Accelerating Computational Reproducibility with the Social Science Reproduction Platform

Metascience Conference

Fernando Hoces de la Guardia, BITSS
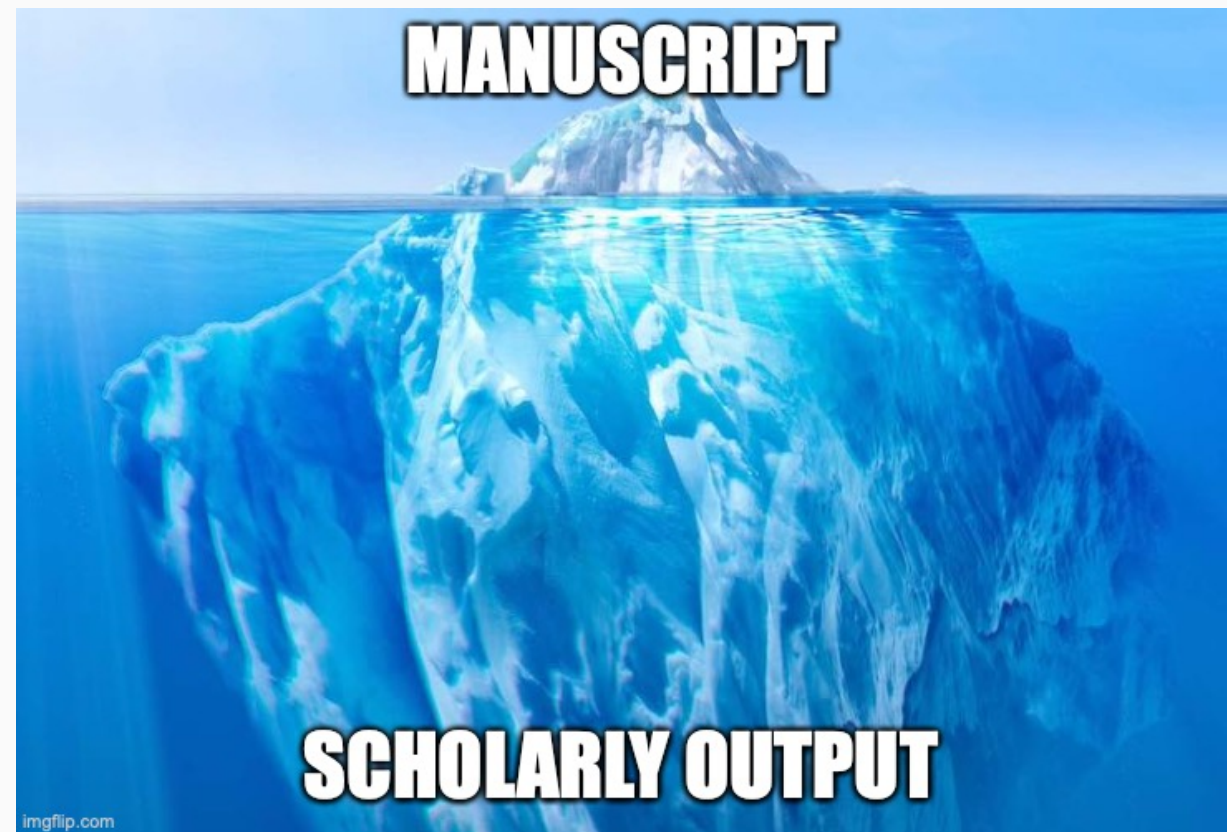September 2021 | slides

Motivation: Computational Reproducibility

Every semester, graduate students around **the world** take an Empirical/Applied [...] course. A typical assignment consists of reproducing the results of a paper and, possibly, testing the robustness of its results.

| Stage	New Knowledge
Scope (select and verify)	Data and code exist?
Assess	Degree of reproducibility for specific part of the paper
Improve	E.g. fixed paths, libraries, added missing files, etc.

"Clarebout Principle":

Buckheit and D.L. Donoho (1995, 2009)

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Test robustness	Results are robust to additional specifications

"Clarebout Principle":
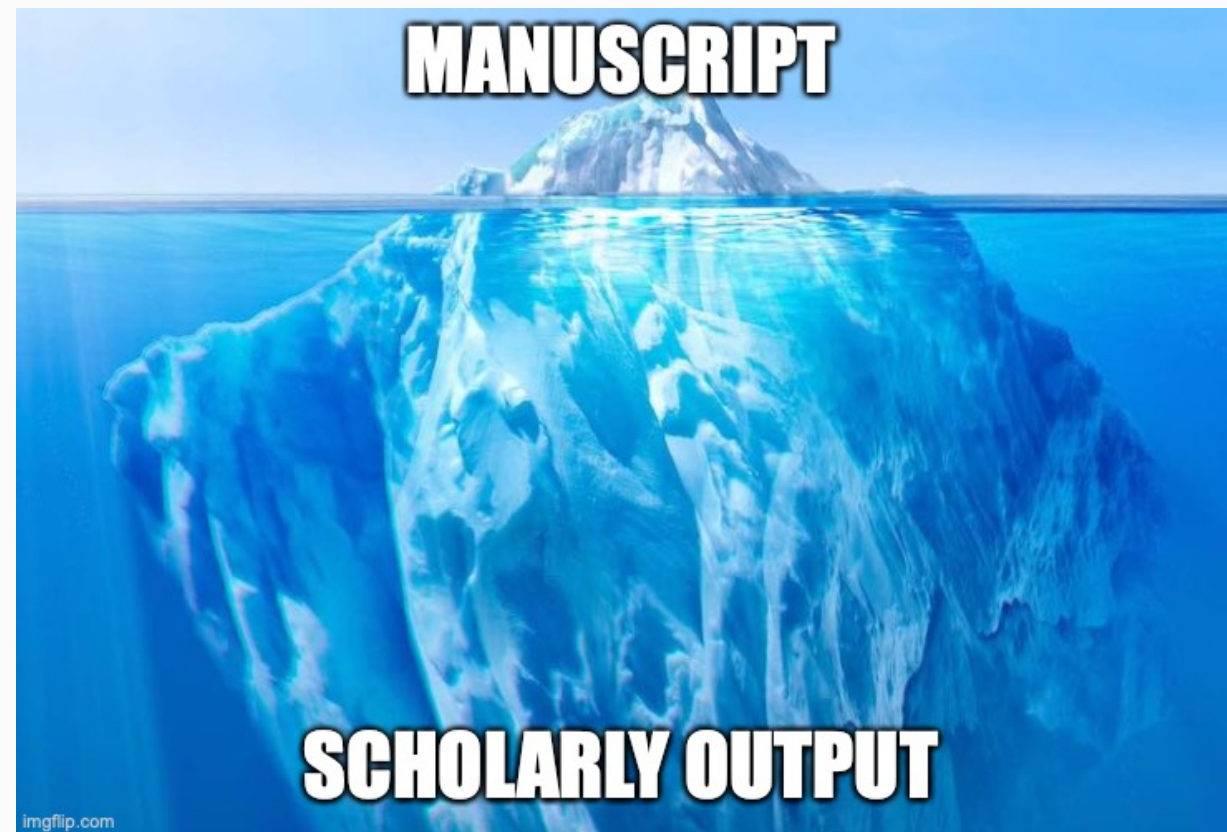
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Accelerating Computational Reproducibility: Framework

Beyond Binary Judgments

Reproductions can easily gravitate towards adversarial exchanges.

- Early career researchers (ECR) have incentives to emphasize unsuccessful reproductions
- Original authors have a more senior position and can use it to deter in-depth reproductions from ECRs.
- The media also focuses on eye-catching headlines

Our approach:

We do not want to say

> "Paper X is (ir)reproducible"

We do want to say

> "Result Y in paper X has a high/low **level** of reproducibility according to **several** reproduction attempts. Moreover, **improvements** have been made to the original reproduction package, **increasing** its reproducibility to a higher level"

ACRe Framework

Each **reproduction attempt** is centered around scientific **claims** (following SCORE).

One paper can contain several claims.

Each claim may be supported by various **display items**: tables, figures & inline results.

A reproduction attempt is at the claim level, and reproducers must record their **specifications** of interest.

Key challenge: **standardization** of concepts and formats.

DI: Display Item
 S: Specificaiton
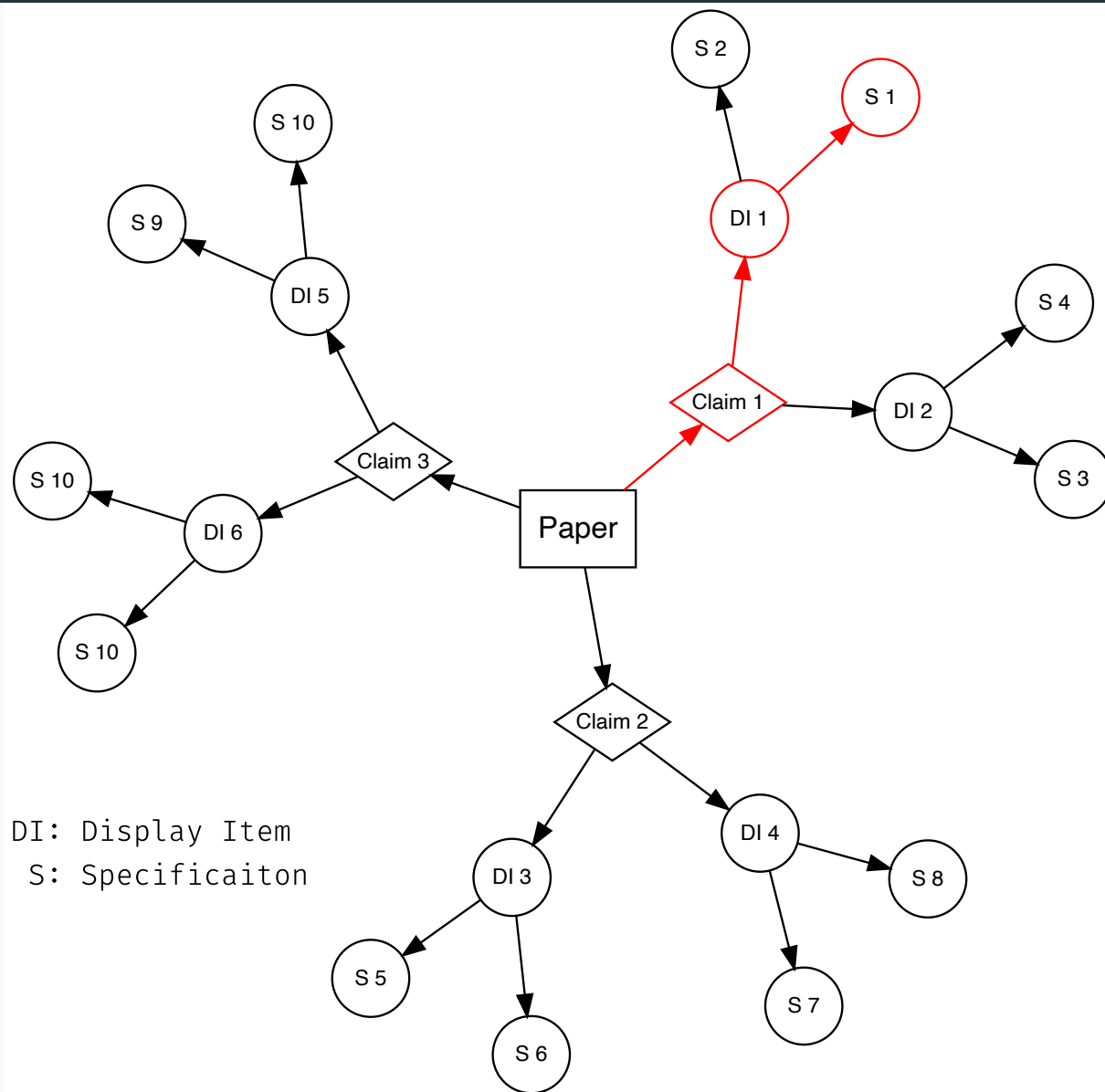
Demo: socialsciencereproduction.org

Select a paper

Article Information

Abstract

How large are the benefits of transportation infrastructure projects, and what explains these benefits? This paper uses archival data from colonial India to investigate the impact of India's vast railroad network. Guided by four results from a general equilibrium trade model, I find that railroads: (1) decreased trade costs and interregional price gaps; (2) increased interregional and international trade; (3) increased real income levels; and (4) that a sufficient statistic for the effect of railroads on welfare in the model accounts well for the observed reduced-form impact of railroads on real income in the data.

Citation

Donaldson, Dave. 2018. "Railroads of the Raj: Estimating the Impact of Transportation Infrastructure." *American Economic Review*, 108 (4-5): 899-934.
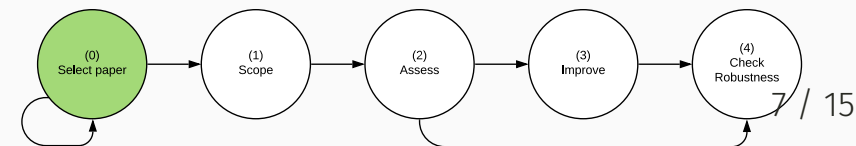
DOI: 10.1257/aer.20101199

Choose Format: ▾

Additional Materials

Data Set (17.80 MB)

Online Appendix (247.97 KB)

Author Disclosure Statement(s) (63.46 KB)

Scope

Col 1: OLS with alpha at historical rates. 1% inc in effc dist (in km) -> 0.088% inc in trade costs

Col 2: NLS with alpha chosen to minimize SSR of col1. effc dist (in km) -> 0.169% inc in trade costs

C. Results

Table 2 presents ordinary least squares (OLS) estimates of equation (12). In column 1 I estimate the effect of the lowest-cost route effective distance on trade costs when the relative costs of each mode (α) are set to observed historical relative freight rate estimates. I use the relative per unit distance freight rates described in Section IB (at their midpoints): $\alpha^{road} = 4.5$, $\alpha^{river} = 3.0$, and $\alpha^{coast} = 2.25$, all relative to the freight rate of railroad transport, normalized to 1). Column 1 demonstrates that the elasticity of trade costs with respect to the lowest-cost route effective distance, calculated at observed freight rates, is 0.088, and this is statistically significant at the 5 percent level.

However, as argued in Section IB, it is possible that these observed relative freight rates do not capture the full benefits (such as increased certainty or time savings) of railroad transport relative to alternative modes of transportation. For this reason the NLS specification in column 2 estimates the relative freight rates (i.e., the parameters α) that minimize the sum of squared residuals in equation (12). Column 2 is my preferred specification. When the mode-wise distance costs (i.e., α) are not restricted to be equal to the observed freight rates, the estimated elasticity of trade costs with respect to effective distance (i.e., δ) rises to 0.169. Even when controlling for all unobserved, time-constant determinants of trade costs between all salt sources and destinations, as well as unrestricted shocks to the source price of each salt type, reductions in trade costs along lowest-cost routes (estimated from railroad-driven time variation in these routes alone) have a large effect on reducing salt price gaps over space.
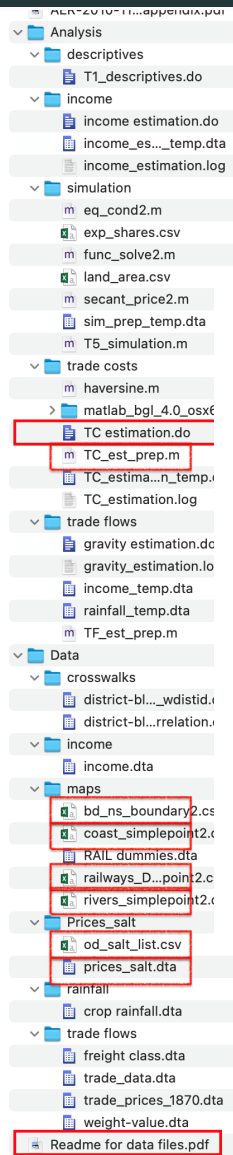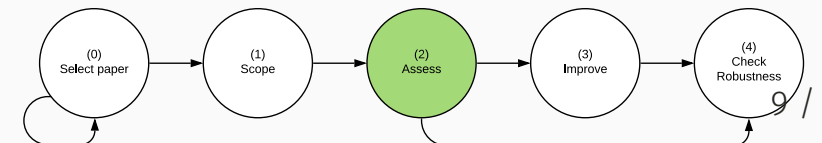
TABLE 2—RAILROADS AND TRADE COSTS: STEP 1

Dependent variable: log salt price at destination	(1)	(2)
log effective distance to source, along lowest-cost route (at historical freight rates)	0.088 (0.028)	
log effective distance to source, along lowest-cost route (at estimated mode costs)		0.169 [0.062, 0.296]
Estimated mode costs per unit distance: Railroad (normalized to 1)		N/A
Road		2.375 [1.750, 10.000]
River		2.250 [1.500, 6.250]
Coast		6.188 [5.875, 10.000]
Observations	7,345	7,345
R^2	0.946	0.946

Notes: Regressions estimating equation (12) using data on 6 types of salt (listed in online Appendix A), from 133 districts in Northern India, annually from 1861 to 1930. Column 1 and column 2 estimated by OLS and NLS respectively; both include salt type × year and salt type × destination fixed effects. "Effective distance to source,
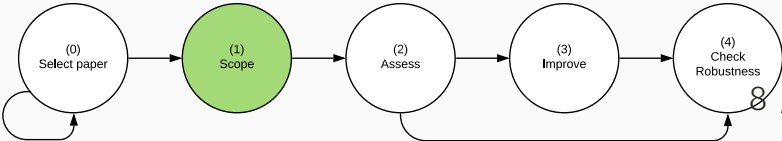
Assess


```
Table 2
└── TC estimation.do
        ├── LCRED_RoX_CoY_RiZ.csv
        │       └── TC_est_prep.m
        │               ├── railways_Dissolve_Simplify2_point2.csv
        │               ├── bd_ns_boundary2.csv
        │               ├── rivers_simplepoint2.csv
        │               ├── rivers_simplepoint2.csv
        │               ├── coast_simplepoint2.csv
        │               └── od_salt_list.csv
        ├── prices_salt.dta
        ├── railways_Dissolve_Simplify2_point2.csv
        ├── bd_ns_boundary2.csv
        ├── rivers_simplepoint2.csv
        ├── coast_simplepoint2.csv
        └── od_salt_list.csv
```

```
▼ 📁 Analysis
  ▼ 📁 descriptives
      📄 T1_descriptives.do
  ▼ 📁 income
      📄 income estimation.do
      📄 income_es..._temp.dta
      📄 income_estimation.log
  ▼ 📁 simulation
      m eq_cond2.m
      📊 exp_shares.csv
      m func_solve2.m
      📊 land_area.csv
      m secant_price2.m
      📄 sim_prep_temp.dta
      m T5_simulation.m
  ▼ 📁 trade costs
      m haversine.m
    > 📁 matlab_bgl_4.0_osx6
      📄 TC estimation.do
      m TC_est_prep.m
      📄 TC_estima...n_temp.(
      📄 TC_estimation.log
  ▼ 📁 trade flows
      📄 gravity estimation.do
      📄 gravity_estimation.lo
      📄 income_temp.dta
      📄 rainfall_temp.dta
      m TF_est_prep.m
▼ 📁 Data
  ▼ 📁 crosswalks
      📄 district-bl..._wdistid.(
      📄 district-bl...rrelation.(
  ▼ 📁 income
      📄 income.dta
  ▼ 📁 maps
      📊 bd_ns_boundary2.cs
      📊 coast_simplepoint2.(
      📄 RAIL dummies.dta
      📊 railways_D...point2.c
      📊 rivers_simplepoint2.(
  ▼ 📁 Prices_salt
      📊 od_salt_list.csv
      📄 prices_salt.dta
  ▼ 📁 rainfall
      📄 crop rainfall.dta
  ▼ 📁 trade flows
      📄 freight class.dta
      📄 trade_data.dta
      📄 trade_prices_1870.dta
      📄 weight-value.dta
  📄 Readme for data files.pdf
```

```
Table 2
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    ├── coast_simplepoint2.csv
    └── od_salt_list.csv
```

Table 3.5: Levels of Computational Reproducibility
(P denotes "partial," C denotes "complete")

| | Availability of materials, and reproducibility | | | | | | | | | |
	Analysis Code		Analysis Data		CRA	Cleaning Code		Raw Data		CRR
	P	C	P	C		P	C	P	C	
L1: No materials	–	–	–	–	–	–	–	–	–	–
L2: Only code	✔	✔	–	–	–	–	–	–	–	–
L3: Partial analysis data & code	✔	✔	✔	–	–	–	–	–	–	–
L4: All analysis data & code	✔	✔	✔	✔	–	–	–	–	–	–
L5: Reproducible from analysis	✔	✔	✔	✔	✔	–	–	–	–	–
L6: All cleaning code	✔	✔	✔	✔	–	✔	✔	–	–	–
L7: Some raw data	✔	✔	✔	✔	–	✔	✔	✔	–	–
L8: All raw data	✔	✔	✔	✔	–	✔	✔	✔	✔	–
L9: All raw data + CRA	✔	✔	✔	✔	✔	✔	✔	✔	✔	–
L10: Reproducible from raw data	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

[a] **Computationally Reproducible from Analytic data (CRA):** The output can be reproduced with minimal effort starting from the *analytic* datasets.

[b] **Computationally Reproducible from Raw data (CRR):** The output can be reproduced with minimal effort from the *raw* datasets.

Improvements & Robustness

Three types of improvements:

1. Improvements at the paper level
2. Improvements at the display-item level
3. Specific future improvements
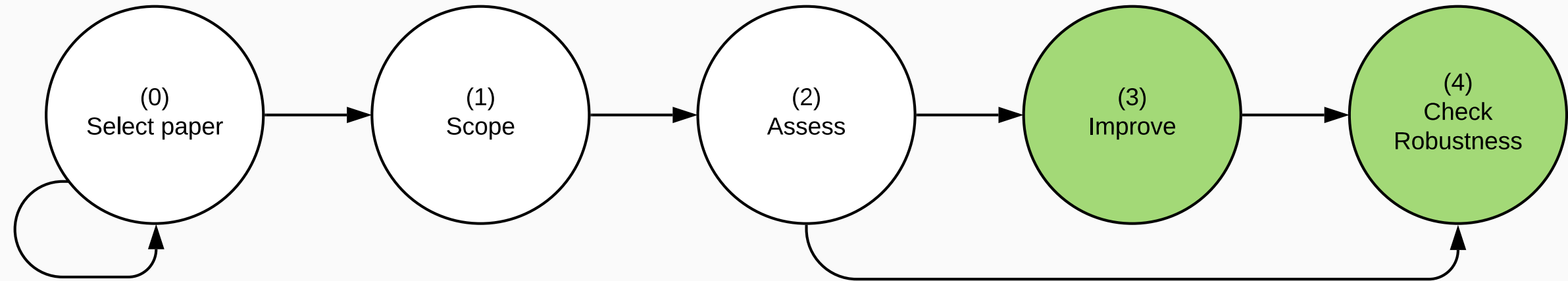
Two main parts for robustness:

1. Increase the number of robustness checks
2. Justify the reasonableness of a specific test

Reproduction of: Railroads of the Raj: Estim
Transportation Infrastructure *American Ecor*
https://doi.org/10.1257/aer.20101199

Reproducer: Emma Ng
Date created: November 19 2020
Date submitted: August 03 2021

Claims assessed: 1
Display Items (DI) assessed: 1
Improvements: 3

Robustness tests:
- Feasible choices added: 0
- Specifications justified: 0

Claims identified by reproducer:
1. "The paper estimated the value of the extent to whi
   within colonial India using OLS and NLS methods. U
   costs of different modes of transportation are estir
   reduction of LCRED (lowest-cost route effective dis
   trading cost. This estimate has a 95% confidence ir

Reproducibility of Display Items:
1. Table 2 - Table 2 -- Railroads and Trade Costs: Step 1. .5

Original reproduction package: https://www.aeaweb.org/articles?id=10.1257/aer.201
Revised reproduction package: https://github.com/em-ng21/railroads-of-the-raj
Original authors' availability for further inquiries: Not sure

⓪ **Select a paper** 👁

    Declare the paper that you will analyze
    which you were unable to obtain acces

    VIEW THIS SECTION

① **Scoping** 👁

② **Assessment** 👁

③ **Improvement** 👁

④ **Robustness** 👁

⓪ **Select a paper** 👁

    Declare the paper that you will analyze in the remainder of the exercise a
    other "candidate" papers for which you were unable to obtain access to a

How Do I Get Started?

Use it for your class
or independent project

Consult the
supporting
guide

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Ask questions

Thank You

acre@berkeley.edu