

Helbling, Marc; Meierrieks, Daniel

Article — Published Version

Global warming and urbanization

Journal of Population Economics

Provided in Cooperation with:
WZB Berlin Social Science Center

Suggested Citation: Helbling, Marc; Meierrieks, Daniel (2022) : Global warming and urbanization, Journal of Population Economics, ISSN 1432-1475, Springer, Berlin, Iss. Latest Articles, pp. --,
<https://doi.org/10.1007/s00148-022-00924-y>

This Version is available at:
<https://hdl.handle.net/10419/265120>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by/4.0>

Appendix A. Supplementary Tables

Supplementary Table 1: Additional Covariates and Other Changes to Baseline Model

Change to Baseline Model →	(1) Add Trade Openness	(2) Add Inequality	(3) Add Rule of Law	(4) Add Square of GDP p.c.	(5) Population Size → Population Density	(6) Democracy index → Regime type	(7) GDP p.c. → Life Expectancy	(8) Youth Dep. Ratio → Total Dep. Ratio	(9) Education → Secondary School Enrollment
<i>Short-Run Estimates</i>									
∑ Δ Urbanization Coefficients	0.913 (0.020)***	0.903 (0.025)***	0.903 (0.025)***	0.903 (0.025)***	0.905 (0.025)***	0.904 (0.025)***	0.905 (0.025)***	0.904 (0.025)***	0.906 (0.022)***
∑ Δ Temperature Coefficients	-0.020 (0.007)***	-0.027 (0.007)***	-0.027 (0.006)***	-0.026 (0.007)***	-0.026 (0.007)***	-0.027 (0.006)***	-0.018 (0.007)**	-0.027 (0.006)***	-0.027 (0.013)**
<i>Long-Run Estimates</i>									
Error Correction	-0.004 (0.001)***	-0.005 (0.001)***	-0.004 (0.001)***	-0.004 (0.001)***	-0.005 (0.001)***	-0.005 (0.001)***	-0.005 (0.001)***	-0.005 (0.001)***	-0.005 (0.001)***
Temperature	4.505 (1.014)***	5.273 (0.969)***	5.367 (1.081)***	5.290 (0.960)***	4.813 (0.967)***	5.202 (0.987)***	2.813 (1.083)***	5.374 (1.042)***	4.390 (1.153)***
Further Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within-R ²	0.88	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Number of Observations	5,274	6,490	6,490	6,490	6,333	6,490	6,484	6,490	3,252

Notes: Dynamic fixed-effects estimates reported. Dependent variable=Δ Urbanization. Error correction=Urbanization_{t-1} (level-data). Further controls=Population size; GDP p.c.; Democracy; Youth dependency ratio; Education equality if not indicated differently. All controls enter all specifications in first-differences and levels in short- and long-run part of model, respectively. Trade openness=Exports and imports as share of GDP (WDI data). Inequality=Index of the equal distribution of resources within a society (V-DEM data). Rule of law=Index measuring the impartial, independent and equal enforcement of the law and government compliance with the law (V-DEM data). Population density=Population size per country area (WDI data). Regime type=indicator variable that differentiates between closed autocracies, electoral autocracies, electoral democracies and liberal democracies (V-DEM data). Life expectancy=Number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life (WDI data). Total dependency ratio=Number of young (under 15 years of age) and elderly people (aged 65 and over) compared to the number of people of working age (i.e., 15-64 years old) (WDI data). Secondary school enrollment=Ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to secondary level of education (WDI data). Driscoll-Kraay standard errors in parentheses. * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$.

Supplementary Table 2: Alternative Estimators

Estimator →	(1)	(2)	(3)
	DFE	PMG	MG
<i>Short-Run Estimates</i>			
$\sum \Delta$ Urbanization Coefficients	0.906 (0.025)***	0.928 (0.009)***	0.856 (0.008)***
$\sum \Delta$ Temperature Coefficients	-0.033 (0.007)***	-0.027 (0.007)***	-0.042 (0.011)***
<i>Long-Run Estimates</i>			
Error Correction	-0.004 (0.001)***	-0.004 (0.001)***	-0.007 (0.001)***
Temperature	8.930 (1.306)***	7.706 (1.590)***	6.594 (1.491)***
Within-R ²	0.85	0.85	0.86
Root Mean Square Error	0.14	0.14	0.14
Number of Observations	6,490	6,490	6,490
<i>Notes:</i> DFE=Dynamic fixed-effects estimator. PMG=Pooled mean-group estimator. MG=Mean-group estimator. Dependent variable= Δ Urbanization. Error correction=Urbanization _{t-1} (level-data). Dynamic short-run specification is always l=1. Driscoll-Kraay standard errors in parentheses. * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$.			

Supplementary Table 3: Instrumental-Variable Estimates of Temperature on Urbanization

	(1)	(2)	(3)	(4)
<i>Short-Run Estimates</i>				
$\sum \Delta$ Urbanization Coefficients	0.904 (0.026)***	0.904 (0.026)***	0.904 (0.026)***	0.903 (0.026)***
$\sum \Delta$ Temperature Coefficients	-0.033 (0.009)***	-0.029 (0.009)***	-0.026 (0.010)**	-0.024 (0.010)**
<i>Long-Run Estimates</i>				
Error Correction	-0.005 (0.001)***	-0.005 (0.001)***	-0.005 (0.001)***	-0.005 (0.001)***
Temperature	6.496 (1.255)***	5.462 (1.374)***	4.545 (1.534)***	4.124 (1.587)***
Baseline Controls	Yes	Yes	Yes	Yes
Regional Shocks	None	Population Size and Youth Dependency	GDP p.c., Democracy and Education	All
Within-R ²	0.85	0.85	0.85	0.85
Number of Observations	6,490	6,490	6,490	6,490
CD-Test (<i>p</i> -value)	(0.00)***	(0.00)***	(0.00)***	(0.00)***
CADF-Test (<i>p</i> -value)	(0.00)***	(0.00)***	(0.00)***	(0.00)***
First-Stage <i>F</i> -Statistic ^(a)	363.32	286.26	307.59	267.57
Anderson-Rubin Test (<i>p</i> -value) ^(b)	(0.00)***	(0.00)***	(0.01)**	(0.04)**
<i>Notes:</i> Instrumental-variable estimates reported. Dependent variable= Δ Urbanization. Error correction= Δ Urbanization _{t-1} (level-data). Dynamic short-run specification is always $l=1$. Baseline controls=Population size; GDP p.c.; Democracy; Youth dependency ratio; Education equality. All controls enter all specifications in first-differences and levels in short- and long-run part of model, respectively. Regional shocks are the mean-levels of respective variables in proximate countries (i.e., countries located in same world region as country of interest). Instrument for temperature=Temperature in proximate countries. (a) Instruments are sufficiently relevant when $F>10$. (b) Tests whether the coefficients of the endogenous regressors in the structural equation are jointly equal to zero and that the over-identifying restrictions are valid. Driscoll-Kraay standard errors in parentheses. * $p<0.1$, ** $p<0.5$, *** $p<0.01$.				

Supplementary Table 4: Short- and Long-Run Correlation between Urbanization and Temperature

	(1)	(2)	(3)
<i>Short-Run Estimates</i>			
$\sum \Delta$ Temperature Coefficients	-0.173 (0.043)***	-0.140 (0.042)***	-0.129 (0.042)***
$\sum \Delta$ Urbanization Coefficients	-0.062 (0.017)***	-0.052 (0.016)***	-0.034 (0.016)**
[95% Confidence Interval]	[-0.096; -0.027]	[-0.085; -0.019]	[-0.066; -0.003]
<i>Long-Run Estimates</i>			
Error Correction	-0.475 (0.054)***	-0.545 (0.049)***	-0.568 (0.050)***
Urbanization	0.034 (0.004)***	0.020 (0.004)***	0.014 (0.003)***
[95% Confidence Interval]	[0.025; 0.042]	[0.012; 0.028]	[0.008; 0.021]
Further Controls	None	Population, GDP p.c., Democracy	All
Within-R ²	0.31	0.33	0.34
Number of Observations	6,490	6,490	6,490
CD-Test (<i>p</i> -value)	(0.00)***	(0.00)***	(0.00)***
CADF-Test (<i>p</i> -value)	(0.00)***	(0.00)***	(0.00)***
Oster's δ associated with Long-Run Urbanization Coefficient	0.27	0.19	0.18

Notes: Dynamic fixed-effects estimates reported. Dependent variable= Δ Temperature. Error correction=Temperature_{t-1} (level-data). Dynamic short-run specification is always $l=1$. Further controls=Population size; GDP p.c.; Democracy; Youth dependency ratio; Education equality. All controls enter all specifications in first-differences and levels in short- and long-run part of model, respectively. Driscoll-Kraay standard errors in parentheses. * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$.

Supplementary Table 5: Instrumental-Variable Estimates of Urbanization on Temperature

	(1)	(2)	(3)	(4)
<i>Short-Run Estimates</i>				
$\Sigma \Delta$ Temperature Coefficients	-0.125 (0.046)***	-0.122 (0.046)***	-0.127 (0.042)***	-0.124 (0.042)***
$\Sigma \Delta$ Urbanization Coefficients	-0.033 (0.017)*	-0.023 (0.015)	-0.035 (0.016)**	-0.027 (0.014)*
<i>Long-Run Estimates</i>				
Error Correction	-0.578 (0.061)***	-0.585 (0.063)***	-0.577 (0.057)***	-0.586 (0.059)***
Urbanization	0.021 (0.019)	-0.001 (0.026)	0.022 (0.018)	0.002 (0.024)
Baseline Controls	Yes	Yes	Yes	Yes
Further Controls	None	Fertility Rate	Temperature t-20	All
Within-R ²	0.34	0.35	0.35	0.36
Number of Observations	6,490	6,490	6,490	6,490
CD-Test (<i>p</i> -value)	(0.00)***	(0.00)***	(0.00)***	(0.00)***
CADF-Test (<i>p</i> -value)	(0.00)***	(0.00)***	(0.00)***	(0.00)***
First-Stage <i>F</i> -Statistic ^(a)	21.69	20.15	22.11	21.54
Anderson-Rubin Test (<i>p</i> -value) ^(b)	(0.34)	(0.99)	(0.29)	(0.93)

Notes: Instrumental-variable estimates reported. Dependent variable= Δ Temperature. Error correction=Temperature_{t-1} (level-data). Dynamic short-run specification is always $l=1$. Baseline controls=Population size; GDP p.c.; Democracy; Youth dependency ratio; Education equality. All controls enter all specifications in first-differences and levels in short- and long-run part of model, respectively. Instrument for urbanization=Share of males ages 15-29 to males ages 15 to 64. Data on fertility rate (births per woman) is from the WDI. (a) Instruments are sufficiently relevant when $F>10$. (b) Tests whether the coefficients of the endogenous regressors in the structural equation are jointly equal to zero and that the over-identifying restrictions are valid. Driscoll-Kraay standard errors in parentheses. * $p<0.1$, ** $p<0.5$, *** $p<0.01$.

Supplementary Table 6: Pairwise Correlations between Moderators

	Initial GDP p.c.	Initial Employment in Agriculture	Initial Temperatures	Initial Urbanization
Initial GDP p.c.				
Initial Employment in Agriculture	-0.66***			
Initial Temperature	-0.53***	0.43***		
Initial Urbanization	0.75***	-0.79***	-0.57***	
Initial Urban Bias	-0.61***	0.58***	0.62***	-0.69***

Note: *** $p < 0.01$ (indicates rejection of the H_0 of zero correlation between variables).

Supplementary Table 7: Cluster Analysis

	Cluster 1	Cluster 2	t-test
Initial Temperature (in °C)	23.41	14.85	53.73 (0.00)***
Initial Urbanization (in %)	16.20	50.11	-91.73 (0.00)***
Initial GDP p.c. (in US\$)	2009,50	8253,71	-57.78 (0.00)***
Initial Employment in Agriculture (in % of total employment)	51.40	13.31	96.63 (0.00)***
Initial Urban Bias (index, 0-1)	0.76	0.36	67.06 (0.00)***

Notes: t-test for equality of means with p-values in parentheses. *** $p < 0.01$ (indicates rejection of the H_0 of equality of means). Number of observations is $N=3,192$ for Cluster 1 and $N=3,135$ for Cluster 2.

Supplementary Table 8: Mediation Analysis without Moderating Variable

	(1)	(2)	(3)	(4)
Dependent Variable →	Agriculture Value Added	Public Goods Rural vs. Urban	Urbanization	Urbanization
<i>Short-Run Estimates</i>				
$\sum \Delta$ Dependent Variable Coefficients	-0.144 (0.045)***	-0.031 (0.031)	0.889 (0.034)***	0.883 (0.036)***
$\sum \Delta$ Temperature	0.709 (0.152)**	0.004 (0.011)	-0.026 (0.008)***	-0.024 (0.008)***
<i>Long-Run Estimates</i>				
Error Correction	-0.131 (0.017)***	-0.055 (0.012)***	-0.004 (0.001)***	-0.005 (0.001)***
Temperature	-3.503 (0.803)***	-0.081 (0.110)	5.901 (1.274)***	4.599 (1.298)***
Equality of Long-Run Temperature Coefficient between Models χ^2 -Statistic] [p > χ^2]				[13.27] [0.00]***
Mediators Added? →			No	Yes
Further Controls	Yes	Yes	Yes	Yes
Within-R ²	0.11	0.05	0.82	0.83
Number of Observations	5,277	6,146	5,024	5,024

Notes: Dynamic fixed-effects estimates reported. Error correction= First lag of respective dependent variable (level-data). Dynamic short-run specification is always l=1. Further controls=Population size; GDP p.c.; Democracy. All controls enter all specifications in first-differences and levels in short- and long-run part of model, respectively. Mediators=Value added in agriculture and public goods provision equity. Driscoll-Kraay standard errors in parentheses. * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$.

Appendix B. List of Countries

Afghanistan	Egypt	Lao PDR	Portugal
Albania	El Salvador	Lebanon	Romania
Argentina	Eswatini	Lesotho	Rwanda
Australia	Ethiopia	Liberia	São Tomé and Príncipe
Austria	Finland	Libya	Saudi Arabia
Belgium	France	Madagascar	Senegal
Benin	Gabon	Malawi	Sierra Leone
Bolivia	Gambia	Malaysia	South Africa
Botswana	Germany	Mali	Spain
Brazil	Ghana	Mauritania	Sri Lanka
Bulgaria	Greece	Mauritius	Sweden
Burkina Faso	Guatemala	Mexico	Switzerland
Burundi	Guinea	Mongolia	Syria
Cabo Verde	Guinea-Bissau	Morocco	Tanzania
Canada	Haiti	Myanmar	Thailand
Central African Republic	Honduras	Namibia	Togo
Chad	Hungary	Nepal	Trinidad and Tobago
Chile	India	Netherlands	Tunisia
China	Indonesia	New Zealand	Turkey
Colombia	Iran	Nicaragua	Uganda
Comoros	Iraq	Niger	United Kingdom
Congo, Dem. Rep.	Ireland	Nigeria	United States
Congo, Rep.	Israel	Norway	Uruguay
Costa Rica	Italy	Oman	Venezuela
Cote d'Ivoire	Jamaica	Pakistan	Vietnam
Cuba	Japan	Panama	Yemen
Cyprus	Jordan	Paraguay	Zambia
Denmark	Kenya	Peru	Zimbabwe
Dominican Republic	Korea (North)	Philippines	
Ecuador	Korea (South)	Poland	
