SUPPLEMENTAL APPENDIX

Structural Change and Cross-Country Growth Empirics

World Bank Economic Review

by

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S1 Time-series properties of the data

Table 1: Second generation panel unit root tests

PANEL (A): AGRICULTURE DATA

	Variables in levels							*Variables in growth rates*					
	log VA pw		**log Labour**		**log Cap pw**			**VA pw**		**Labour**		**Cap pw**	
lags	Ztbar	p	Ztbar	p	Ztbar	p	lags	Ztbar	p	Ztbar	p	Ztbar	p
0	-0.93	0.18	7.88	1.00	7.14	1.00	0	-16.11	0.00	1.01	0.84	-1.63	0.05
1	-1.25	0.11	5.94	1.00	3.03	1.00	1	-10.88	0.00	2.66	1.00	-1.10	0.14
2	2.23	0.99	7.65	1.00	4.78	1.00	2	-5.82	0.00	5.94	1.00	3.49	1.00
3	4.18	1.00	9.18	1.00	4.80	1.00	3	-2.09	0.02	6.64	1.00	4.48	1.00
	Land pw							**Land pw**					
lags	Ztbar	p					lags	Ztbar	p				
0	9.15	1.00					0	-10.40	0.00				
1	6.34	1.00					1	-3.05	0.00				
2	5.48	1.00					2	-0.17	0.43				
3	3.42	1.00					3	2.65	1.00				

PANEL (B): MANUFACTURING DATA

	Variables in levels							*Variables in growth rates*					
	log VA pw		**log Labour**		**log Cap pw**			**VA pw**		**Labour**		**Cap pw**	
lags	Ztbar	p	Ztbar	p	Ztbar	p	lags	Ztbar	p	Ztbar	p	Ztbar	p
0	0.57	0.72	2.05	0.98	1.61	0.95	0	-18.64	0.00	-11.52	0.00	-9.27	0.00
1	1.69	0.95	1.12	0.87	0.28	0.61	1	-9.58	0.00	-7.76	0.00	-5.71	0.00
2	1.68	0.95	3.52	1.00	1.62	0.95	2	-4.61	0.00	-4.36	0.00	-2.94	0.00
3	3.00	1.00	3.08	1.00	2.75	1.00	3	-1.50	0.07	-0.81	0.21	0.23	0.59

PANEL (C): AGGREGATED DATA

	Variables in levels							*Variables in growth rates*					
	log VA pw		**log Labour**		**log Cap pw**			**VA pw**		**Labour**		**Cap pw**	
lags	Ztbar	p	Ztbar	p	Ztbar	p	lags	Ztbar	p	Ztbar	p	Ztbar	p
0	2.29	0.99	5.90	1.00	6.41	1.00	0	-15.30	0.00	-5.25	0.00	-4.01	0.00
1	2.28	0.99	3.84	1.00	3.00	1.00	1	-9.45	0.00	-2.38	0.01	-1.78	0.04
2	4.43	1.00	4.76	1.00	3.51	1.00	2	-3.90	0.00	-0.52	0.30	0.49	0.69
3	4.89	1.00	4.75	1.00	3.77	1.00	3	-1.24	0.11	1.87	0.97	2.89	1.00

PANEL (D): PENN WORLD TABLE DATA

	Variables in levels							*Variables in growth rates*					
	log VA pw		**log Labour**		**log Cap pw**			**VA pw**		**Labour**		**Cap pw**	
lags	Ztbar	p	Ztbar	p	Ztbar	p	lags	Ztbar	p	Ztbar	p	Ztbar	p
0	5.05	1.00	-2.57	0.01	2.27	0.99	0	-14.49	0.00	0.46	0.68	-4.73	0.00
1	5.81	1.00	5.78	1.00	5.26	1.00	1	-7.32	0.00	-2.91	0.00	-3.19	0.00
2	6.10	1.00	6.93	1.00	6.26	1.00	2	-4.99	0.00	1.06	0.86	-2.48	0.01
3	7.62	1.00	6.26	1.00	6.74	1.00	3	-1.78	0.04	1.52	0.94	-1.20	0.12

Notes: We report test statistics and p-values for the Pesaran (2007) CIPS panel unit root test of the variables in our four datasets. In all cases we use $N = 40$, $n = 918$ for the levels data. 'Lags' refers to the augmentation with lagged dependent variables (Augmented Dickey-Fuller test).

S2 Cross-section dependence in the data

Table 2: Cross-section correlation analysis

	Variables in levels				*Variables in FD*			
AGRICULTURE	$\bar{\rho}$	$\lvert\bar{\rho}\rvert$	CD	(p)	$\bar{\rho}$	$\lvert\bar{\rho}\rvert$	CD	(p)
log VA pw	0.33	0.51	42.42	0.00	0.05	0.23	6.32	0.00
log Labour	0.00	0.80	0.94	0.35	0.07	0.56	8.55	0.00
log Capital pw	0.41	0.71	51.52	0.00	0.08	0.41	8.86	0.00
log Land pw	0.02	0.67	3.57	0.00	0.02	0.29	2.91	0.00
MANUFACTURING	$\bar{\rho}$	$\lvert\bar{\rho}\rvert$	CD	(p)	$\bar{\rho}$	$\lvert\bar{\rho}\rvert$	CD	(p)
log VA pw	0.39	0.59	49.87	0.00	0.05	0.22	6.19	0.00
log Labour	0.15	0.62	18.98	0.00	0.14	0.26	17.31	0.00
log Capital pw	0.59	0.76	74.15	0.00	0.07	0.22	8.01	0.00
AGGREGATED	$\bar{\rho}$	$\lvert\bar{\rho}\rvert$	CD	(p)	$\bar{\rho}$	$\lvert\bar{\rho}\rvert$	CD	(p)
log VA pw	0.55	0.67	69.67	0.00	0.08	0.23	10.18	0.00
log Labour	0.04	0.71	5.50	0.00	0.07	0.32	7.93	0.00
log Capital pw	0.76	0.85	94.70	0.00	0.07	0.29	7.78	0.00
PWT	$\bar{\rho}$	$\lvert\bar{\rho}\rvert$	CD	(p)	$\bar{\rho}$	$\lvert\bar{\rho}\rvert$	CD	(p)
log VA pw	0.58	0.72	72.20	0.00	0.14	0.24	17.08	0.00
log Labour	0.94	0.94	114.37	0.00	0.05	0.39	6.21	0.00
log Capital pw	0.70	0.88	87.01	0.00	0.26	0.37	31.57	0.00

Notes: We report the average correlation coefficient across the $N(N-1)$ variable series $\bar{\rho}$, as well as the average absolute correlation coefficient $|\bar{\rho}|$. CD is the formal cross-section correlation tests introduced by Pesaran (2004). Under the H_0 of cross-section independence its statistics is asymptotically standard normal. We use our regression sample $N = 40$, $n = 918$ for the levels data. The same sample is used for the first difference data ($n = 884$) with the exception of the PWT analysis: here we are forced to drop the series for CYP to be able to compute correlation coefficients.

S3 Monte Carlo Simulations

S3.1 Data Generating Process

We run $M = 1,000$ replications of the following DGP for $N = 50$ cross-section elements and $T = 30$ time periods. Our basic setup for the DGP closely follows that of Kapetanios, Pesaran, and Yamagata (2011), albeit with a single rather than two regressors. For notational simplicity we do not identify the different sectors (agriculture and manufacturing) in the following, but all processes and variables are created independently across sectors, unless otherwise indicated.

$$
\begin{aligned}
y_{it} &= \beta_i x_{it} + u_{it} \qquad u_{it} = \alpha_i + \lambda^y_{i1} f_{1t} + \lambda^y_{i2} f_{2t} + \varepsilon_{it} && (1) \\
x_{it} &= a_{i1} + a_{i2} d_t + \lambda^x_{i1} f_{1t} + \lambda^x_{i3} f_{3t} + v_{it} && (2)
\end{aligned}
$$

for $i = 1, \ldots, N$ unless indicated below and $t = 1, \ldots, T$.
The common deterministic trend term (d_t) and individual-specific errors for the x-equation are zero-mean independent AR(1) processes defined as

$$
\begin{aligned}
d_t = 0.5 d_{t-1} + v_{dt} \qquad & v_{dt} \sim N(0, 0.75) \qquad t = -48, \ldots, 1, \ldots, T \qquad d_{-49} = 0 \\
v_{it} = \rho_{vi} v_{i,t-1} + v_{it} \qquad & v_{it} \sim N(0, (1 - \rho^2_{vi})) \qquad t = -48, \ldots, 1, \ldots, T \qquad v_{i,-49} = 0
\end{aligned}
$$

where $\rho_{vi} \sim U[0.05, 0.95]$. The common factors are nonstationary processes

$$
\begin{aligned}
f_{jt} &= \mu_j + f_{j,t-1} + v_{ft} \qquad j = 1,2,3 \qquad v_{ft} \sim N(0,1) \qquad t = -49, \ldots, 1, \ldots, T && (3) \\
& \mu^a_j = \{0.01, 0.008, 0.005\},\ \mu^m_j = \{0.015, 0.012, 0.01\} \qquad f_{j,-50} = 0
\end{aligned}
$$

where we deviate from the Kapetanios et al. (2011) setup by including drift terms. Unless indicated the sets of common factors differ between sectors.
Innovations to y are generated as a mix of heterogeneous AR(1) and MA(1) errors

$$
\begin{aligned}
\varepsilon_{it} &= \rho_{i\varepsilon} \varepsilon_{i,t-1} + \sigma_i \sqrt{1 - \rho^2_{i\varepsilon}}\, \omega_{it} \qquad i = 1, \ldots, N_1 \qquad t = -48, \ldots, 0, \ldots, T \\
\varepsilon_{it} &= \frac{\sigma_i}{\sqrt{1 + \theta^2_{i\varepsilon}}} (\omega_{it} + \theta_{i\varepsilon} \omega_{i,t-1}) \qquad i = N_1 + 1, \ldots, N \qquad t = -48, \ldots, 0, \ldots, T
\end{aligned}
$$

where N_1 is the nearest integer to $N/2$ and $\omega_{it} \sim N(0,1)$, $\sigma^2_i \sim U[0.5, 1.5]$, $\rho_{i\varepsilon} \sim U[0.05, 0.95]$, and $\theta_{i\varepsilon} \sim U[0,1]$. ρ_{vi}, $\rho_{i\varepsilon}$, $\theta_{i\varepsilon}$ and σ_i do not change across replications. Initial values are set to zero and the first 50 observations are discarded for all of the above.
Regarding parameter values, $\alpha_i \sim N(2,1)$ and a_{i1}, $a_{i2} \sim \text{iid}N(0.5, 0.5)$ do not change across replications. To begin with TFP levels α_i are specified to be the same across sectors. The slope coefficient β can vary across countries and across sectors (see below). In case of cross-country heterogeneity we have $\beta_i = \beta + \eta_i$ with $\eta_i \sim N(0, 0.04)$. If the mean of the slope coefficient β is the same across sectors we specify $\beta = 0.5$, otherwise $\beta^a = 0.5$ and $\beta^m = 0.3$ for agriculture and manufacturing respectively.
For the factor loadings may be heterogeneous and are distributed

$$
\begin{aligned}
\lambda^x_{i1} \sim N(0.5, 0.5) \qquad & \text{and} \qquad \lambda^x_{i3} \sim N(0.5, 0.5) && (4) \\
\lambda^y_{i1} \sim N(1, 0.2) \qquad & \text{and} \qquad \lambda^y_{i2} \sim N(1, 0.2) && (5)
\end{aligned}
$$

The above represents our basis DGP for the simulations carried out. We investigate the following ten models (the focus is on those marked with stars):

(1) Cross-country homogeneity (β) and no factors. We set all λ_i to zero such that x and y are stationary and cross-sectionally independent; technology is the same across countries and sectors.

(2) As Model (1) but now we have heterogeneous β across countries.

(3) As Model (2) but with substantially larger heterogeneity in TFP levels across countries.

(4) ★ As Model (2) but with TFP levels in manufacturing are now 1.5 times those in agriculture. We keep this feature for the remainder of setups.

(5) This sees the introduction of common factors (f_{2t} and f_{3t}) albeit with homogeneous factor loadings across countries. Both factors and loadings are independent across sectors. The absence of f_{1t} means there is no endogeneity problem.

(6) ★ As Model (5) but now we have factor loading heterogeneity across countries.

(7) As Model (6) but with factor-overlap between x and y equations: f_{1t} is contained in both of these, inducing endogeneity in a sectoral regression.

(8) ★ As Model (7) but slope coefficients now differ across countries and sectors — for the latter we specify $\beta_i^m = 1 - \beta_i^a$.

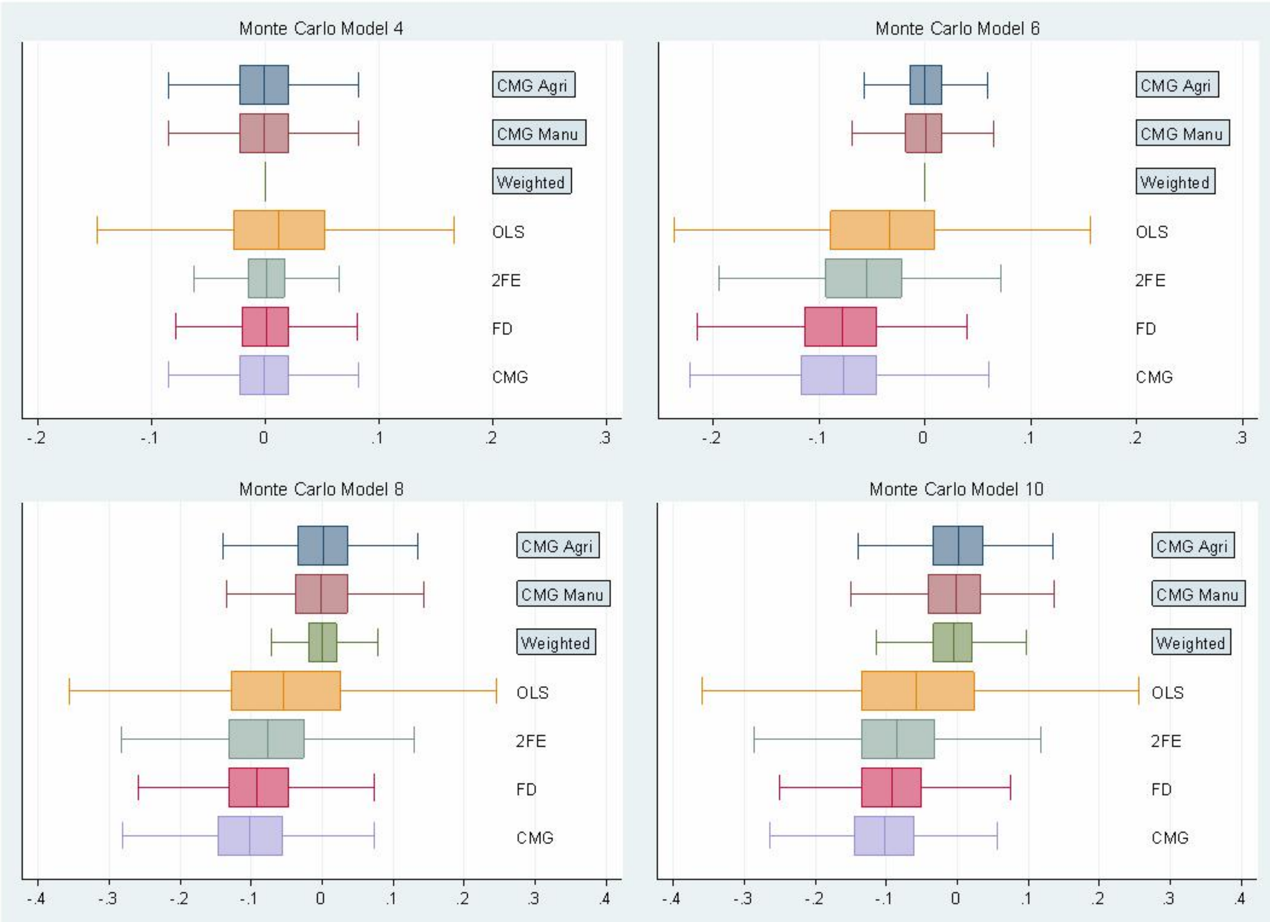
(9) As Model (8) except we now have independent slope coefficients across sectors with means $\beta^m = 0.3$ and $\beta^a = 0.5$.

(10) ★ As Model (9) but we now have the same factor f_{1t} contained in y and x-equations of both sectors, although with differential (and independent) factor loadings.

Models (1) to (4) analyse a homogeneous parameter world without common factors, where aggregation should lead to no problems for estimation. Models (5) to (7) show what happens when factors are introduced. Models (8) and (9) introduce parameter heterogeneity across sectors and Model (10) adds factor-overlap between sectors (on top of overlap across variables within sector).

S3.2 Overview of results

Figure 1: Box plots — Simulation results



Notes: We present box plots for the $M = 1,000$ estimates using various estimators under 4 DGP setups. In all cases the true coefficient is subtracted from the estimates, such that the plots are centred around zero.
The estimators are as follows: 'CMG Agri' and 'CMG Manu' — Pesaran (2006) CMG regressions on the *sector-level* data; Weighted — this is *not* an estimator but the weighted average $\beta^a s_i^a + \beta^m s_i^m$ with β^j the mean sectoral slope coefficient and s_j the sectoral share of total output; the remaining four estimators use the aggregated data: OLS — pooled OLS with $T-1$ year dummies; 2FE — OLS with country and time dummies; FD — OLS with variables in first differences (incl. time dummies); CMG — Pesaran (2006) CMG. We omit the results for the Pesaran and Smith (1995) MG estimator as these are very imprecise and would counter the readability of the graphs. The MC setups are described in detail in Section S3.1 of the Appendix.

S3.3 Detailed results

Table 3: Simulation results

	Model 1					Model 2			
	mean	median	ste$^\bullet$	ste$^\flat$		mean	median	ste$^\bullet$	ste$^\flat$
CMG Agri	0.4999	0.4990	0.0318	0.0324	CMG Agri	0.5007	0.4996	0.0425	0.0424
CMG Manu	0.4999	0.4990	0.0318	0.0324	CMG Manu	0.5007	0.4996	0.0425	0.0424
Weighted	0.5000	0.5000	0.0000		Weighted	0.5007	0.4998	0.0289	
POLS	0.5054	0.5064	0.0462	0.0298	POLS	0.5058	0.5065	0.0572	0.0304
2FE	0.5002	0.5005	0.0248	0.0226	2FE	0.5014	0.5007	0.0392	0.0232
FD	0.5000	0.5007	0.0295	0.0257	FD	0.5014	0.5014	0.0441	0.0262
CCEP	0.4996	0.4997	0.0292	0.0271	CCEP	0.5008	0.5001	0.0424	0.0276
MG	0.4993	0.4987	0.0276	0.0283	MG	0.5001	0.4993	0.0389	0.0399
CMG	0.4999	0.4990	0.0318	0.0324	CMG	0.5007	0.4996	0.0425	0.0424
	Model 3					Model 4			
	mean	median	ste$^\bullet$	ste$^\flat$		mean	median	ste$^\bullet$	ste$^\flat$
CMG Agri	0.4999	0.4990	0.0318	0.0324	CMG Agri	0.4999	0.4990	0.0318	0.0324
CMG Manu	0.4999	0.4990	0.0318	0.0324	CMG Manu	0.4999	0.4990	0.0318	0.0324
Weighted	0.5000	0.5000	0.0000		Weighted	0.5000	0.5000	0.0000	
POLS	0.5310	0.5280	0.1968	0.1128	POLS	0.5119	0.5112	0.0593	0.0365
2FE	0.5002	0.5005	0.0248	0.0226	2FE	0.5002	0.5005	0.0248	0.0226
FD	0.5000	0.5007	0.0295	0.0257	FD	0.5000	0.5007	0.0295	0.0257
CCEP	0.4996	0.4997	0.0292	0.0271	CCEP	0.4996	0.4997	0.0292	0.0271
MG	0.4993	0.4987	0.0276	0.0283	MG	0.4993	0.4987	0.0276	0.0283
CMG	0.4999	0.4990	0.0318	0.0324	CMG	0.4999	0.4990	0.0318	0.0324
	Model 5					Model 6			
	mean	median	ste$^\bullet$	ste$^\flat$		mean	median	ste$^\bullet$	ste$^\flat$
CMG Agri	0.4993	0.4987	0.0299	0.0298	CMG Agri	0.5005	0.5002	0.0238	0.0233
CMG Manu	0.5000	0.5014	0.0311	0.0321	CMG Manu	0.4994	0.5004	0.0253	0.0246
Weighted	0.5000	0.5000	0.0000		Weighted	0.5000	0.5000	0.0000	
POLS	0.4936	0.4936	0.0753	0.0432	POLS	0.4558	0.4669	0.1059	0.0197
2FE	0.4563	0.4571	0.0331	0.0266	2FE	0.4382	0.4450	0.0588	0.0176
FD	0.4427	0.4416	0.0418	0.0268	FD	0.4181	0.4224	0.0517	0.0219
CCEP	0.4516	0.4502	0.0327	0.0278	CCEP	0.4231	0.4326	0.0522	0.0186
MG	0.4663	0.4687	0.3257	0.0369	MG	0.4305	0.4333	0.1816	0.0496
CMG	0.4498	0.4497	0.0362	0.0379	CMG	0.4161	0.4226	0.0516	0.0342
	Model 7					Model 8			
	mean	median	ste$^\bullet$	ste$^\flat$		mean	median	ste$^\bullet$	ste$^\flat$
CMG Agri	0.5000	0.4998	0.0448	0.0436	CMG Agri	0.5009	0.5020	0.0528	0.0520
CMG Manu	0.4979	0.4972	0.0454	0.0445	CMG Manu	0.4986	0.4978	0.0550	0.0528
Weighted	0.5000	0.5000	0.0000		Weighted	0.5007	0.4998	0.0289	
POLS	0.4405	0.4469	0.1212	0.0236	POLS	0.4459	0.4452	0.1299	0.0248
2FE	0.4143	0.4161	0.0700	0.0210	2FE	0.4217	0.4234	0.0807	0.0220
FD	0.4027	0.4011	0.0541	0.0238	FD	0.4106	0.4073	0.0635	0.0245
CCEP	0.3956	0.3987	0.0619	0.0227	CCEP	0.4040	0.4047	0.0702	0.0233
MG	0.6759	0.6585	0.2510	0.0782	MG	0.6826	0.6644	0.2532	0.0828
CMG	0.3897	0.3928	0.0584	0.0496	CMG	0.3985	0.3976	0.0650	0.0560
	Model 9					Model 10			
	mean	median	ste$^\bullet$	ste$^\flat$		mean	median	ste$^\bullet$	ste$^\flat$
CMG Agri	0.5009	0.5020	0.0528	0.0520	CMG Agri	0.5009	0.5020	0.0528	0.0520
CMG Manu	0.2961	0.2972	0.0543	0.0526	CMG Manu	0.2961	0.2972	0.0543	0.0526
Weighted	0.3924	0.3928	0.0391		Weighted	0.3939	0.3946	0.0391	
POLS	0.3383	0.3388	0.1324	0.0246	POLS	0.3400	0.3415	0.1322	0.0246
2FE	0.3151	0.3127	0.0814	0.0217	2FE	0.3163	0.3144	0.0816	0.0217
FD	0.3074	0.3053	0.0625	0.0242	FD	0.3086	0.3071	0.0626	0.0242
CCEP	0.2963	0.2973	0.0666	0.0229	CCEP	0.2976	0.2986	0.0667	0.0229
MG	0.5793	0.5562	0.2558	0.0814	MG	0.5796	0.5561	0.2558	0.0815
CMG	0.2956	0.2962	0.0625	0.0543	CMG	0.2970	0.2976	0.0627	0.0544

Notes: See Section S3.1 in the Appendix for details on the estimators and the DGP in each of the experiments. ste$^\bullet$ marks the empirical standard error and ste$^\flat$ the mean standard error from 1,000 replications. 'CMG Agri' and 'CMG Manu' employ the sector-level data, 'Weighted' calculates the aggregate slope coefficient based on the size (output) and slope of the respective sector, the remaining six estimators use the aggregated data.

S4 Additional tables and figures

Table 4: Pooled regression models (HC-augmented)

PANEL (A): UNRESTRICTED RETURNS TO SCALE

	Agriculture					*Manufacturing*				
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
	POLS	**2FE**	**CCEP**	**CCEP**$^\flat$	**FD**	**POLS**	**2FE**	**CCEP**	**CCEP**$^\flat$	**FD**
log labour	-0.079	-0.151	-0.457	-0.557	-0.085	0.005	0.029	0.121	-0.048	0.162
	[11.71]**	[4.35]**	[1.54]	[1.46]	[1.46]	[0.62]	[0.88]	[1.91]	[0.47]	[4.62]**
log capital pw	0.471	0.671	0.554	0.676	0.595	0.692	0.851	0.533	0.446	0.654
	[61.84]**	[27.20]**	[4.51]**	[4.32]**	[12.60]**	[44.38]**	[22.14]**	[8.00]**	[4.52]**	[14.56]**
log land pw	0.018	-0.020	-0.154	-0.174	0.111					
	[1.17]	[0.48]	[0.56]	[0.50]	[1.14]					
Education	0.241	0.087	0.007	-0.068	0.101	0.226	-0.006	0.152	-0.017	0.095
	[9.95]**	[3.12]**	[0.07]	[0.40]	[1.30]	[11.91]**	[0.21]	[2.04]*	[0.16]	[1.53]
Education^2	-0.010	-0.007	-0.003	0.005	-0.006	-0.009	0.002	-0.006	-0.004	-0.005
	[4.73]**	[4.15]**	[0.49]	[0.50]	[1.23]	[6.22]**	[1.39]	[1.32]	[0.66]	[1.10]
Implied RS†	CRS	CRS	CRS	CRS	IRS	CRS	CRS	CRS		IRS
Implied β_L‡	0.529	0.329	0.446	0.324	0.321	0.308	0.149	0.467		0.508
Mean Education	5.82	5.82	5.82	5.82	5.94	5.82	5.82	5.82	5.82	5.94
Returns to Edu	13.3%	0.7%	-2.9%	-0.7%	3.0%	12.3%	1.9%	8.5%	-6.6%	4.1%
[t-statistic]$^\flat$	[15.71]**	[0.50]	[0.68]	[0.11]	[0.78]	[19.88]**	[1.30]	[3.11]**	[1.56]	[1.54]
$\hat{e}$ integrated$^\natural$	I(1)	I(1)	I(0)	I(1)/I(0)	I(0)	I(1)	I(1)	I(0)	I(0)	I(0)
CD test p-value$^\sharp$	0.11	0.09	0.14	0.21	0.00	0.87	0.18	0.58	0.84	0.00
R-squared	0.91	0.57	1.00	1.00	-	0.91	0.57	1.00	1.00	-
Observations	830	830	830	775	793	860	860	860	775	817

PANEL (B): CONSTANT RETURNS TO SCALE IMPOSED

	Agriculture					*Manufacturing*				
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
	POLS	**2FE**	**CCEP**	**CCEP**$^\flat$	**FD**	**POLS**	**2FE**	**CCEP**	**CCEP**$^\flat$	**FD**
log capital pw	0.502	0.720	0.592	0.709	0.611	0.695	0.839	0.472	0.463	0.558
	[59.09]**	[33.18]**	[5.32]**	[5.08]**	[13.29]**	[49.18]**	[24.30]**	[8.87]**	[5.59]**	[13.85]**
log land pw	0.014	0.078	0.144	0.122	0.124					
	[0.71]	[2.23]*	[0.99]	[0.69]	[1.27]					
Education	0.278	0.069	-0.003	-0.031	0.107	0.226	0.014	0.234	0.036	0.220
	[11.54]**	[2.48]*	[0.03]	[0.23]	[1.38]	[11.80]**	[0.71]	[3.67]**	[0.38]	[3.91]**
Education^2	-0.012	-0.005	0.000	0.002	-0.006	-0.009	0.001	-0.010	-0.007	-0.010
	[6.17]**	[3.19]**	[0.06]	[0.28]	[1.26]	[6.11]**	[0.98]	[2.55]*	[1.22]	[2.41]*
Implied β_L‡	0.498	0.202	0.408	0.291	0.389	0.305	0.162	0.528	0.537	0.443
Mean Education	5.82	5.82	5.82	5.82	5.94	5.82	5.82	5.82	5.82	5.94
Returns to Edu	13.9%	0.8%	-0.7%	-0.3%	3.4%	12.3%	2.7%	11.7%	-4.3%	10.5%
[t-statistic]$^\spadesuit$	[16.25]**	[0.52]	[0.18]	[0.07]	[0.90]	[20.20]**	[2.30]*	[5.25]**	[1.18]	[4.62]**
$\hat{e}$ integrated$^\natural$	I(1)	I(1)	I(0)	I(1)/I(0)	I(0)	I(1)	I(1)	I(0)	I(1)/I(0)	I(0)
CD test p-value$^\sharp$	0.29	0.23	0.07	0.23	0.00	0.88	0.04	0.08	0.02	0.00
R-squared	0.91	0.57	1.00	1.00	-	0.91	0.57	1.00	1.00	-
Observations	830	830	830	775	793	860	860	860	775	817

Notes: We include our proxy for education in levels and as a squared term. Returns to Education are computed from the sample mean ($\bar{E}$) as $\hat{\beta}_E + 2\hat{\beta}_{E2}\bar{E}$ where $\hat{\beta}_E$ and $\hat{\beta}_{E2}$ are the coefficients on the levels and squared education terms respectively. $\spadesuit$ computed via the delta-method. For more details see Notes of Table 1 of the main text.

Table 5: Heterogeneous Manufacturing models (HC-augmented)

	Panel (A): Unrestricted			Panel (B): CRS imposed		
	[1] **MG**	[2] **FDMG**	[3] **CMG**	[4] **MG**	[5] **FDMG**	[6] **CMG**
log labour	-0.305	-0.293	0.097			
	[1.20]	[1.50]	[0.62]			
log capital pw	0.059	0.144	0.426	0.352	0.347	0.386
	[0.22]	[0.74]	[3.73]**	[3.25]**	[3.66]**	[3.95]**
Education	-0.478	0.237	1.248	-0.228	0.085	0.668
	[1.02]	[0.81]	[2.66]*	[0.62]	[0.29]	[2.43]*
Education squared	0.050	0.011	-0.098	0.005	-0.019	-0.042
	[1.38]	[0.35]	[2.67]*	[0.13]	[0.67]	[1.95]
country trend/drift	0.016	0.020		0.008	0.013	
	[1.55]	[2.44]*		[1.16]	[2.23]*	
reject CRS (10%)	38%	8%	38%			
Implied β_L‡	n/a	0.857	0.574	0.648	0.653	0.614
Mean Education	5.82	5.91	5.82	5.87	5.94	5.87
Returns to Edu	-6.3%	-1.3%	10.9%	-6.2%	-2.1%	11.9%
[t-statistic]♭	[1.01]	[0.25]	[1.89]	[1.00]	[0.47]	[1.70]
sign. trends (10%)	15	9		17	7	
$\hat{e}$ integrated♮	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
CD-test (p)♯	0.00	0.00	0.71	0.00	0.00	0.27
Obs (N)	775 (37)	732 (37)	775 (37)	775 (37)	732 (37)	775 (37)

Notes: All averaged coefficients presented are robust means across i. ♭ The returns to education and associated t-statistics are based on a two-step procedure: first the country-specific mean education value ($\bar{E}_i$) is used to compute $\hat{\beta}_{i,E} + 2\hat{\beta}_{i,E2}\bar{E}_i$ to yield the country-specific returns to education. The reported value then represents the robust mean of these N country estimates, s.t. the t-statistic should be interpreted in the same fashion as that for the regressors, namely as a test whether the average parameter is statistically different from zero, following Pesaran and Smith (1995). For other details see Notes for Tables 2 (main text) and 4 (above).

Table 6: Aggregate & PWT data: Pooled models (HC-augmented)

PANEL (A): UNRESTRICTED RETURNS

	Aggregated data				Penn World Table data			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
	POLS	**2FE**	**CCEP**	**FD**	**POLS**	**2FE**	**CCEP**	**FD**
log labour	-0.001	-0.058	0.566	0.083	0.040	-0.064	-0.193	-0.032
	[0.14]	[1.97]*	[4.13]**	[2.50]*	[8.99]**	[3.27]**	[1.49]	[1.11]
log capital pw	0.662	0.782	0.677	0.766	0.725	0.680	0.601	0.676
	[97.95]**	[31.50]**	[7.25]**	[25.24]**	[72.79]**	[24.79]**	[9.12]**	[18.96]**
Education	0.243	-0.004	0.086	0.065	0.041	0.043	0.032	0.103
	[16.97]**	[0.15]	[1.24]	[1.22]	[3.42]**	[2.86]**	[0.80]	[3.41]**
Education squared	-0.010	0.003	-0.007	-0.003	-0.001	-0.002	-0.002	-0.006
	[8.05]**	[1.82]	[1.57]	[0.77]	[1.77]	[2.97]**	[0.83]	[2.94]**
Implied RS†	CRS	DRS	CRS	CRS	CRS	DRS	CRS	CRS
Implied β_L‡	0.337	0.160	0.890	0.318	0.315	0.256	0.206	0.292
Mean Education	5.824	5.824	5.824	5.885	5.822	5.822	5.822	5.883
Returns to Edu	12.9%	2.5%	1.0%	3.4%	2.4%	1.9%	0.9%	3.3%
[t-statistic]$^\flat$	[22.35]**	[1.68]	[0.37]	[1.40]	[6.82]**	[2.02]*	[0.56]	[2.26]*
$\hat{e}$ integrated$^\natural$	I(1)	I(1)	I(0)	I(0)	I(1)	I(1)	I(0)	I(1)/I(0)
CD test p-value$^\sharp$	0.00	0.02	0.59	0.00	0.34	0.22	0.01	0.00
R-squared	0.98	0.87	1.00	-	0.97	0.78	1.00	-
Observations	775	775	775	732	769	769	769	726

PANEL (B): CONSTANT RETURNS TO SCALE IMPOSED

	Aggregated data				Penn World Table data			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
	POLS	**2FE**	**CCEP**	**FD**	**POLS**	**2FE**	**CCEP**	**FD**
log capital pw	0.662	0.798	0.485	0.744	0.694	0.706	0.611	0.691
	[102.10]**	[35.45]**	[7.03]**	[25.48]**	[73.08]**	[27.73]**	[10.05]**	[21.13]**
Education	0.243	-0.016	0.210	0.111	0.043	0.037	0.016	0.092
	[16.98]**	[0.62]	[3.00]**	[2.21]*	[3.30]**	[2.44]*	[0.48]	[3.22]**
Education squared	-0.010	0.004	-0.013	-0.005	-0.001	-0.002	-0.002	-0.006
	[8.17]**	[2.75]**	[2.92]**	[1.37]	[0.97]	[2.12]*	[0.95]	[2.79]**
Constant	1.586				1.843			
	[21.62]**				[20.44]**			
Implied β_L‡	0.338	0.203	0.515	0.256	0.306	0.294	0.390	0.309
Mean Education	5.824	5.824	5.824	5.885	5.822	5.824	5.824	5.883
Returns to Edu	12.9%	2.6%	6.5%	5.8%	3.3%	2.0%	-0.6%	2.7%
[t-statistic]$^\flat$	[22.41]**	[1.68]	[2.56]**	[2.56]**	[8.62]**	[1.99]*	[0.42]	[1.98]*
$\hat{e}$ integrated$^\natural$	I(1)	I(1)	I(0)	I(0)	I(1)	I(1)	I(0)	I(0)
CD test p-value$^\sharp$	0.00	0.00	0.65	0.00	0.25	0.57	0.02	0.00
R-squared	0.98	0.86	1.00		0.97	0.78	1.00	
Observations	775	775	775	732	769	769	769	726

Notes: We include our proxy for education in levels and as a squared term. Returns to Education are computed from the sample mean ($\bar{E}$) as $\hat{\beta}_E + 2\hat{\beta}_{E2}\bar{E}$ where $\hat{\beta}_E$ and $\hat{\beta}_{E2}$ are the coefficients on the levels and squared education terms respectively. $\flat$ computed via the delta-method. For more details see Notes for Tables 3 (in the main text) and (for the education variables) 4 above.

Table 7: Aggregate & PWT data: Heterogeneous models with HC

Panel (A): Unrestricted returns to scale

	Aggregated data			*Penn World Table data*		
	[1] **MG**	[2] **FDMG**	[3] **CMG**	[4] **MG**	[5] **FDMG**	[6] **CMG**
log labour	-0.066	0.269	-0.428	-1.609	-2.478	-1.324
	[0.16]	[0.57]	[1.22]	[1.97]	[3.76]**	[2.79]**
log capital pw	-0.070	-0.021	0.453	0.963	1.245	1.122
	[0.26]	[0.07]	[2.47]*	[4.44]**	[5.99]**	[5.52]**
Education	0.601	0.637	0.489	0.123	0.004	-0.012
	[1.29]	[1.75]	[0.98]	[0.52]	[0.02]	[0.05]
Education squared	-0.089	-0.065	-0.063	-0.002	0.004	-0.001
	[1.76]	[1.70]	[1.48]	[0.11]	[0.25]	[0.03]
country trend/drift	0.005	0.005		0.021	0.008	
	[0.33]	[0.29]		[2.25]*	[0.77]	
Implied RS†	CRS	CRS	CRS	CRS	DRS	DRS
Implied β_L‡	n/a	n/a	0.547	n/a	n/a	n/a
reject CRS (10%)	38%	3%	19%	38%	18%	33%
sign. trends (10%)	44%	32%		44%	10%	
Mean Education	5.72	5.84	5.72	5.72	5.84	5.72
Returns to edu	-7.1%	-3.2%	-11.1%	-4.5%	0.5%	1.3%
[t-statistic]♭	[1.33]	[0.65]	[1.24]	[1.33]	[0.18]	[0.43]
$\hat{e}$ integrated♮	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
CD-test (p)♯	7.23(.00)	7.88(.00)	-0.50(.61)	7.59.00)	9.29.00)	0.98(.33)

Panel (B): CRS imposed

	Aggregated data			*Penn World Table data*		
	[1] **MG**	[2] **FDMG**	[3] **CMG**	[4] **MG**	[5] **FDMG**	[6] **CMG**
log capital pw	0.093	0.151	0.528	0.779	1.052	0.906
	[0.49]	[0.90]	[4.90]**	[5.75]**	[6.43]**	[5.86]**
Education	0.075	0.260	0.683	-0.215	-0.134	0.089
	[0.18]	[0.99]	[1.73]	[1.25]	[0.84]	[0.42]
Education squared	-0.023	-0.023	-0.075	0.013	0.014	-0.023
	[0.65]	[0.89]	[1.57]	[0.82]	[1.13]	[1.16]
country trend/drift	0.017	0.015		-0.001	-0.010	
	[1.96]	[1.33]		[0.21]	[2.08]*	
Implied β_L‡	n/a	n/a	0.472	0.221	n/a	0.094
sign. trends (10%)	37%	32%		37%	34%	
Mean Education	5.79	5.84	5.79	5.79	5.84	5.79
Returns to edu	-9.3%	-4.0%	3.2%	-1.4%	0.3%	-0.2%
[t-statistic]♭	[1.34]	[0.88]	[0.50]	[0.50]	[0.16]	[0.05]
$\hat{e}$ integrated♮	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
CD-test (p)♯	8.05(.00)	8.59(.00)	0.11(.92)	9.75(.00)	10.84(.00)	3.12(.00)

Notes: All averaged coefficients presented are robust means across i. ♭ The returns to education and associated t-statistics are based on a two-step procedure: first the country-specific mean education value ($\bar{E}_i$) is used to compute $\beta_{i,E} + 2\beta_{i,E2}\bar{E}_i$ to yield the country-specific returns to education. The reported value then represents the robust mean of these N country estimates, s.t. the t-statistic should be interpreted in the same fashion as that for the regressors, namely as a test whether the average parameter is statistically different from zero, following Pesaran and Smith (1995). For other details see Notes for Tables 2 (in the main text) and 5 above.

Table 8: Alternative dynamic panel estimators

Panel (A): Agriculture

	Dynamic FE			PMG				CPMG⋆			DGMM	SGMM
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
EC [y_{t-1}]	-0.293	-0.312	-0.300	-0.460	-0.459	-0.624	-0.466	-0.482	-0.503	-0.455	-1.087	-0.432
	[11.80]**	[12.43]**	[11.91]**	[10.63]**	[9.34]**	[14.29]**	[10.44]**	[10.06]**	[9.74]**	[9.34]**	[2.60]**	[5.38]**
capital pw	0.672	0.684	0.582	0.652	0.714	0.036	0.132	0.501	0.464	0.530	1.135	0.776
	[12.47]**	[12.69]**	[7.50]**	[20.16]**	[18.52]**	[0.57]	[3.01]**	[10.78]**	[11.05]**	[10.83]**	[2.85]**	[12.59]**
land pw	0.124	0.121	0.135	0.136	0.367	0.867	0.361	0.247	0.494	0.228	0.083	-0.247
	[1.30]	[1.29]	[1.45]	[2.90]**	[6.43]**	[8.27]**	[8.05]**	[5.03]**	[8.95]**	[4.73]**	[0.35]	[1.17]
trend(s)†			0.001			0.008	0.012					
			[1.59]			[3.36]**	[12.26]**					
Constant	0.667	0.679	0.896	1.072	0.644	4.273	3.084	1.545	1.402	1.298		0.714
	[5.03]**	[4.75]**	[4.58]**	[10.48]**	[7.53]**	[13.11]**	[10.27]**	[10.38]**	[9.69]**	[9.94]**		[4.21]**
lags [trends]‡	1	2	1 [l-r]	1	2	1 [s-r]	1 [l-r]	1	2	1	i: 2-3	i: 2-3
impl. labour	0.328	0.316	0.418	0.212	-0.081	0.098	0.507	0.253	0.042	0.242	-0.135	0.224
obs	894	857	894	894	857	894	894	894	857	872	857	894

Panel (B): Manufacturing

	Dynamic FE			PMG				CPMG⋆			DGMM	SGMM
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
EC [y_{t-1}]	-0.196	-0.195	-0.195	-0.219	-0.181	-0.543	-0.214	-0.245	-0.194	-0.272	-2.196	-0.041
	[9.40]**	[9.16]**	[9.31]**	[6.59]**	[5.97]**	[4.04]**	[4.13]**	[7.16]**	[6.45]**	[7.33]**	[0.72]	[0.65]
capital pw	0.711	0.708	0.637	1.016	1.044	0.298	1.379	0.598	1.264	0.505	1.866	-1.515
	[12.96]**	[12.34]**	[6.85]**	[29.64]**	[33.09]**	[5.34]**	[26.80]**	[11.58]**	[22.28]**	[9.47]**	[3.25]**	[0.40]
trend(s)†			0.001			0.001	-0.010					
			[1.00]			[0.24]	[6.77]**					
Constant	0.452	0.456	0.588	-0.212	-0.228	3.493	-0.977	0.225	-0.434	0.372		1.042
	[3.87]**	[3.73]**	[3.29]**	[5.43]**	[4.95]**	[3.87]**	[4.18]**	[5.68]**	[5.77]**	[6.48]**		[1.80]
lags [trends]‡	1	2	1 [l-r]	1	2	1 [s-r]	1 [l-r]	1	2	1	i: 2-3	i: 2-3
impl. labour	0.289	0.292	0.363	-0.016	-0.044	0.702	-0.379	0.402	-0.264	0.495	-0.866	2.515
obs	902	880	902	902	880	902	902	902	880	879	880	902

Panel (C): Aggregated data

	Dynamic FE			PMG				CPMG⋆			DGMM	SGMM
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
EC [y_{t-1}]	-0.172	-0.176	-0.173	-0.279	-0.277	-0.429	-0.284	-0.292	-0.294	-0.317	-0.380	-0.243
	[8.59]**	[8.39]**	[8.59]**	[6.89]**	[7.25]**	[9.55]**	[6.72]**	[6.98]**	[7.38]**	[7.48]**	[0.71]	[4.21]**
capital pw	0.705	0.709	0.668	0.974	1.015	0.128	0.899	0.891	0.949	0.905	0.271	0.896
	[15.25]**	[14.65]**	[8.17]**	[36.86]**	[37.38]**	[1.90]	[21.11]**	[24.84]**	[24.92]**	[27.54]**	[0.27]	[22.80]**
trend(s)†			0.000			0.011	0.004					
			[0.54]			[6.07]**	[2.42]*					
Constant	0.390	0.393	0.446	-0.100	-0.200	3.061	0.082	-0.062	-0.169	-0.145		0.120
	[4.96]**	[4.62]**	[3.42]**	[3.73]**	[5.18]**	[9.30]**	[4.20]**	[2.53]*	[4.97]**	[4.58]**		[1.44]
lags [trends]‡	1	2	1 [l-r]	1	2	1 [s-r]	1 [l-r]	1	2	1	i: 2-3	i: 2-3
impl. labour	0.295	0.292	0.332	0.026	-0.015	0.872	0.102	0.109	0.051	0.095	0.729	0.104
obs	879	836	879	879	836	879	879	879	836	879	836	879

Panel (D): Penn World Table data

	Dynamic FE			PMG				CPMG⋆			DGMM	SGMM
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
EC [y_{t-1}]	-0.098	-0.101	-0.107	-0.333	-0.138	-0.567	-0.392	-0.338	-0.081	-0.347	0.835	0.031
	[5.82]**	[6.01]**	[6.22]**	[6.70]**	[4.37]**	[12.63]**	[7.88]**	[6.63]**	[2.56]*	[8.24]**	[1.07]	[0.49]
capital pw	0.538	0.553	0.356	0.923	0.916	0.698	0.652	0.903	-0.125	0.731	0.604	0.863
	[8.14]**	[8.66]**	[3.44]**	[130.34]**	[71.72]**	[65.10]**	[67.96]**	[52.90]**	[1.81]	[86.83]**	[0.60]	[1.88]
trend(s)†			0.001			0.002	0.006					
			[2.44]*			[2.57]*	[19.84]**					
Constant	0.363	0.360	0.567	-0.122	-0.020	1.085	0.935	-0.071	0.456	0.504		0.010
	[5.38]**	[5.29]**	[5.28]**	[4.44]**	[1.63]	[13.05]**	[7.79]**	[3.47]**	[2.99]**	[8.29]**		[0.07]
lags [trends]‡	1	2	1 [l-r]	1	2	1 [s-r]	1 [l-r]	1	2	1	i: 2-3	i: 2-3
impl. labour	0.462	0.447	0.645	0.077	0.084	0.302	0.349	0.097	1.125	0.270	0.396	0.137
obs	914	904	914	914	904	914		914	904	873	904	914

Notes: All results are based on an unrestricted error correction model specification (ECM), which is equivalent to a first order autoregressive distributed-lag model, ARDL(1,1) (see Hendry, 1995, p.231f). We report the long-run coefficients on capital per worker (and in the agriculture equations also land per worker). EC [y_{t-1}] refers to the Error-Correction term (speed of adjustment parameter) with the exception of Models [11] and [12], where we report the coefficient on y_{t-1} — conceptually, these are the same, however in the latter we do not impose common factor restrictions like in all of the former models. Note that in the PMG and CPMG models the ECM term is heterogeneous across countries, while in the Dynamic FE and GMM models these are common across i. † In model [6] we include *heterogeneous* trend terms, whereas in [7] a *common* trend is assumed (i.e. linear TFP is part of cointegrating vector). ‡ 'lags' indicates the lag-length of first differenced RHS variables included, with the exception of Models [11] and [12]: here 'i:' refers to the lags (levels in [11], levels and differences in [12] used as instruments. ⋆ In the models in [8] and [9] the cross-section averages are only included for the long-run variables, whereas in the model in [10] cross-section averages for the first-differenced dependent and independent variables (short-run) are also included.

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