



Understanding the Impact of Multi-Nodal Urban Systems on Thailand's Urban Economies: Insights from a Dynamic Recursive Spatial General Equilibrium Model

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This review verifies the reproducibility of the exhibits included in the paper “*Understanding the Impact of Multi-Nodal Urban Systems on Thailand's Urban Economies: Insights from a Dynamic Recursive Spatial General Equilibrium Model*”.

Contents in this review:

1. Main findings
2. List of exhibits and reproducibility status
3. Reproduction Environment

Main findings

- **All exhibits in the paper have been successfully reproduced, with the exception of 2 exhibits that shows a minor discrepancy. See below for more details.**
- The code was successfully executed on a new computer after:
 1. Opening the R project "THAAM26.Rproj"
 2. Restoring the environment by running `renv::restore()` and following the prompts.
 3. Opening the main.R and running the code.
- The output demonstrates consistent stability across multiple runs. Specifically, executing the code two times consecutively yielded identical results.
- The code takes approximately 75 minutes to run.
- We conducted our reproducibility analysis based on the paper shared by the authors.
- **Verification Process and Data Handling:**
 - The reproducibility package relies on one type of data: open.
 - Open data is not included in the reproducibility package due to file size constraints.
 - The Stage-2 calibration uses a gradient-free BOBYQA optimizer whose convergence path is sensitive to CPU microarchitecture, which can produce minor numerical differences across hardware. Minor residual differences remain even when using the authors' pre-computed calibration cache included in the package. These differences are substantively negligible and do not affect any finding,

ordering, or conclusion. All exhibits were produced using our own cold-run outputs. The authors have documented this in the updated README.

- *data_hash_report.csv* lists the SHA256 hashes of all files in the Data folder to support data integrity checks. Users who acquire the open data can use this file to verify that the data has not been altered.

- **Reproducibility Summary:**

- **Data:** All data sources are publicly available but not included in the reproducibility package due to file size constraints.
- **Code:** All code files (from cleaning to analysis) are included in the reproducibility package.
- **Outputs:** All outputs are generated by code included in the reproducibility package.
- **Dependencies environment:** The reviewers reproduced an existing environment for dependencies using dependency files or an environment metadata file provided by the authors.

List of exhibits and reproducibility status

Results in the Main Section of the Paper

- **Table 1** Does not apply as exhibit does not show analysis results.
- **Table 2** Does not apply as exhibit does not show analysis results.
- **Figure 1** Reproduced.
- **Figure 2** Partially reproduced. Small numerical discrepancies of up to 0.01 percentage points due to hardware-dependent floating-point differences in the BOBYQA calibration.
- **Table 3** Partially reproduced. Values differ by at most \$8 in no-investment GDPpc and 0.01 percentage points in scenario gains, consistent with hardware-dependent floating-point differences in the BOBYQA calibration. All qualitative findings and scenario rankings are identical to the published table. (Replicator's output on the left):

	A	B	C	D	E	F	G
1	Year	No-investment GDPpc	Scenario A gain	Scenario B gain	Scenario C gain	Leader	
2	2030	36,912	+1.92%	+1.65%	+1.40%	A	
3	2035	38,513	+4.00%	+3.49%	+3.12%	A	
4	2040	40,876	+6.28%	+5.58%	+5.32%	A	
5	2045	44,099	+8.82%	+8.00%	+8.27%	A	
6	2050	48,290	+11.62%	+10.85%	+12.38%	C	
7							
8							
9							
10							
11							

Table 3. National GDP and GDP per capita gains by scenario, 2030–2050

Year	No-investment GDPpc	Scenario A gain	Scenario B gain	Scenario C gain	Leader
2030	36,913	+1.92%	+1.65%	+1.40%	A
2035	38,512	+4.00%	+3.49%	+3.12%	A
2040	40,874	+6.29%	+5.58%	+5.32%	A
2045	44,094	+8.82%	+8.00%	+8.27%	A
2050	48,282	+11.63%	+10.86%	+12.39%	C

Notes: GDPpc gains are percentage gains in national urban GDP per capita above the no-investment baseline in the same year. No-investment GDPpc is in 2017 USD PPP. The 2050 row is highlighted to indicate the trajectory crossover, where Scenario C overtakes Scenario A as the leading portfolio.

- **Figure 3** Reproduced.
- **Figure 4** Reproduced.
- **Figure 5** Reproduced.
- **Figure 6** Reproduced.
- **Figure 7** Reproduced.
- **Figure 8** Reproduced.
- **Figure 9** Reproduced.
- **Figure 10** Reproduced.

Results in the Annex

- **Figure A.1** Reproduced.
- **Figure B.1** Reproduced.

Reproduction Environment

Paper exhibits were reproduced on a computer with the following specifications:

- OS: Windows 11 Enterprise
- Processor: INTEL(R) XEON(R) PLATINUM 8562Y+ (2.80 GHz) (2 processors)
- Memory available: 32.0 GB
- Software version: R Version 4.5.2