A comment on "Malaria suitability, urbanization and persistence: Evidence from China over more than 2000 years"*

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Abstract

Flückiger and Ludwig (2017) find that areas with higher climatic suitability for Plasmodium falciparum were consistently less urbanized from the early Han expansion in 200 BCE onwards. They further show that this pattern persisted long after malaria eradication and remains evident in the 2000s.

Our replication yields the following summary. Of the 17 tables in the paper, we fully replicated 15 and partially replicated two, with discrepancies arising only in standard errors and R^2 values; however, these differences do not materially affect the paper's main conclusions. Of the six figures, the replication package enables us to reproduce one, partially reproduce another, and not reproduce the remaining four. We also conduct several robustness checks: (1) replicating a subset of results using `R` instead of `Stata`, (2) varying the set of control variables to assess specification sensitivity, and (3) transforming dependent variables to account for skewed distributions. Although these robustness exercises modify some coefficient estimates, they do not meaningfully alter the original authors' findings. Finally, we highlight several issues regarding the quality and completeness of the replication package and offer recommendations to improve reproducibility.

*The replication package for the analysis can be found at https://github.com/hchulkim/malaria-urban-china-EER.

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1 Introduction

We replicate the analysis of Flückiger and Ludwig (2017), who test the effect of climatic suitability for *Plasmodium falciparum* malaria transmission on historical and modern urbanization outcomes for $0.5^{\circ}\times0.5^{\circ}$ grid cells in South China , using cross-sectional regressions with extensive geographic controls, macroregion fixed effects, and clustered or Conley standard errors. The main results show large negative effects of one SD of malaria suitability on historical administrative-seat density, and on modern urban population shares.

1.1 Main Data, Treatment, Period, Population

The study draws on: (i) historical administrative-city data (221 BCE–1911 CE) from CHGIS (2010) and Skinner et al. (2011); (ii) modern urban population data for 1990/2010 from Skinner and Henderson (2012) and Brinkhoff (2015); (iii) climate and geography data from CRU (2000), mean elevation from NOAA's National Geophysical Data Center, and agricultural suitability datasets. The treatment is their temperature-based malaria suitability index, derived from Mordecai et al. (2013). The population is grid cells in historically falciparum-endemic South China.

1.2 Main Scientific Claims

The authors present malaria suitability as a persistent locational fundamental shaping settlement over two millennia and influencing modern development:

> "We show that the climatic potential for *Plasmodium falciparum* malaria transmission constituted a locational fundamental. . . since around 200 BCE. This effect is still detectable in today's distribution of urbanization and economic activity."

Reported effect sizes indicate substantial magnitudes: a one–standard-deviation increase in malaria suitability reduces historical administrative-seat numbers by about **42.8%**, lowers the urban population share by **74.4%**, and decreases hierarchy level by **45.7%**.

> "Evaluated at the sample mean, a one-standard deviation increase in the MSM reduces the share of the total urban population located within a grid cell by 72 percent"

For modern outcomes, a one–standard-deviation increase in malaria suitability is associated with a **71.9%** decline in urban population in 1990, an **80.8%** decline in 2010, and a **63.1%** reduction in manufacturing employment in 1990.

1.3 Robustness Checks in the Original Study

Effects remain robust to alternative malaria indices, alternative population datasets, placebo tests in North China, alternative climate averaging periods, additional geographic fundamentals, and alternative inference approaches:

> "Similar estimates arise using alternative malaria suitability indices." "Our results remain stable irrespective of the inclusion of fundamentals..." "We do not find any significant effect... in North China."

1.4 Reproduction and Replication

We obtained the authors' analysis-ready datasets and partial Stata code from their replication package; raw data and cleaning scripts are not included. Missing appendices were retrieved from the Queen's University Belfast repository. All our replication files, output, and reorganized datasets are stored in the replication repository accompanying this report.

1.5 Computational Reproducibility

We successfully replicate 15 of 17 tables exactly and partially replicate two (minor coefficient or SE differences without substantive impact). We reproduce one, and partially reproduce a second figure; descriptive maps cannot be reproduced due to missing raw data. We detect no coding errors in the authors' scripts. Conley SEs implemented in R (`fixest`) are slightly larger for a 200 km cutoff, but become closer to FL when using 100 km; the malaria coefficient remains significant in all cases.

1.6 Robustness Reproduction

Our checks show that sign and magnitude are sensitive to the inclusion of key controls. Without controls, the coefficient becomes positive; adding elevation restores a negative sign; adding temperature and geographic coordinates yields estimates similar to FL.

Transforming dependent variables (log, log+1, winsorization) leaves effects negative and significant. Revisiting the North China placebo test confirms no effects. When adding urbanization in 1893 in the modern regressions, the malaria coefficient drops to near zero, i.e. the effect is no longer statistically significant.

1.7 Summary

Overall, we reproduce the main tables and effect patterns of Flückiger and Ludwig (2017). Implemented robustness checks confirm that the main negative effects are robust once key controls are included, but also show that historical urbanization fully absorbs the modern relationship. Our assessment is constructive: the core patterns are reproducible, while highlighting that transparent data provision and clearer discussion of essential controls would enhance full replicability.

2 Computational Reproducibility

2.1 Overall assessment of the completeness of the replication package

- Cleaning code: The replication package did not contain any cleaning code for processing data from the raw data.
- Analysis code: The replication package only contained partial codes for the analyses in the paper. For example, code scripts for creating certain figures were missing in the package.
- Raw or analysis data: The replication package only contained processed data for analysis and did not contain certain raw data.

We used the replication package provided by Flückiger and Ludwig (2017). In terms of the raw data and cleaning code, the package did not include the raw data and cleaning codes to create the analysis data. The authors do not clearly document how to locate the raw data used in the paper. Due to this issue, it is not possible to reproduce the result from the raw data.

	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	

In terms of the processed data, the authors partially provided the data necessary for producing the results in the paper. For the provided code scripts, we successfully reproduced most results using the analysis data. During this process, we did not identify any coding errors. However, as we were only given processed data (normalized data), this limited the scope of the robustness checks we could perform (see 3.2 for further details). Table A.1 summarizes the set of tables and figures presented in the original paper and reports the outcome of our replication attempts.

As shown in Table A.1, the majority of figures in the original paper could not be successfully reproduced from the replication package. This was because code scripts and data needed to create the figures were not provided in the package. For instance, while were were able to partially replicate Figure 2, we could not reproduce the top panel which relies on a raw data that were not provided. Still, this missing component is purely descriptive and does not compromise the paper's main results. We were also not able to replicate two figures in the Appendix because the code and data were not provided. These figures are likewise descriptive and do not influence the paper's substantive results. We also discovered very minor discrepancies between the controls included and those mentioned in the note, specifically in reference to the inclusion of the control "Yellow river" which is dropped because of multicollinearity in all specifications. But again this does not alter the main interpretation of the results.

2.2 Reproducibility using different software (R)

To ensure that the main analyses in the paper were not dependent on specific software, we use R programming language to reproduce subsets of the results.

2.2.1 Summary

Overall, the replication process was successful. Most of the results were quantitatively similar to those from Stata. For instance, we replicated the lower panel of Figure 2 from the original paper, as shown in Figure A.1. The replicated figure is quantitatively similar to the result shown in the original paper. Similarly, we also replicated Table 1, Table 2, Table 3, Table 4, Table 5, Figure A.2. and Table B.1. of the original papers in Table A.2, Table A.3, Table A.4, Table A.5, Table A.6, Figure A.2 and Table A.7 which again give equivalent results to the tables provided by the authors.

The only issue encountered during the replication was Table C.11. In the original paper, Table C.11 re-estimates the main specification using Conley standard errors. However, the authors did not specify which software or implementation was used to compute these standard errors. Because an equivalent procedure was difficult to reproduce in Stata, we implemented the replication in R. The *vcov_conley()* function in the *fixest* package requires the cutoff argument to be specified in kilometers; accordingly, we set the cutoff to 200 km, which approximately corresponds to the 2 degrees reported by the authors.

We found that the resulting standard errors from R differed slightly from those reported in the paper. Interestingly, the standard errors became more similar when the cutoff was reduced to 100 km. This discrepancy may stem either from the use of different software or from a potential misstatement of the cutoff distance (i.e., the cutoff the authors have used may have been closer to 1 degree). In any case, the coefficient estimates remained statistically significant under both specifications. We present both sets of results in Table 1 and Table 2, corresponding to the 200 km and 100 km cutoffs, respectively, used in computing the Conley standard errors.

Table 1: Replicating Table C.11. using cutoff 2 degrees (200km)

	Number of seats 1893	Urban share 1893	Hierarchy level 1893	Urban share 1990	Manufacturing share 1990	Urban share 2010
MSM (SD)	-0.497^{**}	-0.744^{*}	-0.428^{***}	-0.719^{**}	-0.631^{*}	-0.808^{*}
	(0.188)	(0.319)	(0.114)	(0.267)	(0.251)	(0.372)
Num. obs.	868	868	868	868	868	868
R^2 (full model)	0.190	0.164	0.141	0.132	0.287	0.139
R^2 (proj model)						
Adj. R^2 (full model)	0.162	0.135	0.112	0.102	0.262	0.110
Adj. R^2 (proj model)						

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Note: This table replicates Table C.11. of the authors' paper. For simplicity, we only focus on showing the estimates for the main variables of interest. We use 200km as the cutoff for the Conley standard errors.

Table 2: Replicating Table C.11. using cutoff 1 degrees (100km)

	Number of seats 1893	Urban share 1893	Hierarchy level 1893	Urban share 1990	Manufacturing share 1990	Urban share 2010
MSM (SD)	-0.497^{***}	-0.744^{**}	-0.428^{***}	-0.719^{**}	-0.631^{**}	-0.808^{**}
	(0.147)	(0.268)	(0.092)	(0.238)	(0.219)	(0.309)
Num. obs.	868	868	868	868	868	868
R^2 (full model)	0.190	0.164	0.141	0.132	0.287	0.139
R^2 (proj model)						
Adj. R^2 (full model)	0.162	0.135	0.112	0.102	0.262	0.110
Adj. R^2 (proj model)						

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Note: This table replicates Table C.11. of the authors' paper. For simplicity, we only focus on showing the estimates for the main variables of interest. We use 100km as the cutoff for the Conley standard errors.

3 Recreate Reproducibility

This section tests the extent to which results can be reproduced using only the information provided in the original study.

Overall summary

It is difficult to reproduce the results using only the information provided in the original study. First, the documentation is limited. For example, the README file is brief and contains only minimal information about the data used.[1] Second, much of the raw data is missing; the authors mostly just provide processed datasets without clearly describing the sources or locations of the original data. Third, a significant portion of the Appendix was not available on the official *European Economic Review* journal website.[2] We were only able to access it by locating the document through a Google search. Consequently, the reproducibility of

[1]We include the README of the authors in Appendix A.3 for reference.

[2]You can check this in the official link: https://www.sciencedirect.com/science/article/pii/S0014292116302355

the replication package is limited and could be improved. Below, we summarize several issues encountered while attempting to reproduce some of the results based on the information available in the original study.

3.1 Missing Appendix sections in the official publication

Significant portions of the Appendix were missing from the officially published version of the paper. This is particularly problematic because, unlike supplementary online appendices that are typically secondary to replication, the main text directly refers to results presented in the Appendix. For instance, the paper repeatedly cites Appendix C, which contains key results and robustness checks, yet this section was entirely absent from the published document. Fortunately, we were able to locate a version of the paper online that included the complete Appendix, which allowed us to replicate those results.[3]

3.2 Recovering the actual raw number of administrative capitals and urban population

In the paper, most dependent variables are normalized by the mean of the corresponding year. For example, the number of administrative capitals within a grid cell is divided by the average number of capitals per grid cell in that year. Thus, the analysis does not use the raw counts directly. This likely explains why the replication package does not include the raw data. In fact, it is impossible to recover the original values from the transformed data, as the yearly means are not provided.[4]

From a reproducibility standpoint, it would still be valuable for the authors to share the raw data for the key variables. Providing the untransformed data would make it easier to verify the data construction process and better understand the meaning of the normalized variables. Without access to the raw data, it is difficult to fully validate how the processed variables were derived, which limits the reproducibility of the analysis.

3.3 Recovering the construction process of the Malaria Suitability (MS) measure

The paper constructs its measure of malaria suitability following Mordecai et al. (2013). According to the authors, they replicate the approach from that study while retaining only the components that do not depend on population density, as described in Appendix A.2 of their paper. However, the paper does not explicitly specify the functional forms used in constructing this measure, referring instead to the original source. It would have been helpful if the authors had clearly presented the functional forms they employed, since they reconstruct the data from the cited study. Providing these details would make the construction process more transparent and easier to follow. For example, it is difficult to infer the exact functional relationships from Table 2 in the referenced paper alone.

Also, it is difficult to recover the actual MS from the data, as the authors do not provide the raw temperature data necessary to create the measure. While the authors do cite the source, it would have been nice if the replication README had more info on the location of the data they are using.

3.4 Variations in the number of grid cells in each $2^\circ \times 2^\circ$ grid cell.

We note that the number of $0.5^\circ \times 0.5^\circ$ cells within a $2^\circ \times 2^\circ$ grid varies across observations. This variation may arise because some grid cells along borders (e.g., the China border or coastal areas) do not fully contain

[3] This is the link to the document we used: https://pure.qub.ac.uk/files/122489170/EER_D_16_00243_Manuscript.pdf

[4] This reason is discussed more in detail in the Appendix B.

Table 2 from Mordecai et al. (2013)

Table 2 The relationships between temperature and the mosquito and parasite life-history traits that determine malaria risk. For each variable, the species studied and the source(s) of the data are given. Thermal performance curves were fitted to the data assuming Brière $cT(T - T_0)(T_m - T)^{1/2}$], B, or Quadratic [$qT^2 + rT + s$] functions, Q, in which T is temperature (°C; see Materials and Methods). Standard deviations for the model parameters are listed in parentheses alongside parameter values. Best fit was determined by Akaike Information Criterion (AIC). The data and best-fit model for each parameter are plotted in Fig. 1

Parameter	Definition	Species	Source	Fit	Fit parameters (standard deviation)		
a	Biting rate (mean oviposition time)$^{-1}$	*Anopheles pseudopunctipennis*	Lardeux *et al.* (2008)	**B**	$c = 0.000203$ (0.0000576)	$T_m = 42.3$ (3.53)	$T_0 = 11.7$ (2.47)
b^*c	Vector competence	*Anopheles quadrimaculatus*	Stratman-Thomas (1940)	**Q**	$q = -0.54$ (0.18)	$r = 25.2$ (9.04)	$s = -206$ (108)
p [$p = e^{-\mu}$]	Daily adult survival probability (p); adult mortality rate (μ)	*Anopheles gambiae*	Bayoh (2001)	**Q**	$q = -0.000828$ (0.0000519)	$r = 0.0367$ (0.00239)	$s = 0.522$ (0.0235)
PDR [PDR = 1/EIP]	Parasite development rate (PDR); extrinsic incubation period (EIP)	*An. gambiae, Anopheles culicifacies, Anopheles stephensi, An. quadrimaculatus, Anopheles atroparvus*	Boyd & Stratman-Thomas (1933); Knowles & Basu (1943); Siddons (1944); Shute & Maryon (1952); Vaughan *et al.* (1992); Eling *et al.* (2001)	**B**	$c = 0.000111$ (0.0000161)	$T_m = 34.4$ (0.000176)	$T_0 = 14.7$ (1.48)
p_{EA}	Egg-to-adult survival probability	*An. gambiae*	Bayoh & Lindsay (2003)	**Q**	$q = -0.00924$ (0.00123)	$r = 0.453$ (0.0618)	$s = -4.77$ (0.746)
MDR [MDR = 1/τ_{EA}]	Mosquito development rate (MDR); larval development time (τ_{EA})	*An. gambiae*	Bayoh & Lindsay (2003)	**B**	$c = 0.000111$ (0.00000954)	$T_m = 34$ (0.000106)	$T_0 = 14.7$ (0.831)
EFD	Eggs laid per adult female per day	*Aedes albopictus*	Delatte *et al.* (2009)	**Q**	$q = -0.153$ (0.0307)	$r = 8.61$ (1.69)	$s = -97.7$ (22.6)

all 16 sub-cells. However, the paper does not provide an explicit explanation for this discrepancy. A clearer discussion of the source of these variations would have been helpful. Figure 1 plots the histogram of number of 0.5 degree grids within a 2 degree grid by year.

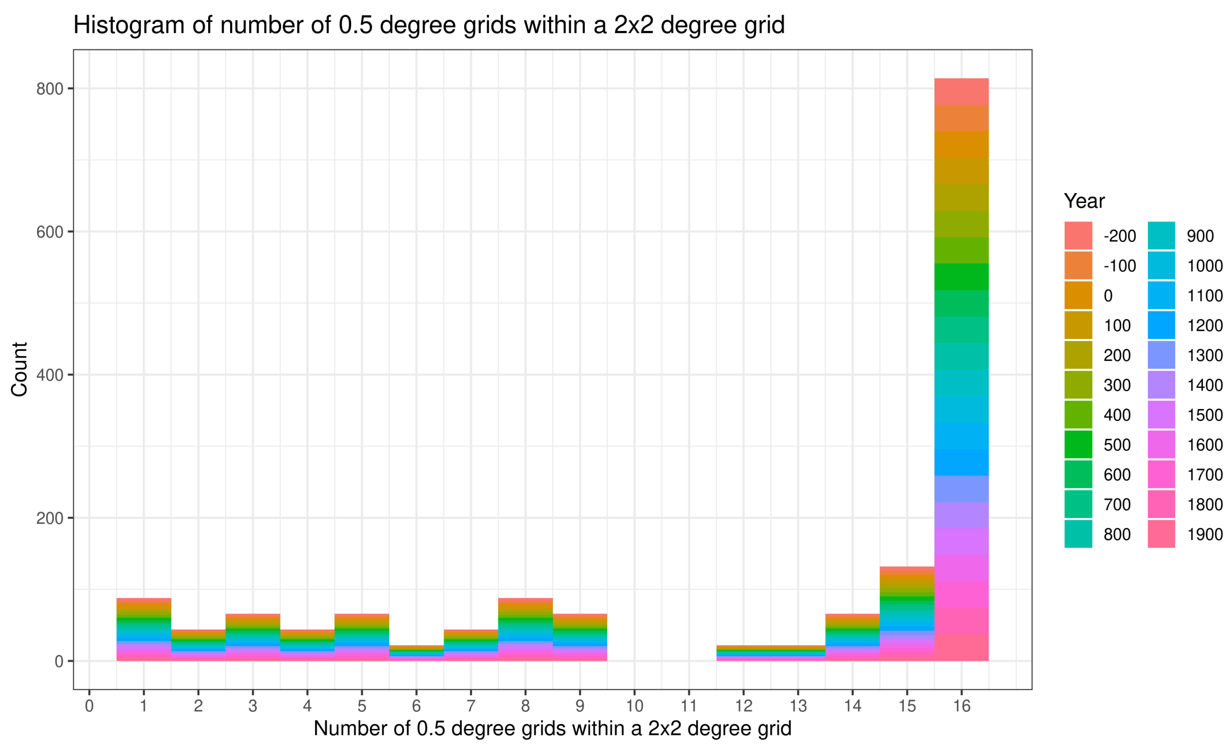

Figure 1: Histogram of number of 0.5° × 0.5° degree grids for each 2 degree grid

Note: This figure plots histogram of number of 0.5 degree grids within a 2 degree grids for each year. Each color represents a given year.

4 Robustness Reproduction and Replication

For the robustness analysis we focus on two main result tables: Table 3, which relates malaria suitability to urbanisation measures in 1893 and Table 4, which relates malaria suitability to urbanisation measures in

1990. We also revisited the placebo test in Table C17 of the Appendix.

4.1 Varying controls

We conduct a replication by varying the number of controls included. We note that the coefficients are unstable and even flip sign depending on what controls are included. However, we also note that in this setting, the inclusion of controls is crucial since the main explanatory variable is likely correlated with important confounders. We note these to be, for example, elevation, geographic coordinates and temperature, all plausibly determinants of both urbanisation and malaria incidence.

We begin with Table 4 of the manuscript, which we regard as the most important set of results because it examines the relationship between malaria suitability (MSM), and urbanization in the modern era and find a negative effect of MSM on urbanization and industrial activity. Table A.8 presents our robustness checks using alternative sets of controls. We find that the coefficient changes sign and becomes positive and significant when all controls are excluded (second panel). Including elevation alone is sufficient to restore a negative coefficient, although it remains insignificant for urban population in 2010 (column 2). We prefer to use the logarithm of elevation, while the manuscript uses elevation in levels, because the variable is highly skewed. When doing so (panel 4), the coefficients retain their sign but are smaller in magnitude. Panel 5 reports the specification that the authors describe as including only "base controls." The manuscript does not clarify why these are considered base controls, but we assume they represent the key confounders. Notably, the coefficient turns positive and becomes insignificant when we exclude either temperature (panel 6) or geographic coordinates (panel 7) from this set of base controls. Suggesting that these two sets of variables are crucial to reproducing the direction of the original results.

A similar pattern emerges when using alternative sets of controls for Table 3 of the manuscript. The corresponding robustness results are reported in Table A.10. Once again, the inclusion of elevation, temperature, and geographic coordinates is crucial for reproducing the direction of the estimated coefficients.

Overall, we consider the inclusion of elevation, geographic coordinates, and temperature to be potentially appropriate, given that they likely address key confounders, but their role should have been discussed more explicitly in the manuscript. In addition, we also note that the malaria suitability index is correlated at 73% with elevation and at 90% with temperature. This is reasonable, since these variables are important determinants of malaria ecology.[5] However, the strength of these correlations raises concerns about the limited independent variation left for identifying the effect of malaria suitability once these controls are included. Perhaps the authors could have mentioned this point explicitly.

4.2 Dependent variables

We conduct an additional replication exercise in which we transform the dependent variables to address their skewness. We do this for the results reported in both Table 3 and Table 4 of the manuscript, with robustness checks presented in Tables A.9 and A.11. We first take the logarithm of the dependent variables. The coefficients remain negative and significant. Because the log transformation drops observations with zero values, the sample size shrinks; this reduction is particularly noticeable for urban population in 2010 (Table A.9, column 2). However, results are very similar when applying the transformation *ln+1*, which retains

[5]This pattern is also evident when we use alternative controls for the placebo test reported in Table A.12. Without controls, the malaria suitability index is positively associated with urbanization in northern China. Once temperature, elevation, and geographic coordinates are included, this relationship disappears. This exercise could have been used to support the main findings: without controls, the malaria suitability measure appears to capture other determinants of urbanization common across the country, whereas with the appropriate controls it isolates malaria-specific variation-which, in the north, should be absent given the lack of a vector capable of transmitting the disease.

observations with zeros. We also obtain consistent results, although smaller in magnitude, when winsorizing the dependent variables by excluding the top and bottom 5% of the distribution (panel 2 of Tables A.9 and A.11).

4.3 Controlling for early urbanisation rate

In Table A.13, we include urbanization in 1893 as an additional control when analysing the effect of malaria suitability on modern-era urbanization. We view this as an extension rather than a robustness check. Urbanization in 1893 is a strong predictor of contemporary urbanization, and once it is included, the effect of malaria suitability disappears. This is consistent with the interpretation that malaria influenced early patterns of urban development, which then persisted over time, rather than generating a continuous influence throughout the subsequent decades.

5 Conclusion

We successfully replicated the core findings of Flückiger and Ludwig (2017), with only minor discrepancies. The main results were broadly robust, though somewhat sensitive to specification changes.

Our replication summary was as follows. Of the 17 tables presented in the original paper, we fully replicated 15 and partially replicated two, with differences limited to standard errors and R^2 values; these discrepancies did not materially affect the paper's main conclusions. Among the six figures, the replication package allowed us to reproduce one, partially reproduce another, and not reproduce the remaining four.

We also conducted several robustness checks to assess the stability of the results: (1) replicating a subset of analyses using `R` instead of `Stata`, (2) varying the number of control variables to test sensitivity, and (3) transforming dependent variables to address skewness in the data. While these exercises caused some variation in point estimates, they did not meaningfully alter the original conclusions.

Overall, our replication confirmed the validity of the main empirical findings in Flückiger and Ludwig (2017), but also highlighted the importance of transparent documentation and well-structured replication materials to ensure full reproducibility.

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A Tables and Figures

Table A.1: Summary of replication outcome

Exhibit	Outcome	Notes
Table 1	Replicated	
Table 2	Replicated	
Figure 2	Partial replication	No code to reproduce the figure. The bottom part was replicated using replicators code. The top part of the figure could not be replicated because the raw data were not provided.
Table 3	Partial replication	Minor differences in: coefficient of column 1, and SE and R2 in column 2. These differences do not affect the interpretation of the results.
Table 4	Replicated	
Table 5	Replicated	
Figure A1	Not replicated	No code provided, and no raw data available to replicate figure
Figure A2	Replicated	No code provided. Reproduced using our own code.
Figure B1	Not replicated	No code provided, probably created using GIS software
Table B1	Partial replication	Very minor differences in rounding
Figure B2	Not replicated	No code provided, probably created using GIS software
Figure B3	Not replicated	No code provided, probably created using GIS software
Figure B4	Not replicated	No code provided, probably created using GIS software
Table C1	Replicated	
Table C2	Replicated	
Table C3	Replicated	
Table C4	Replicated	
Table C5	Replicated	
Table C6	Replicated	
Table C7	Replicated	
Table C8	Replicated	
Table C9	Replicated	
Table C10	Replicated	
Table C11	Partial replication	Could not exactly reproduce Conley (1999) standard errors due to missing information on the specific Stata command used by the authors. Reasonably similar standard errors were obtained using the replicators' R code, although the cutoff definition had to differ slightly from that described in the authors' table notes.
Table C12	Replicated	
Table C13	Replicated	
Table C14	Replicated	
Table C15	Replicated	
Table C16	Replicated	
Table C17	Replicated	

Table A.2: Replicating Table 1

Variable	Mean	Std. Dev.	Min	Max	Obs.
UrbanShare1893	1	2.900	0.000	25.334	868
UrbanShare1990	1	3.265	0.000	69.924	868
UrbanShare2010	1	4.111	0.000	70.317	868
ManufacturingShare1990	1	2.621	0.000	50.724	868
MSMSD	0	1.000	-2.526	3.489	868

Note: This table replicates Table 1 of the authors' paper.

Table A.3: Replicating Table 2

	Pre-eradication	Pre-eradication	Pre-eradication	Urban Population 1893	Urban Population 1893
MSM (SD)	0.132^{***}			-0.821^{***}	
	(0.044)			(0.266)	
Population 1893		0.013^{**}			
		(0.006)			
Population 1990			0.011^{**}		
			(0.005)		
Pre-eradication Malaria Prevalence					0.462^{**}
					(0.205)
Adj. R^2	0.122	0.118	0.118	0.053	0.048
Num. obs.	868	868	868	868	868

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: This table replicates Table 2 of the authors' paper. For simplicity, we only focus on showing the estimates for the main variables of interest. Standard errors reported in parentheses.

Table A.4: Replicating Table 3

	Number of seats 1893	Urban population 1893	Hierarchy level 1893	Urban population 1893
MSM (SD)	-0.497^{***}	-0.744^{**}	-0.428^{***}	
	(0.160)	(0.290)	(0.104)	
Number of seats 1893				1.053^{***}
				(0.176)
Num. obs.	868	868	868	868
R^2 (full model)	0.190	0.164	0.141	0.250
R^2 (proj model)				
Adj. R^2 (full model)	0.162	0.135	0.112	0.224
Adj. R^2 (proj model)				

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: This table replicates Table 3 of the authors' paper. For simplicity, we only focus on showing the estimates for the main variables of interest. Standard errors reported in parentheses.

Table A.5: Replicating Table 4

	Urban population 1990	Urban population 2010	Manufacturing employment 1990
MSM (SD)	-0.719^{***}	-0.808^{***}	-0.631^{***}
	(0.229)	(0.299)	(0.204)
Num. obs.	868	868	868
R^2 (full model)	0.132	0.139	0.287
R^2 (proj model)			
Adj. R^2 (full model)	0.102	0.110	0.262
Adj. R^2 (proj model)			

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: This table replicates Table 4 of the authors' paper. For simplicity, we only focus on showing the estimates for the main variables of interest.

Table A.6: Replicating Table 5

	Urban share	Industry share	Log manufacturing output per capita	Log income per capita	Han share	Natural rate of increase	Child share	In-migration share
MSM (SD)	-0.041^{**}	-0.091^{***}	-0.250^{***}	-0.292^{***}	-0.232^{***}	0.001	0.037	-0.010^{*}
	(0.020)	(0.017)	(0.059)	(0.097)	(0.042)	(0.001)	(0.110)	(0.005)
Num. obs.	1148	1148	958	804	1147	1106	1107	1105
R^2 (full model)	0.104	0.548	0.160	0.420	0.513	0.372	0.547	0.223
R^2 (proj model)								
Adj. R^2 (full model)	0.078	0.535	0.130	0.396	0.499	0.353	0.533	0.199
Adj. R^2 (proj model)								

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: This table replicates Table 5 of the authors' paper. For simplicity, we only focus on showing the estimates for the main variables of interest.

Table A.7: Replicating Table B.1.

	Mean	SD	Min	Max	N
Urban share	0.15	0.15	0.02	0.95	1148
Industry share	0.46	0.12	0.18	0.78	1148
Log manufacturing output per capita	0.82	0.47	-1.98	3.22	958
Log income per capita	-2.37	0.59	-4.92	0.27	804
Han share	0.83	0.29	0.01	1.00	1147
Natural rate of increase	0.02	0.01	-0.05	0.05	1106
Child share	2.07	0.66	0.71	4.15	1107
In-migration share	0.03	0.05	0.00	0.65	1105
Malaria suitability(SD)	-0.00	1.00	-2.96	3.50	1171

Note: This table replicates Table B.1. of the authors' paper. The values are rounded to two decimal places.

Table A.8: Robustness: Table 4 with varying controls

	(1) Urban population 1990	(2) Urban population 2010	(3) Manufacturing employment 1990
1) Original results			
MSMSD	-0.719***	-0.808***	-0.631***
	(-3.14)	(-2.70)	(-3.10)
All Controls	Yes	Yes	Yes
Observations	868	868	868
2) Without controls			
MSMSD	0.169*	0.315**	0.163*
	(1.94)	(2.06)	(1.78)
Observations	868	868	868
3) Controlling for elevation			
MSMSD	-0.527**	-0.397	-0.684**
	(-2.37)	(-1.37)	(-2.52)
Elevation	-0.00134***	-0.00137***	-0.00163***
	(-3.52)	(-3.08)	(-3.50)
Observations	868	868	868
4) Controlling for elevation (log)			
MSMSD	-0.311*	-0.252	-0.438**
	(-1.77)	(-1.22)	(-2.55)
Elevation (log)	-0.760***	-0.900***	-0.953***
	(-3.06)	(-3.27)	(-3.95)
Observations	868	868	868
5) Original with base controls			
MSMSD	-1.240***	-1.716***	-1.208***
	(-3.33)	(-3.06)	(-3.61)
Base Controls	Yes	Yes	Yes
Observations	868	868	868
6) Base controls excluding temperature			
MSMSD	0.103	0.0236	-0.0911
	(0.69)	(0.13)	(-0.59)
Area	-0.000505*	-0.00109**	-0.00119***
	(-1.90)	(-2.32)	(-3.13)
Longitude	0.0685	0.105**	0.120**
	(1.61)	(2.01)	(2.64)
Abs latitude	0.0688	-0.0162	0.0345
	(1.51)	(-0.26)	(0.77)
Observations	868	868	868
7) Base controls excluding longitude and latitude			
MSMSD	0.0378	-0.149	0.205
	(0.20)	(-0.60)	(0.96)
Area	-0.00110**	-0.00161**	-0.00195***
	(-2.58)	(-2.55)	(-3.16)
Temperature	0.472**	0.244	0.514**
	(2.28)	(0.80)	(2.40)
Temperature sq	-0.0131*	-0.00279	-0.0166**
	(-1.77)	(-0.24)	(-2.11)
Observations	868	868	868

Base Controls include temperature, temperature squared, longitude, latitude, and area of grid cell. T-values are reported in parentheses. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table A.9: Additional Robustness checks: Table 4

	(1) Urban population 1990	(2) Urban population 2010	(3) Manufacturing employment 1990
1) Original results			
MSMSD	-0.719***	-0.808***	-0.631***
	(-3.14)	(-2.70)	(-3.10)
All Controls	Yes	Yes	Yes
Observations	868	868	868
2) Log of dependent variable			
MSMSD	-1.360***	-0.701***	-1.619***
	(-6.33)	(-2.67)	(-6.61)
All Controls	Yes	Yes	Yes
Observations	843	256	843
Winzorising (top and bottom 5%)			
MSMSD	-0.421***	-0.333***	-0.561***
	(-5.17)	(-3.53)	(-5.58)
All Controls	Yes	Yes	Yes
Observations	782	825	782

T-values are reported in parentheses. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table A.10: Robustness: Table 3 with varying controls

	(1) Seats 1893	(2) Urban population 1893	(3) Hierarchy 1893
1) Original results			
MSMSD	-0.497***	-0.744**	-0.428***
	(-3.11)	(-2.56)	(-4.11)
All Controls	Yes	Yes	Yes
Observations	868	868	868
2) Without controls			
MSMSD	0.0776	0.135*	0.0668*
	(1.53)	(1.71)	(1.77)
Observations	868	868	868
3) Controlling for elevation			
MSMSD	-0.185***	-0.567***	-0.122***
	(-3.24)	(-2.97)	(-2.90)
Elevation	-0.000505***	-0.00135***	-0.000364***
	(-5.07)	(-4.07)	(-6.15)
Observations	868	868	868
4) Controlling for elevation (log)			
MSMSD	-0.0221	-0.285*	-0.00424
	(-0.39)	(-1.90)	(-0.10)
Elevation (log)	-0.158***	-0.667***	-0.113***
	(-3.05)	(-3.24)	(-3.58)
Observations	868	868	868
5) Original with base controls			
MSMSD	-0.404***	-1.194***	-0.329***
	(-2.65)	(-4.04)	(-3.12)
Base Controls	Yes	Yes	Yes
Observations	868	868	868
6) Base controls excluding temperature			
MSMSD	0.0557	0.0838	0.0334
	(0.54)	(0.49)	(0.61)
Area	0.000117	-0.000487	0.0000824
	(1.08)	(-1.32)	(0.90)
Longitude	0.0295*	0.0685*	0.0223***
	(1.75)	(1.76)	(2.85)
Abs latitude	0.0256	0.0778	0.00810
	(0.80)	(1.40)	(0.54)
Observations	868	868	868
7) Base controls excluding longitude and latitude			
MSMSD	0.0385	0.0313	-0.0161
	(0.27)	(0.17)	(-0.19)
Area	-0.000152	-0.00113**	-0.0000935
	(-1.09)	(-2.15)	(-0.89)
Temperature	0.331***	0.641***	0.245***
	(3.54)	(2.97)	(3.66)
Temperature sq	-0.00951***	-0.0185***	-0.00644***
	(-4.14)	(-2.70)	(-3.68)
Observations	868	868	868

Base Controls include temperature, temperature squared, longitude, latitude, and area of grid cell. T-values reported in parentheses. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table A.11: Additional Robustness checks: Table 3

	(1) Seats 1893	(2) Urban population 1893	(3) Hierarchy 1893
1) Original results			
MSMSD	-0.497***	-0.744**	-0.428***
	(-3.11)	(-2.56)	(-4.11)
All Controls	Yes	Yes	Yes
Observations	868	868	868
2) Log of dependent variable			
MSMSD	-0.181**	-1.117***	-0.143***
	(-2.00)	(-4.45)	(-3.26)
All Controls	Yes	Yes	Yes
Observations	602	602	602
Winzorising (top and bottom 5%)			
MSMSD	-0.435***	-0.333***	-0.383***
	(-3.76)	(-4.74)	(-4.07)
All Controls	Yes	Yes	Yes
Observations	858	825	855

T-values reported in parentheses. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table A.12: Robustness: Table C17 (placebo) with varying controls

	(1) Urban pop 1893	(2) Urban pop 1893	(3) Emp 1893	(4) Urban pop 1990	(5) Urban pop 2010	(6) Emp 1990
1) Original results						
MSMSD	-0.108	-0.324	-0.0625	-0.0317	0.276	-0.0795
	(-0.46)	(-0.69)	(-0.51)	(-0.07)	(0.76)	(-0.17)
All Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	621	621	621	621	621	621
2) Without controls						
MSMSD	0.653***	0.787***	0.293***	0.800***	0.769***	0.869***
	(8.02)	(5.78)	(9.27)	(5.81)	(6.31)	(5.34)
All Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	621	621	621	621	621	621
3) Controlling for elevation						
MSMSD	0.516***	0.555***	0.133**	0.516***	0.429***	0.577***
	(4.61)	(3.35)	(2.27)	(3.53)	(3.08)	(3.17)
Elevation	-0.000160**	-0.000271**	-0.000187***	-0.000330***	-0.000395***	-0.000340**
	(-2.12)	(-2.22)	(-3.82)	(-2.87)	(-3.24)	(-2.34)
Observations	621	621	621	621	621	621
4) Controlling for elevation (log)						
MSMSD	0.459***	0.285	0.217***	0.0709	0.237	0.282
	(3.34)	(1.09)	(2.98)	(0.35)	(1.11)	(1.13)
Elevation (log)	-0.143	-0.370*	-0.0563	-0.537***	-0.391**	-0.432**
	(-1.42)	(-1.79)	(-1.16)	(-3.73)	(-2.41)	(-2.17)
Observations	621	621	621	621	621	621
5) Original with base controls						
MSMSD	0.0391	-0.0473	-0.111	0.206	0.271	0.227
	(0.18)	(-0.14)	(-0.93)	(0.62)	(0.83)	(0.63)
Base controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	621	621	621	621	621	621
6) Base controls excluding temperature						
MSMSD	0.529***	0.701***	0.167***	0.661***	0.555***	0.712***
	(5.13)	(4.13)	(3.62)	(3.73)	(3.51)	(3.26)
Area	0.000989***	0.000145	0.000326	-0.00120	-0.00135	0.0000695
	(2.86)	(0.16)	(1.59)	(-1.50)	(-1.07)	(0.06)
Longitude	0.0314**	0.0263	0.0274***	0.0376**	0.0529***	0.0484**
	(2.42)	(1.35)	(3.78)	(2.15)	(3.81)	(2.31)
Abs latitude	-0.0146	0.0255	-0.0359**	0.0265	0.00588	0.0525
	(-0.48)	(0.49)	(-2.34)	(0.44)	(0.10)	(0.75)
Observations	621	621	621	621	621	621
7) Base controls excluding longitude and latitude						
MSMSD	0.364*	0.580*	-0.0169	0.694*	0.617	0.870*
	(1.96)	(1.88)	(-0.16)	(1.74)	(1.63)	(1.98)
Area	0.000527	-0.000534	0.0000826	-0.00185**	-0.00199	-0.000786
	(1.58)	(-0.54)	(0.36)	(-2.32)	(-1.56)	(-0.67)
Temperature	0.0130	-0.00940	0.0421***	-0.00990	0.00344	-0.0246
	(0.96)	(-0.45)	(5.66)	(-0.47)	(0.17)	(-1.03)
Temperature sq	0.00391	0.00388	0.00234	0.00212	0.00199	0.00145
	(1.32)	(0.91)	(1.46)	(0.49)	(0.43)	(0.31)
Observations	621	621	621	621	621	621

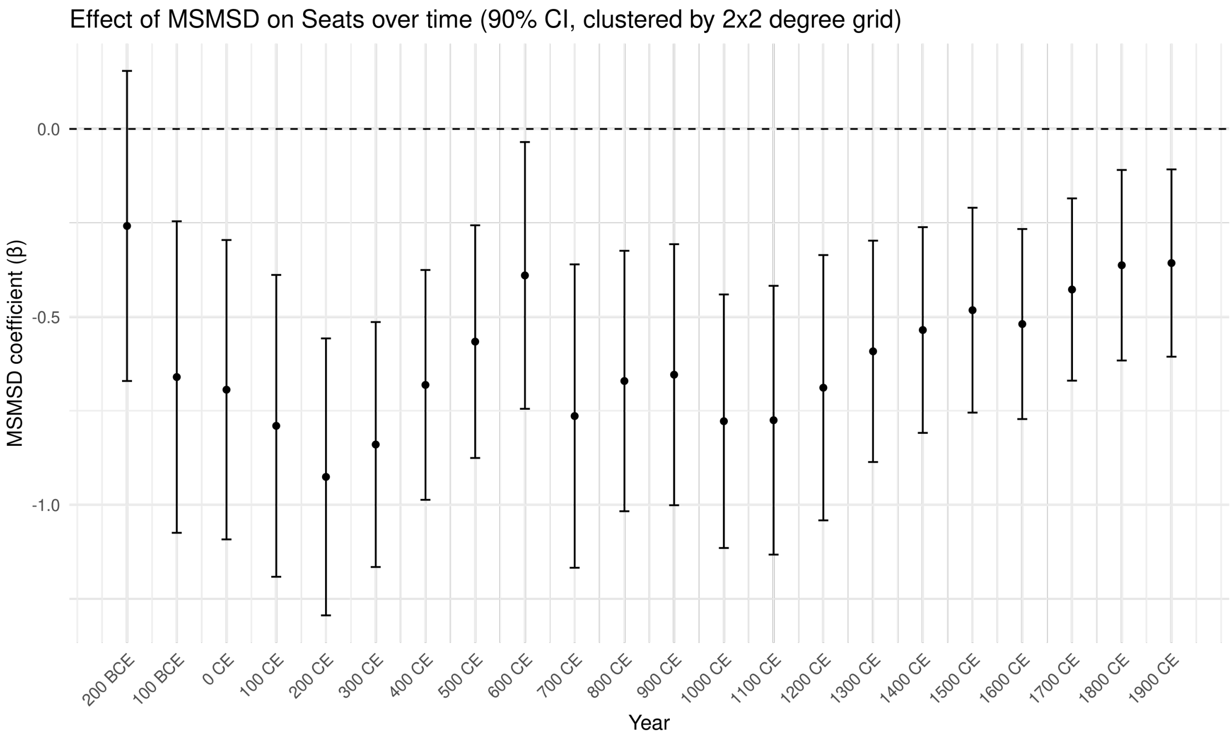
Base Controls include temperature, temperature squared, longitude, latitude, and area of grid cell. T-values reported in parentheses. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table A.13: Controlling for urbanisation in 1893

	(1) Seats 1990	(2) Urban population 2010	(3) Manufacturing employment 1990
MSMSD	-0.127	-0.118	-0.236
	(-0.86)	(-0.56)	(-1.37)
UrbanShare1893	0.797***	0.928***	0.532***
	(5.12)	(5.01)	(4.64)
All Controls	Yes	Yes	Yes
Observations	868	868	868

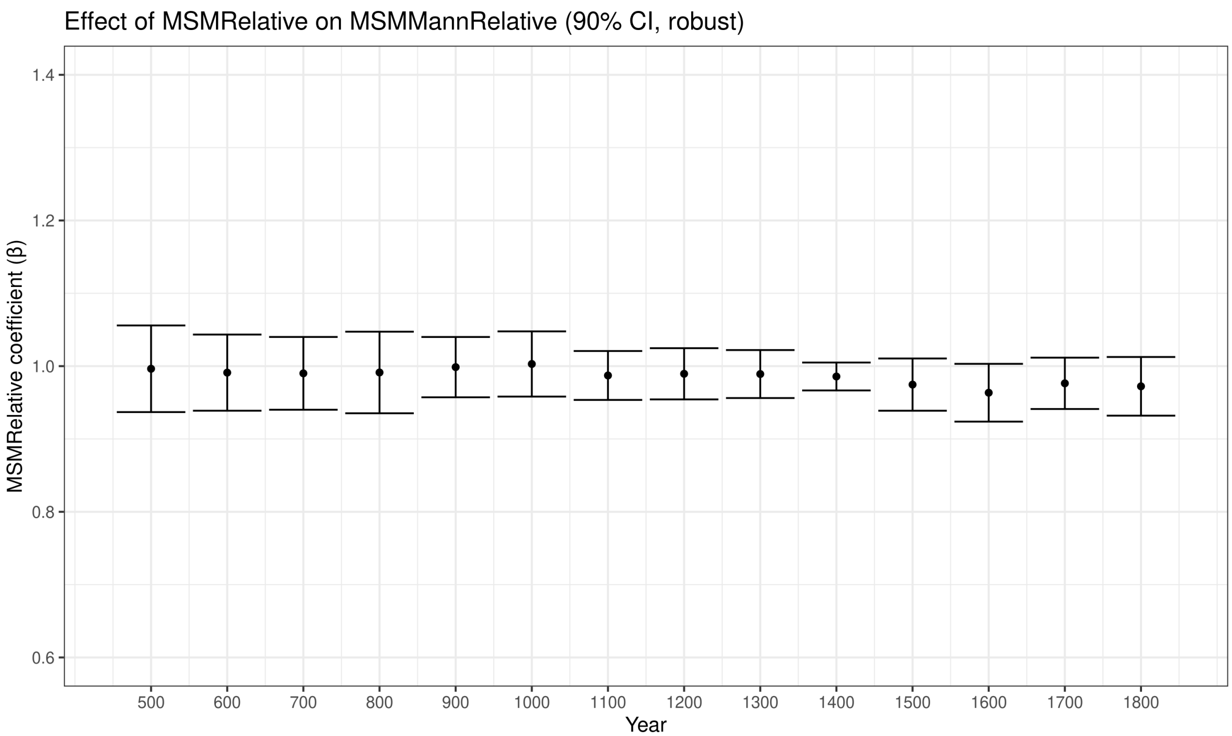
T-values reported in parentheses. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Figure A.1: Replicating Lower section of Figure 2



Note: This figure replicates the lower section of Figure 2 in the authors' paper.

Figure A.2: Replicating Figure A.2.



Note: This figure replicates Figure A.2. of the authors' paper.

Data and replication files

Malaria Suitability, Urbanization and Persistence:
Evidence From China Over More Than 2000 Years

Replication Code

- EER-D-16-00243_Main.do contains the Stata code with which the results presented in the main part (Tables 1–5) can be replicated.
- EER-D-16-00243_Appendix.do contains the Stata code with which the results presented in the Appendix can be replicated.

Data sets

Three datasets are used in the main empirical analysis:

- **SouthChinaPixelLevelMain.dta**: Cross section grid-cell level dataset.
- **PanelSouthChina.dta**: Grid-cell level panel dataset.
- **CountyLevelDataset.dta**: Cross section county-cell level dataset.

Additionally, there are seven datasets that are employed in robustness checks.

- **MannEtAl2009Data.dta**: 5×5 degree grid-cell level panel dataset.
- **NorthChinaPixelLevel.dta**: Cross section grid-cell level dataset for North China.
- **PanelPooledChina.dta**: Grid-cell level panel dataset (covering China Proper).
- **SouthChinaPixelLevel19011925.dta**: Dataset in which climate variables are constructed using data between 1901 and 1925.
- **SouthChinaPixelLevel19261950.dta**: Dataset in which climate variables are constructed using data between 1926 and 1950.
- **SouthChinaPixelLevel19511975.dta**: Dataset in which climate variables are constructed using data between 1951 and 1975.
- **SouthChinaPixelLevel19762000.dta**: Dataset in which climate variables are constructed using data between 1976 and 2000.

Figure A.3: README document of the authors

B Construction of the dependent variable measures

In this section, we write down our understanding of the way the authors created the dependent variables (respective to the mean). We will focus on the seats variable as other dependent variables are also constructed similarly.

The paper seem to define the normalized seat variable as (c is grid-cell and t is time period):

$$y_{c,t} = \frac{\text{seats}_{c,t}}{\overline{\text{seats}}_t}$$

where

$$\overline{\text{seats}}_t = \frac{1}{N}\sum_{c=1}^{N} \text{seats}_{c,t},$$

and N is the number of grid cells (868 in their case).

This normalization scales each grid cell's value relative to the mean for that year.

If we do not have the information on $\overline{\text{seats}}_t$, we cannot recover the absolute number of seats - only the relative ranking across grid cells.

By definition:

$$\sum_{c=1}^{N} y_{c,t} = N$$

and any scalar multiple of the true seat values would produce the same normalized data:

$$y_{c,t} = \frac{\lambda_t \text{seats}_{c,t}}{\lambda_t \overline{\text{seats}}_t} = y_{c,t}$$