When Convergence Is Arithmetic: A Common-Increment Benchmark for Productivity

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Abstract

Equal absolute productivity gains imply faster percentage growth from lower levels, so negative convergence coefficients need not indicate catch-up. I decompose conventional beta into the coefficient implied by a common sample-mean absolute increment and a residual, and ask how robust measured international convergence is to benchmark and data vintage. In Penn World Table (PWT) TFP and a long-run advanced-country panel the benchmark ranges from more than all measured convergence to divergence, and out of sample it describes some samples better than proportional growth, others worse. Applied to the PWT team's 1990–2019 GDP-per-hour illustration, it implies six times the observed slope: relative to equal absolute gains, that near-global sample diverges. Across PWT 10.0, 10.01 and 11.0 on matched samples, conventional beta keeps its sign but the split moves, through a documented, nearly level-uncorrelated growth revision in 10.01 and through China and Venezuela in 11.0. Fixed-core production residuals never separate from zero.

JEL codes: O47, O33, C23.

Keywords: productivity convergence; additive growth; total factor productivity; beta convergence; data vintages.

1 Introduction

How much of measured international productivity catch-up is arithmetic? The standard beta-convergence regression asks whether initially less productive economies subsequently grow faster (Baumol, 1986; Barro and Sala-i Martin, 1992). A negative slope is commonly read as catch-up: technology diffusion, capital deepening, institutional improvement, or movement toward a common steady state. That reading presumes that percentage growth is the natural object to compare across initial levels. If productivity instead advances by similar absolute amounts across countries, the same advance is a larger percentage gain for the country that starts lower, and a negative slope appears with no catch-up at all.

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The premise has recent support. Jones et al. (2026), superseding Philippon (2022), find that U.S. TFP is better described by additive than exponential growth and report supporting evidence from forecasts and international series. The denominator intuition itself is prior art: Philippon (2022) contrasts absolute TFP increments with percentage-growth comparisons across advanced economies, noting how higher initial levels compress the latter. This paper does not claim to originate that observation.

It turns the observation into a diagnostic for cross-country data. For each country and window, I construct the growth rate implied by giving every country the balanced sample's mean annual absolute TFP increment, and subtract it from observed growth. Because the operation is performed country by country before estimation, the conventional convergence coefficient is exactly the sum of a denominator (benchmark) coefficient and a residual coefficient. Additive accounting of beta coefficients has precedent in the convergence literature (de la Fuente, 2001); the contribution here is the particular common-level-increment counterfactual and a matched-country, matched-window, matched-release map of where it is large, where its sign reverses, and when its residual interpretation is fragile. The common increment is estimated from the same outcomes being decomposed. It is not an identified technology shock, and residual beta is not a causal estimate of diffusion.

Three findings follow. First, the benchmark is economically large but regime-dependent. In 1959/60–1979/80 it accounts for most or more of measured convergence in both PWT and the Bergeaud–Cette–Lecat (BCL) advanced-country panel. In PWT 1979–1999 the sample-mean TFP increment is negative, so the benchmark predicts divergence while residual growth converges. After 1999 the expanding-sample split is roughly even. Second, the split depends on the productivity concept and on country composition. Production and welfare TFP agree after 1999 but not before; OECD labor-productivity convergence inside an ex-post rich club is almost entirely arithmetic; near-global Maddison GDP per capita hides a large arithmetic component beneath a near-zero conventional beta. Third, and most relevant to anyone estimating catch-up on PWT, the split is not invariant to the data release even though the sign of conventional beta is. On identical countries and windows, PWT 10.0, 10.01, and 11.0 give negative conventional beta in every window, but in the fixed 60-country core the post-1999 production residual point estimate moves from $+0.0014$ to -0.0010 to -0.0034. I show why. The 10.01 change is a documented change in the construction of investment-price deflators that lowered measured 1999–2019 TFP growth in 59 of the 60 countries, with revisions nearly uncorrelated with initial level (Gouma et al., 2023); conventional beta moved by only $+0.0006$, but the sample-mean increment fell by two-thirds, raising denominator beta by 0.0030 and hence lowering residual beta by 0.0024. The 11.0 change is concentrated in two countries: China's switch to official national accounts (Inklaar and Gräler, 2025) and Venezuela's revised 1999 level. In every release the fixed-core residual interval includes zero. Finally, applied to the PWT team's own 1990–2019 illustration (Marapin et al., 2023), in which a slope of -0.21 per doubling of GDP per hour is attributed mainly to TFP, the benchmark implies a slope of -1.26: measured convergence in that near-global sample is one sixth of what equal absolute gains would produce, and a held-out comparison indicates that growth there was closer to proportional than additive.

The input accounting is untouched; the scale against which it is read changes.

The contribution is methodological and interpretive. This is not a new causal determinant of productivity, nor does it eliminate genuine catch-up. It supplies a specification check when an additive or mixed productivity process is plausible, and it records a property of that check: because the benchmark depends on the level of a small sample mean, same-signed revisions to measured growth that are uncorrelated with initial level move the split while leaving the conventional slope almost unchanged. Classical critiques of beta convergence emphasize ex-post sample selection (De Long, 1988) and regression to the mean (Friedman, 1992; Quah, 1993); convergence-accounting exercises already split beta into additive factor contributions (de la Fuente, 2001). The diagnostic here instead asks what beta would be under a common *level* increment in the observed sample. Its practical implication is that a convergence estimate on PWT should report the release, the country set, conventional beta, and both components. The benchmark is not an empirically identified component of technological progress.

2 The denominator decomposition

Let $A_{i0} > 0$ denote country i's initial productivity and let the observation window contain T years. Write its endpoint as

$$A_{iT} = A_{i0} + T\bar{\Delta} + U_i, \tag{1}$$

where $\bar{\Delta}$ is the cross-country mean annual absolute increment in the balanced sample and U_i is the remaining cumulative increment. Observed annual log growth is

$$g_i = \frac{1}{T} \log\left(\frac{A_{iT}}{A_{i0}}\right). \tag{2}$$

Define the common-increment or denominator benchmark

$$g_i^D = \frac{1}{T} \log\left(\frac{A_{i0} + T\bar{\Delta}}{A_{i0}}\right) = \frac{1}{T} \log\left(1 + \frac{T\bar{\Delta}}{A_{i0}}\right), \tag{3}$$

and residual growth $g_i^R = g_i - g_i^D$. This log benchmark is defined only when $A_{i0} + T\bar{\Delta} > 0$ for every included country. The implementation rejects a window otherwise; every reported primary and matched-release window passes this check. Regressing each component on $a_{i0} = \log A_{i0}$ with the same sample and controls yields

$$\hat{\beta} = \hat{\beta}^D + \hat{\beta}^R. \tag{4}$$

This identity follows from OLS linearity and, as an accounting device, does not by itself establish a new convergence mechanism (de la Fuente, 2001). It does not rely on the common-increment model being true. The mean absolute increment is a within-sample counterfactual chosen for transparency. Countries may have different shocks, measurement error, institutions, or frontier exposure; all of these can affect both the benchmark and the residual. Neither coefficient is a causal parameter.

The benchmark's sign is informative. Its local slope is

$$\frac{\partial g_i^D}{\partial \log A_{i0}} = -\frac{\bar{\Delta}}{A_{i0} + T\bar{\Delta}}. \tag{5}$$

When $\bar{\Delta} > 0$, identical absolute advances mechanically imply beta convergence. When $\bar{\Delta} < 0$, an identical absolute loss is proportionally larger for initially less productive countries and mechanically implies divergence. When $\bar{\Delta} = 0$, the component vanishes. Thus the benchmark's algebraic sign can reverse; it does not manufacture a negative coefficient in every sample. Observing this sign pattern alone is not a test that actual productivity growth follows an additive law. Under common proportional growth, $A_{iT} = A_{i0}e^{gT}$, all countries have the same log growth and $\hat{\beta} = 0$. If $g > 0$, the sample-mean absolute increment is positive, so $\hat{\beta}^D < 0$ and $\hat{\beta}^R > 0$ exactly offset. For example, assigning 2-percent annual proportional growth for 20 years to the 60 PWT 10.0 fixed-core production start levels in 1999 gives $\hat{\beta} = 0$, $\hat{\beta}^D = -0.0201$, and $\hat{\beta}^R = +0.0201$. A positive residual beta can therefore represent proportional growth rather than economically meaningful divergence.

The ratio $s^D = \hat{\beta}^D/\hat{\beta}$ is reported only when conventional beta is negative. It is descriptive, not a structural share. Values above one mean residual growth offsets some mechanically predicted convergence; negative values mean denominator arithmetic opposes observed convergence. Near-zero conventional beta makes the ratio unstable, so the two coefficient components are the primary estimands.

A further property matters for the release comparison below. Write $w_i = (a_{i0} - \bar{a})/\sum_j (a_{j0} - \bar{a})^2$ for the OLS weights of the unconditional regression, so that $\hat{\beta} = \sum_i w_i g_i$ and $\hat{\beta}^D = \sum_i w_i g_i^D$ with $\sum_i w_i = 0$. Consider a revision that changes country i's measured annual growth by δ_i while leaving its initial level A_{i0} fixed, as a pure growth-path revision does under the start-year anchoring of Section 3. Then $\hat{\beta}$ moves by exactly $\sum_i w_i \delta_i = \mathrm{cov}(\delta_i, a_{i0})/\mathrm{var}(a_{i0})$ in sample moments: zero for a uniform change, and small when the changes are nearly uncorrelated with initial level. The same revision multiplies each endpoint A_{iT} by $e^{T\delta_i}$ and therefore changes $\bar{\Delta}$ by approximately the sample mean of $\delta_i A_{iT}$, a change that can be large relative to a small $\bar{\Delta}$ even when every δ_i is small. With initial levels fixed, $\hat{\beta}^D$ is strictly decreasing in $\bar{\Delta}$ and equals zero at $\bar{\Delta} = 0$, so a downward revision (negative δ_i) raises $\hat{\beta}^D$: toward zero while $\bar{\Delta}$ remains positive, and through zero if its sign flips. By the identity, $\hat{\beta}^R$ absorbs the difference. The decomposition therefore attributes a same-signed, level-uncorrelated growth revision largely to the residual. This is a limitation of the diagnostic, and Section 6 shows that it is what one PWT release did.

3 Data and empirical design

The archived primary source is Penn World Table 10.0, which covers 183 countries from 1950 through 2019 (Feenstra et al., 2015; Groningen Growth and Development Centre, 2021). The 10.01 release enters as an intermediate comparison (Groningen Growth and Development Centre, 2023). PWT distinguishes variables suitable for within-country growth from variables suitable for cross-country

level comparisons. For production TFP, I anchor each country's `rtfpna` path to its start-year `ctfp` level. I apply the same bridge to welfare-relevant `rwtfpna` and `cwtfp`. This preserves within-country changes while making initial levels comparable across countries in each window.

Two later releases are compared on the exact PWT 10.0 country sets and windows rather than silently replacing the primary vintage. PWT 10.01 is a minor revision whose release note describes a single methodological change: asset-price deflators are now normalised to the national-accounts investment deflator before, rather than after, ICT prices are harmonised to U.S. quality-adjusted deflators. This primarily affects the `*na` growth variables, including `rtfpna` and `rwtfpna`, lowering average 1970–2010 TFP growth across the 118 countries with TFP data from 0.41 to 0.22 percent per year while the cross-country correlation of growth rates between the two releases is 0.98–0.99; the note states that the `c*` level variables are primarily determined by purchasing power parities, which are unchanged, although it lists `ctfp` and `cwtfp` among the affected variables (Gouma et al., 2023). PWT 11.0 is a major revision with the same variable definitions: it incorporates ICP 2021 purchasing power parities with a 2021 reference year, national-accounts revisions through 2023, and official GDP data for China in place of the alternative Wu series previously used; the two Chinese series differ by 3.3 percentage points of annual growth over 1979–1998 and 1.3 points over 1998–2021 (Groningen Growth and Development Centre, 2025; Inklaar and Gräler, 2025). Because the bridge uses a level anchor and a growth path, each release difference can be split exactly into an anchor channel, a growth-path channel, and an interaction term by combining one release's start-year `ctfp` with the other release's `rtfpna` ratio.

The second frozen source is the long-term productivity database of Bergeaud et al. (2016). Its PPP-converted TFP levels provide a balanced panel of 23 advanced economies and a different measurement architecture. The primary estimates use the locally archived release through 2022. The February 2026 version 2.7 extends through 2024 and revises historical sources (Bergeaud et al., 2026); the matched-version check below retains the original 23 countries and 1960–2020 endpoints, excluding the new `ZE` aggregate.

The primary design uses non-overlapping 20-year windows: 1960–1980, 1980–2000, and 2000–2020 in BCL; and 1959–1979, 1979–1999, and 1999–2019 in PWT. Sampling uncertainty is obtained from 1,999 country bootstrap draws within each window. I do not treat rolling windows as independent replications. Rolling estimates at five-year intervals and horizons of 10, 15, 20, 25, and 30 years are descriptive stability checks.

The benchmark is intentionally sparse. I therefore separate robustness checks along three margins. First, I hold country composition fixed at the intersection observed in all four endpoints: 23 BCL countries and 60 countries for each PWT concept. Second, I replace the mean absolute increment with the median and a symmetric 10-percent trimmed mean. Third, for PWT I add start-year log human capital and log capital–output ratio to all three regressions. The controls proxy for steady-state heterogeneity without conditioning on subsequent outcomes. Because every component uses the same design matrix and observations, the conditional coefficient identity remains exact.

4 Results

Table 1 reports the exact coefficient decomposition. Early-period convergence is almost entirely consistent with a common absolute increment. In BCL over 1960–1980, conventional beta is −0.0255 and denominator beta is −0.0205. In PWT over 1959–1979, denominator beta slightly exceeds conventional beta for both production and welfare TFP, leaving a residual coefficient near zero or positive.

Table 1: Conventional beta and its two components

Dataset	Period	N	Conventional β	Denominator β^D	Residual β^R
BCL PPP	1960–1980	23	-0.0255	-0.0205	-0.0050
BCL PPP	1980–2000	23	-0.0082	-0.0124	0.0042
BCL PPP	2000–2020	23	0.0080	-0.0054	0.0134
PWT production	1959–1979	60	-0.0116	-0.0120	0.0004
PWT production	1979–1999	91	-0.0054	0.0032	-0.0086
PWT production	1999–2019	118	-0.0145	-0.0071	-0.0074
PWT welfare	1959–1979	60	-0.0102	-0.0132	0.0029
PWT welfare	1979–1999	91	-0.0103	0.0055	-0.0158
PWT welfare	1999–2019	118	-0.0176	-0.0092	-0.0083

Notes: Annual log TFP growth is regressed on log initial TFP. The denominator component gives every country the balanced sample's mean annual absolute increment. Residual beta is conventional beta minus denominator beta. The identity holds up to displayed rounding.

The middle period reverses the benchmark sign. From 1979 to 1999, PWT 10.0's common absolute increment is negative. The denominator coefficient is therefore positive: 0.0032 for production TFP and 0.0055 for welfare TFP. Conventional convergence in that period comes from residual beta, not denominator arithmetic. The production mean-increment bootstrap interval includes zero, however, so its sign is less precisely estimated than the welfare counterpart. This sign reversal shows that the procedure does not label every sample convergent.

Table 2: Mean absolute increments determine the benchmark sign

Dataset	Period	Mean increment	Bootstrap 95% interval
BCL PPP TFP	1960–1980	0.1590	[0.1363, 0.1814]
BCL PPP TFP	1980–2000	0.1215	[0.0915, 0.1534]
BCL PPP TFP	2000–2020	0.0574	[0.0277, 0.1010]
PWT 10.0 production	1959–1979	0.0088	[0.0064, 0.0111]
PWT 10.0 production	1979–1999	-0.0022	[-0.0045, 0.0002]
PWT 10.0 production	1999–2019	0.0035	[0.0020, 0.0050]
PWT 10.0 welfare	1959–1979	0.0112	[0.0087, 0.0136]
PWT 10.0 welfare	1979–1999	-0.0035	[-0.0060, -0.0010]
PWT 10.0 welfare	1999–2019	0.0046	[0.0031, 0.0062]

Notes: Point estimates are from the archived primary releases; intervals are 2.5th–97.5th percentiles of the existing 1,999-draw country bootstraps, with the mean recomputed in every draw. BCL and PWT level units differ, so increment magnitudes are not directly comparable across families. The sign of the unadjusted benchmark slope follows the sign of this increment; the table is not a test of additive growth.

Since 1999, both PWT 10.0 measures split conventional convergence almost evenly in their

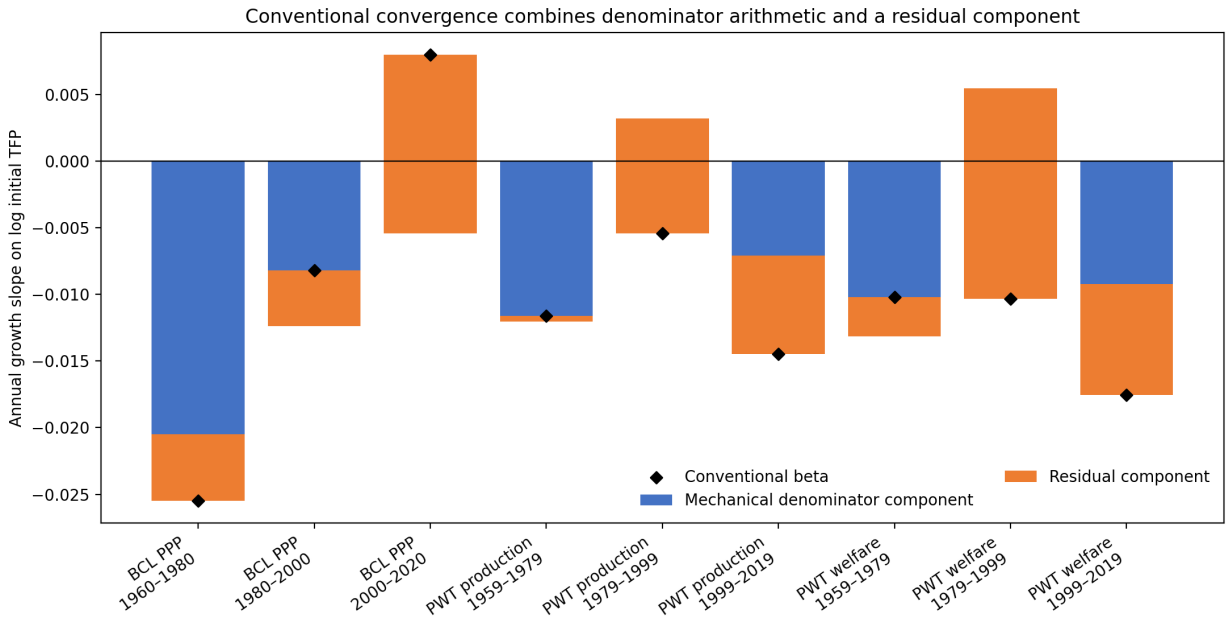


Figure 1: The conventional convergence coefficient is the sum of a denominator component and a residual component.

available-country samples. Production beta of −0.0145 consists of denominator beta −0.0071 and residual beta −0.0074; welfare beta of −0.0176 consists of −0.0092 and −0.0083. The fixed-sample results below show that the production split should not be read as invariant to country entry. BCL differs over 2000–2020: conventional beta is positive even though denominator beta remains negative; its residual coefficient is positive enough to offset the negative benchmark coefficient. This is a comparison with a specified counterfactual, not evidence by itself of an economic divergence mechanism.

Conditional on the frozen source releases and country-resampling design, the early denominator-share estimates are comparatively precise. The bootstrap probability that the share exceeds one-half is 0.995 in BCL 1960–1980, 0.989 for PWT production 1959–1979, and 0.993 for PWT welfare in the same period. For 1999–2019, the corresponding probabilities are 0.454 and 0.568: the point estimates are near one-half, but sampling uncertainty counsels against a sharp majority claim. These probabilities do not incorporate uncertainty from subsequent data revisions.

Table 3: Country-bootstrap diagnostics

Dataset	Period	$\Pr(\beta^D/\beta \geq 0.5)$	$\Pr(\beta^R \geq 0)$	Median share
BCL PPP	1960–1980	1.00	0.14	0.80
BCL PPP	1980–2000	0.93	0.78	1.40
BCL PPP	2000–2020	0.10	0.98	1.69
PWT production	1959–1979	0.99	0.55	1.05
PWT production	1979–1999	0.00	0.07	-0.53
PWT production	1999–2019	0.45	0.02	0.48
PWT welfare	1959–1979	0.99	0.77	1.29
PWT welfare	1979–1999	0.00	0.02	-0.53
PWT welfare	1999–2019	0.57	0.01	0.52

Notes: 1,999 country-resampling draws per row. The share ratio is defined for bootstrap draws with negative conventional beta. Probabilities use the complete set of successful draws, with non-negative conventional-beta draws not counted as evidence that the share exceeds one-half.

5 Application: what the benchmark adds to an existing convergence exercise

The PWT team's own convergence illustration, published as a blog post with interactive charts rather than as a refereed study, is a natural test of whether the diagnostic changes how an existing result should be read. Marapin et al. (2023) regress average annual growth of GDP per hour over 1990–2019 on the 1990 level of GDP per hour (PWT 10.01, 103 countries, log-2 scale) and obtain a slope of -0.21 percentage points per doubling of the initial level; they then split that slope exactly into the contributions of capital per unit of output ($+0.26$), human capital (-0.07), and TFP (-0.40), and conclude that TFP has been the main contributing factor to labour-productivity convergence. Their interactive chart embeds the 103 country observations and the three contributions, so the exercise can be reproduced from their own data: Table 4, Panel A, recovers all four slopes to two decimals, and the published contributions add up to the published total to within 0.001 percentage points. Their 1990 level matches PWT 10.01 `cgdpo`/(`emp`×`avh`) to machine precision for the 48 countries with observed hours; for 47 of the other 55 countries the chart uses a common imputed value of 1,795.6 hours per worker, and for the remaining eight a country-specific value. Their human-capital contribution equals the growth of `hc`, and their TFP panel equals growth minus the other two contributions to within 0.1 percentage points, with one exception (Taiwan, whose chart growth rate also differs from the PWT-computed rate by the same 0.1 points).

Table 4: The PWT team's 1990–2019 convergence illustration and the common-increment split

Slope per doubling of 1990 GDP per hour (pp per year)	Published	Reproduced	95% interval
Panel A. The PWT team's input accounting (their decomposition)			
GDP per hour	-0.21	-0.21	
Capital per unit of output	+0.26	+0.26	
Human capital	-0.07	-0.07	
TFP (residual)	-0.40	-0.40	
Panel B. Common-increment split of the same GDP-per-hour slope (this paper)			
Conventional $\hat{\beta}$ (= Panel A, GDP per hour)	-0.21	-0.21	[-0.40, 0.00]
Denominator $\hat{\beta}^D$ (increment 0.32 USD/hour/year)		-1.26	[-1.37, -1.14]
Residual $\hat{\beta}^R$		+1.06	[+0.81, +1.29]
Denominator share of conventional slope		6.08	[3.06, 34.90]
Panel C. Same split, countries with observed 1990 hours only (48 countries)			
Conventional $\hat{\beta}$		-0.53	[-0.76, -0.17]
Denominator $\hat{\beta}^D$		-1.28	[-1.42, -1.09]
Residual $\hat{\beta}^R$		+0.75	[+0.53, +1.04]

Notes: Slopes are OLS coefficients on $\log_2$ of 1990 GDP per hour, in percentage points of annual growth per doubling, computed from the chart data of Marapin et al. (2023) (103 countries, PWT 10.01). Panel A reproduces their published decomposition by input. Panel B applies this paper's decomposition to the same outcome and regressor: the denominator slope gives every country the sample-mean absolute increment of GDP per hour (2017 dollars per hour per year), and the residual is the remainder. Intervals are 2.5th–97.5th percentiles of a 1,999-draw country bootstrap that recomputes the common increment in every draw. Panel C repeats Panel B for the 48 countries whose 1990 hours are observed rather than imputed. The final level used for the increment is the chart's own hybrid: the PPP-based 1990 level grown at the national-accounts rate, so the increment is in 2017 dollars per hour of that hybrid series. The denominator share is reported for completeness; its interval is conditional on draws with a negative conventional slope (1,951 of 1,999), with a small conventional slope it is unstable, and the coefficients are the estimands.

The benchmark changes the scale against which the -0.21 should be read. The sample-mean absolute increment is 0.32 dollars of GDP per hour per year; giving every country that increment would by itself produce a slope of -1.26 per doubling (interval $[-1.37, -1.14]$), six times the measured convergence. The residual slope is therefore $+1.06$ ($[+0.81, +1.29]$): relative to equal absolute gains, the poorer countries in this near-global sample grew *less*, not more. This is divergence relative to the additive benchmark only: the conventional slope remains negative, and the benchmark describes this sample poorly (Section 6). The subsample with observed 1990 hours gives the same picture (conventional -0.53, denominator -1.28, residual $+0.75$). Two readings follow, and both leave the PWT team's accounting intact. First, the measured convergence of -0.21 is small by the benchmark's standard; observed growth across these 103 countries was much closer to common proportional growth, under which the conventional slope would be zero and the residual would exactly offset the denominator term, than to common absolute growth. Section 6 finds the same out of sample. Second, the attribution of the measured slope to TFP, capital and human capital is an exact accounting of the -0.21 by input; the common-increment split is an exact accounting of the same slope by counterfactual. They answer different questions and can be reported side by side: TFP is the main input behind the modest measured convergence, and that convergence is roughly one sixth of what equal absolute advances in GDP per hour would have generated. Neither statement is causal.

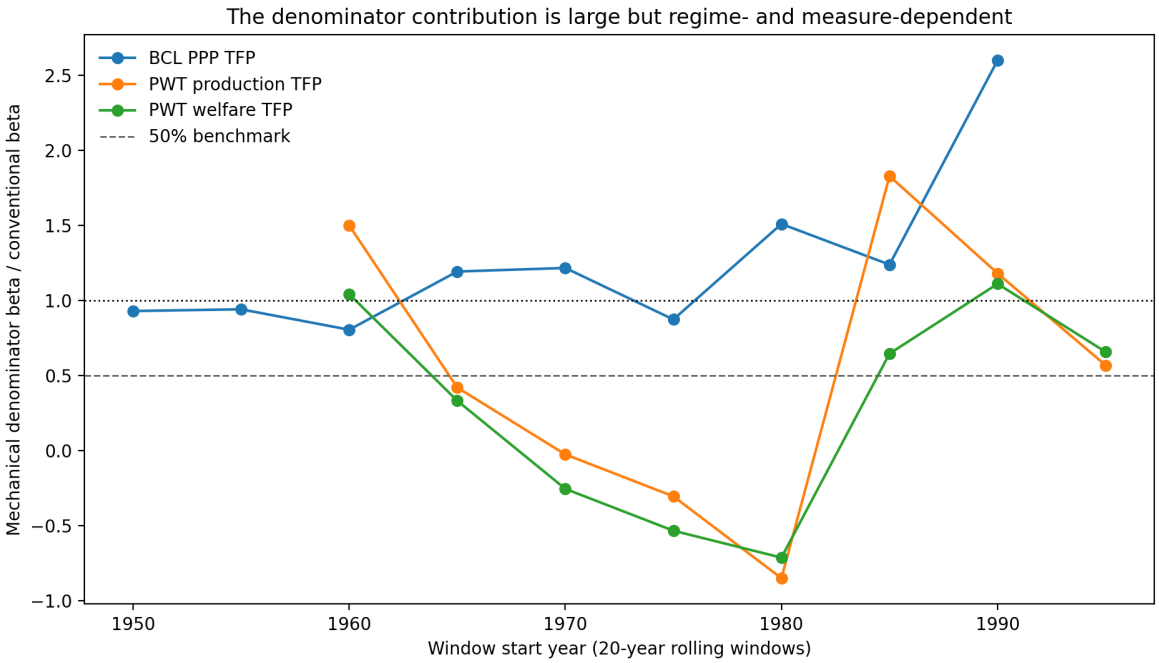


Figure 2: Descriptive rolling-window estimates. Lines connect overlapping 20-year windows and should not be interpreted as independent replications.

6 Robustness and interpretation

The rolling-window atlas shows why pooling window estimates into a single headline is misleading. For negative-beta 20-year windows, the median denominator ratio is 1.19 in BCL, 0.49 for PWT production TFP, and 0.49 for PWT welfare TFP. These windows overlap in countries and calendar time and are therefore not independent observations. Their value is to expose regime changes, not to raise an artificial replication count.

The pattern is also robust to horizon, but its magnitude declines with longer PWT windows. Appendix Table 12 reports median ratios among negative-beta windows. BCL remains near one at 25- and 30-year horizons, whereas PWT ratios decline toward 0.2–0.33. Longer windows average across positive- and negative-increment regimes and leave more room for country-specific cumulative dynamics.

The production and welfare results are close after 1999 but differ in earlier magnitudes. This is useful rather than inconvenient: it shows that conclusions about catch-up depend partly on the productivity concept. A convergence claim should state whether it concerns productive capacity, welfare-relevant productivity, or another measured residual.

Table 5 holds countries fixed across all three periods in the archived primary releases. BCL is already balanced, so its estimates are unchanged. PWT's 1959–1979 estimates are also unchanged because that first window defines the 60-country intersection. In PWT 10.0 the middle-period denominator coefficient changes from 0.0032 in the 91-country production window to −0.0012 in

the fixed sample, although the welfare coefficient remains positive. The post-1999 production result also changes: among the fixed 60 countries, denominator beta is −0.0047 while residual beta has a slightly positive point estimate. Welfare TFP remains split almost evenly. These are properties of the PWT 10.0 release; the matched-release comparison below shows that the fixed-core production residual has a negative point estimate already in PWT 10.01, and why.

Table 5: Fixed-country-sample decomposition

Dataset	Period	N	Conventional β	Denominator β^D	Residual β^R
BCL PPP	1960–1980	23	-0.0255	-0.0205	-0.0050
BCL PPP	1980–2000	23	-0.0082	-0.0124	0.0042
BCL PPP	2000–2020	23	0.0080	-0.0054	0.0134
PWT production	1959–1979	60	-0.0116	-0.0120	0.0004
PWT production	1979–1999	60	-0.0032	-0.0012	-0.0019
PWT production	1999–2019	60	-0.0033	-0.0047	0.0014
PWT welfare	1959–1979	60	-0.0102	-0.0132	0.0029
PWT welfare	1979–1999	60	-0.0105	0.0016	-0.0121
PWT welfare	1999–2019	60	-0.0114	-0.0058	-0.0055

Notes: Countries must have valid levels at all four endpoints within a data family. The fixed samples contain 23 BCL countries and 60 countries for each PWT measure.

Table 6 explains the sensitivity *within PWT 10.0*. I partition each expanding PWT window into the fixed 60-country core and later-coverage countries, then decompose the pooled OLS cross-product exactly into within-core, within-entrant, and between-group terms. "Entrant" denotes entry into the endpoint-balanced estimation sample, not necessarily a newly created country. In production TFP after 1999, the 58 entrants begin at a mean level of 0.52 versus 0.74 in the core. With the full-sample benchmark held fixed, their within-group residual beta is −0.0123, compared with 0.0028 in the core; the corresponding HC1 standard errors are 0.0056 and 0.0035. The within-entrant contribution to pooled residual beta is −0.0067; the combined between-group contribution is −0.0015. This exact descriptive accounting does not establish a vintage-invariant claim that residual production catch-up is absent from the core: the PWT 10.01 and 11.0 core point estimates are negative. Welfare TFP is less discontinuous in PWT 10.0: both groups have negative within-group residual beta, although the entrant contribution is again larger.

Table 6: Mechanism behind PWT sample-composition sensitivity

Panel A. Within-group residual slopes under the pooled benchmark

Dataset	Period	Entrants	Full β^R	Core slope	Entrant slope
PWT production	1979–1999	31	-0.0086	-0.0066	-0.0112
PWT production	1999–2019	58	-0.0074	0.0028	-0.0123
PWT welfare	1979–1999	31	-0.0158	-0.0160	-0.0227
PWT welfare	1999–2019	58	-0.0083	-0.0038	-0.0104

Panel B. Exact contributions to the pooled residual slope

Dataset	Period	Core within	Entrant within	Between	Sum = β^R
PWT production	1979–1999	-0.0036	-0.0051	0.0001	-0.0086
PWT production	1999–2019	0.0008	-0.0067	-0.0015	-0.0074
PWT welfare	1979–1999	-0.0101	-0.0078	0.0021	-0.0158
PWT welfare	1999–2019	-0.0011	-0.0055	-0.0018	-0.0083

Notes: Panel A shows group slopes under the pooled common-increment benchmark; these slopes do not add directly. Panel B shows their exact pooled-OLS cross-product contributions: core within + entrant within + between = full residual beta, up to rounding. The between term combines both groups' between cross-products. Core slope differs from the rebenchmarked fixed-sample slope in Table 5. Post-1999 production group-slope HC1 standard errors are 0.0035 (core) and 0.0056 (entrants); this is descriptive, not a causal contrast.

Matched releases: what moved, and why

Figure 3 summarizes the release comparison. Across PWT 10.0, 10.01, and 11.0, on exactly the same 60 countries and windows, conventional beta keeps a negative point estimate and every residual interval includes zero. Between 10.0 and 10.01 the denominator and residual components move in opposite directions while conventional beta moves little (+0.0006 over 1999–2019 and +0.0015 over 1979–1999, both well inside the intervals); between 10.01 and 11.0 conventional beta itself moves (-0.0035 and -0.0053). The bottom panels show where the residual changes come from: from 10.0 to 10.01, a growth revision of the same sign in 59 of the 60 countries whose contributions are spread across many of them (the eight largest carry 58 percent of the absolute contributions); from 10.01 to 11.0, a revision that is not same-signed (26 of the 60 countries are revised down) and whose contributions are concentrated in two countries (the eight largest carry 71 percent). The rest of this subsection documents the figure. The primary tables retain their byte-verified PWT 10.0 and archived BCL 2.6 inputs. Table 7 compares the three releases for production TFP on the original 10.0 country sets and windows; no later outcomes or new countries enter. The 36-row PWT audit (both concepts), paired-bootstrap results, the attribution files, and source hashes accompany the replication materials. In the expanding samples the benchmark sign is stable across releases, which largely reflects the sign of the mean absolute increment, but its magnitude is not: the post-1999 production denominator share is 0.49 in 10.0, 0.29 in 10.01, and 0.37 in 11.0. Conventional beta is negative in every window of every release.

Table 7: Matched PWT releases, production TFP

Window	Sample	Release	N	$\bar{\Delta}$	$\hat{\beta}$	$\hat{\beta}^D$	$\hat{\beta}^R$ [95% interval]
1959–1979	expanding	10.0	60	+0.0088	-0.0116	-0.0120	+0.0004
		10.01	60	+0.0083	-0.0113	-0.0112	-0.0001
		11.0	60	+0.0087	-0.0077	-0.0112	+0.0034
	fixed 60	10.0	60	+0.0088	-0.0116	-0.0120	+0.0004 [-0.0073, +0.0080]
		10.01	60	+0.0083	-0.0113	-0.0112	-0.0001 [-0.0078, +0.0075]
		11.0	60	+0.0087	-0.0077	-0.0112	+0.0034 [-0.0066, +0.0112]
1979–1999	expanding	10.0	91	-0.0022	-0.0054	+0.0032	-0.0086
		10.01	91	-0.0037	-0.0055	+0.0056	-0.0112
		11.0	91	-0.0037	-0.0068	+0.0067	-0.0135
	fixed 60	10.0	60	+0.0009	-0.0032	-0.0012	-0.0019 [-0.0113, +0.0081]
		10.01	60	-0.0007	-0.0017	+0.0011	-0.0027 [-0.0124, +0.0079]
		11.0	60	-0.0006	-0.0069	+0.0010	-0.0079 [-0.0181, +0.0052]
1999–2019	expanding	10.0	118	+0.0035	-0.0145	-0.0071	-0.0074
		10.01	118	+0.0020	-0.0146	-0.0043	-0.0103
		11.0	118	+0.0026	-0.0142	-0.0053	-0.0089
	fixed 60	10.0	60	+0.0026	-0.0033	-0.0047	+0.0014 [-0.0048, +0.0108]
		10.01	60	+0.0009	-0.0027	-0.0017	-0.0010 [-0.0068, +0.0083]
		11.0	60	+0.0015	-0.0062	-0.0028	-0.0034 [-0.0085, +0.0024]

Notes: Each window uses exactly the same countries in all three releases: the expanding sample is the set available in PWT 10.0 for that window, and the fixed 60 are the countries with valid production TFP at all four endpoints in PWT 10.0. $\bar{\Delta}$ is the mean annual absolute increment in start-year-anchored `ctfp` units. Bracketed intervals for the fixed core are 2.5th–97.5th percentiles of a 1,999-draw country bootstrap that recomputes the common increment in every draw; identical index draws are used across releases within a window. These per-release intervals and the paired release-difference intervals quoted in the text come from two separate 1,999-draw country bootstraps. Welfare TFP (archived) has positive fixed-core residual point estimates in 1959–1979 and negative estimates in both later windows across all three releases. In PWT 11.0, both later-window welfare residuals exclude zero under HC1 inference.

The fixed-core interpretation changes more than the expanding-sample one. In the same 60 production-TFP countries over 1999–2019, residual beta is +0.0014 in PWT 10.0, −0.0010 in 10.01, and −0.0034 in 11.0. This zero crossing is *relative to the common-increment benchmark only*: conventional beta remains negative in all three releases (−0.0033, −0.0027, and −0.0062), so it is not a reversal of conventional convergence against a proportional-growth null. The individual residual intervals in Table 7 all include zero, and the 10.0 positive point estimate is itself fragile: omitting Venezuela alone gives −0.0010 in PWT 10.0. The 10.0-to-10.01 *difference* is better determined than the levels, and the 10.0-to-11.0 difference excludes zero. A 1,999-draw *paired* country bootstrap, recomputing each release's common increment, gives 95-percent percentile intervals for post-1999 production residual-beta differences of $[-0.0037, -0.0009]$ for 10.01 minus 10.0, $[-0.0083, 0.0020]$ for 11.0 minus 10.01, and $[-0.0107, -0.0002]$ for 11.0 minus 10.0, and every one of the 60 leave-one-country-out differences is negative for each pair. The fixed-core 1979–1999 denominator beta likewise moves from −0.0012 to +0.0011 between 10.0 and 10.01 and is +0.0010 in 11.0; but the fixed-core mean increment is within noise in every release, with bootstrap probabilities of a positive increment of 0.75, 0.29, and 0.35, so that sign change should not be read as a regime result.

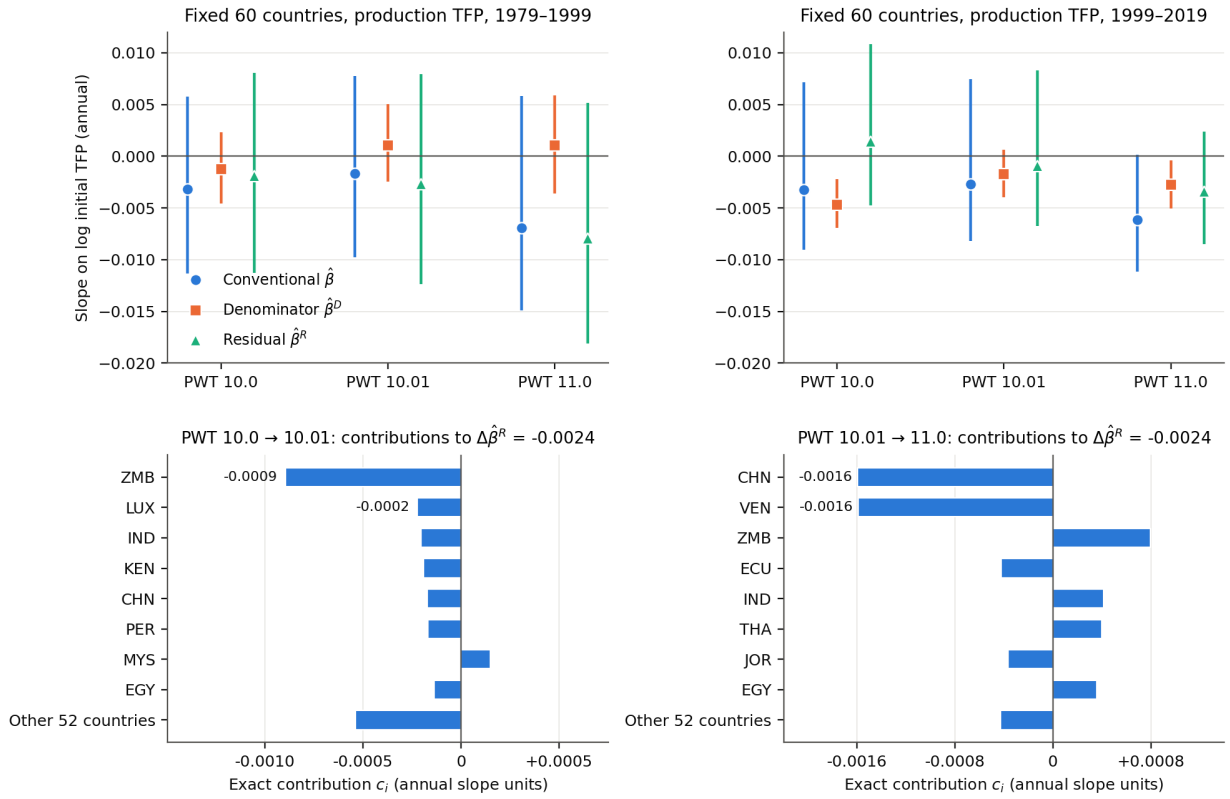


Figure 3: The matched-release result in one figure. Top: conventional, denominator and residual slopes in the fixed 60-country production core by PWT release, with 95-percent country-bootstrap intervals (identical index draws across releases within a window). Bottom: the eight largest exact country contributions c_i to the change in residual beta between releases over 1999–2019, with the other 52 countries aggregated.

Table 8 attributes the two fixed-core release differences to channels and to countries. Panel A splits each difference exactly into the part obtained by switching only the start-year level anchor (`ctfp`), the part obtained by switching only the growth path (the `rtfpna` ratio), and an interaction. Panel B decomposes the residual-beta difference across countries using $\Delta\hat{\beta}^R = \sum_i c_i$ with $c_i = w_i^B g_i^{R,B} - w_i^A g_i^{R,A}$, which sums exactly.

Table 8: Attribution of fixed-core release differences

Panel A. Release differences split by revision channel (fixed 60 countries, production TFP)

Window	Releases	Statistic	Total	Growth path	Level anchor	Interaction
1979–1999	10.0 → 10.01	Conventional $\hat{\beta}$	+0.0015	+0.0006	+0.0013	-0.0003
		Mean increment $\bar{\Delta}$	-0.0016	-0.0016	+0.0001	-0.0001
		Denominator $\hat{\beta}^D$	+0.0023	+0.0024	-0.0002	+0.0000
		Residual $\hat{\beta}^R$	-0.0008	-0.0019	+0.0015	-0.0004
1979–1999	10.01 → 11.0	Conventional $\hat{\beta}$	-0.0053	-0.0033	+0.0007	-0.0027
		Mean increment $\bar{\Delta}$	+0.0001	+0.0005	-0.0001	-0.0002
		Denominator $\hat{\beta}^D$	-0.0000	-0.0007	+0.0005	+0.0002
		Residual $\hat{\beta}^R$	-0.0052	-0.0026	+0.0003	-0.0029
1999–2019	10.0 → 10.01	Conventional $\hat{\beta}$	+0.0006	+0.0005	+0.0001	-0.0000
		Mean increment $\bar{\Delta}$	-0.0017	-0.0017	+0.0001	-0.0000
		Denominator $\hat{\beta}^D$	+0.0030	+0.0029	+0.0000	-0.0000
		Residual $\hat{\beta}^R$	-0.0024	-0.0024	+0.0001	-0.0000
1999–2019	10.01 → 11.0	Conventional $\hat{\beta}$	-0.0035	-0.0019	-0.0011	-0.0004
		Mean increment $\bar{\Delta}$	+0.0006	+0.0007	-0.0001	-0.0001
		Denominator $\hat{\beta}^D$	-0.0011	-0.0012	+0.0001	+0.0001
		Residual $\hat{\beta}^R$	-0.0024	-0.0007	-0.0012	-0.0005

Panel B. Concentration of the residual-beta difference across countries

Window	Releases	$\Delta\hat{\beta}^R$	Two largest c_i	Half of $\sum \lvert c_i \rvert$	LOO range	Negative
1979–1999	10.0 → 10.01	-0.0008	IND -0.0006, TWN +0.0005	8	[-0.0014, -0.0002]	60/60
1979–1999	10.01 → 11.0	-0.0052	CHN -0.0064, JOR +0.0011	3	[-0.0068, +0.0008]	59/60
1999–2019	10.0 → 10.01	-0.0024	ZMB -0.0009, LUX -0.0002	6	[-0.0027, -0.0020]	60/60
1999–2019	10.01 → 11.0	-0.0024	CHN -0.0016, VEN -0.0016	4	[-0.0041, -0.0007]	60/60

Notes: Fixed 60 countries, production TFP. "Growth path only" combines release A's `ctfp` anchors with release B's `rtfpna` ratios; "level anchor only" does the reverse; the interaction is the remainder, so the three columns sum to the total. Arrows read from the earlier to the later release. In Panel B, c_i is country i's exact contribution to the residual-beta difference, the leave-one-out (LOO) range is the release difference recomputed on 59 countries, and "negative" counts omissions for which that difference is negative. Country codes are ISO3.

The two release steps have different anatomies. From 10.0 to 10.01 the change is almost entirely a growth-path revision, and a broad one: measured 1999–2019 production-TFP growth is lower in 10.01 for 59 of the 60 core countries, by a median 0.20 percentage points per year. The revisions are not uniform (cross-country standard deviation 0.15 points), but they are same-signed and nearly uncorrelated with initial level (correlation +0.14). This is consistent with the deflator change described in the release note, which lists no other methodological change and reports an average TFP-growth reduction of 0.19 points per year over 1970–2010 across the 118 countries with TFP data (Gouma et al., 2023). Such a revision barely moves conventional beta (+0.0006), but it cuts the fixed-core mean increment from 0.0026 to 0.0009 and moves denominator beta from −0.0047 to −0.0017; by the identity, residual beta moves by −0.0024 (= +0.0006 − 0.0030). The 1999 level anchors also move (median absolute change 0.022 log points), but the anchor channel contributes only +0.0001. Six countries account for half of the absolute contributions, with Zambia the largest, but the difference is negative in all 60 leave-one-out samples. The same mechanism, with every one of the 60 countries revised down, turns the 1979–1999 fixed-core mean increment from slightly

positive to slightly negative and hence flips the sign of a near-zero denominator beta. From 10.01 to 11.0 the change is instead concentrated. China's 1999–2019 production-TFP growth is 2.25 percentage points per year higher in 11.0, coinciding with PWT's move to official Chinese national accounts (the release also revises schooling data and labor-share estimation), and Venezuela's 1999 anchor is 0.27 log points higher while its already negative increment becomes more negative. These two countries contribute −0.0016 each to a total of −0.0024; four countries account for half of the absolute contributions, and partially offsetting positive contributions come from Zambia, India, and Thailand. In this step the level-anchor channel (−0.0012) exceeds the growth-path channel (−0.0007). In the 1979–1999 window China alone contributes −0.0064 to a residual-beta difference of −0.0052, its 1979 anchor falling by 0.74 log points and its growth rising by 3.6 points per year; omitting China the 11.0-minus-10.01 difference is +0.0008. There the interaction term (−0.0029) exceeds both channels, so the channel split is uninformative and the country attribution carries the result.

Three lessons follow. First, the fixed-core "sign change" across releases is a reallocation inside intervals that include zero, not evidence that the economic behavior of the core countries was re-measured as divergent and then convergent. Second, the diagnostic is sensitive to exactly the kind of revision PWT 10.01 made: a same-signed change in measured growth, nearly uncorrelated with initial level, that leaves conventional beta almost intact but changes the common increment on which the benchmark is built. A reader who wants the benchmark/residual split must therefore state the release. Third, the 11.0 differences are a China (and Venezuela) story; the PWT release note documents the China change and the direction observed here is consistent with it, although the TFP revision exceeds the note's GDP-growth revision and 11.0 also changed other inputs, while the source of the Venezuela revision is not singled out in the note and is not attributed here. Revisions jointly change level anchors and within-country paths; the paired and leave-one-out intervals condition on the observed releases and independent-country resampling, not on future revisions or common shocks. The same attribution for welfare TFP (archived with the replication files) shows the same growth-channel pattern from 10.0 to 10.01 in both later windows, with 59 or 60 of the 60 countries revised down and the fixed-core residual-beta difference negative in all 60 leave-one-out samples, and essentially no 10.01-to-11.0 change in the 1999–2019 window (+0.00002). In BCL, version 2.7 preserves a negative denominator beta in all three windows and positive conventional beta in 2000–2020.

In the archived primary releases, the common-increment estimate is not driven by extreme level changes. Appendix Table 13 replaces the mean with the median and a symmetric 10-percent trimmed mean. All 27 denominator coefficients retain the baseline sign, which is largely a check that these alternative common increments have the same sign, not 27 independent confirmations of an economic mechanism. For PWT 10.0 production after 1999, denominator beta ranges from −0.0062 to −0.0073. The estimator check and the release check answer different questions.

Appendix Table 14 reports conditional PWT 10.0 estimates. Adding start-year human capital and capital–output ratio preserves the three sign regimes. The conditional denominator share

after 1999 is 0.36 for production TFP and 0.39 for welfare TFP, below the unconditional one-half estimates because conditional residual convergence is stronger. Conditioning changes the allocation between the two components; it does not turn the common-increment benchmark into a causal estimand.

Finally, a leave-one-country-out audit recomputes every primary window once for each included country. The sign of denominator beta is unchanged in every omission across all nine windows. Given the algebraic link between its sign and the mean increment, this only rules out the narrow concern that one country changes the sign of that sample mean; it is not a separate test of additive growth.

Is the common increment empirically informative? A held-out comparison

The benchmark is a reference, but a reference is more useful if it also describes the data. Table 9 compares four predictors of a country's annual log growth, each fitted on all other countries in the same sample and window and evaluated on the held-out country (leave-one-country-out): common proportional growth (one parameter, the mean log growth), the common absolute increment used throughout this paper (one parameter), a two-parameter mixture $A_{iT} = A_{i0}e^{gT} + T\Delta$ fitted by least squares, and the conventional two-parameter linear regression of growth on log initial level. Each predictor is used as specified rather than as a fitted growth model: the common absolute increment is the sample-mean level change, exactly as the benchmark uses it, whereas the other three are least-squares fits in log growth. The comparison is therefore between these prediction rules as applied, not a contest between growth-model families. It is descriptive and cross-sectional; it is not a test of any country's growth law, which Jones et al. (2026) address with time-series methods.

Table 9: Leave-one-country-out prediction error of four growth benchmarks

Dataset	Window	N	Prop.	Abs.	Mixture	Linear	Best	$\lvert e_A\rvert < \lvert e_P\rvert$
BCL PPP TFP	1960–1980	23	1.08	0.74	0.76	0.76	Abs.	0.74
BCL PPP TFP	1980–2000	23	0.82	0.81	0.81	0.81	Abs.	0.43
BCL PPP TFP	2000–2020	23	0.59	0.66	0.61	0.61	Prop.	0.43
PWT production	1959–1979	60	1.26	1.19	1.20	1.19	Linear	0.58
PWT production	1979–1999	91	1.29	1.30	1.30	1.29	Prop.	0.55
PWT production (fixed 60)	1979–1999	60	1.19	1.19	1.20	1.20	Prop.	0.52
PWT production	1999–2019	118	1.59	1.44	1.42	1.41	Linear	0.65
PWT production (fixed 60)	1999–2019	60	0.96	0.94	0.96	0.97	Abs.	0.58
PWT welfare	1959–1979	60	1.17	1.13	1.13	1.12	Linear	0.63
PWT welfare	1979–1999	91	1.57	1.63	1.57	1.56	Linear	0.57
PWT welfare (fixed 60)	1979–1999	60	1.30	1.31	1.29	1.29	Linear	0.60
PWT welfare	1999–2019	118	1.63	1.45	1.42	1.39	Linear	0.75
PWT welfare (fixed 60)	1999–2019	60	1.18	1.12	1.12	1.12	Abs.	0.62
PWT 10.01 GDP per hour	1990–2019	103	1.39	2.35	1.38	1.37	Linear	0.38

Notes: Root-mean-square error of the predicted annual log growth of the held-out country, in percentage points per year, over all countries in the sample. "Best" is the lowest column. The absolute-increment rule is estimated from level changes and the other three from log-growth errors, as described in the text. The last column is the share of countries for which the absolute-increment prediction has a smaller absolute error than the proportional one. PWT rows use PWT 10.0 TFP with the paper's start-year anchoring; the last row is the 103-country GDP-per-hour sample of Section 5. For 1959–1979 the expanding PWT sample is the 60-country core.

The common absolute increment is a competitive one-parameter description in some samples and not in others. It predicts held-out countries better than proportional growth in BCL 1960–1980 (0.74 percentage points against 1.08, beating proportional growth for 74 percent of countries) and in every post-1999 PWT sample, by margins of 0.02 to 0.18 points (1.44 against 1.59 for expanding production TFP and 1.45 against 1.63 for expanding welfare TFP). It is close to proportional growth in the 1979–1999 windows, where the mean increment is near zero or negative, and in BCL 1980–2000, with proportional growth better by 0.05 points for expanding welfare TFP in 1979–1999. It is worse in BCL 2000–2020 and much worse in the near-global GDP-per-hour sample (2.35 against 1.39), consistent with that sample's large positive residual in Section 5. The sign of the mean increment determines the benchmark slope's sign; its predictive usefulness is a separate empirical question. The two-parameter linear regression is best in 7 of the 14 rows and within 0.03 points of the best predictor in all but one (the fixed-60 production sample after 1999, where the absolute increment is best), and the mixture adds little to it: where the absolute increment describes the data, it captures most of what the linear slope captures with one parameter fewer. The benchmark is a description in the early-window and post-1999 TFP samples where this paper reports it as accounting for much of measured convergence, and a reference rather than a description elsewhere.

Independent-data replication

The decomposition should not depend on the PWT and BCL measurement architectures. Table 10 repeats the exercise on two independently constructed sources: Maddison Project real GDP per capita in 2011 international dollars (Bolt and van Zanden, 2020), whose windows mirror the PWT windows with the final window shifted to 1998–2018, and OECD Productivity Database constant-PPP levels (OECD, 2026b), using GDP per person employed for the two non-overlapping PWT-matched windows and GDP per hour worked where the hours margin is observed. Neither source measures TFP, so the replication tests whether the arithmetic transfers across data families and productivity concepts, not whether the TFP-specific regime timing reappears.

Table 10: Independent-data replication

Dataset	Period	N	Conventional β	Denominator β^D	Residual β^R
Maddison GDP pc	1959–1979	151	0.0010	-0.0248	0.0258
Maddison GDP pc	1979–1999	153	0.0032	-0.0207	0.0239
Maddison GDP pc	1998–2018	169	-0.0022	-0.0286	0.0264
OECD GDP/worker	1979–1999	14	-0.0113	-0.0311	0.0198
OECD GDP/worker	1999–2019	41	-0.0211	-0.0201	-0.0010
OECD GDP/hour	1995–2015†	37	-0.0147	-0.0170	0.0023
OECD GDP/hour	2004–2024†	32	-0.0150	-0.0126	-0.0024

Notes: Same estimator and reporting as Table 1. †The two GDP-per-hour windows overlap by eleven years and are descriptive. OECD constant-PPP GDP per person employed covers only 14 countries at the 1979 endpoints; hour-based OECD measures begin in 1995. The OECD, EA20, and EU27_2020 aggregates are excluded.

Three results carry over. First, every replication window has a negative denominator coefficient, as the benchmark's algebra requires when the common absolute increment is positive; this sign

alone is not independent evidence for an additive growth law. Second, the component accounts for 95 percent of OECD GDP-per-worker convergence over 1999–2019, with a bootstrap probability of 0.99 that the share exceeds one-half, and it exceeds measured convergence over 1979–1999 among the 14 early-coverage countries, where residual beta is positive. Selection into an ex-post rich club (De Long, 1988) and denominator arithmetic can therefore compound within this benchmark. Third, the near-global Maddison panel exhibits a large offsetting decomposition. Conventional beta is near zero or positive in the first two windows and only -0.0022 in 1998–2018, while the denominator component ranges from -0.021 to -0.029 and residual beta is positive with bootstrap probability 1.000 in all three windows. This is a statement relative to the common-increment benchmark; common proportional growth can also produce a positive residual beta. What does not carry over is the PWT 10.0 1979–1999 sign reversal: GDP-per-capita and labor-productivity increments are positive in every replication window, so the replication confirms the arithmetic and its magnitude rather than the TFP-specific regime dates or a causal mechanism.

GDP-based productivity can be unusually sensitive to multinational activity in Ireland and Luxembourg (OECD, 2026a). Excluding both countries leaves the OECD conclusion intact: the denominator share is 0.92 rather than 0.95 for GDP per worker in 1999–2019, 1.10 rather than 1.16 for GDP per hour in 1995–2015, and 0.75 rather than 0.84 for GDP per hour in 2004–2024. The full exclusion audit is archived rather than selectively substituted for the prespecified baseline.

A separate replication isolates the growth-measurement architecture. Table 11 keeps the paper's PWT 10.0 `ctfp` level anchors but replaces the growth path with the EU KLEMS & INTANProd value-added TFP index (Luiss Lab of European Economics, 2023), an independently constructed national-accounts growth-accounting series, in a matched 12-country sample over 1999–2019. Under a gate locked before execution, the KLEMS decomposition agrees with matched-sample PWT in the signs of conventional beta and the common-increment benchmark, and the KLEMS denominator shares of 0.43 for the total economy and 0.34 for the market economy lie inside the wide matched-PWT country-bootstrap 95-percent interval $[0.04, 0.44]$. The benchmark-sign agreement mostly reflects positive mean increments and should not be counted as a separate empirical validation. In a focused 1,999-draw country bootstrap, the KLEMS residual-beta interval is $[-0.0120, 0.0193]$ for the total economy and $[-0.0316, -0.0055]$ for the market economy; the former does not separate from zero. Because the anchor is still PWT 10.0, this tests the growth architecture rather than independent levels; the Maddison and OECD panels above provide the independent-levels comparison.

Table 11: Growth-architecture replication: EU KLEMS TFP growth with identical PWT level anchors, matched-sample 1999–2019 window.

	Total economy	Market economy
Countries	12	12
Actual β, KLEMS growth	-0.0100	-0.0200
Actual β, PWT growth (matched)	-0.0210	-0.0210
Denominator β, KLEMS	-0.0043	-0.0068
Denominator β, PWT (matched)	-0.0036	-0.0036
Residual β, KLEMS	-0.0057	-0.0132
KLEMS residual bootstrap 95% interval	[-0.0120, 0.0193]	[-0.0316, -0.0055]
Denominator share, KLEMS	0.429	0.341
Denominator share, PWT (matched)	0.173	0.173
PWT bootstrap 95% share interval	[0.040, 0.435]	[0.040, 0.435]

Several limitations define the claim. The common increment is a benchmark, not an estimate of a global technology frontier. Measurement error can enter initial levels and increments jointly, and Section 6 shows that a same-signed revision to measured growth that is uncorrelated with initial level is attributed largely to the residual by construction. Fixed samples trade composition stability for external validity, and the PWT release comparison shows that a substantive residual sign can depend on revisions even when the denominator-sign regime survives. Spatial dependence, common shocks, and country-specific trends are not modeled. A demanding extension would need a structural model or independent variation to attribute residual convergence to diffusion rather than to other sources.

7 Conclusion

A negative beta coefficient is not by itself evidence of catch-up through diffusion. The decomposition applied here separates it exactly into a common-increment benchmark and a residual, but neither is a causal attribution. Across PWT and BCL TFP, independent Maddison and OECD level data, and a matched EU KLEMS growth-accounting comparison, the benchmark component ranges from more than all measured convergence to opposing convergence, and its sign follows the sign of the sample-mean increment.

The international result is a statement about robustness with two parts. Measured convergence itself is robust in sign: on identical countries and windows, conventional beta has a negative point estimate in every window of PWT 10.0, 10.01, and 11.0. In the fixed 60-country core, however, the country-bootstrap interval for conventional beta itself includes zero in six of the nine window–release cells (all of 1979–1999 and 1999–2019), so the post-1979 fixed-core slopes are imprecise in every release. Its arithmetic content is not: the benchmark/residual split moves across releases, and in the fixed 60-country core the post-1999 production residual crosses zero *relative to the common-increment benchmark* while its interval includes zero in every release. The attribution shows that this movement has identifiable sources rather than being diffuse noise: a documented

change to investment-price deflators in PWT 10.01 that lowered measured TFP growth in nearly every country, almost independently of initial level, cutting the common increment by two-thirds while leaving conventional beta almost unchanged, and in PWT 11.0 the switch to official Chinese national accounts together with a revised Venezuelan level. The first of these is also a caution about the diagnostic itself, which attributes such revisions largely to the residual.

Two further checks bound the benchmark's usefulness. Out of sample, the common absolute increment predicts held-out countries better than common proportional growth in BCL 1960–1980 and in the post-1999 PWT samples, no better in the 1979–1999 windows, and worse in BCL 2000–2020 and in the near-global GDP-per-hour sample, so it is a description in some samples and a reference in others. Applied to the PWT team's 1990–2019 illustration, it leaves their input accounting intact and adds the scale: the measured slope of -0.21 per doubling is about one sixth of the arithmetic benchmark, and relative to that benchmark the near-global sample diverges. Three extensions would sharpen the diagnostic without changing its descriptive status: industry-level decompositions around technology transitions in which the contribution of a new technology is plausibly a common absolute increment; firm-level panels in which the benchmark can be computed in physical or fixed-quality units; and continued matched-release tracking as PWT and other databases are revised. Survival of the broad sign pattern across revisions would still not identify the underlying growth law.

The practical recommendation is to report conventional beta, the beta generated by a clearly specified common absolute increment, and residual beta, together with the data release and country set. Doing so does not choose additive growth in advance. It shows what conventional beta would contain under one transparent level-growth counterfactual, and it makes visible when a change in that content comes from a change in the data rather than in the economies being compared.

A Additional robustness tables

Tables 12–14 report the horizon, common-increment-estimator and conditional checks discussed in Section 6.

Table 12: Median denominator share by window horizon

Dataset	10 years	15 years	20 years	25 years	30 years
BCL PPP	1.32	1.18	1.19	0.97	0.97
PWT production	0.51	0.67	0.49	0.35	0.33
PWT welfare	0.52	0.53	0.49	0.25	0.21

Notes: Medians are calculated across descriptive rolling windows with negative conventional beta. Windows overlap and are not used as independent observations for inference.

Table 13: Denominator beta under robust common-increment estimators

Dataset	Period	Mean	Median	10% trimmed mean
BCL PPP	1960–1980	-0.0205	-0.0201	-0.0206
BCL PPP	1980–2000	-0.0124	-0.0118	-0.0123
BCL PPP	2000–2020	-0.0054	-0.0043	-0.0043
PWT production	1959–1979	-0.0120	-0.0123	-0.0123
PWT production	1979–1999	0.0032	0.0023	0.0029
PWT production	1999–2019	-0.0071	-0.0062	-0.0073
PWT welfare	1959–1979	-0.0132	-0.0138	-0.0129
PWT welfare	1979–1999	0.0055	0.0030	0.0040
PWT welfare	1999–2019	-0.0092	-0.0081	-0.0080

Notes: Entries are $\hat{\beta}^D$. The trimmed estimator drops the lowest and highest 10 percent of annual absolute country increments before computing the common benchmark.

Table 14: Conditional PWT convergence decomposition

Dataset	Period	N	Conventional β	Denominator β^D	Residual β^R
PWT production	1959–1979	60	-0.0136	-0.0121	-0.0014
PWT production	1979–1999	91	-0.0079	0.0032	-0.0111
PWT production	1999–2019	118	-0.0193	-0.0069	-0.0124
PWT welfare	1959–1979	60	-0.0099	-0.0132	0.0033
PWT welfare	1979–1999	91	-0.0146	0.0054	-0.0201
PWT welfare	1999–2019	118	-0.0231	-0.0090	-0.0141

Notes: Every regression includes start-year log human capital and log capital–output ratio. HC1 standard errors are archived with the machine-readable results. The beta identity holds using the common estimation sample.

Data availability

The analysis uses third-party PWT, BCL, Maddison Project, OECD, and EU KLEMS data. A raw-data-free replication package is available from the author. It provides source URLs, version-specific input hashes, acquisition instructions, analysis code, tests, and aggregate results, including the matched-release attribution reported in Tables 7 and 8, the held-out benchmark comparison, and the chart data of Marapin et al. (2023) (CC BY) used in Section 5. For the fixed 60-country PWT sample it also includes the per-country diagnostics behind Tables 7 and 8: start-year log levels, anchor and growth revisions, mean increments, exact per-country contributions, and leave-one-country-out release differences, all derived from PWT releases distributed under a Creative Commons Attribution license. Provider raw inputs are excluded, since public access to an input does not imply permission to redistribute it; users obtain them from the documented provider routes.

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Conflict of interest

The author declares no conflicts of interest.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work the author used OpenAI Codex and Anthropic Claude to assist with research, with drafting, editing and reviewing the manuscript, and with developing and checking the analysis code. The author directed this use and takes full responsibility for the content.

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