

APPENDIX A: UNIT ROOT TESTS

System GMM requires mean stationarity rather than full stationarity. Regardless, this section provides unit root tests for the variables using Harris–Tzavalis, Im–Pesaran–Shin, and Fisher–type Dickey–Fuller methods. While the Harris–Tzavalis test assumes an autoregressive process common to all panels, the Im–Pesaran–Shin, and Fisher-type tests allows for panel heterogeneity. Furthermore, Fisher–type Dickey–Fuller test allows for serial correlation up to one lag.

Results in Tables A.1, A.2 and A.3 indicate stationarity in first differences across all tests. At levels, however, results appear to be sensitive to the assumption of a homogenous autoregressive process. This study prioritizes the Im–Pesaran–Shin and Fisher-type Dickey–Fuller test results, as they are robust to panel heterogeneity. The latter also accounts for serial correlation.

Table A. 1 *Harris–Tzavalis Unit Root Test for the Level and Differences of Variables*

Variables	rho	z	p-value	rho	z	p-value
	Level			Difference		
$\Delta \ln y_{it}$	−0.09	−11.05	0.000			
$\ln y_{it}$	0.99	12.17	1.000			
$\ln y_{it-1}$	0.98	11.95	1.000	−0.10	−11.13	0.000
$\ln y_{it-2}$	0.97	11.66	1.000	−0.12	−9.90	0.000
$\ln IECPC_{it}$	0.99	12.03	1.000	−0.09	−10.97	0.000
$\ln SWSED_{it}$	0.93	10.75	1.000	0.11	−6.74	0.000
NMR_{it}	−0.03	−9.72	0.000	−0.65	−22.88	0.000
$\ln OP_{it}$	0.84	8.95	1.000	−0.32	−15.87	0.000
$\ln VR_{it}$	0.98	11.97	1.000	0.01	−8.90	0.000
$\ln URB_{it}$	0.96	11.45	1.000	−0.22	−13.66	0.000

Notes: Time trend and panel means are included. Cross-sectional means are removed H_0 : Panels contain unit roots, H_a : Panels are stationary, AR parameter is common. Asymptotics: $N \rightarrow \text{Infinity}$, T Fixed

Table A. 2 *Im–Pesaran–Shin Unit Root Test for the Level and Differences of Variables*

Variables	t-bar	Z– t-tilde- bar	p-value	t-bar	Z– t-tilde- bar	p-value
	Level			Difference		
$\Delta \ln y_{it}$	−3.19	−7.95	0.000			
$\ln y_{it}$	−2.01	−2.85	0.002			
$\ln y_{it-1}$	−2.10	−3.70	0.000	−3.35	−8.87	0.000
$\ln y_{it-2}$	−2.35	−4.46	0.000	−3.22	−8.35	0.000
$\ln IECPC_{it}$	−2.30	−5.34	0.000	−3.46	−9.42	0.000
$\ln SWSED_{it}$	−2.30	−4.49	0.000	−3.71	−10.48	0.000
NMR_{it}	−4.09	−11.25	0.000	−5.22	−12.64	0.000
$\ln OP_{it}$	−2.77	−6.75	0.000	−4.07	−10.85	0.000
$\ln VR_{it}$	−5.15	−7.65	0.000	−4.69	−10.91	0.000
$\ln URB_{it}$	−2.52	−6.17	0.000	−3.93	−11.19	0.000

Notes: Time trend and panel means are included. Cross-sectional means are removed. H_0 : All panels contain unit roots, H_a : Some panels are stationary. AR parameter is panel-specific. Asymptotics: Fixed T and N for t-bar, $N \rightarrow \text{Infinity}$, T Fixed for t- Z-t-tilde-bar. Critical Values for t-bar: %1,–2.39, 5%,–2.32, %10: –2,29

Table A. 3 *Fisher-Type Dickey–Fuller Unit Root Test for the Level and Differences of Variables*

Variables	Inverse χ^2 P stat	p-value	Inverse normal Z stat	p- value	Inverse χ^2 P stat	p-value	Inverse normal Z stat	p- value
	Level				Differenced			
$\Delta \ln y_{it}$	382.49	0.000	−13.48	0.000				
$\ln y_{it}$	249.80	0.000	−8.37	0.000				
$\ln y_{it-1}$	284.61	0.000	−10.25	0.000	249.80	0.000	−8.37	0.000
$\ln y_{it-2}$	307.43	0.000	−11.07	0.000	401.59	0.000	−14.16	0.000
$\ln IECPC_{it}$	289.24	0.000	−10.38	0.000	362.86	0.000	−13.15	0.000
$\ln SWSED_{it}$	187.48	0.000	−5.58	0.000	394.70	0.000	−14.34	0.000
NMR_{it}	368.86	0.000	−13.44	0.000	364.26	0.000	−13.34	0.000
$\ln OP_{it}$	312.38	0.000	−11.15	0.000	355.16	0.000	−12.77	0.000
$\ln VR_{it}$	292.25	0.000	−10.35	0.000	441.03	0.000	−15.45	0.000
$\ln URB_{it}$	275.77	0.000	−9.59	0.000	518.07	0.000	−16.91	0.000

Notes: Drift Term is Included. Panel means are included. Cross-sectional means are removed. ADF regressions have 1 lag. H_0 : All panels contain unit roots, H_a : Some panels are stationary. AR parameter is panel-specific. Asymptotics: $T \rightarrow \text{Infinity}$. P statistic requires number of panels to be finite. Other statistics are suitable for finite or infinite number of panels.

APPENDIX B: NICKELL BIAS

Table B. 1 Pooled OLS, System GMM and Fixed Effects Estimators for Columns (5) and (6) in Table 4

	(1)	(2)	(3)	(4)	(5)	(6)
	Pooled OLS	System GMM	Fixed Effects	Pooled OLS	System GMM	Fixed Effects
$\ln y_{it-1}$	0.888*** (0.050)	1.323*** (0.226)	0.653*** (0.074)	-0.112** (0.050)	0.323 (0.226)	-0.347*** (0.074)
$\ln y_{it-2}$	0.089* (0.045)	-0.485** (0.187)	-0.080* (0.047)	0.089* (0.045)	-0.485** (0.187)	-0.080* (0.047)
$\ln VR_{it}$	0.004 (0.105)	0.899*** (0.310)	0.509* (0.268)	0.004 (0.105)	0.899*** (0.311)	0.509* (0.268)
NMR_{it}	-0.089 (0.135)	2.043** (0.981)	-0.009 (0.138)	-0.089 (0.135)	2.043** (0.981)	-0.009 (0.138)
$\ln OP_{it}$	-0.004 (0.004)	-0.001 (0.029)	-0.002 (0.004)	-0.004 (0.004)	-0.001 (0.029)	-0.002 (0.004)
$\ln IECPC_{it}$	0.005** (0.002)	0.054*** (0.015)	0.024*** (0.008)	0.005** (0.002)	0.054*** (0.015)	0.024*** (0.008)
$\ln SWSED_{it}$	0.007 (0.014)	-0.037 (0.084)	-0.005 (0.025)	0.007 (0.014)	-0.037 (0.084)	-0.005 (0.025)
$\ln URB_{it}$	0.023 (0.194)	1.590*** (0.585)	0.796 (0.514)	0.023 (0.194)	1.591*** (0.585)	0.796 (0.514)
$\ln VR_{it} \times \ln URB_{it}$	-0.002 (0.025)	-0.221*** (0.077)	-0.109 (0.065)	-0.002 (0.025)	-0.221*** (0.077)	-0.109 (0.065)
Constant	0.216 (0.838)	-5.288** (2.437)	-0.034 (2.089)	0.216 (0.838)	-5.292** (2.440)	-0.034 (2.089)
$\alpha_1^S + \alpha_2^S$ ^a	0.977	0.839	0.573	-0.023	-0.161	-0.427
Std.Err.	0.012	0.084	0.073	0.012	0.084	0.073
p-value	0.000	0.000	0.000	0.061	0.060	0.000
Panel FE	No	Yes	Yes	No	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	561	561	561	561	561	561
Groups		51	51		51	51
Avg.Obs.per Group		11	11		11	11
Within R ²			0.89			0.65
R ²	0.97			0.55		
F DoF	19		19	19		19
F stat	3224.73		225.65	60.86		82.52
p-value	0.000		0.000	0.000		0.000

Notes: Table B.1 presents the pooled OLS and fixed-effects results as discussed in the “Robustness of Results” Section. Columns (2) and (4) in this table correspond to columns (5) and (6) in Table 4, respectively. As noted, the GMM estimates for the sum of lagged variables fall within the expected range, supporting the validity of the models. Discrepancies in the findings regarding control variables are likely due to factors such as unaccounted individual effects, Nickell bias, and endogeneity in the pooled OLS and fixed-effects estimators. Windmeijer-corrected and cluster-robust standard errors robust to heteroskedasticity, serial correlation and finite- sample bias are reported in parentheses in columns (2) and (4). In columns (1), (3), (4) and (6), standard errors are cluster-robust and robust to heteroskedasticity and serial correlation.

^a The sum of coefficients of $\ln y_{it-1} + \ln y_{it-2}$

*** p<0.01, ** p<0.05, * p<0.10

APPENDIX C: MORAN'S I STATISTICS

Table C. 1 *Moran's I Statistics for Regressions in Columns (5) and (6) in Table 4*

	Table 4 Column (5)		Table 4 Column (6)	
	$\chi^2(1)$	Prob > χ^2	$\chi^2(1)$	Prob > χ^2
2011	0.14	0.713	0.14	0.713
2012	2.54	0.111	2.54	0.111
2013	0.31	0.575	0.31	0.575
2014	1.03	0.311	1.03	0.311
2015	0.05	0.829	0.05	0.829
2016	0.89	0.346	0.89	0.346
2017	1.54	0.215	1.54	0.215
2018	1.40	0.238	1.40	0.238
2019	1.71	0.192	1.71	0.192
2020	0.48	0.490	0.48	0.490
2021	0.02	0.902	0.02	0.902

Notes: These statistics are based on an inverse-distance weights matrix. As discussed in the “Robustness of Results” Section, the null hypothesis of no spatial dependence cannot be rejected at standard significance levels.

APPENDIX D: INSTRUMENTS FOR LEVEL AND DIFFERENCED EQUATIONS IN TABLE 4

Table D. 1 *Instruments for Table 4*

	(1)		(2)		(3)		(4)		(5)		(6)	
	Level Eq.	Diff. Eq.	Level Eq.	Diff. Eq.	Level Eq.	Diff. Eq.	Level Eq.	Diff. Eq.	Level Eq.	Diff. Eq.	Level Eq.	Diff. Eq.
$\ln y_{it-1}$	lag(1 1)	lag(2 4)	lag(1 1)	lag(2 4)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 2)	lag(2 2)	lag(1 2)	lag(2 2)
$\ln VR_{it}$	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)
$\ln IECPC_{it}$	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)
$\ln SWSED_{it}$	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)
$\ln URB_{it}$			lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)
$\ln VR_{it} \times \ln URB_{it}$					lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)
$\ln OP_{it}$							lag(1 1)	lag(2 3)	lag(1 1)	lag(2 3)	lag(1 1)	lag(2 3)
NMR_{it}									lag(1 1)	lag(2 2)	lag(1 1)	lag(2 2)