

Accelerating Computational Reproducibility with the Social Science Reproduction Platform

Toronto Workshop on Reproducibility

Fernando Hoces de la Guardia, BITSS

February 2022 | [slides](#)

The Berkeley Initiative for Transparency in the Social Sciences works to improve the credibility of science by advancing transparency, reproducibility, rigor, and ethics in research and policy analysis.

Core ACRe

Aleks Bogdanoski

Albert Chae

Fernando Hoces de la Guardia

Edward Miguel

Lars Vilhuber



BERKELEY INITIATIVE FOR TRANSPARENCY
IN THE SOCIAL SCIENCES

We are part of the Center for Effective Global Action (CEGA).



Many Others

CEGA staff

Undergrad and Graduate RAs

Catalysts

Outside Collaborators
(Researchers, Programmers)

M2: More Inclusive Concept Scholarly Output

Clarebout Principle:

“An article about computational science in a scientific publication is not the scholarship itself, it’s merely scholarship advertisement. The actual scholarship is the complete software development environment and the complete set of instructions which generated the figures.”

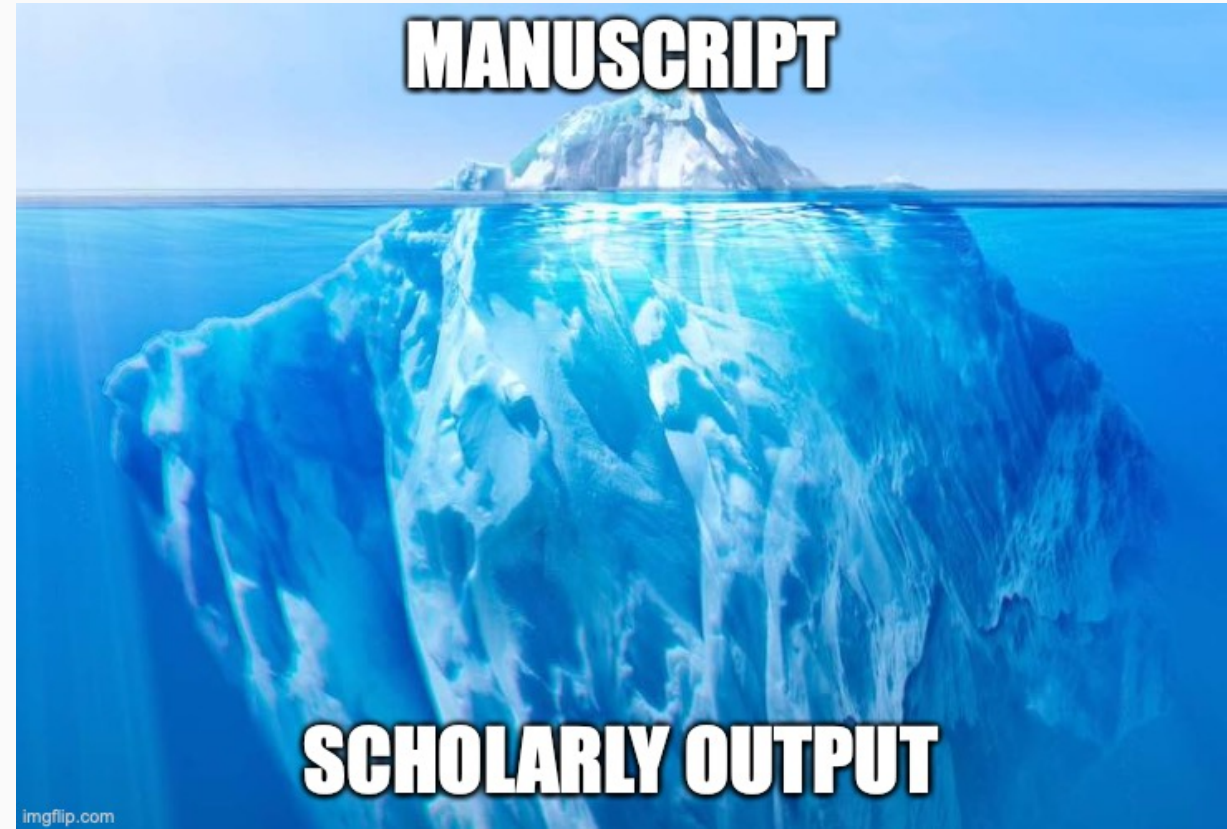
Buckheit and D.L. Donoho (1995, 2009)

M2: More Inclusive Concept Scholarly Output

Clarebout Principle:

“An **article** about computational science in a scientific publication is not the scholarship itself, **it’s merely scholarship advertisement**. The actual **scholarship is the complete software development environment and the complete set of instructions which generated the figures.**”

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



M2: More Inclusive Concept Scholarly Output

Potential benefits of following the Clarebout Principle

Well discussed potential positive effects on:

- Pedagogy
- Incremental generation of knowledge

Under discussed:

- Possible positive effect on diversity, equity and inclusion: no connections or language skills ("appropriate politeness") required to obtain materials

M3: Prevent Loss of Knowledge

Every semester, graduate students around **the world** take an Empirical/Applied [...] Economics 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.
Test robustness	Results are robust to additional specifications

M3: Prevent Loss of Knowledge

- In each of the previous steps there was valuable new knowledge
- This knowledge is not usually disseminated
 - End of semester report, or presentation that is not published.
 - Language across courses is not standard (reproduction? replication?)
 - Current attempts to record this are closer to a full paper format (see [Replication Wiki](#))
- As a result there is a large amount of missed knowledge.
 - Each new semester, new students repeat similar excesses and have to reinvent the wheel.
 - Lost opportunity for building on top of previous exercises.
 - Lost opportunity for aggregating the new knowledge.

Context for ACRE

- American Economics Association (AEA) creates first data policy in 2006.
 - Must publish some data (waivers available)
- AEA updates **policy in 2019**.
 - Must post all data and code. Publication is conditional on verifying reproducibility (if confidential: must document extensively)
 - A new requirement is to post all cleaning code, even for data that is not public
- We should expect high levels of computational reproducibility after 2019 (AEA).
- We should not demand 100% reproducibility before, but we could identify the gaps and try to improve some.

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

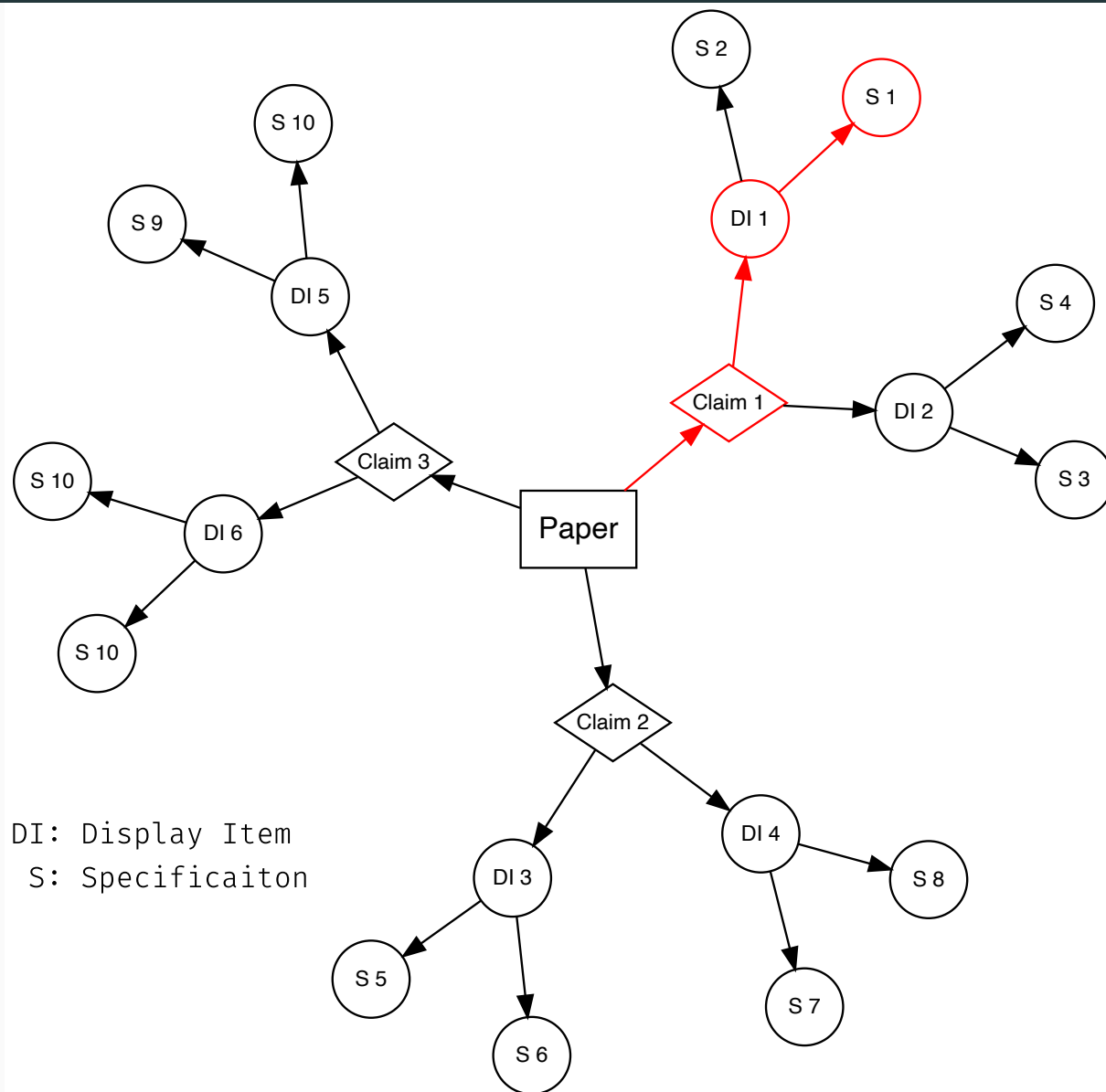
Each **reproduction attempt** is centered around scientific **claims** (following **SCORE**).

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.



Demo: socialsciencereproduction.org

[Home](#)[About](#)[Events](#)[Guide](#)[Forum](#)[Metrics](#)

Welcome to the

Social Science Reproduction Platform

Accelerating computational
reproducibility in the social sciences

GET STARTED!

Search reproductions by paper title, DOI, or author name



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:

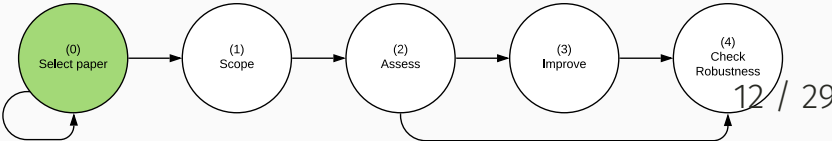


Additional Materials

Data Set (17.80 MB)

Online Appendix (247.97 KB)

Author Disclosure Statement(s) (63.46 KB)



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 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 $\alpha^{coast} = 2.25$ 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 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.

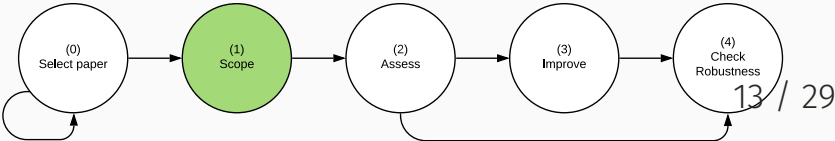
TABLE 2—RAILROADS AND TRADE COSTS: STEP 1

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)		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 \times year and salt type \times destination fixed effects. “Effective distance to source.”

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



Assess

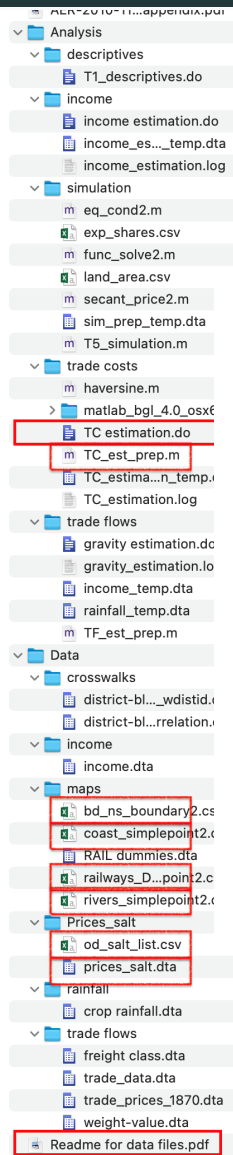
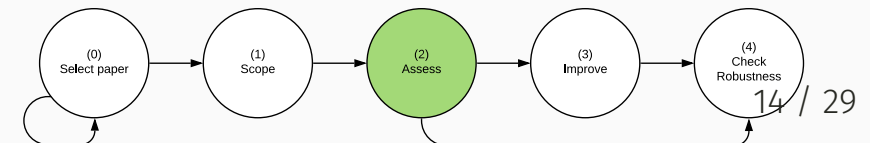


Table 2

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	



Assess

Analysis
descriptives
T1_descriptives.do
income
income estimation.do
income_es..._temp.dta
income_estimation.log
simulation
eq_cond2.m
exp_shares.csv
func_solve2.m
land_area.csv
secant_price2.m
sim_prep_temp.dta
T5_simulation.m
trade costs
haversine.m
matlab_bg1_4.0_osxf
TC estimation.do
TC_est_prep.m
TC_estima...n_temp.dta
TC_estimation.log
trade flows
gravity estimation.do
gravity_estimation.lo
income_temp.dta
rainfall_temp.dta
TF_est_prep.m
Data
crosswalks
district-bl...wdistid.dta
district-bl...relation.dta
income
income.dta
maps
bd_ns_boundary2.csv
coast_simplepoint2.csv
RAIL_dummies.dta
railways_D...point2.csv
rivers_simplepoint2.csv
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

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	

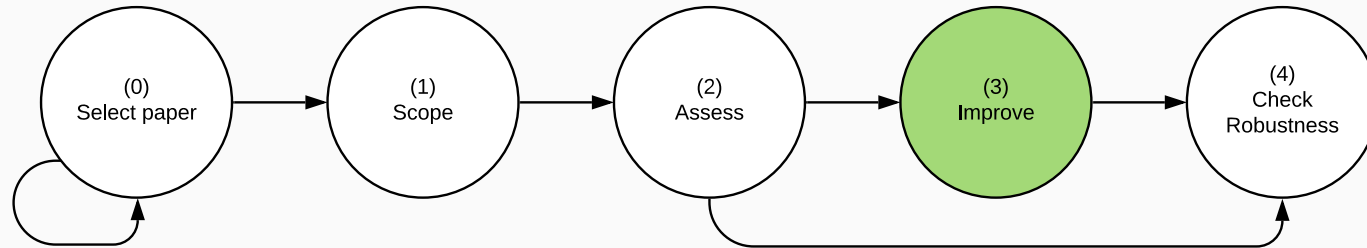
Table 3.5: Levels of Computational Reproducibility
(P denotes “partial,” C denotes “complete”)

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



Three types of improvements:

1. Improvements at the paper level
2. Improvements at the display-item level
3. Specific future improvements

Improvements: Paper-level

- Use version control software (Git/Github).
- Improve documentation: comments, indentations, object names, etc.
- Re-organize the reproduction package into a set of folders and sub-folders that follow **standardized best practices**, and add a master script that executes all the code in order, with no further modifications. **See AEA's reproduction template.**
- Literate programming environment (e.g., Jupyter notebooks, RMarkdown)
- Re-write code using a different statistical software (ideally open source, like R, Python, or Julia).
- Set up a computing capsule (e.g., **Binder** and **Code Ocean**).



Improvements: Display item-level

- Adding missing raw data: files or meta-data
 - Example: "Add raw temperature and relative humidity data"
- Adding missing analytic data files
 - Example: "Copy the row files from Data folder into new `Analysis\trade cost\Input`"
- Adding missing analysis or cleaning code
 - Example: "Replaced broken Wald bootstrap code with updated code/command"
- Debugging code
 - Example: "was counting each group 4 times in round 1, so fixed that"



Improvements: future possible

We ask reproducer to leave concise and actionable tasks for other reproducers in the future.

Example 1:

"Revise the .aml and .bat code scripts to reflect reorganized structure"

Example 2:

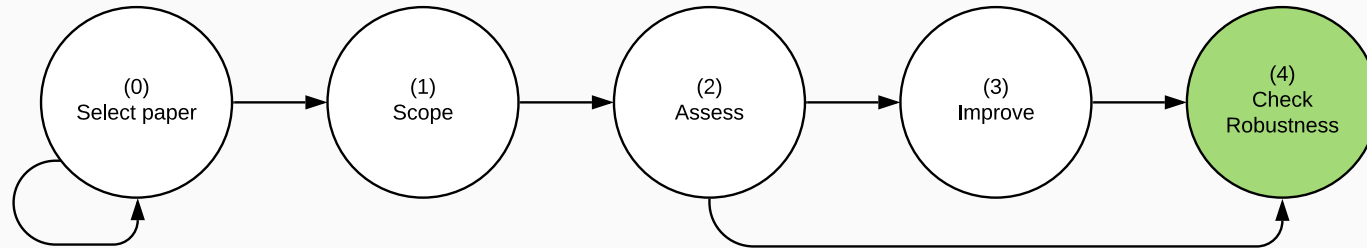
"Provide data and codes generating the other two figures in the paper, which are not given in the replication file."

Example 3:

"Table 3 can be reproduced identically from the [...] analytic data files. I was not able to reproduce the analytic data files due to lack of access to ArcGIS software, but the code scripts and raw data files [...] are included in the reproduction package."



Robustness Checks



Two main parts for robustness:

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

Robustness

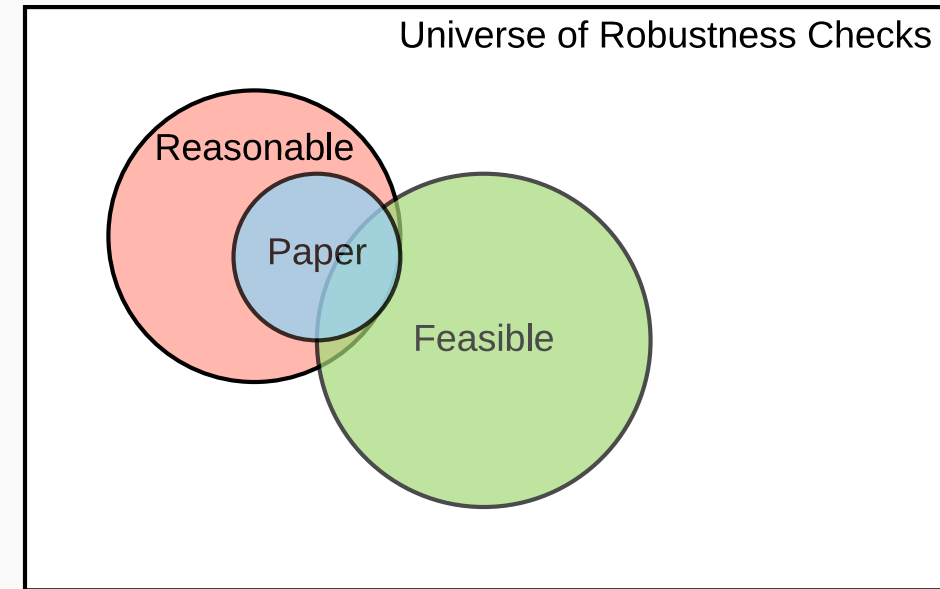
Robustness checks: any possible change in a computational choice, both in data analysis and data cleaning

Reasonable specifications (Simonsohn et. al., 2018):

1. Sensible tests of the research question
2. Expected to be statistically valid, and
3. Not redundant with other specifications in the set.

Reproducers will be able to record two types of contributions:

- Mapping the universe of robustness checks
- Proposing a specific robustness check



Completed Reproduction: Example

Reproduction of: Railroads of the Raj: Estimating the Value of Transportation Infrastructure
American Economic Review
<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 which the costs of different modes of transportation are estimated using the reduction of LCRED (lowest-cost route effective distance trading cost. This estimate has a 95% confidence interval."

Reproducibility of Display Items:

1. Table 2 - Table 2 -- Railroads and Trade Costs: Step 1. ...

Original reproduction package: <https://www.aeaweb.org/articles?id=10.1257/aer.20101199>

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 in the remainder of the exercise and other "candidate" papers for which you were unable to obtain access to

[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 and other "candidate" papers for which you were unable to obtain access to

Completed Reproduction: Example

Reproduction of: Railroads of the Raj: Estimating Transportation Infrastructure American Economic Review
<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 which within colonial India using OLS and NLS methods. It costs of different modes of transportation are estimated reduction of LCRED (lowest-cost route effective distance trading cost. This estimate has a 95% confidence interval

Reproducibility of Display Items:

1. Table 2 - Table 2 -- Railroads and Trade Costs: Step 1. ...

Original reproduction package: <https://www.aeaweb.org/articles?id=10.1257/aer.20101199>

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 in the remainder of the exercise and record other "candidate" papers for which you were unable to obtain access to a reproduction package. See detailed guidance [here](#).

0 Select a paper

Declare the paper that you will analyze in the remainder of the exercise and record other "candidate" papers for which you were unable to obtain access to a reproduction package. See detailed guidance [here](#).

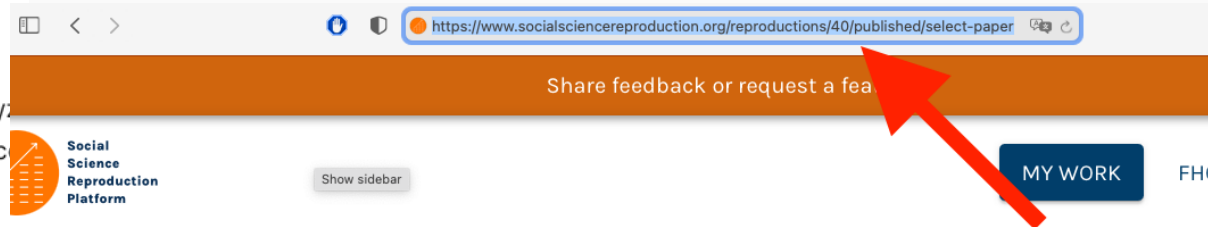
[VIEW THIS SECTION](#)

1 Scoping

2 Assessment

3 Improvement

4 Robustness



Select a paper

Declare the paper that you will analyze in the remainder of the exercise and record other "candidate" papers for which you were unable to obtain access to a reproduction package. See detailed guidance [here](#).

[RETURN TO STAGES OVERVIEW](#)

Basic information

- **Share it:** Original authors, instructors, other researchers, add it to your CV
- **Discuss it:** Discourse forum for reproductions
- **Cite it:** Reproduction DOI coming soon

Promoting a Constructive Exchange

- 1 - Contacting the original author(s) when there is no reproduction package
 - 2 - Contacting the original author(s) to request specific missing items of a reproduction package
 - 3 - Asking for additional guidance when some materials have been shared
 - 4 - Response when the original author has refused to share due to *undisclosed reasons*
 - 5 - Response when the original author has refused to share due to legal or ethical restrictions of the data
 - 6 - Contacting the original author to share the results of your reproduction exercise
 - 7 - Responding to hostile responses from original authors
- Under development: sample responses from authors to reproducers

Example 1: There is no reproduction package

Subject: Reproduction package for [“Title of the paper”]

Dear Dr. [Lastname of Corresponding Author],

I am contacting you to request a reproduction package for your paper titled [Title] which was published in [Reference]. A reproduction package may contain (raw and/or analytic) data, code, and other documentation that makes it possible to reproduce paper. Would you be able to share any of these items?

I am a [position] at [Institution], and I would like to reproduce the results, tables, and other figures using the reproduction materials mentioned above. I have chosen this paper because [add context ...]. **Unfortunately, I was not able to locate any of these materials on the journal website, Dataverse [or other data and code repositories], or in your website.**

I will record the result of my reproduction attempt on ACRE [...]. With your permission, I will also record the materials you share with me, which would allow access for other reproducers and avoid repeated requests directed to you. Please let me know if there are any legal or ethical restrictions that apply to all or parts of the reproduction materials so that I can take that into consideration during this exercise.

In addition to your response above, would you be available to respond to future (non-repetitive) inquiries from me or other reproducers conducting an ACRE exercise? **Though your cooperation with my and/or any future request would be extremely helpful, please note that you are *not required to comply*.**

Since I am required to complete this project by [date], I would appreciate your response by [deadline].

Let me know if you have any questions. Please also feel free to contact my supervisor/instructor [Name (email)] for further details on this exercise. Thank you in advance for your help!

Best regards,

[Reproducer]

Example 1: Following up on additional materials

Template email:

Subject: Clarification for reproduction materials for ["Title of the paper"]

Dear Dr. [Lastname of Corresponding Author],

Thank you for sharing the materials. They have been immensely helpful for my work.

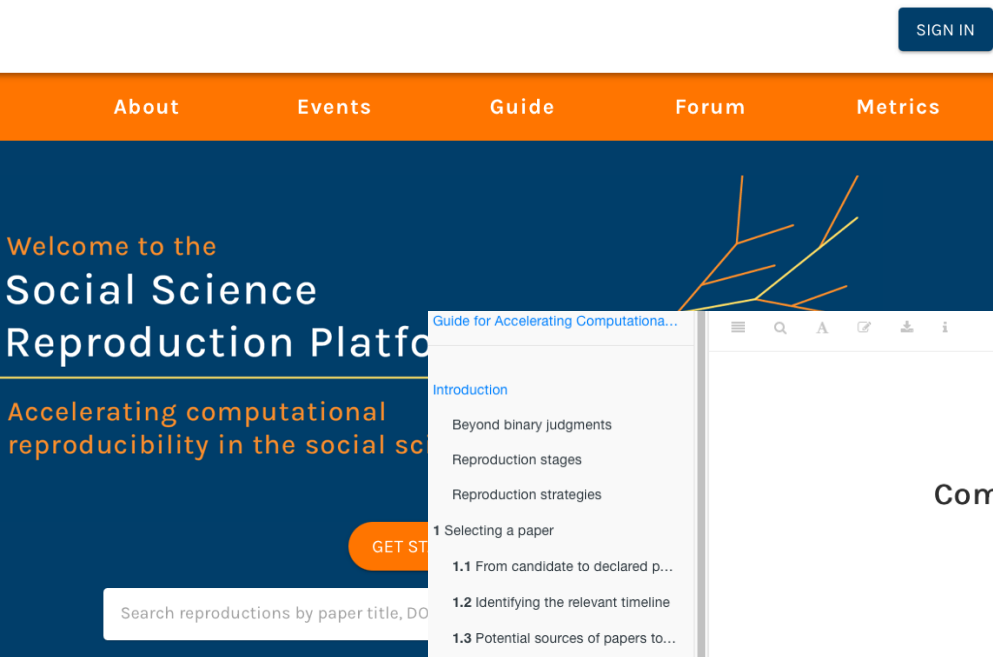
Unfortunately, I ran into a few issues as I delved into the reproduction exercise, and I think your guidance would be helpful in resolving them. **[Describe the issues and how you have tried to resolve them. Describe whatever files or parts of the data or code are missing. Refer to examples 1 and 2 below for more details]**.

Thank you in advance for your help.

Best regards,

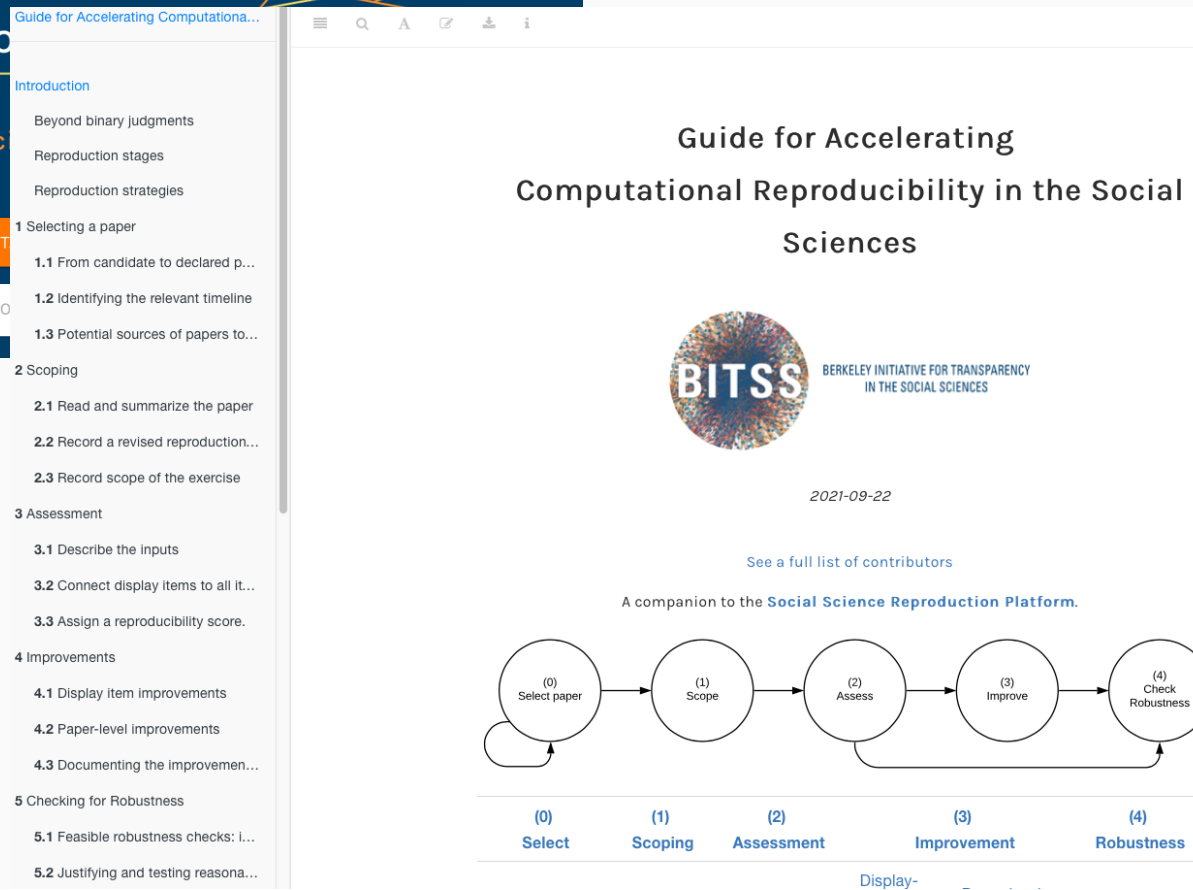
[Reproducer]

How Do I Get Started?



Consult the
supporting
guide

Use it for your class
or independent project



How Do I Get Started?

About

Events

Guide

Forum

Metrics

WELCOME TO THE

SOCIAL SCIENCE

REPRODUCTION PLATFORM

ACCELERATING COMPUTATIONAL

REPRODUCIBILITY IN THE SOCIAL SCIENCES

GET STARTED

Search reproductions by paper title, DOI, or keyword

Guide for Accelerating Computational Reproducibility in the Social Sciences

Introduction

Beyond binary judgments

Reproduction stages

Reproduction strategies

1 Selecting a paper

1.1 From candidate to declared paper

1.2 Identifying the relevant timeline

1.3 Potential sources of papers to consider

2 Scoping

2.1 Read and summarize the paper

2.2 Record a revised reproduction

2.3 Record scope of the exercise

3 Assessment

3.1 Describe the inputs

3.2 Connect display items to all items

3.3 Assign a reproducibility score

4 Improvements

4.1 Display item improvements

4.2 Paper-level improvements

4.3 Documenting the improvements

5 Checking for Robustness

5.1 Feasible robustness checks: 1.0

5.2 Justifying and testing reasonableness

Use it for your class or independent project

Consult the supporting guide

SIGN IN

Guide for Accelerating Computational Reproducibility in the Social Sciences

BITSS

BERKELEY INITIATIVE FOR TRANSPARENCY IN THE SOCIAL SCIENCES

2021-09-22

See a full list of contributors

A companion to the [Social Science Reproduction Platform](#).

(0) Select paper

(1) Scope

(2) Assess

(3) Improve

(4) Check Robustness

(0) Select

(1) Scoping

(2) Assessment

(3) Improvement

(4) Robustness

Social Science Reproduction Platform

all categories

all tags

Categories

Latest

New (3)

Unread (1)

Top

+ New Topic

Category

Topics

Latest

Getting Started

Version 1.0, developed in April 2021

0

Reproductions

Discuss and share resources about ongoing or completed reproductions sorted by papers reproduced. To join the discussion about a particular paper, look up the paper's DOI, replacing "." with "-".

5

1 unread

Tips for Reproducibility

Find and share tips and resources for reproducible workflows that aren't linked to a particular reproduction.

1

Help

Ask questions on how to use the SSRP.

3

3 new

For instructors

Connect with a community of

0

Welcome to Discourse

Nov '20

0

Restricted-use data

Help

23h

0

Catalog of reproductions

Help

23h

0

No replication package

Help

23h

1

Feedback for my reproduction of Twenty-year economic impacts of deworming

Reproductions

10-1073-pnas-2023185118

Aug 11

1

How to use the SSRP

Jul 22

2

Ask questions

28 / 29

Thank You

acre@berkeley.edu