, reason_beta, reason_r25, origin. Only the core specification; no aggregating supplemental models or choosing best-fitting ones.
- map-geometry.csv: municipality_id, panel_geometry_wkt, is_bornholm, geometry_provenance, mapping_status. These are verified cartographic inputs, not outcomes; no estimates or geographic membership inferred by renderer.
- city-labels.csv: label, x, y, label_x, label_y, mapping_status. Coordinates share the verified projected map system. Four labels only as in P.
- appendix-release.csv: specification key, measure, status, reason; the release mask itself is not an additional scientific test.

All estimates/SEs/counts stay unfilled until lawful execution. Actual result comparisons may report rebuilt minus printed value and the printed precision, without an agreement band. No current value is initialized from P/D1/D2.

Consequences

Complete outputs permit a descriptive municipal account within the exact completed specification; partial outputs permit only their named scope. Boundary states prohibit the corresponding map, comparison or correlation. Atom 2 and Atom 3 wait for this module's completion, but must independently check which core estimates actually exist. Supplementary results do not replace blocked main results. Operational failure blocks dependent activation.

Binding shared rules and scientific status

This protocol incorporates prereg/data-contract.md (exact candidate fields, meanings, keys, coverage and unresolved joins), identification.md, governance.md and the exact gap definitions G01–G20 in prereg/replication/deviations.md. P/R/D1/D2 locators are defined there. [S] marks source-explicit instructions; [E] marks meaning-preserving engineering; [U] marks a missing scientific decision; [C] marks conflicting source statements; [A] marks unavailable original inputs. Only S and E authorize computation. All preregistered targets are descriptive. There is no observed result in this file.

Common execution and output contract

[E] Evaluate activation using the native condition. Before a target calculation, inspect only the source resolution record and governed input schema. Required joins must satisfy their documented person/year or municipality identity cardinality. An unexpected duplicate or ambiguous crosswalk is a STOP, never an averaging/drop rule. These are internal integrity assertions, not new empirical diagnostics.

[E] Per target, write a row to outputs/atom-000001/target-status.csv with columns target_id, source_locator, status, gap_ids, reason, output_file, origin. Status is completed, unresolved_source, unavailable_original, data_boundary, suppressed, unrun or operational_failure. Origin is replication for newly executed outputs; published values are never accepted as those inputs. STOP produces an empty numeric field and an explicit reason, not zero, NA-as-zero, an estimate or a null. No such result file is populated at registration. All future paths are relative to a governed evidence root, not this World or a microdata mount guessed here.

[E] Before execution distinguish a known source gap from a runtime failure: if any required decision is G01–G20 and unresolved in this frozen registration, emit STOP_UNRESOLVED_SOURCE for that target; do not prompt an executor to choose. If a source-defined original input is not retrieved, emit unavailable_original. If a resolved dependency is demonstrated absent in governed runtime, emit data_boundary. If access fails without establishing absence, report operational failure and leave the Atom unrealized. A later source clarification requires a new registration version; this protocol contains no permission to resolve it.

[E] Record target-local boundaries without dropping sibling targets. A sibling can complete only if every scientific decision on its path is independently source-supported. Shared blockers here affect many or all empirical targets; partial states do not assert that a currently computable sibling exists. Deterministic sort order and output-column renaming are engineering only.

Uncertainty, controls, multiplicity, power, negative controls and sensitivity analyses are copied only where specified below. Otherwise: not specified in source; not added. No p-value, direction, magnitude, sample-size score or numerical agreement tolerance determines the completion state. No independent review is claimed. The preregistration compatibility ratings are uncalibrated format fields.

Complete registration fields

```
id: atom-000001
topic: Danish municipal mobility
atom_result: prereg
atom_strength: null
atom_shape: null
evidence_paths: []
concepts: []
literature: []
bonds: []
preregistration:
  version: 1
  mode: canonical
  question: How does intergenerational income mobility vary across Danish
    childhood municipalities under the source's main and supplementary
    ↪ specifications?
  rationale: 'First stated contribution in P: one municipal mobility analysis
    with related outcomes, sample description and appendix specifications;
    no panel or linkage split.'
  assumption: Only paper/appendix-explicit rules and meaning-preserving
    ↪ engineering
    are executable; unresolved source choices stay blocked. Schema evidence
    is not runtime availability.
  target_strength: descriptive
  target_shape: comparison
  ratings:
    importance: 1
    novelty: 1
    feasibility: 1
    data_advantage: 1
    informativeness: 0
  tables:
    - IND
    - CPST
    - FAIN
    - BEF
    - BEFBOP
    - BEFADR
  activation: 'TRUE'
  verdicts:
    - key: complete
      region: 'First: a completed audit exists, every rebuildable target in
        this module has a source-supported estimate and required
        ↪ uncertainty/release
        disposition, and all inventory context/not-rebuilt targets are
        ↪ explicitly
        accounted for; no unresolved scientific prerequisite remains for any
        rebuildable target.'
      says: Describe only the completed registered quantities; contextual or
        explicitly not-rebuilt targets are not replicated findings. Completion
        does not mean numerical agreement or independent validation.
    - key: partial
      region: 'Second: completed audit, at least one substantive registered
        target estimated faithfully, at least one other required target has
        a documented source/input/data/uncertainty boundary; not complete.'
      says: Report exactly the estimated targets and preserve all blocked
        ↪ siblings.
        No substitute specification stands in for an unavailable target.
    - key: source_boundary
      region: 'Third: completed audit, no substantive target estimated, and
```

```

    at least one necessary source decision remains unresolved or
    ↪ conflicting.
    This takes precedence over concurrent input gaps.'
  says: No estimate is licensed for the affected module under the extracted
    source specification. Report exact source gaps; this is not a null
    ↪ effect.
- key: input_boundary
  region: 'Fourth: completed audit, no substantive target estimated, no
    unresolved scientific source decision is the binding cause, and an
    ↪ original
    input or required governed field is demonstrably unavailable.'
  says: The registered target cannot be estimated with the documented
    ↪ inputs.
    Report the missing input, not a negative scientific finding.
- key: otherwise
  region: otherwise
  says: Report unresolved scientific scope explicitly. Operational failures
    and unrun work remain unrealized and are never assigned a scientific
    null.
protocol: |-
# Danish municipal mobility, including the source's related specifications

## Question, narrative role and target set

[S] P introduction's first contribution: describe intergenerational income
mobility across Danish childhood municipalities. Table 1 supplies the
↪ sample
description; Eq. (1) supplies the regression family; Figure 1 displays
↪ beta and
r25. The online appendix extends the same analysis with individual
↪ incomes,
old boundaries, parental endpoint ages 15/18/20, log-income elasticities
↪ and
quintile transitions. These related specifications stay in this one Atom.
No sex subgroup regression, place treatment effect or separate linkage
↪ Atom is added.

The core rank specification is post-2007 municipalities, endpoint age 18,
yvar=fam_rank, xvar=parent_rank. All 72 supplemental specification tuples
↪ and
their 720 var-label targets are enumerated without values in
prereg/replication/appendix-specifications.yaml. D1-only joint quintile
↪ counts,
rank_rank flag and publication-schema differences are retained in the
↪ target
inventory as unresolved legacy targets, not silently discarded.

## Cohort, time and measurement

[S] P §2: children born 1973-1977; child observed at least once in
↪ 2010-2015;
matched parent(s) observed at least once from 1980 through the year the
↪ child
turns 18. Calendar year of birth plus endpoint age defines the stated
↪ final year
(main 1991-1995 across cohorts; supplemental ages 15 and 20 give
↪ 1988-1992 and
1993-1997). This arithmetic does not define within-year timing. No causal
↪ time
zero exists; 1980 is the source's childhood observation start.

```

[S] R p.3: parent total = IND.PERINDKIALT; child total = IND.PERINDKIALT_13. [E] Annual person-income keys are PNR plus the
 ↳ delivery's
 income-year index. Candidate CPST/FAIN parent/residence links cover the
 ↳ early
 period; BEF documents the adult spouse and later demographic fields. See
 ↳ shared
 contract for exact fields. Do not treat these candidates as
 ↳ interchangeable.
 [U] G01/G02 block parent identity, annual snapshot, spouse timing and
 ↳ incomplete
 annual component rules. Death/emigration/nonresident observation handling
 ↳ is
 not specified beyond the source's at-least-once inclusion rules; no
 ↳ censoring
 or survival restriction is added.

[S] Form annual child-plus-any-registered-spouse income sums, and annual
 registered mother-plus-father sums. Deflate annual values using Danish
 ↳ CPI,
 then take source time averages and convert to 2015 USD (P \$2). Individual
 child/mother/father means are included by R. [U] G03 stops unspecified
 ↳ CPI/FX
 and G02 stops the missing-component/denominator decisions. Negative
 ↳ income is
 not automatically dropped from ranks or descriptive statistics.

[S] Rank child family and parental income within child birth cohorts (P
 ↳ \$2).
 The R formulas establish fractional parental prediction points .25, .50,
 ↳ .75.
 [U] G04 stops rank universe/tie/normalization details. No implementation
 ↳ rank
 function is selected. R names separate individual-income rank measures;
 ↳ their
 precise ranking populations also remain unresolved.

[S] Assign childhood municipality as the one occupied for the most years
 observed from 1980 to age 18; main analysis uses 98 post-reform
 ↳ municipalities.
 [U] G05 stops equal-year ties, reference dates, split-area crosswalks and
 ↳ the
 geographic window for age-15/20 specifications. No population weighting or
 adult-location assignment replaces childhood residence.

Ordered executable pseudocode

```

```text
REGISTER all Table 1 cells; core municipal alpha/beta/r25/r50/r75;
 every appendix tuple/var; map labels/geometry and legacy targets.
FOR target IN original-order target inventory:
 READ only its registered source locators, gap IDs and input schema.
 IF unresolved scientific prerequisite: STOP_UNRESOLVED_SOURCE(target,
 ↳ gaps).
 ELSE IF original input unavailable: STOP_UNAVAILABLE_ORIGINAL(target).
 ELSE:
 RESOLVE documented person-key classes and source-defined annual
 ↳ dates.
```

```

ASSERT one record per authorized person/date and
 ↳ person/income-year.
JOIN child -> registered parent(s)/spouse -> annual income by
 ↳ ID/year;
 require many-to-one lookups, no multiplication of child
 ↳ records.
ON duplicate/ambiguous mapping: STOP_DATA_BOUNDARY for consuming
 ↳ targets.
SELECT birth cohorts and at-least-once criteria exactly as P/R
 ↳ specify;
 never modify them to reproduce a published N.
APPLY annual sums, CPI adjustment, averaging and ranks only when
 ↳ each
 source rule is settled; otherwise STOP before the first
 ↳ operation.
ASSIGN source childhood municipality only when G05 is settled.
DISPATCH Table 1 / rank regression / log regression / quintile
 ↳ target.
...

```

This is literal guarded pseudocode: with the frozen gaps, the unresolved  
 ↳ branch  
 is the disposition. The code path is not an instruction to invent the  
 ↳ missing  
 preconditions. Supported algebra below is retained so a source-supported  
 ↳ sibling  
 is not lost merely because another target is blocked.

### Table 1

```

[S] Preserve this row order: observations in adulthood; female; married
 ↳ between
2010-2015; child mean income; family mean income; parents' mean income;
 ↳ mother's
mean income; father's mean income; mother's age in 1980; father's age in
 ↳ 1980;
moves by age 18; share in assigned municipality; share living with both
 ↳ parents;
share living with mother; share living with father. Report N, mean, SD,
 ↳ 25th
percentile, median, 75th percentile for each. Income units are 2015 USD,
 ↳ ages
years, adulthood observations and moves counts, and other rows
 ↳ indicators/shares.

```

```

[E] Given a source-defined row vector z, N is the number of
 ↳ source-eligible
observations and mean = sum(z)/N. [U] G06: source-defined missingness, SD
 ↳ and
quantile functions are not supplied, so do not choose ddof or a
 ↳ percentile type.
No empirical "balance test" or test against the printed values is added.

```

### Municipal regression family

```

[S] For each source municipality c, preserve

```

```

$$R^{child}_{i}=\alpha_c+\beta_c R^{parent}_{i}+\epsilon_i.$$

```

[U] G07: fitting/weight and covariance specifications for this municipal  
 ↳ model  
 are not explicitly settled by the retrieved P/R. Stop fitting; do not  
 ↳ infer  
 unweighted OLS from the separate Figure 2 caption. [E] If alpha/beta are  
 lawfully available from this registered fit, compute exactly  
 $r_{25} = \alpha + 0.25\beta$ ,  $r_{50} = \alpha + 0.50\beta$ ,  $r_{75} = \alpha + 0.75\beta$ .  
 These are fractional child-rank units. A display in percentile points  
 ↳ multiplies  
 the estimate by 100 and labels that change; it does not rerank anything.  
 Preserve alpha\_se/beta\_se appendix targets, but do not add CIs or compute  
 prediction uncertainty from marginal SEs without covariance/source  
 ↳ support.

[S] Supplementary rank pairs are c\_rank/fam\_rank crossed with  
 parent\_rank/mom\_rank/dad\_rank. Related log pairs are c\_inc\_log/fam\_inc\_log  
 crossed with parent\_inc\_log/mom\_inc\_log/dad\_inc\_log, at ages 15/18/20 and  
 ↳ both  
 geographic systems as the retrieved labels document. Do not create  
 ↳ cross-type  
 rank/log combinations. [S] R resets child/family incomes below zero to  
 ↳ 1000 DKK  
 for logs. [U] G15 leaves zeros, parental nonpositives, log base and  
 ↳ transformation  
 order unresolved: STOP all log-derived estimands rather than repair them.  
 Retain alpha/beta/SE labels; log beta is the source elasticity target,  
 ↳ not a  
 rank-persistence measure. [C] G17: r25/r50/r75 labels exist for log  
 ↳ models, but  
 their percentile interpretation is unsupported. These 108 targets are  
 NOT\_REBUILT\_UNRESOLVED, no fractional-log evaluation or  
 ↳ back-transformation.

### Quintile transitions and appendix release

[S] D2/R retain x\_q1\_N, x\_q5\_N and q1q1/q1q5/q5q1/q5q5 for rank pairs.  
 Dataset metadata names transitions between extreme quintiles. [C] R's  
 ↳ repeated  
 descriptions conflict with the destination labels; [U] quintile ties and  
 ranking/denominator rules are unresolved. STOP transition and  
 ↳ marginal-count  
 targets (G04/G16); do not choose a presumed conditional-probability  
 ↳ formula.  
 D1's q1q1\_N/q1q5\_N/q5q1\_N/q5q5\_N and rank\_rank flag remain legacy labels  
 without a reconstructed definition. These do not become new analyses.

[S] R p.3 removes municipal appendix records with N<25 and suppresses  
 ↳ quintile  
 information when any relevant observed quintile group has N<5. [E] N<25  
 ↳ can  
 be applied only to a resolved, lawfully generated source appendix match  
 ↳ count;  
 do not truncate the scientific analysis cohort to achieve a publication N.  
 [U] G18 stops the ambiguous quintile mask. Suppression is a release  
 ↳ status,  
 not zero, failure of mobility, or an empirical result threshold.

## Maps and geographic prose

[S] Figure 1 has beta left, r25 right; darker indicates less mobility,  
 ↳ meaning  
 darker at larger beta and smaller r25. Label Aalborg, Aarhus, Odense and  
 Copenhagen, and frame/move Bornholm northwest as in P caption. [E] The  
 implemented renderer consumes estimates and verified projected polygons;  
 continuous grey scales, layout and text positions are presentation  
 ↳ choices,  
 not new bins or mobility classes. [A/U] G14/G05 block missing original  
 ↳ geometry  
 and geographic identities. No rural/urban contrast is fitted. Rural labels  
 require the cited original classification; no score or cutoff is invented.

## ## Evidence interfaces

All filenames below are under outputs/atom-000001/. In addition to  
 target-status.csv and a private integrity log (no person IDs exported),  
 ↳ write:

- table1.csv: row\_id, statistic [N/mean/sd/p25/median/p75], value, unit,  
 status, reason, origin. Explicitly blocked cells have empty value.
- municipal-estimates.csv: municipality\_id, municipality\_name,  
 muni\_post2007reform, age\_child, yvar, xvar, measure, estimate, unit,  
 ↳ status,  
 reason, origin. Measures are exactly the registered appendix labels/core  
 quantities; no inferred columns become new outcomes.
- core-map.csv: municipality\_id, municipality\_name, beta, r25,  
 ↳ status\_beta,  
 status\_r25, reason\_beta, reason\_r25, origin. Only the core  
 ↳ specification;  
 no aggregating supplemental models or choosing best-fitting ones.
- map-geometry.csv: municipality\_id, panel\_geometry\_wkt, is\_bornholm,  
 geometry\_provenance, mapping\_status. These are verified cartographic  
 ↳ inputs,  
 not outcomes; no estimates or geographic membership inferred by  
 ↳ renderer.
- city-labels.csv: label, x, y, label\_x, label\_y, mapping\_status.  
 ↳ Coordinates  
 share the verified projected map system. Four labels only as in P.
- appendix-release.csv: specification key, measure, status, reason; the  
 release mask itself is not an additional scientific test.

All estimates/SEs/counts stay unfilled until lawful execution. Actual  
 ↳ result  
 comparisons may report rebuilt minus printed value and the printed  
 ↳ precision,  
 without an agreement band. No current value is initialized from P/D1/D2.

## ## Consequences

Complete outputs permit a descriptive municipal account within the exact  
 completed specification; partial outputs permit only their named scope.  
 Boundary states prohibit the corresponding map, comparison or correlation.  
 Atom 2 and Atom 3 wait for this module's completion, but must  
 ↳ independently  
 check which core estimates actually exist. Supplementary results do not  
 replace blocked main results. Operational failure blocks dependent  
 ↳ activation.

## ## Binding shared rules and scientific status

This protocol incorporates prereg/data-contract.md (exact candidate  
 ↪ fields, meanings,  
 keys, coverage and unresolved joins), identification.md, governance.md  
 ↪ and the exact  
 gap definitions G01-G20 in prereg/replication/deviations.md. P/R/D1/D2  
 ↪ locators are  
 defined there. [S] marks source-explicit instructions; [E] marks  
 ↪ meaning-preserving  
 engineering; [U] marks a missing scientific decision; [C] marks  
 ↪ conflicting source  
 statements; [A] marks unavailable original inputs. Only S and E authorize  
 ↪ computation.  
 All preregistered targets are descriptive. There is no observed result in  
 ↪ this file.

## ## Common execution and output contract

[E] Evaluate activation using the native condition. Before a target  
 ↪ calculation,  
 inspect only the source resolution record and governed input schema.  
 ↪ Required joins  
 must satisfy their documented person/year or municipality identity  
 ↪ cardinality.  
 An unexpected duplicate or ambiguous crosswalk is a STOP, never an  
 ↪ averaging/drop  
 rule. These are internal integrity assertions, not new empirical  
 ↪ diagnostics.

[E] Per target, write a row to outputs/atom-000001/target-status.csv with  
 ↪ columns  
 target\_id, source\_locator, status, gap\_ids, reason, output\_file, origin.  
 ↪ Status is  
 completed, unresolved\_source, unavailable\_original, data\_boundary,  
 ↪ suppressed,  
 unrun or operational\_failure. Origin is replication for newly executed  
 ↪ outputs;  
 published values are never accepted as those inputs. STOP produces an  
 ↪ empty  
 numeric field and an explicit reason, not zero, NA-as-zero, an estimate  
 ↪ or a null.  
 No such result file is populated at registration. All future paths are  
 ↪ relative  
 to a governed evidence root, not this World or a microdata mount guessed  
 ↪ here.

[E] Before execution distinguish a known source gap from a runtime  
 ↪ failure:  
 if any required decision is G01-G20 and unresolved in this frozen  
 ↪ registration,  
 emit STOP\_UNRESOLVED\_SOURCE for that target; do not prompt an executor to  
 ↪ choose.  
 If a source-defined original input is not retrieved, emit  
 ↪ unavailable\_original.  
 If a resolved dependency is demonstrated absent in governed runtime, emit  
 data\_boundary. If access fails without establishing absence, report  
 ↪ operational  
 failure and leave the Atom unrealized. A later source clarification  
 ↪ requires a  
 new registration version; this protocol contains no permission to resolve  
 ↪ it.

[E] Record target-local boundaries without dropping sibling targets. A  
 ↳ sibling  
 can complete only if every scientific decision on its path is  
 ↳ independently  
 source-supported. Shared blockers here affect many or all empirical  
 ↳ targets;  
 partial states do not assert that a currently computable sibling exists.  
 Deterministic sort order and output-column renaming are engineering only.

Uncertainty, controls, multiplicity, power, negative controls and  
 ↳ sensitivity  
 analyses are copied only where specified below. Otherwise: not specified  
 ↳ in  
 source; not added. No p-value, direction, magnitude, sample-size score or  
 ↳ numerical  
 agreement tolerance determines the completion state. No independent  
 ↳ review is  
 claimed. The preregistration compatibility ratings are uncalibrated  
 ↳ format fields.

## Danish municipal mobility

Prospective source-faithful registration. All empirical outputs remain unfilled. The registration payload above is authoritative. No independent scientific review or replication execution has occurred.

### Reference implementation

Entry point and supported/unresolved components for atom-000001: [execution index](#).  
 See [engineering review](#). This pointer does not amend the registered protocol.

## atom-000002: International mobility comparison

### Distribution of municipal mobility in the source's international comparison

#### Question and fixed scope

[S] P §3 second findings paragraph compares Danish municipalities with the paper's US county and Canadian Census District estimates. This is the second contribution, a distinct aggregate comparison rather than a new individual regression. Danish inputs are the core age-18/family-on-parents specification from Atom 1; no alternate age/income/geography can substitute for it. International values are published reference context. The explicit FSV table boundary authorizes no US/Canadian microdata reconstruction.

## Inputs, definitions and target order

[S] First preserve population-size context: Danish municipal mean/median in 2015, US mean after excluding the largest 30 counties using 2010 census population, and Canadian mean after excluding the largest 10 districts using 2011 population. These are context targets, not cohort restrictions. Danish population context is not the linked-child sample size. Candidate Danish population status fields are CPST/BEF.PNR, KOM and reference dates; P does not identify the precise 2015 count date, aggregation or source extraction. It remains unavailable/unresolved, not a new population-count exercise.

[S] Next preserve average beta (Canada/Denmark versus US), then means and SDs of r25, r50 and r75 for US and Denmark, then the difference between average r75 and average r25 in percentile points, and the paper's qualitative dispersion comparison. All published constants and printed precision live in prereg/replication/published-reference-targets.md. No Canadian percentile means, Canadian SDs, pooled international test or additional geography is added.

[U] G10: the paper does not settle area weights, missing-estimate policy or the SD denominator. The 30/10 exclusions do not transfer to mobility summaries. The data source versions and Canadian tracts/districts wording remain unresolved. [C] G08: average beta is not an inverse transform or a causal mobility index.

## Ordered executable pseudocode

```

REQUIRE done(atom-000001).
REGISTER every population-context and mobility-summary target in source order.
READ Atom 1 core target statuses, not its headline state alone.
FOR each Danish core aggregate target:
 IF needed core estimates not completed: emit upstream boundary, no
 ↪ estimate.
 ELSE IF G10's weighting/missing/SD choice affects target:
 STOP_UNRESOLVED_SOURCE(target, G10).
 ELSE compute the exact source-defined summary on the fixed municipality
 ↪ set.
FOR each external-country target:
 mark reference_only_not_rebuilt; do not execute a new external analysis.
IF source-defined Danish means of r75 and r25 are completed:
 span_pp = 100 * (mean_r75 - mean_r25).
ELSE no span estimate.
FOR completed Danish summary with an identical published definition:
 comparison difference = rebuilt - published reference, in matched units;
 report published decimal precision; do not classify replication success.
```

The source-silent mean weights are not filled by an assumed arithmetic mean. The span identity is [E] and has no unresolved numerical threshold. It cannot be evaluated using published rather than rebuilt means. No test of cross-country equality, slope differences, variance ratios or confidence-band overlap is added. The source's "about three times" sentence stays a historical comparison target; it is not a registered success region or permission for a new variance test.

## Estimator, uncertainty and evidence interfaces

This Atom adds only source-mentioned aggregate summaries and comparison arithmetic to the municipal analysis. Statistical inference for national differences, multiplicity, power, controls, diagnostics or robustness: not specified in source; not added. Unknown source weights and SD convention are explicit boundaries. No estimates are derived from confidential data here.

Future outputs under `outputs/atom-000002/`:

- `country-summary.csv`: `country` [Denmark/United States/Canada], `geography`, `statistic` [population\_mean/population\_median/beta\_mean/r25\_mean/r25\_sd/r50\_mean/r50\_sd/r75\_mean/r75\_sd/span\_pp], `estimate`, `unit`, `status`, `reason`, `origin`. Only source-inventoried country/statistic combinations are permitted. External references are held in a separate reference table, not in estimate.
- `comparison.csv`: `target_id`, `rebuilt_value`, `published_reference`, `difference`, `unit`, `published_precision`, `status`, `reason`, `origin`. All rebuilt/difference fields empty unless corresponding registered Danish target completed.
- `target-status.csv` as in the common contract. No figure is added; these were prose results in P and remain a prose/table presentation in the manuscript.

## Consequences and scope ceiling

Completed compatible Danish summaries may be compared descriptively with known foreign benchmarks; this does not establish identical measurement, different opportunity sets, causal country effects or independent external replication. Reference-only foreign targets can coexist with completed Danish scope and must remain explicitly not rebuilt. Partial/boundary outcomes report precisely which Danish summaries could not be computed. No missing result is interpreted as convergence, equivalence or evidence of similar countries.

## Binding shared rules and scientific status

This protocol incorporates `prereg/data-contract.md` (exact candidate fields, meanings, keys, coverage and unresolved joins), `identification.md`, `governance.md` and the exact gap definitions G01–G20 in `prereg/replication/deviations.md`. P/R/D1/D2 locators are defined there. [S] marks source-explicit instructions; [E] marks meaning-preserving engineering; [U] marks a missing scientific decision; [C] marks conflicting source statements; [A] marks unavailable original inputs. Only S and E authorize computation. All preregistered targets are descriptive. There is no observed result in this file.

## Common execution and output contract

[E] Evaluate activation using the native condition. Before a target calculation, inspect only the source resolution record and governed input schema. Required joins must satisfy their documented person/year or municipality identity cardinality. An unexpected duplicate or ambiguous crosswalk is a STOP, never an averaging/drop rule. These are internal integrity assertions, not new empirical diagnostics.

[E] Per target, write a row to outputs/atom-000002/target-status.csv with columns target\_id, source\_locator, status, gap\_ids, reason, output\_file, origin. Status is completed, unresolved\_source, unavailable\_original, data\_boundary, suppressed, unrun or operational\_failure. Origin is replication for newly executed outputs; published values are never accepted as those inputs. STOP produces an empty numeric field and an explicit reason, not zero, NA-as-zero, an estimate or a null. No such result file is populated at registration. All future paths are relative to a governed evidence root, not this World or a microdata mount guessed here.

[E] Before execution distinguish a known source gap from a runtime failure: if any required decision is G01–G20 and unresolved in this frozen registration, emit STOP\_UNRESOLVED\_SOURCE for that target; do not prompt an executor to choose. If a source-defined original input is not retrieved, emit unavailable\_original. If a resolved dependency is demonstrated absent in governed runtime, emit data\_boundary. If access fails without establishing absence, report operational failure and leave the Atom unrealized. A later source clarification requires a new registration version; this protocol contains no permission to resolve it.

[E] Record target-local boundaries without dropping sibling targets. A sibling can complete only if every scientific decision on its path is independently source-supported. Shared blockers here affect many or all empirical targets; partial states do not assert that a currently computable sibling exists. Deterministic sort order and output-column renaming are engineering only.

Uncertainty, controls, multiplicity, power, negative controls and sensitivity analyses are copied only where specified below. Otherwise: not specified in source; not added. No p-value, direction, magnitude, sample-size score or numerical agreement tolerance determines the completion state. No independent review is claimed. The preregistration compatibility ratings are uncalibrated format fields.

## Complete registration fields

```
id: atom-000002
topic: International mobility comparison
atom_result: prereg
atom_strength: null
atom_shape: null
evidence_paths: []
concepts: []
literature: []
bonds: []
preregistration:
 version: 1
 mode: canonical
 question: How does the distribution of the source's Danish municipal
 ↪ mobility
 measures compare descriptively with its published US and Canadian
 ↪ benchmarks?
 rationale: 'Second stated contribution in P: distinct area-distribution
 comparison with source foreign values retained as external references,
 not new external experiments.'
 assumption: Only paper/appendix-explicit rules and meaning-preserving
 ↪ engineering
 are executable; unresolved source choices stay blocked. Schema evidence
 is not runtime availability.
```

```

target_strength: descriptive
target_shape: comparison
ratings:
 importance: 1
 novelty: 1
 feasibility: 1
 data_advantage: 1
 informativeness: 0
tables:
- BEF
- CPST
activation: done(atom-000001)
verdicts:
- key: complete
 region: 'First: a completed audit exists, every rebuildable target in
 this module has a source-supported estimate and required
 ↪ uncertainty/release
 disposition, and all inventory context/not-rebuilt targets are
 ↪ explicitly
 accounted for; no unresolved scientific prerequisite remains for any
 rebuildable target.'
 says: Describe only the completed registered quantities; contextual or
 explicitly not-rebuilt targets are not replicated findings. Completion
 does not mean numerical agreement or independent validation.
- key: partial
 region: 'Second: completed audit, at least one substantive registered
 target estimated faithfully, at least one other required target has
 a documented source/input/data/uncertainty boundary; not complete.'
 says: Report exactly the estimated targets and preserve all blocked
 ↪ siblings.
 No substitute specification stands in for an unavailable target.
- key: source_boundary
 region: 'Third: completed audit, no substantive target estimated, and
 at least one necessary source decision remains unresolved or
 ↪ conflicting.
 This takes precedence over concurrent input gaps.'
 says: No estimate is licensed for the affected module under the extracted
 source specification. Report exact source gaps; this is not a null
 ↪ effect.
- key: input_boundary
 region: 'Fourth: completed audit, no substantive target estimated, no
 unresolved scientific source decision is the binding cause, and an
 ↪ original
 input or required governed field is demonstrably unavailable.'
 says: The registered target cannot be estimated with the documented
 ↪ inputs.
 Report the missing input, not a negative scientific finding.
- key: otherwise
 region: otherwise
 says: Report unresolved scientific scope explicitly. Operational failures
 and unrun work remain unrealized and are never assigned a scientific
 null.
protocol: |-
 # Distribution of municipal mobility in the source's international
 ↪ comparison

 ## Question and fixed scope

 [S] P §3 second findings paragraph compares Danish municipalities with the

```

paper's US county and Canadian Census District estimates. This is the  
 ↪ second  
 contribution, a distinct aggregate comparison rather than a new individual  
 regression. Danish inputs are the core age-18/family-on-parents  
 ↪ specification  
 from Atom 1; no alternate age/income/geography can substitute for it.  
 International values are published reference context. The explicit FSV  
 ↪ table  
 boundary authorizes no US/Canadian microdata reconstruction.

## Inputs, definitions and target order

[S] First preserve population-size context: Danish municipal mean/median  
 ↪ in  
 2015, US mean after excluding the largest 30 counties using 2010 census  
 population, and Canadian mean after excluding the largest 10 districts  
 ↪ using  
 2011 population. These are context targets, not cohort restrictions.  
 ↪ Danish  
 population context is not the linked-child sample size. Candidate Danish  
 population status fields are CPST/BEF.PNR, KOM and reference dates; P  
 ↪ does not  
 identify the precise 2015 count date, aggregation or source extraction. It  
 remains unavailable/unresolved, not a new population-count exercise.

[S] Next preserve average beta (Canada/Denmark versus US), then means and  
 SDs of r25, r50 and r75 for US and Denmark, then the difference between  
 ↪ average  
 r75 and average r25 in percentile points, and the paper's qualitative  
 dispersion comparison. All published constants and printed precision live  
 ↪ in  
 prereg/replication/published-reference-targets.md. No Canadian percentile  
 means, Canadian SDs, pooled international test or additional geography is  
 ↪ added.

[U] G10: the paper does not settle area weights, missing-estimate policy  
 ↪ or  
 the SD denominator. The 30/10 exclusions do not transfer to mobility  
 ↪ summaries.  
 The data source versions and Canadian tracts/districts wording remain  
 ↪ unresolved.  
 [C] G08: average beta is not an inverse transform or a causal mobility  
 ↪ index.

## Ordered executable pseudocode

```
```text
REQUIRE done(atom-000001).
REGISTER every population-context and mobility-summary target in source
  ↪ order.
READ Atom 1 core target statuses, not its headline state alone.
FOR each Danish core aggregate target:
  IF needed core estimates not completed: emit upstream boundary, no
  ↪ estimate.
  ELSE IF G10's weighting/missing/SD choice affects target:
    STOP_UNRESOLVED_SOURCE(target, G10).
  ELSE compute the exact source-defined summary on the fixed
  ↪ municipality set.
FOR each external-country target:
```

```

        mark reference_only_not_rebuilt; do not execute a new external
        ↪ analysis.
    IF source-defined Danish means of r75 and r25 are completed:
        span_pp = 100 * (mean_r75 - mean_r25).
    ELSE no span estimate.
    FOR completed Danish summary with an identical published definition:
        comparison difference = rebuilt - published reference, in matched
        ↪ units;
        report published decimal precision; do not classify replication
        ↪ success.
...

```

The source-silent mean weights are not filled by an assumed arithmetic
 ↪ mean.
 The span identity is [E] and has no unresolved numerical threshold. It
 ↪ cannot
 be evaluated using published rather than rebuilt means. No test of
 ↪ cross-country
 equality, slope differences, variance ratios or confidence-band overlap
 ↪ is added.
 The source's "about three times" sentence stays a historical comparison
 ↪ target;
 it is not a registered success region or permission for a new variance
 ↪ test.

Estimator, uncertainty and evidence interfaces

This Atom adds only source-mentioned aggregate summaries and comparison
 arithmetic to the municipal analysis. Statistical inference for national
 differences, multiplicity, power, controls, diagnostics or robustness:
 not specified in source; not added. Unknown source weights and SD
 ↪ convention
 are explicit boundaries. No estimates are derived from confidential data
 ↪ here.

Future outputs under outputs/atom-000002/:

- country-summary.csv: country [Denmark/United States/Canada], geography,
 statistic [population_mean/population_median/beta_mean/r25_mean/r25_sd/
 r50_mean/r50_sd/r75_mean/r75_sd/span_pp], estimate, unit, status,
 ↪ reason,
 origin. Only source-inventoried country/statistic combinations are
 ↪ permitted.
 External references are held in a separate reference table, not in
 ↪ estimate.
- comparison.csv: target_id, rebuilt_value, published_reference,
 ↪ difference,
 unit, published_precision, status, reason, origin. All
 ↪ rebuilt/difference
 fields empty unless corresponding registered Danish target completed.
- target-status.csv as in the common contract. No figure is added; these
 ↪ were
 prose results in P and remain a prose/table presentation in the
 ↪ manuscript.

Consequences and scope ceiling

Completed compatible Danish summaries may be compared descriptively with
 known foreign benchmarks; this does not establish identical measurement,
 different opportunity sets, causal country effects or independent external

replication. Reference-only foreign targets can coexist with completed
↪ Danish
scope and must remain explicitly not rebuilt. Partial/boundary outcomes
↪ report
precisely which Danish summaries could not be computed. No missing result
↪ is
interpreted as convergence, equivalence or evidence of similar countries.

Binding shared rules and scientific status

This protocol incorporates prereg/data-contract.md (exact candidate
↪ fields, meanings,
keys, coverage and unresolved joins), identification.md, governance.md
↪ and the exact
gap definitions G01-G20 in prereg/replication/deviations.md. P/R/D1/D2
↪ locators are
defined there. [S] marks source-explicit instructions; [E] marks
↪ meaning-preserving
engineering; [U] marks a missing scientific decision; [C] marks
↪ conflicting source
statements; [A] marks unavailable original inputs. Only S and E authorize
↪ computation.
All preregistered targets are descriptive. There is no observed result in
↪ this file.

Common execution and output contract

[E] Evaluate activation using the native condition. Before a target
↪ calculation,
inspect only the source resolution record and governed input schema.
↪ Required joins
must satisfy their documented person/year or municipality identity
↪ cardinality.
An unexpected duplicate or ambiguous crosswalk is a STOP, never an
↪ averaging/drop
rule. These are internal integrity assertions, not new empirical
↪ diagnostics.

[E] Per target, write a row to outputs/atom-000002/target-status.csv with
↪ columns
target_id, source_locator, status, gap_ids, reason, output_file, origin.
↪ Status is
completed, unresolved_source, unavailable_original, data_boundary,
↪ suppressed,
unrun or operational_failure. Origin is replication for newly executed
↪ outputs;
published values are never accepted as those inputs. STOP produces an
↪ empty
numeric field and an explicit reason, not zero, NA-as-zero, an estimate
↪ or a null.
No such result file is populated at registration. All future paths are
↪ relative
to a governed evidence root, not this World or a microdata mount guessed
↪ here.

[E] Before execution distinguish a known source gap from a runtime
↪ failure:
if any required decision is G01-G20 and unresolved in this frozen
↪ registration,

emit STOP_UNRESOLVED_SOURCE for that target; do not prompt an executor to
 ↳ choose.
 If a source-defined original input is not retrieved, emit
 ↳ unavailable_original.
 If a resolved dependency is demonstrated absent in governed runtime, emit
 data_boundary. If access fails without establishing absence, report
 ↳ operational
 failure and leave the Atom unrealized. A later source clarification
 ↳ requires a
 new registration version; this protocol contains no permission to resolve
 ↳ it.

[E] Record target-local boundaries without dropping sibling targets. A
 ↳ sibling
 can complete only if every scientific decision on its path is
 ↳ independently
 source-supported. Shared blockers here affect many or all empirical
 ↳ targets;
 partial states do not assert that a currently computable sibling exists.
 Deterministic sort order and output-column renaming are engineering only.

Uncertainty, controls, multiplicity, power, negative controls and
 ↳ sensitivity
 analyses are copied only where specified below. Otherwise: not specified
 ↳ in
 source; not added. No p-value, direction, magnitude, sample-size score or
 ↳ numerical
 agreement tolerance determines the completion state. No independent
 ↳ review is
 claimed. The preregistration compatibility ratings are uncalibrated
 ↳ format fields.

International mobility comparison

Prospective source-faithful registration. All empirical outputs remain unfilled. The registration payload above is authoritative. No independent scientific review or replication execution has occurred.

Reference implementation

Entry point and supported/unresolved components for atom-000002: [execution index](#). See [engineering review](#). This pointer does not amend the registered protocol.

atom-000003: Municipal demographic correlations

Correlations of municipal characteristics with mobility

Question, unit and narrative role

[S] P §3 third contribution and Figure 2: describe correlations between municipal characteristics and beta, r25, r50 and r75. This entire 12-row, four-series analysis belongs to one Atom. The unit is a municipality with the source-defined time-averaged demographic characteristic and core age-18/family-on-parents mobility measures from

Atom 1. There are no controls, interactions, separate subgroup models or policy effects in this module.

Exact source row order and unresolved construction

Unless overridden below, P specifies working ages 18–65 and the municipal time average over 1980–1995. That rule does not settle age reference date, year inclusion under missingness, denominator population or historical classification. Exact candidate fields and keys are in data-contract.md.

Row ID	Printed construct and source window	Source restriction and remaining decision
bottom_decile	Share from bottom income decile; 1980–1995	Population aged 25 and older, not capped at 65 by a default. IND income candidate plus CPST/FAIN/BEF residence. Income concept, national/local deciles, ties, thresholds, numerator and denominator unresolved (G11).
top_decile	Share from top income decile; 1980–1995	Same explicit age exception and unresolved decile construction; no top-tail trimming.
gini	Gini coefficient; 1987–1993	Original Statistics Denmark (2017) series required; not reconstructed from IND. Original series unavailable (G13).
outside_labor	Share outside labor market; 1980–1995	Working-age population, students excluded from labor numbers. RAS/IDAP/AKM source status and student code definitions unresolved; no complement-of-employment shortcut (G11).

Row ID	Printed construct and source window	Source restriction and remaining decision
employed	Share employed; 1980–1995	Same age/student restriction; exact employment and denominator definition unresolved.
married	Share of married individuals; 1980–1995	Candidate CPST/FAIN/BEF.CIVST; source snapshot and marital-status code mapping not specified.
single_parents	Share of single parents; 1980–1995	FAIN/BEF family and parent-link candidates; individual versus family denominator, dependent-child age and single status unresolved.
teen_births	Teen births per capita; 1980–1995	FTBARN/FTFORAEL source birth/parent histories are candidates; no teen cutoff, maternal/event date or population denominator selected by extractor. P's general 18–65 statement does not resolve the teen numerator definition.
nonwestern	Share of non-western immigrants; 1980–1995	Prose includes first and second generation; IEPE/BEF IE_TYPE/OPR LAND candidates. Non-western country list vintage, annual historical linkage and denominator unresolved.
university	Share university educated; 1981–1995	UDDA.HFAUDD/HF_VFRA candidates; source education-code list and snapshot rule missing. Footnote 5 specifies levels, not years of education.

Row ID	Printed construct and source window	Source restriction and remaining decision
vocational	Share vocationally educated; 1981–1995	Same source level-based construction; exact vocational code list and treatment of successive degrees unresolved.
crime	Criminal offences per capita; 1990–1997	KRAN case/offence-geography candidates; reported versus committed versus adjudicated event, offence coverage, case duplicates, geographic mapping and denominator unresolved. KRAF convictions cannot be substituted.

Each row is crossed with beta, r25, r50, r75 in that order. The paper supplies no additional sex/region subgroups. Geographic descriptions in the prose are interpretation of these associations, not source-supported subgroup tests.

Ordered executable pseudocode

```

REQUIRE done(atom-000001).
REGISTER 48 row/measure targets, each with point and 95%-CI slots.
FOR characteristic in the fixed Figure 2 row order:
  CHECK only the source-defined characteristic rules and candidate schemas.
  IF G11 or row-specific G13 unresolved/unavailable:
    emit explicit boundary for that row's 4 targets; preserve all slots.
  ELSE:
    RESOLVE authorized annual person/event reference and municipality
    ↪ keys;
    ASSERT documented cardinalities; stop duplicate/ambiguous geography.
    APPLY source age/window/student/education restrictions exactly;
    do not introduce missing-year averages, imputation or proxies.
    CALCULATE source-defined annual numerator/denominator and the stated
    municipal time average only when all definitions are
    ↪ settled.
  FOR measure in [beta,r25,r50,r75]:
    REQUIRE corresponding core Atom 1 estimate for the same municipality.
    IF upstream target unavailable: emit upstream boundary, no
    ↪ correlation.
    ELSE IF G12 regression/standardization/weights/CI unresolved:
      STOP_UNRESOLVED_SOURCE(characteristic, measure, G12).
    ELSE execute source-specified correlation/OLS-SE procedure and emit
    its point estimate and 95% interval without added significance
    ↪ test.
RENDER only precomputed values and explicit boundary rows using figure2.py.

```

[S] Figure 2 caption specifies 95% CIs based on OLS standard errors. [U] It does not fully describe correlation fitting direction/standardization/weights, covariance implementation or critical-value distribution/df; G12 stops these. Do not implement Fisher-z, bootstrap, robust/clustered uncertainty, population weights or a default normal/t critical value. No arbitrary positive/negative effect bands or CI-exclusion test is added. Do not choose a complete-case municipality intersection silently to obtain a plot.

Evidence interfaces and display semantics

Future outputs under `outputs/atom-000003/`:

- `characteristics.csv`: `municipality_id`, `characteristic`, `window_start`, `window_end`, `value`, `unit`, `status`, `reason`, `origin`. No person records exported; values empty where construction is unresolved.
- `correlations.csv`: `characteristic`, `measure`, `estimate`, `lower`, `upper`, `n_municipalities`, `status`, `reason`, `origin`. Each of 48 pairs appears exactly once, in fixed order. Point and interval are correlation units; no manual sign reversal of beta. For a source-blocked target, `estimate/lower/upper/N` are all empty, `status` explains the gap. If only uncertainty is unresolved after a valid point calculation, keep its point with `status point_only` and both interval columns empty; do not manufacture CI bounds.
- `target-status.csv` and private integrity log as in the common contract.

[S/E] Figure 2 is an ordered horizontal correlation-and-interval display with four offset series and a zero reference line. Color, spacing and legend are presentation engineering, not estimator choices. The implemented template accepts no raw registers and fits no model. It retains each unavailable row, prints its no-estimate reason and never draws missing values at zero. It rejects `published_reference` input in place of replication evidence.

Interpretation and consequences

Future Results may describe direction and size of the completed associations, reporting source-supported uncertainty as supplied. Beta's interpretation is rank persistence; the other measures are fitted child rank. Opposite sign orientation is explained, not forcibly imposed. Do not promise the paper's reported directions or write that all four measures agree unless actual completed outputs support that description. Complete/partial states permit only ecological descriptive association, never employment, family, immigrant, education or crime effects. Boundary/otherwise/unrun outcomes remain visible without claims of zero association. Source uncertainty is not converted into an inconclusive statistical test.

Binding shared rules and scientific status

This protocol incorporates `prereg/data-contract.md` (exact candidate fields, meanings, keys, coverage and unresolved joins), `identification.md`, `governance.md` and the exact gap definitions G01–G20 in `prereg/replication/deviations.md`. P/R/D1/D2 locators are defined there. [S] marks source-explicit instructions; [E] marks meaning-preserving

engineering; [U] marks a missing scientific decision; [C] marks conflicting source statements; [A] marks unavailable original inputs. Only S and E authorize computation. All preregistered targets are descriptive. There is no observed result in this file.

Common execution and output contract

[E] Evaluate activation using the native condition. Before a target calculation, inspect only the source resolution record and governed input schema. Required joins must satisfy their documented person/year or municipality identity cardinality. An unexpected duplicate or ambiguous crosswalk is a STOP, never an averaging/drop rule. These are internal integrity assertions, not new empirical diagnostics.

[E] Per target, write a row to outputs/atom-000003/target-status.csv with columns target_id, source_locator, status, gap_ids, reason, output_file, origin. Status is completed, unresolved_source, unavailable_original, data_boundary, suppressed, unrun or operational_failure. Origin is replication for newly executed outputs; published values are never accepted as those inputs. STOP produces an empty numeric field and an explicit reason, not zero, NA-as-zero, an estimate or a null. No such result file is populated at registration. All future paths are relative to a governed evidence root, not this World or a microdata mount guessed here.

[E] Before execution distinguish a known source gap from a runtime failure: if any required decision is G01–G20 and unresolved in this frozen registration, emit STOP_UNRESOLVED_SOURCE for that target; do not prompt an executor to choose. If a source-defined original input is not retrieved, emit unavailable_original. If a resolved dependency is demonstrated absent in governed runtime, emit data_boundary. If access fails without establishing absence, report operational failure and leave the Atom unrealized. A later source clarification requires a new registration version; this protocol contains no permission to resolve it.

[E] Record target-local boundaries without dropping sibling targets. A sibling can complete only if every scientific decision on its path is independently source-supported. Shared blockers here affect many or all empirical targets; partial states do not assert that a currently computable sibling exists. Deterministic sort order and output-column renaming are engineering only.

Uncertainty, controls, multiplicity, power, negative controls and sensitivity analyses are copied only where specified below. Otherwise: not specified in source; not added. No p-value, direction, magnitude, sample-size score or numerical agreement tolerance determines the completion state. No independent review is claimed. The preregistration compatibility ratings are uncalibrated format fields.

Complete registration fields

```
id: atom-000003
topic: Municipal demographic correlations
atom_result: prereg
atom_strength: null
atom_shape: null
evidence_paths: []
concepts: []
literature: []
bonds: []
```

```

preregistration:
  version: 1
  mode: canonical
  question: How do the source-defined municipal characteristics correlate
    with the four source mobility measures?
  rationale: 'Third stated contribution in P: all related characteristic rows
    and four outcome series remain one ecological correlation analysis.'
  assumption: Only paper/appendix-explicit rules and meaning-preserving
    ↪ engineering
    are executable; unresolved source choices stay blocked. Schema evidence
    is not runtime availability.
  target_strength: descriptive
  target_shape: association
  ratings:
    importance: 1
    novelty: 1
    feasibility: 1
    data_advantage: 1
    informativeness: 0
  tables:
    - IND
    - CPST
    - FAIN
    - BEF
    - RAS
    - IDAP
    - AKM
    - UDDA
    - IEPE
    - FTBARN
    - FTFORAEL
    - KRAN
    - KRAF
  activation: done(atom-000001)
  verdicts:
    - key: complete
      region: 'First: a completed audit exists, every rebuildable target in
        this module has a source-supported estimate and required
        ↪ uncertainty/release
        disposition, and all inventory context/not-rebuilt targets are
        ↪ explicitly
        accounted for; no unresolved scientific prerequisite remains for any
        rebuildable target.'
      says: Describe only the completed registered quantities; contextual or
        explicitly not-rebuilt targets are not replicated findings. Completion
        does not mean numerical agreement or independent validation.
    - key: partial
      region: 'Second: completed audit, at least one substantive registered
        target estimated faithfully, at least one other required target has
        a documented source/input/data/uncertainty boundary; not complete.'
      says: Report exactly the estimated targets and preserve all blocked
        ↪ siblings.
        No substitute specification stands in for an unavailable target.
    - key: source_boundary
      region: 'Third: completed audit, no substantive target estimated, and
        at least one necessary source decision remains unresolved or
        ↪ conflicting.
        This takes precedence over concurrent input gaps.'
      says: No estimate is licensed for the affected module under the extracted

```

```

    source specification. Report exact source gaps; this is not a null
    ↪ effect.
- key: input_boundary
  region: 'Fourth: completed audit, no substantive target estimated, no
    unresolved scientific source decision is the binding cause, and an
    ↪ original
    input or required governed field is demonstrably unavailable.'
  says: The registered target cannot be estimated with the documented
    ↪ inputs.
    Report the missing input, not a negative scientific finding.
- key: otherwise
  region: otherwise
  says: Report unresolved scientific scope explicitly. Operational failures
    and unrun work remain unrealized and are never assigned a scientific
    null.
protocol: |-
# Correlations of municipal characteristics with mobility

## Question, unit and narrative role

[S] P §3 third contribution and Figure 2: describe correlations between
municipal characteristics and beta, r25, r50 and r75. This entire 12-row,
four-series analysis belongs to one Atom. The unit is a municipality with
the source-defined time-averaged demographic characteristic and core
age-18/family-on-parents mobility measures from Atom 1. There are no
↪ controls,
interactions, separate subgroup models or policy effects in this module.

## Exact source row order and unresolved construction

Unless overridden below, P specifies working ages 18-65 and the municipal
time average over 1980-1995. That rule does not settle age reference date,
year inclusion under missingness, denominator population or historical
classification. Exact candidate fields and keys are in data-contract.md.

| Row ID | Printed construct and source window | Source restriction and
↪ remaining decision |
|---|---|---|
| bottom_decile | Share from bottom income decile; 1980-1995 | Population
↪ aged 25 and older, not capped at 65 by a default. IND income
↪ candidate plus CPST/FAIN/BEF residence. Income concept,
↪ national/local deciles, ties, thresholds, numerator and denominator
↪ unresolved (G11). |
| top_decile | Share from top income decile; 1980-1995 | Same explicit
↪ age exception and unresolved decile construction; no top-tail
↪ trimming. |
| gini | Gini coefficient; 1987-1993 | Original Statistics Denmark (2017)
↪ series required; not reconstructed from IND. Original series
↪ unavailable (G13). |
| outside_labor | Share outside labor market; 1980-1995 | Working-age
↪ population, students excluded from labor numbers. RAS/IDAP/AKM source
↪ status and student code definitions unresolved; no
↪ complement-of-employment shortcut (G11). |
| employed | Share employed; 1980-1995 | Same age/student restriction;
↪ exact employment and denominator definition unresolved. |
| married | Share of married individuals; 1980-1995 | Candidate
↪ CPST/FAIN/BEF.CIVST; source snapshot and marital-status code mapping
↪ not specified. |

```

```

| single_parents | Share of single parents; 1980-1995 | FAIN/BEF family
↳ and parent-link candidates; individual versus family denominator,
↳ dependent-child age and single status unresolved. |
| teen_births | Teen births per capita; 1980-1995 | FTBARN/FTFORAEL
↳ source birth/parent histories are candidates; no teen cutoff,
↳ maternal/event date or population denominator selected by extractor.
↳ P's general 18-65 statement does not resolve the teen numerator
↳ definition. |
| nonwestern | Share of non-western immigrants; 1980-1995 | Prose
↳ includes first and second generation; IEPE/BEF IE_TYPE/OPR LAND
↳ candidates. Non-western country list vintage, annual historical
↳ linkage and denominator unresolved. |
| university | Share university educated; 1981-1995 | UDDA.HFAUDD/HF_VFRA
↳ candidates; source education-code list and snapshot rule missing.
↳ Footnote 5 specifies levels, not years of education. |
| vocational | Share vocationally educated; 1981-1995 | Same source
↳ level-based construction; exact vocational code list and treatment of
↳ successive degrees unresolved. |
| crime | Criminal offences per capita; 1990-1997 | KRAN case/offence-geo
↳ graphy candidates; reported versus committed versus adjudicated
↳ event, offence coverage, case duplicates, geographic mapping and
↳ denominator unresolved. KRAF convictions cannot be substituted. |

```

Each row is crossed with beta, r25, r50, r75 in that order. The paper
↳ supplies
no additional sex/region subgroups. Geographic descriptions in the prose
↳ are
interpretation of these associations, not source-supported subgroup tests.

Ordered executable pseudocode

```

```text
REQUIRE done(atom-000001).
REGISTER 48 row/measure targets, each with point and 95%-CI slots.
FOR characteristic in the fixed Figure 2 row order:
 CHECK only the source-defined characteristic rules and candidate
 ↳ schemas.
 IF G11 or row-specific G13 unresolved/unavailable:
 emit explicit boundary for that row's 4 targets; preserve all
 ↳ slots.
 ELSE:
 RESOLVE authorized annual person/event reference and
 ↳ municipality keys;
 ASSERT documented cardinalities; stop duplicate/ambiguous
 ↳ geography.
 APPLY source age/window/student/education restrictions exactly;
 do not introduce missing-year averages, imputation or
 ↳ proxies.
 CALCULATE source-defined annual numerator/denominator and the
 ↳ stated
 ↳ municipal time average only when all definitions are
 ↳ settled.
 FOR measure in [beta,r25,r50,r75]:
 REQUIRE corresponding core Atom 1 estimate for the same
 ↳ municipality.
 IF upstream target unavailable: emit upstream boundary, no
 ↳ correlation.
 ELSE IF G12 regression/standardization/weights/CI unresolved:
 STOP_UNRESOLVED_SOURCE(characteristic, measure, G12).

```

```

 ELSE execute source-specified correlation/OLS-SE procedure and
 ↪ emit
 its point estimate and 95% interval without added
 ↪ significance test.
RENDER only precomputed values and explicit boundary rows using
↪ figure2.py.
...
```

[S] Figure 2 caption specifies 95% CIs based on OLS standard errors. [U]  
 ↪ It  
 does not fully describe correlation fitting  
 ↪ direction/standardization/weights,  
 covariance implementation or critical-value distribution/df; G12 stops  
 ↪ these.  
 Do not implement Fisher-z, bootstrap, robust/clustered uncertainty,  
 ↪ population  
 weights or a default normal/t critical value. No arbitrary  
 ↪ positive/negative  
 effect bands or CI-exclusion test is added. Do not choose a complete-case  
 municipality intersection silently to obtain a plot.

## ## Evidence interfaces and display semantics

Future outputs under outputs/atom-000003/:

- characteristics.csv: municipality\_id, characteristic, window\_start, window\_end, value, unit, status, reason, origin. No person records  
 ↪ exported;  
 values empty where construction is unresolved.
- correlations.csv: characteristic, measure, estimate, lower, upper, n\_municipalities, status, reason, origin. Each of 48 pairs appears  
 ↪ exactly  
 once, in fixed order. Point and interval are correlation units; no  
 ↪ manual  
 sign reversal of beta. For a source-blocked target,  
 ↪ estimate/lower/upper/N  
 are all empty, status explains the gap. If only uncertainty is  
 ↪ unresolved  
 after a valid point calculation, keep its point with status point\_only  
 ↪ and  
 both interval columns empty; do not manufacture CI bounds.
- target-status.csv and private integrity log as in the common contract.

[S/E] Figure 2 is an ordered horizontal correlation-and-interval display  
 ↪ with  
 four offset series and a zero reference line. Color, spacing and legend  
 ↪ are  
 presentation engineering, not estimator choices. The implemented template  
 accepts no raw registers and fits no model. It retains each unavailable  
 ↪ row,  
 prints its no-estimate reason and never draws missing values at zero. It  
 rejects published\_reference input in place of replication evidence.

## ## Interpretation and consequences

Future Results may describe direction and size of the completed  
 ↪ associations,  
 reporting source-supported uncertainty as supplied. Beta's interpretation  
 ↪ is  
 rank persistence; the other measures are fitted child rank. Opposite sign

orientation is explained, not forcibly imposed. Do not promise the paper's reported directions or write that all four measures agree unless actual completed outputs support that description. Complete/partial states permit only ecological descriptive association, never employment, family,  
→ immigrant,  
education or crime effects. Boundary/otherwise/unrun outcomes remain  
→ visible  
without claims of zero association. Source uncertainty is not converted  
→ into  
an inconclusive statistical test.

## ## Binding shared rules and scientific status

This protocol incorporates prereg/data-contract.md (exact candidate  
→ fields, meanings,  
keys, coverage and unresolved joins), identification.md, governance.md  
→ and the exact  
gap definitions G01-G20 in prereg/replication/deviations.md. P/R/D1/D2  
→ locators are  
defined there. [S] marks source-explicit instructions; [E] marks  
→ meaning-preserving  
engineering; [U] marks a missing scientific decision; [C] marks  
→ conflicting source  
statements; [A] marks unavailable original inputs. Only S and E authorize  
→ computation.  
All preregistered targets are descriptive. There is no observed result in  
→ this file.

## ## Common execution and output contract

[E] Evaluate activation using the native condition. Before a target  
→ calculation,  
inspect only the source resolution record and governed input schema.  
→ Required joins  
must satisfy their documented person/year or municipality identity  
→ cardinality.  
An unexpected duplicate or ambiguous crosswalk is a STOP, never an  
→ averaging/drop  
rule. These are internal integrity assertions, not new empirical  
→ diagnostics.

[E] Per target, write a row to outputs/atom-000003/target-status.csv with  
→ columns  
target\_id, source\_locator, status, gap\_ids, reason, output\_file, origin.  
→ Status is  
completed, unresolved\_source, unavailable\_original, data\_boundary,  
→ suppressed,  
unrun or operational\_failure. Origin is replication for newly executed  
→ outputs;  
published values are never accepted as those inputs. STOP produces an  
→ empty  
numeric field and an explicit reason, not zero, NA-as-zero, an estimate  
→ or a null.  
No such result file is populated at registration. All future paths are  
→ relative  
to a governed evidence root, not this World or a microdata mount guessed  
→ here.

[E] Before execution distinguish a known source gap from a runtime  
→ failure:

if any required decision is G01-G20 and unresolved in this frozen  
 ↪ registration,  
 emit STOP\_UNRESOLVED\_SOURCE for that target; do not prompt an executor to  
 ↪ choose.  
 If a source-defined original input is not retrieved, emit  
 ↪ unavailable\_original.  
 If a resolved dependency is demonstrated absent in governed runtime, emit  
 data\_boundary. If access fails without establishing absence, report  
 ↪ operational  
 failure and leave the Atom unrealized. A later source clarification  
 ↪ requires a  
 new registration version; this protocol contains no permission to resolve  
 ↪ it.

[E] Record target-local boundaries without dropping sibling targets. A  
 ↪ sibling  
 can complete only if every scientific decision on its path is  
 ↪ independently  
 source-supported. Shared blockers here affect many or all empirical  
 ↪ targets;  
 partial states do not assert that a currently computable sibling exists.  
 Deterministic sort order and output-column renaming are engineering only.

Uncertainty, controls, multiplicity, power, negative controls and  
 ↪ sensitivity  
 analyses are copied only where specified below. Otherwise: not specified  
 ↪ in  
 source; not added. No p-value, direction, magnitude, sample-size score or  
 ↪ numerical  
 agreement tolerance determines the completion state. No independent  
 ↪ review is  
 claimed. The preregistration compatibility ratings are uncalibrated  
 ↪ format fields.

## Municipal demographic correlations

Prospective source-faithful registration. All empirical outputs remain unfilled. The registration payload above is authoritative. No independent scientific review or replication execution has occurred.

## Reference implementation

Entry point and supported/unresolved components for atom-000003: [execution index](#). See [engineering review](#). This pointer does not amend the registered protocol.