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Public Infrastructure and Economic Development: Evidence from Postal Systems – Reproduction Report on Rogowski et al. (2022)

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Public Infrastructure and Economic Development: Evidence from Postal Systems - Reproduction Report on Rogowski et al. (2022)

FLORIAN NEUBAUER, JULIAN ROSE, JÖRG ANKEL-PETERS¹

December 2023

Rogowski et al. (2022) use secondary data to study the impact of historic postal infrastructure on economic development, both cross-country and within the US. Their results suggest a large positive effect of post offices on economic development that is robust across various sensitivity checks. We successfully computationally reproduce all results. In a robustness assessment, we find the results to be robust to simple changes in the analysis but observe some sensitivity to accounting for spatial trends in the cross-country analysis. Additionally, we correct a coding inconsistency, showing that in the corrected version, one main robustness check for the US-analysis is no longer supporting the result. Despite this, we find the results to be overall robust given the numerous analyses and robustness checks in the original paper.

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1. Introduction

Rogowski et al. (2022) – henceforth RGMC - investigate the impact of postal systems on economic development from the 19th century onwards. Positive impacts are expected because the expansion of postal services facilitated communication, commerce, advertising, remittances, job searches, investment monitoring, technology dissemination, and integration of remote areas. The study employs four types of analyses (see Figure 1): short-term cross-country (STCC), long-term cross-country (LTCC), short-term US county-level (STUS), and long-term US county-level (LTUS).

In this reproduction report, we conduct a computational reproduction and a robustness reproduction² using the provided reproduction package from the Harvard Dataverse. We successfully reproduce all results published in the original paper. Despite this successful reproduction, we note that the authors did not provide the full raw data, as some datasets contain already manipulated data. Moreover, some datasets lack variable labels or a codebook, so that a robustness reproduction is difficult. We acknowledge that providing all raw data with comprehensive documentation is not yet the norm in the social sciences. We also conduct a series of robustness checks and find that the results hold for most of them.

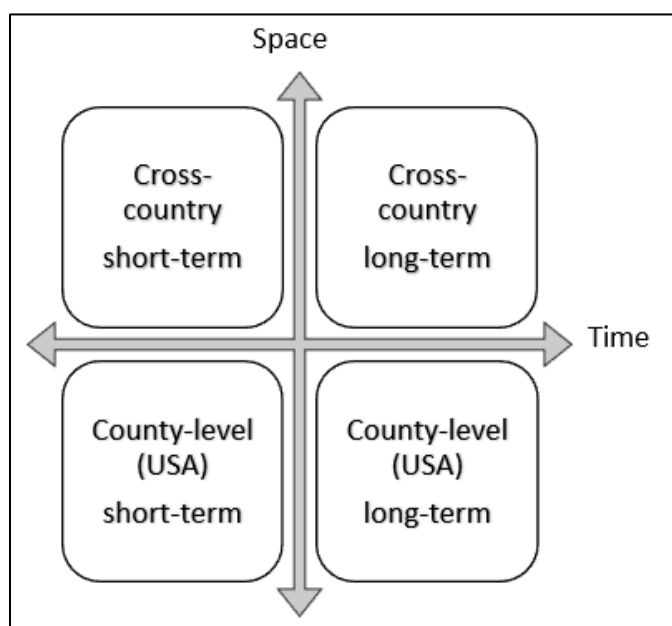
RGMC highlight a positive relationship between postal systems and economic development in all four analyses. The LTCC results indicate that a 20% increase in post offices per capita in 1900 is associated with a 3% increase in GDP in 2000, while STCC analyses show a positive but modest effect. At the U.S. County level, a 25% increase in post offices in a county is linked to a 5-6% increase in farm values, manufacturing outputs, and capital investments in manufacturing in the short term (STUS). In the long run, a 25% increase in post offices in 1896 corresponds to a 2% higher median income in 2000 for U.S. counties (LTUS). The authors conduct robustness tests for each analysis, all supporting the main results.

For the LTCC analysis, the treatment variable is the number of post offices per country in 1900, sourced from the Universal Postal Union (UPU) spanning from 1875 to 2007. RGMC examine the relationship between post offices and GDP growth for 77 countries over time. For the STCC analysis, RGMC employ panel data to study the association between postal systems, measured

² See Dreber and Johannesson (2023).

as stock of per capita post offices, and growth at 5-year intervals. Importantly, the authors note significant endogeneity issues in the cross-country analysis (STCC and LTCC) since assignment of post offices is not random and varies across countries due to geographical, political, and other circumstances. To tackle these endogeneity issues, they conduct analyses focusing solely on counties in the U.S. (STUS and LTUS).

Figure 1: Overview of the different analyses in Rogowski et al. (2022)



For the panel analysis in the U.S. (STUS), RGMC utilize comprehensive panel data encompassing approximately 2,700 U.S. counties, recorded at ten-year intervals from 1846 to 1896. This dataset includes information on the number of post offices and economic indicators such as farm values, value of manufacturing output, and capital investment in manufacturing, obtained from nineteenth-century census reports spanning from 1850 to 1900. The STUS evaluation involves regressing the outcome variable on a lagged measure of the number of post offices, allowing for an analysis of immediate impacts. In contrast, the LTUS analysis explores the relationship between post offices in 1896 and logged median household income in the year 2000, incorporating additional covariates such as population, percentage of the population born outside the United States, and population density, each measured from the 1890 Census and in log form.

This background of a multi-contextual empirical analysis is important when assessing our only two problematic findings. First, in line with Kelly (2020)'s recommendation, we introduce

dummy variables for World Bank regions to the LTCC analysis. This is to account for spatial trends in persistence regressions given that spatial data tends to be highly autocorrelated. We find that the inclusion of those dummy variables renders the LTCC results statistically insignificant suggesting some sensitivity of this finding. Second, we address a discrepancy between the paper and code regarding a robustness check focusing on U.S. counties with stable borders (LTUS). The corrected estimation deviates from the original results, impacting one of the robustness checks in RGMC. Additionally, we implemented several simple robustness checks, which all support the original results, such as the inclusion of additional control variables in the STCC analysis or the reconstruction of the treatment variable (STCC) from the provided data using the information in the paper (both not reported in this report). Overall, given the multitude of supporting robustness checks in RGMC as well as our robustness checks, we affirm the overall robustness of the results.

2. Computational Reproduction

We assess the computational reproducibility of RGMC based on the original data and code ('reproduction package'), accessible from the Harvard Dataverse (Rogowski et al., 2020). RGMC provide a 'read-me' document, outlining the contents of the reproduction package, including datasets, code, a codebook, and computing specifications. Unfortunately, the codebook only covers the final datasets used for the analyses but not the preliminary datasets, which RGMC use to construct the analysis dataset. Additionally, missing variable labels in many datasets impede the identification of variables.

RGMC employ 18 preliminary datasets to generate six final datasets for various aspects of the analysis. The lack of information regarding the preliminary datasets makes it challenging to understand how imputations were carried out and whether the data is raw data (or a scientific use file) or already manipulated. For instance, the dataset "postal_imputation" contains already imputed data, and it is unclear how the authors did this. Moreover, the authors do not provide the full code or data on how they created the stock variable (treatment variable). Following the BITSS' *Guide for Accelerating Computational Reproducibility in the Social Sciences*, the lack of raw data leads to a reproducibility level seven out of ten.³

³ See: <https://bitss.github.io/ACRE/>

Despite this, thanks to the well-documented reproduction package, we successfully replicate RGMC's main results from Tables 1-3.

Table 1 summarizes the results of the computational reproduction showing that the results are not fully reproducible from raw data.

Table 1: Assessment of computational reproduction

	Fully	Partial	No
Raw data provided		x	
Cleaning code provided	x		
Analysis data provided	x		
Analysis code provided	x		
Reproducible from raw data		x	
Reproducible from analysis data	x		

3. Robustness Reproduction

3.1 Long-Term Cross Country Analysis (LTCC)

For the LTCC analysis, RGMC document substantial positive effects of postal infrastructure on GDP (0.174, SE: 0.082, p-value<0.05). For our robustness check, we follow Kelly's (2020) suggestion to include dummy variables for the World Bank regions to control for spatial trends. Kelly (2020) emphasizes that fitting spatial trends can lead to misleading correlations. Moreover, he highlights the challenge posed by high spatial autocorrelation in economic variables, making it crucial to carefully consider and control for such spatial influences to avoid mistaking incidental correlations for significant relationships. Kelly (2020) proposes two simple robustness checks: first, the introduction of the World Bank regions as dummy variables; second, introduction of longitude and latitude as control variables.

In line with findings from Kelly (2020) regarding the substantial impact of regional dummies, we observe a similar pattern when incorporating them into RGMC's analysis. The initially positive and significant long-term effect of post offices in 1900 on economic development in 2000 decreases by 30% and turns insignificant; the coefficient for the number of post offices

undergoes a change from 0.174 (SE: 0.082, $p < 0.05$) to 0.116 (SE: 0.089, $p = 0.200$). This adjustment results in a reduction in effect size, rendering the association statistically insignificant, even at the 10% significance level, in alignment with Kelly's observations for other studies. Overall, our robustness check points to some sensitivity of the LTCC results and calls for a more careful discussion of Kelly's (2020) critique.

3.2 Long-Term U.S. Counties Analysis (LTUS)

RGMC find substantial positive impacts of postal infrastructure in 1896 on both median income and the number of manufacturing establishments in 2000, across numerous specifications. In our robustness checks, we specifically focus on the sub-sample of counties with stable borders, a critical aspect of the original paper's robustness analysis, as the stable sample is less vulnerable to bias from endogenous changes in borders.

RGMC state for this robustness test that *"We re-estimated our benchmark models focusing only on counties in **states** in which no county borders underwent changes between 1896 and 2000, which includes 13 states"* (Rogowski et al. 2022, p12 f.). Our understanding of this sentence is that they re-run the analysis including only states where no county border has changed. Yet, from their code it seems they include states in which **at least one** county has a stable border over time. This analysis has obviously very different implications. We therefore follow the description in the paper and include only states with stable borders for all counties, which applies to seven states in the data.

In Table 2, we present the results of our robustness check. The first two columns showcase RGMC's preferred specification, and the robustness check as initially reported, where inclusion criteria might not align accurately with the stated approach. In contrast, the third Column presents the corrected robustness check, adhering strictly to including only counties from states with stable county borders. The coefficient in this corrected robustness check indicates a very small and statistically insignificant effect, contrary to the original findings. While this robustness check offers a crucial caveat to the original paper's results, it's important to emphasize that it does not invalidate the original claims. A transparent discussion of the implications of this failed robustness test would have further enriched the paper's transparency and interpretation.

As additional robustness check, RGMC re-estimate their models for those states where county lines changed minimally, which is according to RGMC the case for 14 states. They find that in this sample the original finding is supported. We reproduce this robustness check, confirming the finding but noting that 15 states fall into this category.

Table 2: Results of the analysis including only states with stable county borders between 1896 and 2000

DV = Median income (2000)	RGMC		Reproduction Results
	Preferred Specification	Robustness Check: No change in <i>at least one</i> county border	Robustness Check: No change in <i>any</i> county border
Post offices (ln), 1896	0.081 (0.01)	0.044 (0.023)	0.008 (0.032)
p-Value	0.000 ¹	0.056 ¹	0.813
Number of observations (counties)	2,551	805	459
Name of display item	Table 3	Table A.16	-
Page	12	OA 19	-
Column	1	1	-
Row	1	1	-

Notes. OA means 'Online Appendix'. Standard errors in parentheses.

5. Conclusion

In this reproduction report, we have successfully reproduced the original results reported in Rogowski et al. (2022) using the provided reproduction package. We only highlighted some missing raw data and a lack of a clear description for some of the preliminary data in the reproduction package, posing challenges for the robustness reproduction. Subsequently, we conducted two robustness checks:

- inclusion of dummy variables for the World Bank regions according to Kelly (2020) in the LTCC analysis
- correcting a discrepancy between code and paper for stable counties in the LTUS analysis.

Our results demonstrate that the inclusion of dummy variables for World Bank regions, as proposed by Kelly (2020), renders the LTCC effects statistically insignificant and reduces the effect size. Furthermore, we correct a discrepancy between paper and code in the sample for a

robustness check in the LTUS analysis. When using the correct sample for the robustness check, it does no longer support the original finding. While these robustness checks reveal some sensitivity of the results, it is important to emphasize that the overall conclusion of the paper remains intact. RGMC conduct a wide array of analyses and robustness checks, all of which consistently pointing towards positive effects of postal services on economic outcomes.

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