H HEURISTICS

H HEURISTICS CONCEPTS · RESEARCH REPORT

Convergence Economics

The mechanisms, constraints, incentives and policies governing convergence between economies



Hunter Hughes
Founder, H Heuristics

H Heuristics Research Report · November 2026

researchreports.hheuristics.com

CONTENTS

Contents

SECTIONS 1–7 · CONCEPT, EVIDENCE AND MECHANISMS

Executive Summary 4

1 The Case for a Field 6
1.1 A question without a home 6
1.2 Growth is not convergence 6
1.3 Why now 7

2 Definition and Scope 8
2.1 The proposed definition 8
2.2 The central intellectual proposition 8
2.3 Unit of analysis 9
2.4 Boundaries 9

3 Intellectual Foundations 10
3.1 Six traditions 10
3.2 The empirical turn 11

4 The Empirical Record 12
4.1 Four decades of mixed results, then an exception 12
4.2 Beta convergence, 2000–2019 and since 13
4.3 Long-run mobility 13

5 Seven Convergences 14
5.1 The seven kinds 14
5.2 A dashboard against the frontier 14
5.3 The convergences do not move together 16
5.4 What income convergers did on the other fronts 16

6 Eight Mechanisms 17
6.1 The mechanisms and their functions 17
6.2 Why none is automatically sufficient 18

7 Testing the Mechanisms 19
7.1 Design 19
7.2 Which mechanisms are associated with catch-up? 19
7.3 None is sufficient on its own 20
7.4 Stacks matter 21
7.5 Do complements work as expected? 21

Data and Methods 39

SECTIONS 8–14 · CONDITIONS, POLICY AND AGENDA

8 Structural Transformation and the Industrial Route 22
8.1 Why structure matters 22
8.2 The industrial hump has flattened 22
8.3 Which catch-up lasted? 23
8.4 Routes beyond classic manufacturing 23

9 Constraints on Speed 25
9.1 What a binding constraint is 25
9.2 Absorptive capacity 26
9.3 Finance and debt 26
9.4 Power and infrastructure 26
9.5 Governance 26

10 Incentives 27
10.1 Why incentives belong in the field 27
10.2 Four sets of actors 27
10.3 Four incentive failures 28
10.4 International incentives 28

11 Policies 29
11.1 Principles of convergence policy 29
11.2 A policy map by mechanism 29
11.3 Industrial policy that works 29
11.4 Regional policy: lessons from convergence inside the European Union 30
11.5 International policy as part of national strategy 30

12 The Speed of Convergence 31
12.1 Convergence arithmetic 31
12.2 What speeds have been achieved? 31
12.3 Scenarios to 2100 32

13 Sustainability, Demography and Systemic Risk 34
13.1 The environmental route 34
13.2 Demography 34
13.3 Systemic risk 35

14 A Research Programme 37
14.1 Ten propositions 37
14.2 Data and methods 37
14.3 From concept to use 37
14.4 Conclusion 37

References 41

EXHIBITS

Figures, Tables and Boxes

Figure 1 Income relative to the high-income level... 7
Table 1 Convergence Economics and adjacent fields 9
Figure 2 Timeline of ideas about convergence 11
Figure 3 Catch-up by decade, 1950–2022 12
Figure 4 Mobility in relative income, 1960–2022 13
Table 2 Seven convergences: headline gaps 15
Figure 5 Seven convergences against the frontier 15
Figure 6 Correlation between convergence dimensions 16
Table 3 Eight mechanisms: function, evidence, failure 17
Figure 7 The structure of Convergence Economics 18
Table 4 Mechanism indicators and results 20
Figure 8 Sufficiency of single mechanisms 20
Figure 9 Complementarity tests 21
Figure 10 The manufacturing hump, 1995–99 and 2015–19 23
Table 5 Fastest 25-year catch-up windows by driver 24
Figure 11 Four binding constraints by income group 25
Table 6 Actors and incentives 27
Table 7 Policy levers by mechanism 30
Table 8 Years to reach 50% and 75% of the high-income... 31
Figure 12 Years to 50% of the high-income level 32
Figure 13 Scenarios of the growth advantage to 2100 33
Figure 14 Population by income group, 2000–2100 35
Figure 15 Setbacks by income group and period 36
Table 9 Ten propositions 38
Table 10 Data sources 39

ABOUT THIS REPORT

Suggested citation. Hughes, H. (2026). *Convergence Economics: The Mechanisms, Constraints, Incentives and Policies Governing Convergence Between Economies*. H Heuristics Research Report, November 2026.

Status of the framework. Convergence Economics is presented here as a proposed framework open to testing. The phrase has been used before in a narrower sense, for nominal convergence ahead of European monetary union (De Grauwe, 1996); this report uses it for the study of real convergence between economies. It builds on, and does not replace, the established literatures it draws on.

Licence. Text and figures are released under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 licence. Data remain subject to the terms of their original publishers.

Data and methods. All data are public (World Bank, Penn World Table, Maddison Project, UNDP, UN, Our World in Data). Calculations, scenarios and any errors are the author's. Blue text links to sources; figure, table and section references link within the document.

EXECUTIVE SUMMARY

Executive Summary

For two hundred years economists have asked whether poor countries will catch up with rich ones. The question has been answered with a growth model, a regression or a slogan. This report argues that it deserves a field of its own: Convergence Economics, the study of how, when and why economies close the gap, and what stops them.

Between 2000 and 2019 a majority of developing economies grew faster than the rich world for the first time in modern history, and average income in the Global South rose from 13% to 22% of the high-income level. Since 2019 that momentum has faded: the figure reached 24% in 2024, and without China and India it has not moved since 2000. Whether the twenty-first century closes the gaps that the last two centuries opened is therefore an open question, and one that rests on mechanisms we understand only in parts. **Convergence Economics** is proposed here as the field that brings those parts together.

24%
Global South income as a share of the high-income level in 2024 (PPP), up from 13% in 2000

3.7%
Low-income countries' share in 2024, down from 4.2% in 2000

90% → 64%
of lagging economies outgrew the US in 2000–10, then in 2010–22

90%
of economies strong in 5–6 of eight mechanisms converged in 2000–19, against 32% of those strong in 0–2

PROPOSED DEFINITION

The definition used in this report

Convergence Economics is the study of the mechanisms, conditions, constraints, and policies governing the reduction of economic disparities between countries and regions, with particular emphasis on the processes through which developing economies approach the productivity, technological capabilities, income levels, and productive sophistication of advanced economies.

The framework examines how capital accumulation, technological diffusion, institutional development, human capital, infrastructure investment, international trade, and structural transformation interact to influence long-term economic convergence. It also considers how environmental sustainability, demographic change, and systemic risks affect the feasibility and quality of convergence.

Central question. How can economies at different stages of development progressively narrow their economic disparities and achieve higher levels of productive capacity and prosperity?

Principal findings

- **Convergence is real but narrow, and conditional on the period.** The Global South rose from 13% to 24% of high-income income between 2000 and 2024. Excluding China and India the share was 18% in 2000 and 20% in 2024. Across the 99 developing economies with data, 71% outgrew high-income countries in 2000–19, but only 48% did in 2019–24 (Section 4).
- **Sustained catch-up is rare.** In the Maddison data, only 20% of 25-year windows for lagging economies show a growth advantage of 2 points a year or more, and 10% show 3 points. Of 99 economies below a quarter of US income in 1960, 76 were still below a quarter in 2022 (Figure 4).
- **Convergence comes in seven kinds that do not move together.** The average rank correlation between the seven (eight with infrastructure) is only 0.20. Schooling gaps narrowed in 88% of economies whose income lost ground and 82% of those that converged: a gain on one front does not guarantee the others (Section 5).
- **No single mechanism is sufficient.** Even in the top third on the strongest mechanism, 23% of economies failed to converge; on schooling gains the figure is 58%. Mechanisms are associated with catch-up far more strongly in combination: 90% of economies strong on five or six of eight converged (Section 7).
- **Complementarity is real but not simple.** Of ten tested pairings, only 2 show a significant interaction, and in one of them the mechanism matters *less* where its supposed complement is strong. The evidence favours bundles over single gates (Figure 9).
- **The industrial route has narrowed.** At $10,000 of income the predicted manufacturing share of GDP fell from 17% in the 1990s to 13% in 2015–19, and the manufacturing share fell in 47 of 82 developing economies after 2000 (Section 8).
- **Constraints are binding in finance and power.** Median interest payments take 13% of government revenue in low-income countries (from 3% in 2010), and a person in a low-income country uses 170 kWh of electricity a year against 8,804 in rich countries (Section 9).
- **The clock is long.** At a steady 2-point annual growth advantage, the Global South reaches half of high-income income in about 38 years, lower-middle-income countries in 62 and low-income countries in 130. Speed matters more than any single policy (Section 12).

Priorities

- **Treat convergence as a bundle.** Plan and fund mechanisms together: the evidence points to stacks of complementary investments, not silver bullets.
- **Measure seven convergences, not one.** Track productivity, technology, structure, capital, human capital, institutions and infrastructure, and sustainability against the frontier, in relative and absolute terms.
- **Build absorptive capacity first.** Skills, management, institutions and reliable infrastructure decide whether imported technology and capital become productivity.
- **Lower the cost of capital.** Debt service and risk premia are among the most binding constraints and the most changeable by international action.
- **Align incentives and build the field.** Make catch-up pay for the actors who must deliver it, and test the propositions in Section 14 with open data.

SECTION 01

The Case for a Field

Convergence is the central story of development and the least integrated subject in economics. Its pieces live in growth theory, development economics, trade, finance, economic geography and economic history, and none of them owns the whole question.

IN BRIEF

- Whether poorer economies catch up is the defining question of global development, yet no single field integrates the answer.
- Growth economics asks why economies grow; convergence asks why they grow at different rates and what lets some catch up.
- A field of Convergence Economics would study mechanisms, constraints, incentives and policies together, and treat convergence as plural.

1.1 A question without a home

The gap between rich and poor economies is among the largest facts of the modern world. In 2024, average income in the high-income economies was about $58,000 per person at purchasing-power parity; in the Global South it was about $14,000, and in low-income countries about $2.2,000 (World Bank, 2026). Closing even part of that gap would change more lives than almost any other economic event. The question of whether and how it closes has been asked since at least Gerschenkron's account of the advantages of backwardness (Gerschenkron, 1962) and Solow's model of diminishing returns to capital (Solow, 1956).

Yet the answer is scattered. Growth theory explains why economies expand and, in its neoclassical form, predicts that poorer ones should catch up if conditions are alike (Barro and Sala-i-Martin, 1992). Development economics studies the structural shifts, institutions and policies of poor economies. International trade theory asks how openness shares technology and markets. Finance asks how capital flows across borders. Economic geography asks where activity clusters. Economic history asks how the Great Divergence opened (Pomeranz, 2000). Each field treats convergence as a by-product of its own subject. None treats it as the subject.

1.2 Growth is not convergence

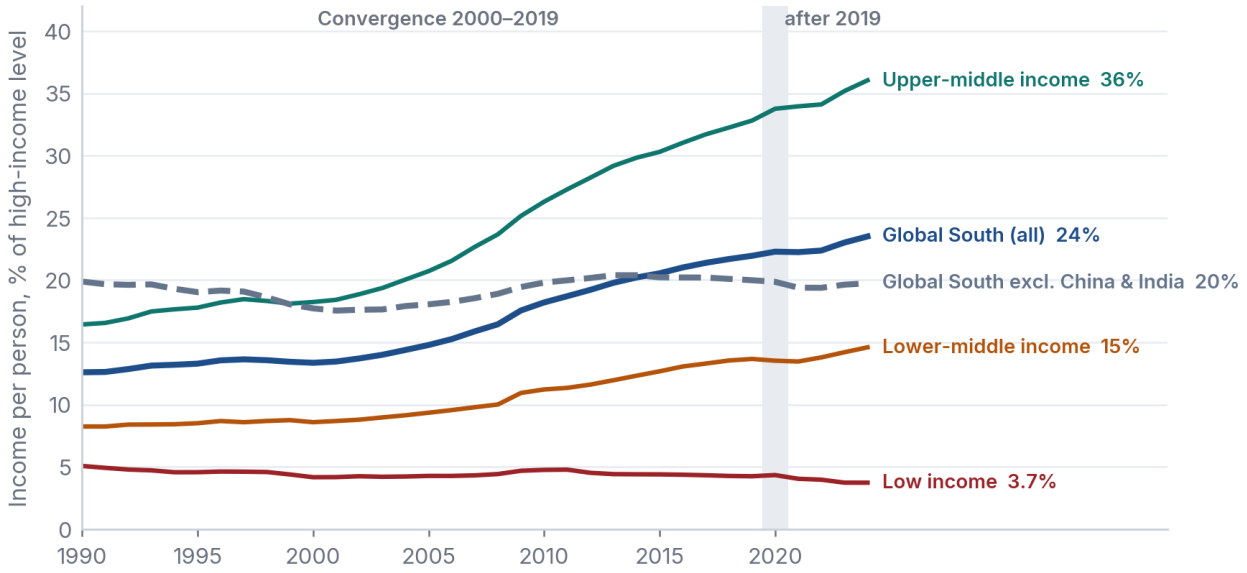
The distinction matters. A country can grow steadily and still fall behind, if the frontier grows faster. A country can grow fast and converge in income while falling short on skills, technology or institutions that will matter for the next stage. Growth economics asks why economies grow. Convergence Economics asks why economies develop at different rates, what enables some to catch up, and what prevents others from doing so. It shifts analytical attention toward the relationship between economic growth and the international distribution of productive capabilities.

The record shows why this is not a semantic point. Since 2000 the Global South as a whole has converged in income, from 13% to 24% of the high-income level, yet low-income countries have slipped from 4.2% to 3.7%, and the absolute dollar gap between the Global South and the high-in-

come economies widened from about $36,000 to $45,000 per person. Whether this counts as convergence depends on the measure, the group and the period: exactly the questions a field of study exists to settle (Figure 1).

Figure 1 Convergence since 2000 is a story of China, India and upper-middle-income economies

Income per person as % of the high-income level, 1990–2024



Source: H Heuristics calculations from World Bank World Development Indicators, GDP per capita, PPP (constant international $) (World Bank, 2026). Population-weighted averages; income groups are current World Bank classes (World Bank, 2025b); 101 developing economies with at least one million people in 2000.

1.3 Why now

Four developments make the field timely. First, the data: Penn World Table, the Maddison Project, the World Bank indicators and national statistics now allow convergence to be tracked across dozens of dimensions and centuries (Groningen Growth and Development Centre, 2025; Bolt and van Zanden, 2024; World Bank, 2026). Second, the pattern has changed: after decades of divergence, the 2000s brought what some call a new era of unconditional convergence (Patel et al., 2021; Kremer et al., 2022), and the 2020s have cast doubt on it. Third, the route is under pressure: manufacturing-led catch-up may be harder for latecomers (Rodrik, 2016), and the carbon budget limits the fossil route (Forster et al., 2025). Fourth, the stakes are rising: most of the world's population growth to 2100 will occur in the economies that most need to converge (United Nations, 2024).

SECTION 02

Definition and Scope

Convergence Economics is defined by its central question, its unit of analysis and its commitments. This section sets out all three, and the boundaries that separate it from its neighbours.

IN BRIEF

- The field studies mechanisms, conditions, constraints and policies that govern the narrowing of disparities between countries and regions.
- Its unit is the economy's position relative to the frontier, along several dimensions and over time.
- It is distinct from, and dependent on, growth, development, trade and geography.

2.1 The proposed definition

Convergence Economics

Convergence Economics is the study of the mechanisms, conditions, constraints, and policies governing the reduction of economic disparities between countries and regions, with particular emphasis on the processes through which developing economies approach the productivity, technological capabilities, income levels, and productive sophistication of advanced economies. The framework examines how capital accumulation, technological diffusion, institutional development, human capital, infrastructure investment, international trade, and structural transformation interact to influence long-term economic convergence. It also considers how environmental sustainability, demographic change, and systemic risks affect the feasibility and quality of convergence.

Proposed definition, Hunter Hughes, H Heuristics, 2026

Four words carry the weight. **Mechanisms** are the engines that move economies toward the frontier. **Conditions** are what decide whether the engines work. **Constraints** are the binding limits on speed. **Policies** are what governments and international institutions can change. Incentives, treated here as part of conditions, are the reasons actors have to build or block convergence.

2.2 The central intellectual proposition

The field organises itself around a single question:

> *"How can economies at different stages of development progressively narrow their economic disparities and achieve higher levels of productive capacity and prosperity?"*
>
> Central question of Convergence Economics

The question is deliberately about *progressive* narrowing and about *productive capacity*, not merely income. Income can be borrowed, extracted or windfall. Productive capacity, meaning the skills, technology, organisations and infrastructure that generate income, is what endures. That is why the long-run records of resource-rich economies sit uneasily in convergence tables (Section 4).

2.3 Unit of analysis

The basic unit is an economy's position relative to the frontier on some dimension, s = (value in the follower) ÷ (value at the frontier), and its change over time. This simple ratio carries three requirements. First, the frontier must be named: here, the population-weighted average of high-income economies, or the United States in long-run comparisons. Second, relative and absolute gaps must both be reported, because they can move in opposite directions: the ratio can rise while the dollar gap widens. Third, the dimension must be stated, since convergence in income does not imply convergence in skills or technology. Section 5 returns to all three.

2.4 Boundaries

Convergence Economics borrows from its neighbours and adds a distinct emphasis. Table 1 sets out the relationship.

Table 1 How Convergence Economics relates to adjacent fields

Field	Core question	What Convergence Economics adds
Growth economics	Why do economies grow?	Why they grow at different rates; the follower–frontier gap as the object of study
Development economics	How do poor economies develop and reduce poverty?	A comparative, frontier-relative frame; speed and time-to-parity
International trade	How does openness change specialisation and income?	Trade as one of eight mechanisms, whose effect depends on complements
Economic geography	Where does activity locate and cluster?	The international (not only regional) distribution of productive capabilities
Economic history	How did the Great Divergence arise?	Mechanisms of reversal; the conditions of catch-up in today's world
Environmental and ecological economics	How do economies relate to environmental limits?	Sustainability as the seventh convergence and a constraint on routes

Source: H Heuristics.

The field is also bounded by what it does not claim. It does not propose a new growth model; it uses existing models where they fit. It does not claim that convergence is inevitable, desirable at any cost, or the only goal of development. Poverty, health and wellbeing remain outcomes in their own right; convergence compares capacities between economies.

SECTION 03

Intellectual Foundations

A century of work already bears on convergence. This section sets out the main traditions, what each explains and where each falls short, and why their combination is the starting point of the field.

IN BRIEF

- Six traditions bear on convergence: neoclassical, endogenous growth, latecomer and structural, institutional, trade and diffusion, and complexity.
- Each explains part of the pattern; none explains why convergence has been rare and then common and then rare again.
- Recent empirical work has found conditional and, for a time, unconditional convergence.

3.1 Six traditions

The oldest tradition is the **latecomer** view. Gerschenkron argued that economic backwardness can be an advantage, because latecomers can borrow technology and substitute institutions for the missing preconditions of industrial growth (Gerschenkron, 1962). Abramovitz added that catch-up depends on a country's *social capability*, its education, institutions and organisations, to absorb technology (Abramovitz, 1986). Lewis modelled the transfer of surplus labour from agriculture to industry as the engine of early development (Lewis, 1954).

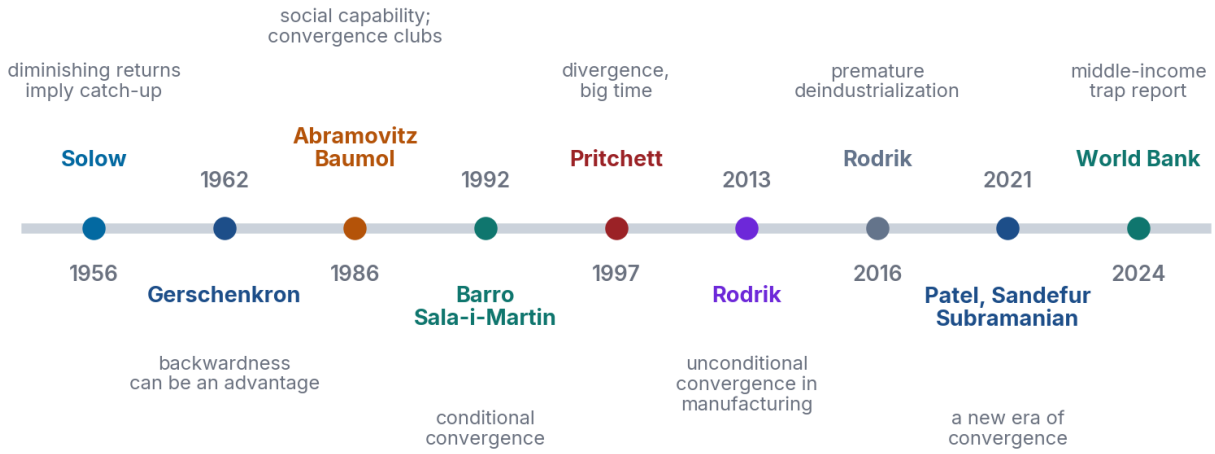
The **neoclassical** tradition formalised catch-up as diminishing returns. In Solow's model, capital earns more where it is scarce, so poorer economies should grow faster and converge, if they share savings, population growth and technology (Solow, 1956). Empirically, unconditional convergence failed for most of the twentieth century, but conditional convergence, toward country-specific steady states, held at about two per cent a year in many samples (Barro, 1991; Barro and Sala-i-Martin, 1992; Mankiw et al., 1992; Baumol, 1986).

Endogenous growth theories put knowledge at the centre. Lucas emphasised human capital, Romer and Aghion and Howitt emphasised innovation, and Nelson and Phelps showed how education speeds technology diffusion (Lucas, 1988; Romer, 1990; Aghion and Howitt, 1992; Nelson and Phelps, 1966). The implication for convergence is that the speed of catch-up depends on the capacity to absorb ideas, not on capital alone.

The **institutional** tradition asks why capacity differs. North treated institutions as the rules of the game that shape incentives, and Acemoglu, Johnson and Robinson traced modern income differences to early institutions (North, 1990; Acemoglu et al., 2001). The **trade and diffusion** tradition studies how ideas and goods cross borders: openness and trade can raise income (Frankel and Romer, 1999), and technologies spread with long lags (Comin and Hobijn, 2010). The **complexity** tradition measures productive sophistication by what countries export and holds that an economy's capabilities constrain where it can go next (Hausmann et al., 2007; Hidalgo and Hausmann, 2009).

Figure 2 Ideas about convergence have swung between optimism and doubt

Selected contributions to the study of convergence, 1956–2024



Source: H Heuristics, from the works cited in the text (Solow, 1956; Gerschenkron, 1962; Abramovitz, 1986; Baumol, 1986; Barro and Sala-i-Martin, 1992; Pritchett, 1997; Rodrik, 2013; Rodrik, 2016; Patel et al., 2021; World Bank, 2024). Dates are of publication; the selection is illustrative, not exhaustive.

3.2 The empirical turn

Three recent findings frame the field's agenda. First, **conditional convergence** is found in many samples but is weak, and its measured strength depends on the sample and method (Johnson and Papageorgiou, 2020). Second, **unconditional convergence appeared** around the turn of the century for the first time in the modern record: Patel, Sandefur and Subramanian found that poorer countries began to grow faster than richer ones from the 1990s onward, and Kremer, Willis and You documented a similar shift from the 1990s (Patel et al., 2021; Kremer et al., 2022). Third, **the new era is fragile**: it depended on a commodity and credit boom, on China and India, and on favourable external conditions, and the 2020s have been less kind (Section 4). Pritchett and Summers warned that rapid growth episodes rarely persist (Pritchett and Summers, 2014). Rodrik found that manufacturing alone showed unconditional convergence, while the economy as a whole did not, and then that latecomers deindustrialise at lower income levels than their predecessors (Rodrik, 2013; Rodrik, 2016). The World Bank's 2024 report counts 108 middle-income economies as facing a trap, and notes how few have graduated to high income since 1990 (World Bank, 2024).

SECTION 04

The Empirical Record

Before explaining convergence, the field needs agreed facts. Four decades of near-standstill, a decade of rapid catch-up and a pause since 2019 show that convergence is real, uneven and not guaranteed.

IN BRIEF

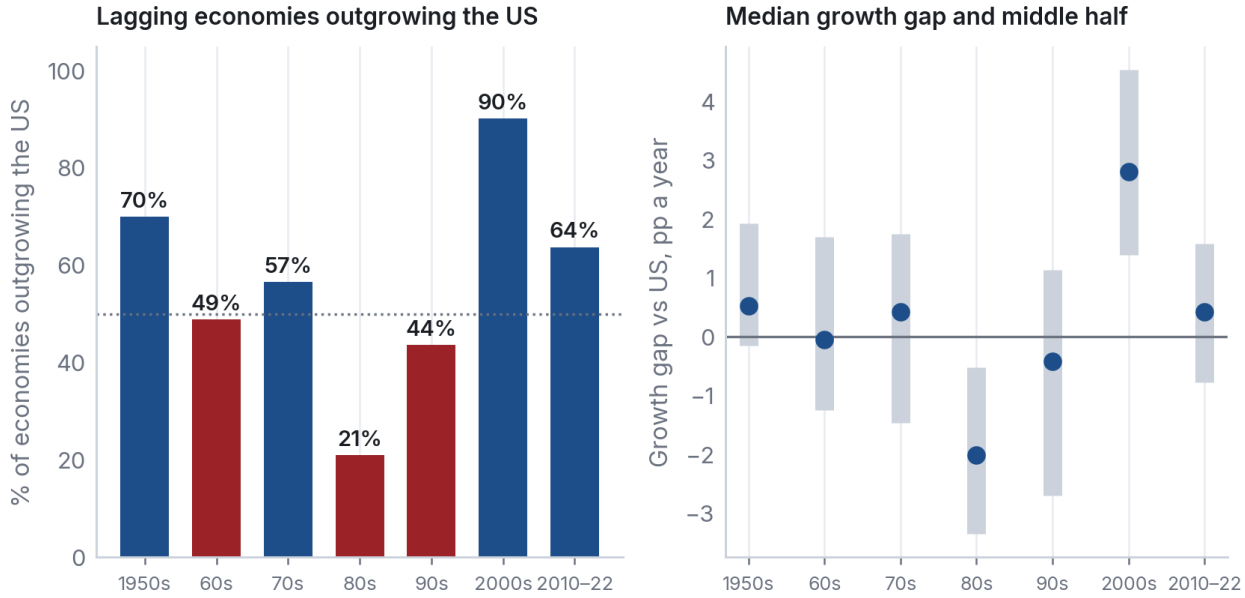
- Global South income rose from 13% to 24% of the high-income level in 2000–2024, but only from 18% to 20% without China and India.
- In the 2000s, 90% of lagging economies outgrew the US; in the 1980s, 21% did.
- Of 99 economies below a quarter of US income in 1960, 76 were still there in 2022.

4.1 Four decades of mixed results, then an exception

Long-run data from the Maddison Project allow the question to be put simply: in each decade since 1950, what share of economies that began below half of US income grew faster than the United States? The answer, in Figure 3, swings widely. In the 1950s, 70% did. In the 1980s, the decade of debt crises and structural adjustment, only 21% did, and the median lagging economy lost ground. In the 2000s, 90% outgrew the United States and the median gap was +2.8 points a year: the best decade of catch-up in the record (Bolt and van Zanden, 2024). From 2010 to 2022 the share fell back to 64%, and the median gap to +0.4.

Figure 3 Catch-up swung from the worst decade on record to the best, and back

Left: % of lagging economies growing faster than the US. Right: annual growth gap vs the US, percentage points



Source: H Heuristics calculations from the Maddison Project Database 2023 (Bolt and van Zanden, 2024). Sample: economies below 50% of US income per person at the start of each period (123 to 140 economies). Right panel: dots are medians, bars the 25th to 75th percentile.

4.2 Beta convergence, 2000–2019 and since

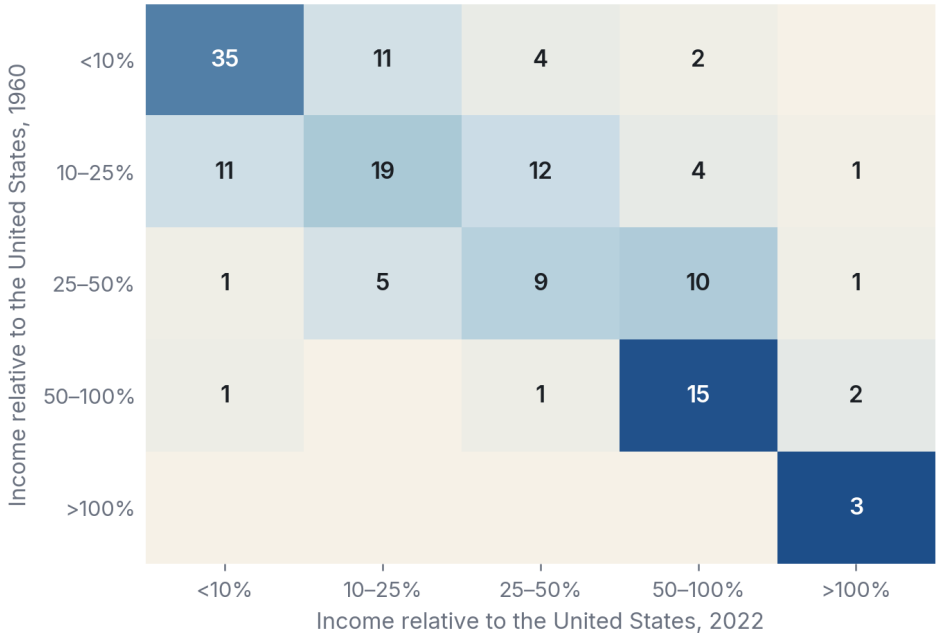
A standard summary is beta convergence: do economies that start poorer grow faster? Among 100 developing economies, the slope of growth on initial log income was -0.41 (robust s.e. 0.23) in 2000–19, meaning slightly faster growth for poorer economies. For 2019–24 it is +0.50 (s.e. 0.29): the sign has reversed. Both coefficients are weakly determined and explain very little of the variation (R^2 of 0.03 and 0.02). These estimates use purchasing-power-parity income and a sample of economies with at least a million people, so they differ in detail from estimates in earlier H Heuristics reports, but the pattern is the same: a brief period in which being poor helped, and a return to no clear advantage (Hughes, 2026c; Hughes, 2026d).

4.3 Long-run mobility

The longest comparison asks where economies ended up. Figure 4 sorts 147 economies by income relative to the US in 1960 and 2022. Of the 99 that started below a quarter of US income, 76 were still below that line in 2022; seven rose above half, all but one of them small economies (Singapore, Taiwan, Oman, South Korea, Malta, Cyprus and Seychelles). Mobility is greater in the middle: of the 26 economies that began between a quarter and a half of US income, 11 ended above half. This matches Pritchett's 'divergence, big time' for the poor (Pritchett, 1997).

Figure 4 Most poor economies in 1960 were still poor in 2022; escapes were few and mostly small

Number of economies by income relative to the United States, 1960 and 2022



Source: H Heuristics calculations from the Maddison Project Database 2023 (Bolt and van Zanden, 2024). Cells show the number of economies; shading shows the share of each row.

SECTION 05

Seven Convergences

Convergence is not one thing. Productivity, technology, structure, capital, human capital, institutions and sustainability each have their own gap, their own speed and their own drivers.

IN BRIEF

- The seven convergences are measured separately against the high-income frontier, in relative and absolute terms.
- They move at very different speeds: internet use in the Global South went from 5% to 73% of the high-income level; manufacturing output per person from 8% to 11%.
- Across countries, the changes are only weakly correlated (mean rank correlation 0.20).

5.1 The seven kinds

Following the framework, convergence is divided into seven kinds, each with its own question:

- **Productivity convergence:** how differences in labour productivity, total factor productivity and productive efficiency narrow between economies.
- **Technological convergence:** how technology adoption, innovation, knowledge transfer and research capabilities reduce international technological disparities.
- **Structural convergence:** how economies develop more sophisticated productive structures, diversify industries and move toward higher-value activities.
- **Capital convergence:** how investment, financial development, capital accumulation and access to financing influence economic catch-up.
- **Human capital convergence:** how education, skills, health and workforce capabilities contribute to narrowing economic disparities.
- **Institutional and infrastructure convergence:** how institutional effectiveness, infrastructure quality and economic coordination influence development trajectories.
- **Sustainable economic convergence:** how catch-up can occur alongside decarbonization, environmental improvement and reduced systemic vulnerability.

5.2 A dashboard against the frontier

Table 2 gives one headline indicator for each kind, using public data (institutions and infrastructure each get one). Every indicator is expressed as a share of the high-income level in the same year, so that a rising number means catch-up in relative terms; for carbon intensity the ratio is inverted so that a number below 100 means the Global South is dirtier than the frontier per dollar of output.

The table shows four patterns. **Technology converged fastest**: internet use in the Global South went from 5% to 73% of the high-income level, though this measures access and says little about quality or use. **Structure and infrastructure converged slowly from a very low base**: manufac-

Table 2 Seven convergences: headline gaps against high-income economies

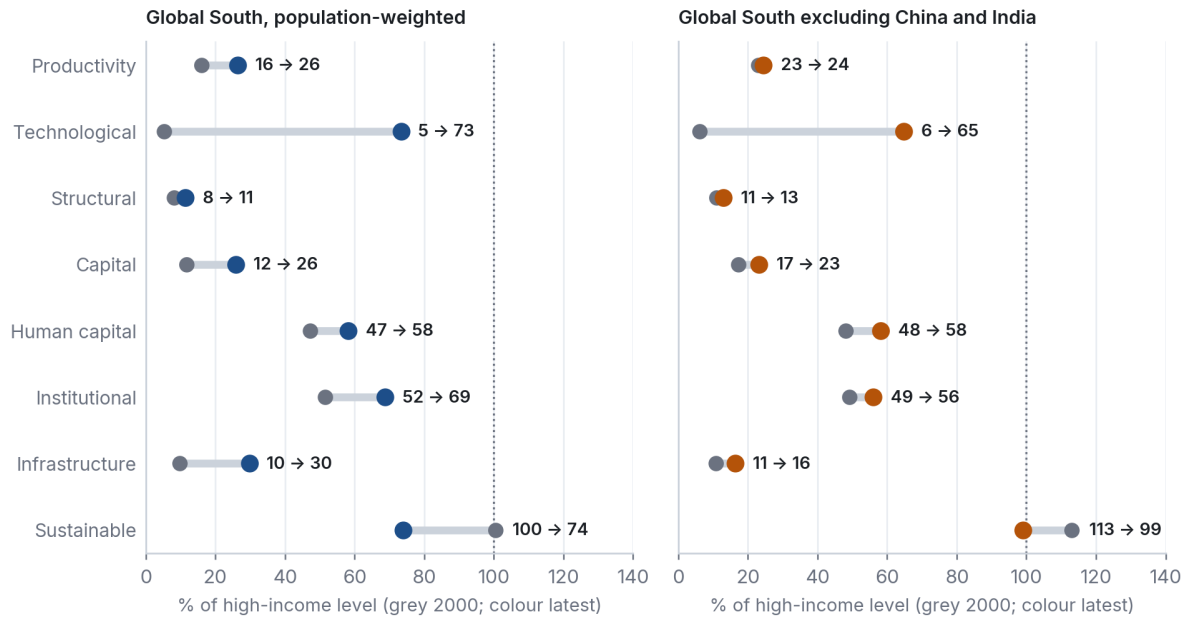
Kind	Headline indicator	GS 2000	GS latest	GS excl. CN/IN	LIC latest	Relative / absolute gap
Productivity	Output per worker (US$ PPP)	16	26	24	5	closing / wider
Technological	Internet users (% of people)	5	73	65	22	closing / narrower
Structural	Manufacturing value added per person (US$)	8	11	13	1	closing / wider
Capital	Capital stock per worker (US$ PPP)	12	26	23	3	closing / wider
Human capital	Mean years of schooling, adults	47	58	58	32	closing / narrower
Institutional	Government effectiveness (WGI, rescaled)	52	69	56	37	closing / narrower
Infrastructure	Electricity use per person (kWh)	10	30	16	2	closing / narrower
Sustainable	CO_2 per US$ of GDP (kg, inverted)	100	74	99	164	widening / wider

Source: H Heuristics calculations from World Development Indicators, Penn World Table 11, UNDP, WGI and Our World in Data (World Bank, 2026; Groningen Growth and Development Centre, 2025; UNDP, 2025; World Bank, 2025a; Our World in Data, 2025). Values are population-weighted (GDP-weighted for carbon intensity) averages as % of the high-income average in the same year; latest year is 2023 or 2024 (2022 for carbon intensity). GS = Global South (101 economies); LIC = low-income countries (21).

turing output per person is 11% of the high-income level and electricity use 30%. **Low-income countries are standing still** on productivity (7% to 5%) and on capital per worker (3% to 3%). And **sustainable economic convergence is going the wrong way** in relative terms: rich countries cut their carbon intensity faster, so the Global South now emits 1.4 times as much CO_2 per dollar of output as they do, against parity in 2000.

Figure 5 Technology has converged fastest; structure, capital and infrastructure remain far from the frontier

Seven convergences: Global South as % of the high-income level, 2000 and latest, with and without China and India



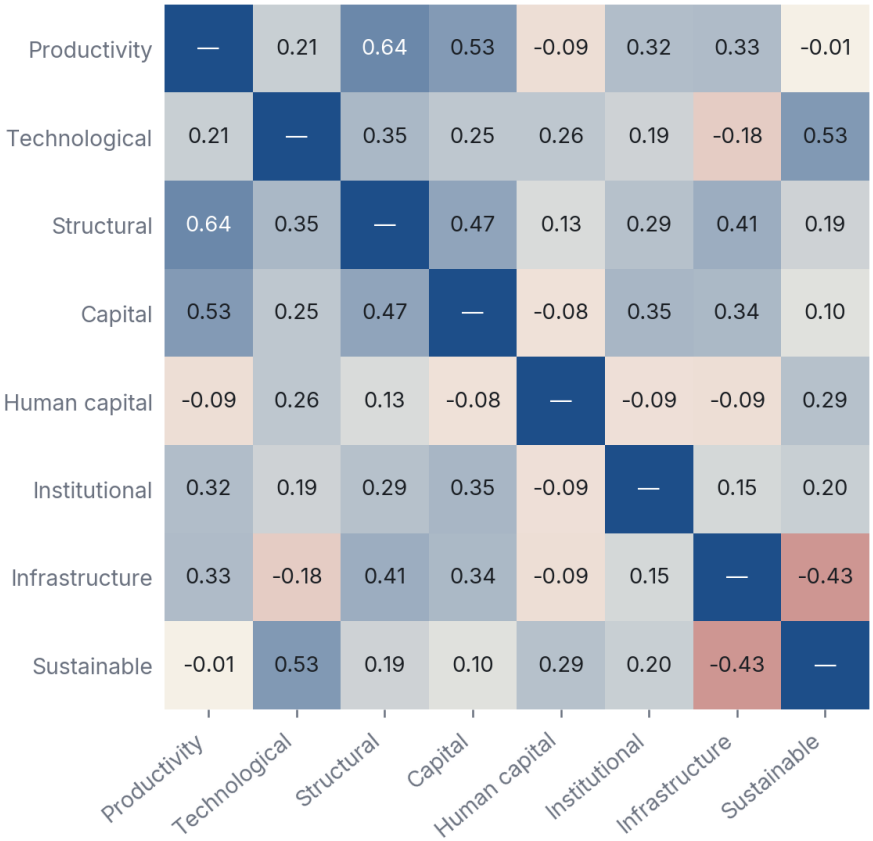
Source: H Heuristics calculations as in Table 2. Each dot is the group's value as a percentage of the high-income level; grey is 2000, colour is the latest year. For carbon intensity the ratio is high-income intensity divided by the group's, so a value below 100 means a higher intensity than the frontier.

5.3 The convergences do not move together

Convergence in each dimension can be measured for each country as the change since 2000 in its position relative to the high-income frontier, scaled by the spread of countries in 2000. Across the economies with data, the average rank correlation between the eight changes is 0.20, ranging from -0.44 (infrastructure with sustainability) to 0.64 (productivity with structure) (Figure 6). Gains in one dimension are therefore a weak guide to gains in another. Only 4 of 62 economies narrowed the gap on all eight; 38 narrowed it on six or more.

Figure 6 Convergence on one front is a weak guide to convergence on another

Rank correlation between changes in the eight convergence measures



Source: H Heuristics calculations. Spearman rank correlations across developing economies of the change since 2000 in distance from the high-income frontier on each dimension, scaled by the 2000 cross-country standard deviation; sign adjusted so that positive means catching up. 75 to 100 economies per dimension.

5.4 What income convergers did on the other fronts

Economies that outgrew high-income countries by at least a point a year in 2000–19 narrowed the gap on 6.4 of the eight dimensions on average, against 4.4 for economies that lost ground (34 and 16 economies with complete data). Productivity, structure and infrastructure separate the two groups most sharply. Two dimensions do not: schooling gaps narrowed for 88% of the economies that lost ground and 82% of those that converged, and the technology gap for 56% and 59%. Sustainability separates nobody: only 21% of the converging economies and 19% of the others improved their carbon intensity faster than the high-income average. Catch-up in income has so far come with little catch-up in the quality of growth.

SECTION 06

Eight Mechanisms

Eight engines are said to move economies toward the frontier. Each has strong theory and some evidence. None has been shown to work alone.

IN BRIEF

- Technology diffusion, capital accumulation, human capital, industrialization, trade, foreign direct investment, institutions and infrastructure are the core mechanisms.
- Each has a characteristic function and a characteristic way of failing.
- The mechanisms are not automatically sufficient: effectiveness depends on complementary capabilities, institutional conditions, investment quality and the ability to absorb new technologies.

6.1 The mechanisms and their functions

Table 3 sets out the eight mechanisms, the economic function each performs, the core evidence, and the way each typically fails. The functions are those proposed in the framework; the evidence and failure modes are from the literature.

Table 3 Eight mechanisms: function, evidence and typical failure

Mechanism	Economic function	Core evidence	Typical failure
Technology diffusion	Accelerates productivity catch-up	Adoption lags have shortened, but use remains uneven (Comin and Hobijn, 2010)	Access without use; weak management and skills (Bloom et al., 2013)
Capital accumulation	Expands productive capacity	Raises output per worker; explains under half of income gaps (Caselli, 2005)	Diminishing returns without ideas; misallocation (Hsieh and Klenow, 2009)
Human capital development	Improves workforce capabilities	Cognitive skills predict growth (Hanushek, 2012)	Years of schooling without learning (Pritchett, 2001)
Industrialization	Enables structural transformation	Manufacturing converges unconditionally (Rodrik, 2013)	Premature deindustrialization (Rodrik, 2016)
International trade	Expands market access and knowledge transfer	Trade raises income (Frankel and Romer, 1999); exporting raises quality (Atkin et al., 2017)	Commodity specialisation; low-value position in value chains (Rodrik, 2018)
Foreign direct investment	Facilitates capital and technology transfer	Growth effect depends on host skills (Borensztein et al., 1998)	Enclaves with few linkages
Institutional development	Improves economic coordination	Institutions explain long-run income gaps (Acemoglu et al., 2001; North, 1990)	Capability traps; reform without delivery (Andrews et al., 2013)
Infrastructure investment	Reduces structural development constraints	Transport links raise incomes by cutting trade costs (Donaldson, 2018)	Unreliable service; build without maintenance

Source: H Heuristics synthesis; functions from the Convergence Economics framework.

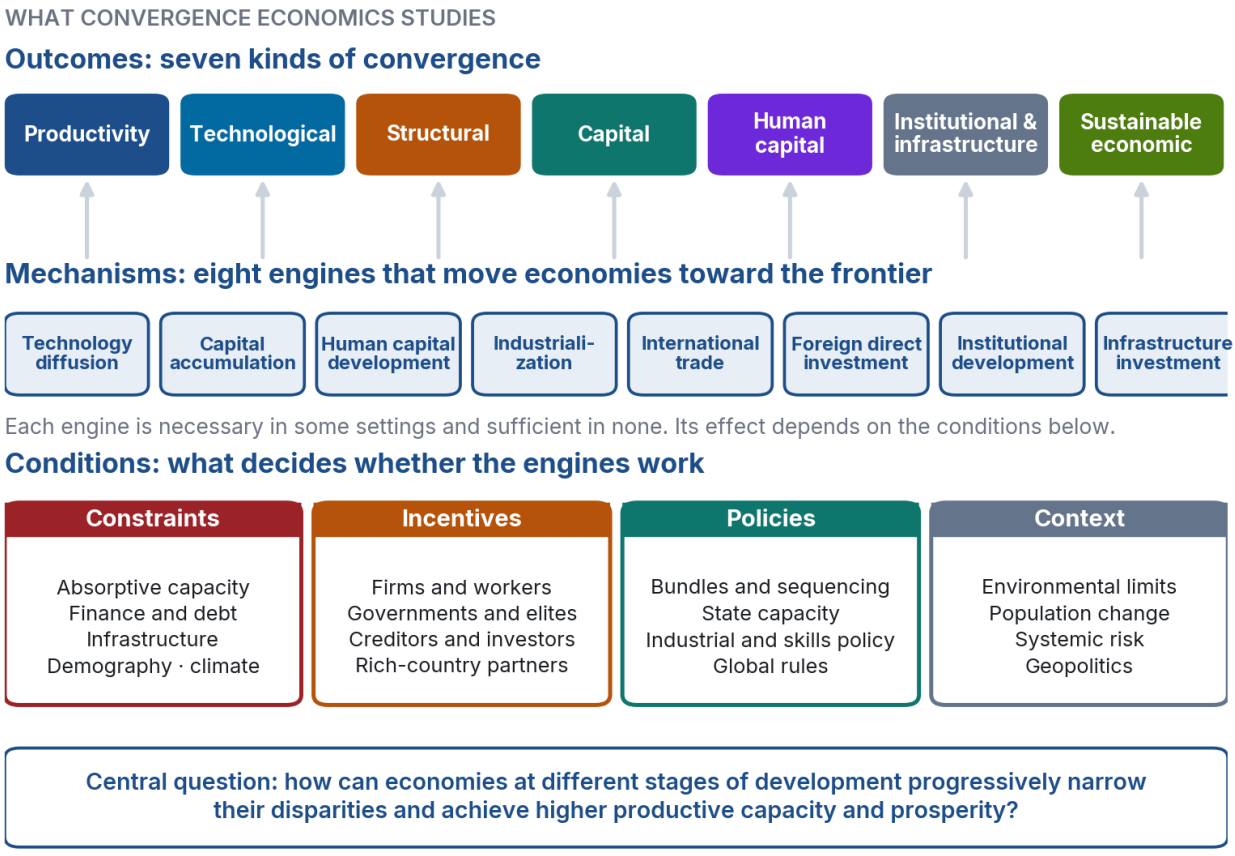
6.2 Why none is automatically sufficient

An important distinction is that these mechanisms are not automatically sufficient for convergence. Their effectiveness depends on complementary capabilities, institutional conditions, investment quality and the ability to absorb new technologies. The literature offers several concrete examples. Foreign investment raises growth only where the host economy has a minimum stock of human capital (Borensztein et al., 1998). Schooling expansions that do not build skills leave growth unchanged (Pritchett, 2001). Capital piles up as low-return projects where resources are misallocated, and Hsieh and Klenow estimated that removing misallocation would raise manufacturing productivity by large margins in China and India (Hsieh and Klenow, 2009). Managers who adopt better practices raise productivity, but many firms do not adopt them (Bloom et al., 2013). Each case is a story of a mechanism that works only when something else is present.

A second feature is that mechanisms overlap. Trade carries technology; FDI carries capital, technology and management; infrastructure supports trade and industry; institutions shape all of them. A map of the mechanisms is therefore less a list than a network, which is why the field treats their combination as the object of study (Figure 7).

Figure 7 Convergence Economics studies outcomes, mechanisms and the conditions that connect them

Structure of the field



Source: H Heuristics, based on the Convergence Economics framework. Outcomes follow the seven kinds of convergence; mechanisms are the eight engines; conditions are the constraints, incentives, policies and context studied in Sections 9 to 13.

SECTION 07

Testing the Mechanisms

Which mechanisms are associated with catch-up, whether any is sufficient, and whether they work better together are empirical questions. A simple audit of developing economies in 2000–19 gives first answers.

IN BRIEF

- Across 76 developing economies, income at the start explains only 9% of the variation in catch-up speed; adding eight mechanisms raises that to 70%.
- Technology diffusion, capital, institutions, industrialization, FDI and infrastructure are each positively associated with catch-up; schooling gains are not.
- Combinations matter: 32% of economies strong on 0–2 mechanisms converged, 90% of those strong on 5–6.

7.1 Design

The audit asks, for the 76 developing economies with complete data, how the growth advantage over high-income economies in 2000–19 relates to eight mechanism indicators (listed in Table 4). Flows (investment, FDI, trade) are averaged over the period; stocks (internet use, schooling, nonagricultural employment, electricity) are measured as gains; institutions are average government effectiveness. An economy is counted as having *converged* if its income grew at least one point a year faster than the high-income average: 40 of 76, or 53%, did. The audit is descriptive. Mechanisms are measured over the same window as catch-up, so reverse causation and common causes cannot be ruled out, and the sample is small. Its value is in the pattern and in what fails to show.

7.2 Which mechanisms are associated with catch-up?

Table 4 lists the indicators and three measures of association: a rank correlation, a partial correlation that holds initial income fixed, and the standardised coefficient from a regression that includes all eight mechanisms together.

Seven of the eight mechanisms are positively and significantly associated with catch-up once initial income is held fixed (Table 4). Technology diffusion shows the strongest association (partial correlation +0.68), then capital accumulation (+0.50), institutions and industrialization (+0.39 each), FDI (+0.37) and infrastructure (+0.35). Trade is the weakest of the seven (+0.22). Schooling gains are not associated with faster catch-up (rank correlation -0.20, partial -0.09), which echoes the finding that years of schooling alone do not translate into growth when learning is weak (Pritchett, 2001; Hanushek, 2012). With all eight in one regression only technology (+1.46), institutions (+0.54) and capital (+0.44) retain significance, and the model explains 70% of the variation, against 9% for initial income alone.

Table 4 Mechanism indicators and their association with catch-up speed, 2000–2019

Mechanism	Indicator	Rank corr.	Partial corr.	Joint coef.	Joint p<0.05
Technology diffusion	Gain in internet use (pp)	+0.25	+0.68	+1.46	yes
Capital accumulation	Investment rate (% of GDP)	+0.53	+0.50	+0.44	yes
Institutional quality	Government effectiveness (SD)	+0.22	+0.39	+0.54	yes
Industrialization	Gain in non-agricultural employment (pp)	+0.49	+0.39	+0.13	no
Foreign direct investment	FDI inflows (% of GDP)	+0.35	+0.37	+0.04	no
Infrastructure	Gain in electricity use (log)	+0.31	+0.35	+0.23	no
International trade	Trade openness (% of GDP)	+0.14	+0.22	+0.01	no
Human capital	Gain in years of schooling	-0.20	-0.09	-0.30	no

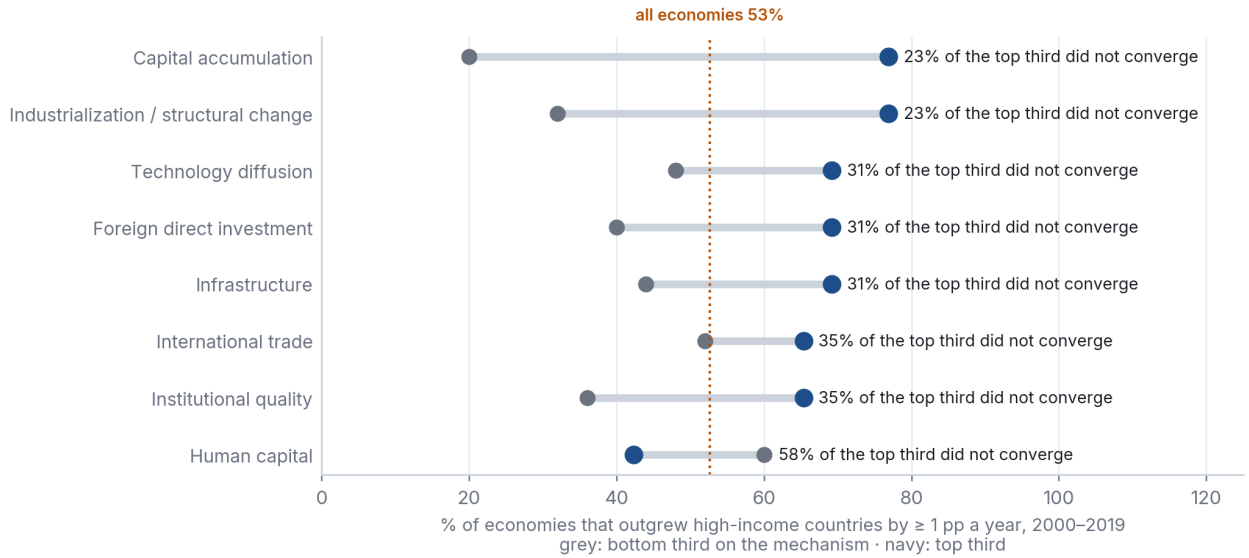
Source: H Heuristics calculations from World Development Indicators, WGI and UNDP (World Bank, 2026; World Bank, 2025a; UNDP, 2025). n = 76 developing economies. Catch-up speed is the annual growth advantage over high-income economies in percentage points. Partial correlation controls for initial log income; joint coefficients are standardised effects from one regression with all eight mechanisms and initial income (robust standard errors); initial income has a joint coefficient of -1.88 (p<0.001).

7.3 None is sufficient on its own

The framework's key caution is that mechanisms are not automatically sufficient. The data agree. Taking the top third of economies on each mechanism (Figure 8), the share that converged ranges from 42% (schooling gains) to 77% (capital accumulation), against 53% for the whole sample. Even on the best-performing mechanisms, about 23% of the economies in the top third failed to converge. And no mechanism is necessary either: on any single mechanism, 28% to 50% of the convergers sit in the top third, so most converge without leading on it.

Figure 8 Strength on any one mechanism leaves a large share of economies short of convergence

% of economies that converged: bottom third vs top third on each mechanism



Source: H Heuristics calculations. Top and bottom third of the audit sample on each mechanism indicator; 'converged' means a growth advantage of at least 1 point a year over high-income economies in 2000–19. n = 76; 40 converged.

7.4 Stacks matter

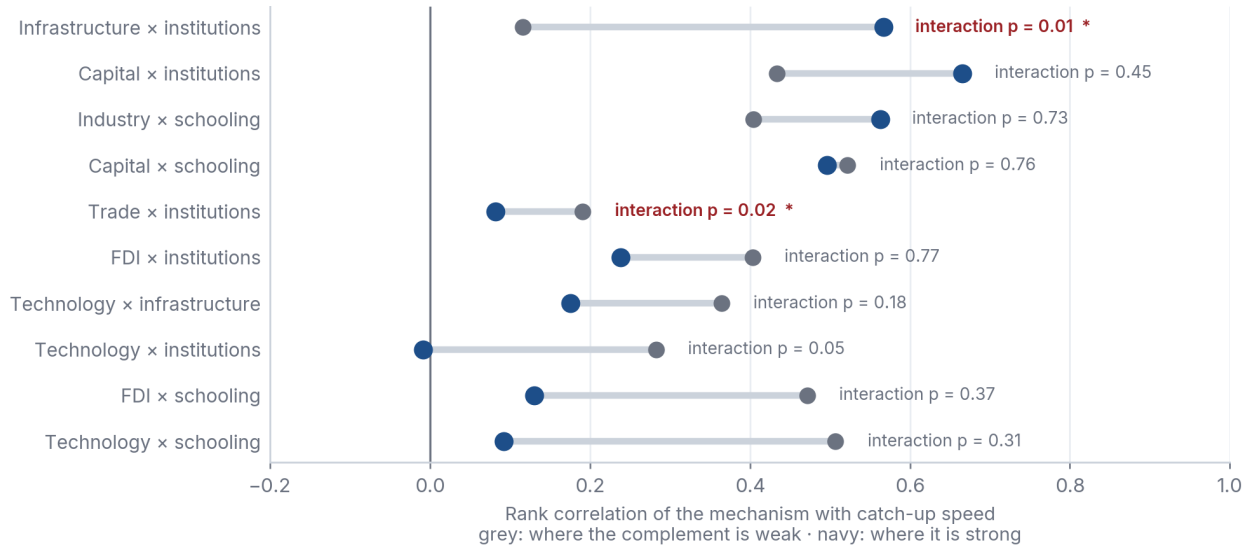
What does predict convergence is the number of mechanisms that are strong at the same time. Counting the mechanisms in which an economy is in the top third, the share that converged rises from 32% (0 to 2 mechanisms, n = 31) to 59% (3 to 4, n = 34) and 90% (5 to 6, n = 10); the rank correlation with catch-up speed is 0.52. Of the 11 economies strong on five or more mechanisms, 10 converged; the exception is Jordan. The result is suggestive, not conclusive (the stack count is built from the same indicators, and the top groups are small), but it fits the central claim: convergence is a property of bundles.

7.5 Do complements work as expected?

The literature predicts that some mechanisms depend on specific complements: technology on skills and institutions, FDI on skills, infrastructure on institutions. Figure 9 tests ten such pairings by comparing the mechanism's association with catch-up where the complement is weak (below the median) and strong. The result is mixed. Only 2 of ten interactions are significant at the 5% level: infrastructure works better where institutions are stronger (interaction p = 0.01), as expected, while trade is *less* strongly associated with catch-up where institutions are strong (p = 0.02). For technology and institutions the interaction is close to significant (p = 0.05) and negative: technology gains matter more where governance is weaker, consistent with diminishing returns once basic capacity exists, and with the earlier finding that adoption gates were not supported in the data (Hughes, 2026d). The honest reading is that the complementarity story is plausible but not general, and that a handful of strong pairings probably matter more than a universal rule.

Figure 9 Complements matter for some pairings and not for others

Mechanism × complement: association with catch-up where the complement is weak vs strong



Source: H Heuristics calculations. For each pair, the rank correlation of the first mechanism with catch-up speed in economies below (grey) and above (navy) the median on the second. The p-value is for the interaction term in a regression controlling for initial income; * marks p < 0.05. n = 76; ten pairings tested, so one or two significant results are expected by chance.

SECTION 08

Structural Transformation and the Industrial Route

Moving workers from low-productivity farming to higher-productivity activity has been the main engine of catch-up. The classic way to do it, manufacturing for export, now carries less of the load.

IN BRIEF

- At $10,000 of income, the predicted manufacturing share of GDP fell from 17% in the 1990s to 13% in 2015–19.
- Manufacturing's share of GDP fell by more than a point in 47 of 82 developing economies after 2000, and rose in 20.
- The fastest long catch-up episodes are mostly resource booms; the sustained export-manufacturing cases are few.

8.1 Why structure matters

Productivity differs enormously between sectors in poor economies. Workers in agriculture produce far less per person than workers elsewhere, a gap that Gollin, Lagakos and Waugh found to be large and persistent even after adjusting for hours and human capital (Gollin et al., 2014). Moving labour from the low-productivity to the high-productivity sector raises output without requiring any improvement within sectors: this is the engine in Lewis's model and the core of structural convergence (Lewis, 1954). The shift is far from complete. In 2019 agriculture still employed about 57% of workers in low-income countries and 40% in lower-middle-income countries, against 3% in high-income ones, although each group has moved (67% and 56% in 2000) (World Bank, 2026).

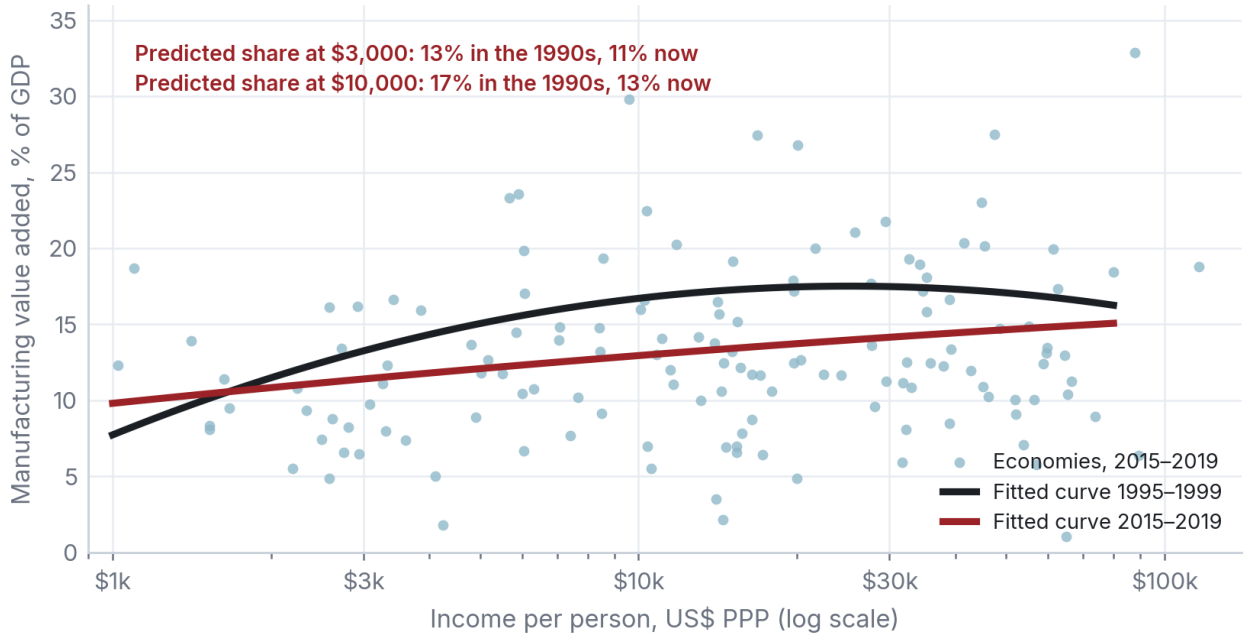
Whether structural change helps depends on where workers go. McMillan, Rodrik and Verduzco-Gallo found that it raised aggregate productivity growth in Asia and lowered it in Africa and Latin America, where workers moved to low-productivity services and informal work rather than to modern industry (McMillan et al., 2014). The destination, not the move, is what matters.

8.2 The industrial hump has flattened

Industrialization has historically followed a hump: manufacturing's share of output and employment rises with income and then falls as services take over. Rodrik showed that latecomers now peak earlier and lower, a pattern he calls premature deindustrialization, driven by global competition, labour-saving technology and the shift of manufacturing to a few exporters (Rodrik, 2016). A comparison of the cross-section in 1995–99 and 2015–19 shows the same flattening in value-added shares (Figure 10). At $3,000 of income per person the predicted manufacturing share of GDP fell from 13% to 11%; at $10,000, from 17% to 13%; at $25,000, from 18% to 14%.

Figure 10 At every income level, manufacturing takes a smaller share of output than it did twenty years ago

Manufacturing value added as % of GDP against income per person, with fitted curves



Source: H Heuristics calculations from World Development Indicators: manufacturing value added (% of GDP) and GDP per capita, PPP, averaged over 1995–99 and 2015–19 (World Bank, 2026). Quadratic fits in log income; 127 and 142 economies. Shares are in current prices, so part of the fall reflects the falling relative price of manufactured goods.

The same shift shows in individual economies. Between 2000 and 2019, manufacturing's share of GDP fell by more than a point in 47 of 82 developing economies with data and rose in 20; among the 56 with income below $15,000 in 2019, the share fell in 31. Group averages are consistent: low-income countries moved from 8% to 9%, lower-middle-income from 15% to 14%, upper-middle-income from 19% to 21%, while high-income economies fell from 17% to 13%. These are shares of output, not of employment or of world manufacturing; employment shares would add detail but are patchier in developing economies.

8.3 Which catch-up lasted?

The Maddison data identify each economy's fastest 25-year stretch of growth relative to the United States. The leaders are not what a manufacturing-centred story would predict (Table 5). Of the 23 economies with a best window of 4.4 points a year or more, 13 are resource-led (oil, gas, diamonds or mining), 5 are classic export-manufacturing cases (South Korea, Japan, Taiwan, Singapore and China), and the rest are post-conflict or post-transition recoveries from very low bases. Resource windows tend to be short, volatile and reversible; the manufacturing cases built broad capabilities.

Table 5 The fastest 25-year catch-up windows, by main driver

Main driver	n	Growth gap vs US (pp a year)	Economies and best window
Export manufacturing	5	4.7–6.0	South Korea (1966–1991), Japan (1950–1975), Taiwan (1968–1993), Singapore (1966–1991), China (1992–2017)
Resource-led	13	4.5–10.2	Equatorial Guinea (1984–2009), Qatar (1990–2015), Kuwait (1991–2016), Libya (1954–1979), Iraq (1991–2016), Botswana (1966–1991), Mongolia (1993–2018), Angola (1986–2011), Turkmenistan (1997–2022), Oman (1951–1976), Bahrain (1990–2015), Azerbaijan (1995–2020), Saudi Arabia (1952–1977)
Recovery or transition	5	4.6–6.1	Montenegro (1994–2019), Lebanon (1989–2014), Romania (1992–2017), Afghanistan (1994–2019), Myanmar (1995–2020)

Source: H Heuristics calculations from the Maddison Project Database 2023 (Bolt and van Zanden, 2024). Each economy's best 25-year window (start years 1950–1997) among economies that began below half of US income; the classification by main driver is the author's. Windows of 4.4 points a year or more.

8.4 Routes beyond classic manufacturing

If the hump has flattened, convergence must find other routes. Candidates include agriculture-linked industry that raises yields and processes output, tradable services such as business-process and software work, tourism, and clean-technology supply chains. Rodrik argued that new technologies and global value chains make export manufacturing a narrower path for latecomers and that services and agriculture will have to carry more of the load (Rodrik, 2018). Evidence for services-led convergence is thinner, and its employment effects look smaller, so the field's agenda includes finding which routes generate productive jobs at scale. Economic complexity analysis suggests that the products an economy can make next are constrained by what it makes today, so the most promising routes usually build on existing capabilities (Hausmann et al., 2007; Hidalgo and Hausmann, 2009).

SECTION 09

Constraints on Speed

Mechanisms move economies toward the frontier only as fast as the binding constraints allow. Absorptive capacity, finance, power and infrastructure, demography and climate limit how quickly even well-designed strategies can work.

IN BRIEF

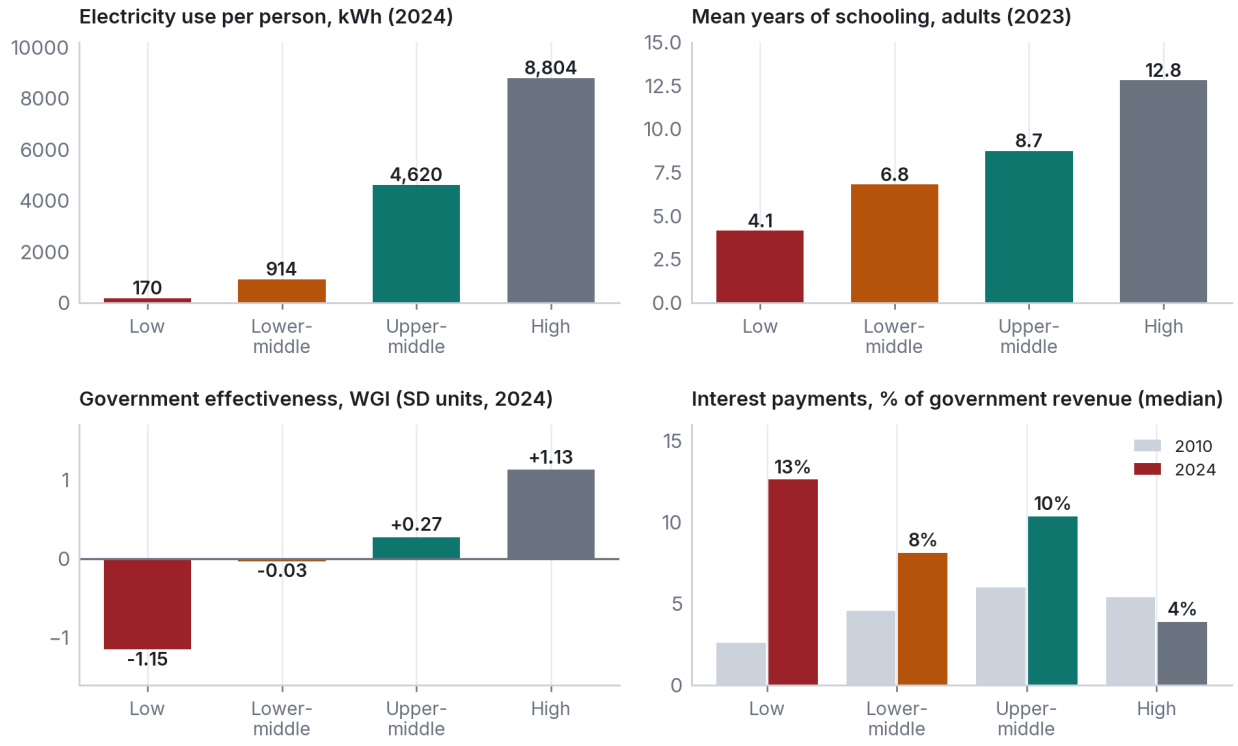
- Median interest payments take 13% of government revenue in low-income countries, up from 3% in 2010.
- Electricity use per person is 170 kWh in low-income countries and 8,804 in high-income ones.
- Government effectiveness scores -1.1 in low-income countries and +1.1 in high-income ones.

9.1 What a binding constraint is

A constraint is binding when relaxing it would raise growth the most and relaxing others would raise it little. The idea, central to growth diagnostics, is that remedies should target the constraint, not the symptoms. The constraints below recur in the literature and in the data; which binds in a given country is an empirical question. Figure 11 shows four of them.

Figure 11 Power, skills, governance and the cost of debt are all far from the frontier in low-income countries

Four constraints by World Bank income group



Source: H Heuristics calculations from World Development Indicators, WGI, UNDP and the World Bank's debt data (World Bank, 2026; World Bank, 2025a; UNDP, 2025). Population-weighted group averages, except interest payments, which are group medians (2010: 11 low-income and 40 high-income economies with data; 2024: 9 low-income and 38 high-income). Electricity use is for 2024.

9.2 Absorptive capacity

The oldest constraint is the ability to use what already exists. Nelson and Phelps showed that education speeds technology diffusion, and Abramovitz that social capability limits catch-up (Nelson and Phelps, 1966; Abramovitz, 1986). Adults in low-income countries have 4.1 years of schooling on average, against 12.8 in high-income countries, and the gap in learning is larger than the gap in years (Hanushek, 2012). Internet access shows the pace of convergence in availability (20% of people in low-income countries against 93% in high-income) and its limits: access is a start, and capability to use it productively comes more slowly.

9.3 Finance and debt

Capital is cheap to the frontier and dear to the follower. The cost of capital for clean energy in developing economies is often two to three times higher than in rich ones (IEA, 2024a). Debt service has risen: median interest payments were 3% of government revenue in low-income countries in 2010 and 13% in 2024; in lower-middle-income countries the figures were 5% and 8%, while in high-income countries they fell from 5% to 4% (World Bank, 2026). Of the 44 developing economies with 2024 data, 23 spent at least a tenth of revenue on interest, home to 1.1 billion people, and 7 at least a fifth (0.5 billion). Revenue spent on debt service is not spent on schools, grids or health, and the pressure falls most where public investment is most needed (Boston University GDP Center, 2025). The data cover only some low-income countries, so these are indicative figures.

9.4 Power and infrastructure

Unreliable and scarce infrastructure raises the cost of every other mechanism. Electricity use per person in low-income countries is 170 kWh a year, about 2% of the high-income level; in lower-middle-income countries it is 914 kWh. The Global South as a whole has risen from 10% to 30% of the high-income level since 2000, with most of that gain in China and India. Infrastructure is both a mechanism and a constraint: transport links raised incomes in colonial India by lowering trade costs (Donaldson, 2018).

9.5 Governance

Government effectiveness, which measures the quality of public services and policy implementation, scores -1.15 in low-income countries and +1.13 in high-income ones, in units of the global standard deviation (World Bank, 2025a). Andrews, Pritchett and Woolcock describe capability traps, in which reform adopts the form without the function (Andrews et al., 2013). Institutional constraints are the slowest to change, so design should usually take them as given when choosing where to start.

SECTION 10

Incentives

Mechanisms are operated by people and organisations with their own interests. Convergence happens where the actors who must build it gain from doing so, and stalls where they do not.

IN BRIEF

- Firms underinvest in discovering what an economy can produce profitably, because the gains spread to rivals.
- Governments, creditors and partners each have reasons to support and to block catch-up.
- Well-designed rewards and rules turn the interests of each group toward convergence.

10.1 Why incentives belong in the field

A mechanism is a function, but an investment is a decision. Technology diffusion needs firms that adopt; capital accumulation needs savers and investors; institutional development needs governments that give up rents. Whether they do depends on what they gain. North put the point in general terms: institutions are the humanly devised constraints that structure incentives (North, 1990). Convergence Economics therefore asks, for every mechanism, who must act, what they gain and what stops them.

10.2 Four sets of actors

Four groups of actors shape whether a mechanism is used: firms, governments, creditors and investors, and rich-country partners. Table 6 sets out what each stands to gain and lose, and the design levers that move them.

Table 6 Who gains and who loses from convergence, and how to align incentives

Actor	Incentive to support	Incentive to resist	Design lever
Firms	New markets, lower costs, better technology	Cost of learning borne alone; incumbents protected by the status quo	Cost-sharing for adoption, competition policy, export support
Governments	Revenue, legitimacy, electoral reward	Rents from control; short horizons; fear of losing power to new groups	Credible commitments, performance-linked funding, transparency
Creditors and investors	Returns on productive investment	Risk premia, home bias, fear of default	Guarantees, blended finance, better data on repayment capacity
Rich-country partners	Larger markets, stability, climate security	Competition for jobs and markets; control of technology	Trade and technology agreements, climate finance, shared standards

Source: H Heuristics synthesis, drawing on North (1990) and Hausmann and Rodrik (2003) (North, 1990; Hausmann and Rodrik, 2003).

10.3 Four incentive failures

Learning externalities. Hausmann and Rodrik argue that discovering which products an economy can produce at low cost is an information problem: the first firm to try bears the cost of failure while successful imitators share the gain, so private investment in discovery falls short of the social optimum (Hausmann and Rodrik, 2003). This is the core rationale for policies that share the risk of exploration.

Coordination failures. Investments that pay only if others invest too, such as a supplier cluster that needs a buyer and a buyer that needs suppliers, can leave an economy stuck in a low-investment equilibrium, the logic of the 'big push' (Rosenstein-Rodan, 1943) and of Hirschman's backward and forward linkages (Hirschman, 1958). **Rent protection.** Where incumbents benefit from restricted competition, reforms that would raise productivity are blocked, which is one reading of the institutional account of divergence (Acemoglu et al., 2001). **Mismatched time horizons.** Convergence pays over decades while politics, debt maturities and investor mandates run for years; short horizons favour consumption and extraction over capability.

EVIDENCE

An example of aligning incentives

Atkin, Khandelwal and Osman gave a random sample of Egyptian rug producers access to export orders from foreign buyers. The firms that received them improved quality, productivity and profits, evidence that exporting taught firms how to do better (Atkin et al., 2017). A firm that learns by exporting captures only part of the value of that learning, which is why a case can be made for helping firms reach export markets. The example also shows the field's method: identify the mechanism (trade as knowledge transfer), the actor (the firm), the incentive failure (learning that others can copy), and a lever (a small, targeted subsidy to market access).

10.4 International incentives

At the international level the incentives are more mixed. Rich-country firms and governments gain from larger markets and from stability and climate security in poorer ones, but they also face competition and wish to protect technology and jobs. The cost of capital, the terms of debt restructuring, the openness of markets and the rules on technology and subsidy are all set where developing economies have limited voice. A convergence-friendly international system would reduce the penalty for being behind, and the case for doing so rests on shared interest: a larger, richer, more stable world economy, and a lower-carbon route to it (Commission on Growth and Development, 2008).

SECTION 11

Policies

Policy turns mechanisms into outcomes. The evidence favours bundles over single reforms, capacity before ambition, competition inside industrial policy and an international system that stops penalising followers.

IN BRIEF

- Policy should target the binding constraint and the mechanisms that complement it, not copy another country's list.
- Industrial policy has worked when it is disciplined by competition and by results; it has failed when it protects.
- International policy on debt, capital costs, technology and trade is part of national convergence strategy.

11.1 Principles of convergence policy

Five principles follow from the evidence in this report. **Treat convergence as a bundle**: mechanisms work together, and strength on five or six of eight was associated with convergence far more often than strength on one (Section 7). **Start from the binding constraint**: a diagnosis of what limits growth in a given economy comes before a menu of reforms. **Build absorptive capacity early**, because technology, capital and trade deliver most where skills, management and governance are in place. **Discipline support with competition and results**. **Measure progress on seven fronts** so that gains on one are not mistaken for gains on all.

11.2 A policy map by mechanism

Table 7 maps national and international levers onto the eight mechanisms, with an indicator for tracking each.

11.3 Industrial policy that works

Industrial policy is the most contested lever. Rodrik argues that the question is not whether to do it but how: policy should be embedded in a dialogue with business, support activities with learning externalities, carry sunsets and be held to performance (Rodrik, 2004). Aghion and co-authors found that sectoral subsidies were associated with higher productivity growth in Chinese firms when they were targeted at competitive sectors or increased competition within a sector (Aghion et al., 2015). Juhász found that temporary protection from imports during the Napoleonic blockade led to the adoption of mechanised cotton spinning in French regions that were exposed to it, and that the effect persisted (Juhász, 2018). Together the studies suggest that protection can work when it is temporary, targeted at a learnable activity and paired with competitive pressure.

Table 7 Policy levers by mechanism, national and international

Mechanism	National levers	International levers	Indicator to track
Technology diffusion	Digital public infrastructure, firm adoption programmes, technical standards	Technology partnerships, open standards, licensing terms	Adoption by firms; internet use and quality
Capital accumulation	Public investment management, financial deepening, SME credit	Concessional and blended finance; lower borrowing costs	Investment rate; cost of capital
Human capital	Foundational learning, health, technical and vocational training	Education finance, skills mobility, research networks	Learning outcomes; skills of workers
Industrialization	Competition-disciplined sectoral policy, special zones, logistics	Market access, supply-chain partnerships	Manufacturing and tradable services employment
Trade	Tariff and trade-cost reduction, export support, standards	Open and predictable rules; trade finance	Export diversification and sophistication
FDI	Investment climate, linkage programmes, skills for suppliers	Investment treaties; political-risk insurance	Local content; supplier upgrading
Institutions	Problem-driven reform, performance budgeting, anti-corruption	Technical assistance; peer review	Government effectiveness; delivery metrics
Infrastructure	Maintenance budgets, regulatory reform, resilient design	Project preparation; guarantees; climate finance	Reliable power and logistics; service quality

Source: H Heuristics synthesis.

11.4 Regional policy: lessons from convergence inside the European Union

The European Union has run the world's largest convergence programme. Becker, Egger and von Ehrlich found that receiving the top-tier structural-fund status raised regional growth, but they found no clear effect on employment (Becker et al., 2010). The result illustrates two themes of this report: transfers can raise output but not necessarily jobs, and what the money does depends on what the region can absorb. Lessons for the Global South should be drawn carefully, since the EU's members share a market, legal order and institutions that most developing regions lack.

11.5 International policy as part of national strategy

Four international levers deserve emphasis because they act on the binding constraints in Section 9. **Debt**: timely restructuring and relief, and contingent clauses that pause payments after disasters, protect public investment. **Capital costs**: guarantees, blended finance and local-currency lending lower the cost of clean investment (IEA, 2024a). **Technology**: partnerships and open standards speed diffusion where firms lack frontier access. **Market access and rules**: predictable trade rules and fair treatment of subsidies and carbon border measures decide whether latecomers can use the routes they have left (Rodrik, 2018). Facilities such as the IMF's Resilience and Sustainability Trust show how multilateral lending can be tied to reform and to resilience (IMF, 2025).

SECTION 12

The Speed of Convergence

Convergence is an arithmetic of speed. A small difference in annual growth separates a gap that closes within a lifetime from one that lasts for centuries.

IN BRIEF

- At a steady 2-point growth advantage, the Global South would reach half of the high-income level in about 38 years, lower-middle-income countries in 62 and low-income countries in 130.
- A 2-point advantage sustained for 25 years has occurred in 20% of windows for lagging economies; 3 points in 10%.
- The Global South's 2000–19 advantage of 2.6 points falls to 0.6 without China and India.

12.1 Convergence arithmetic

If a follower's income per person grows d points a year faster than the frontier's, the time needed to move from a current ratio r to a target ratio R is $\ln(R/r) \div d$. The Global South now stands at 24% of the high-income level, lower-middle-income countries at 15%, upper-middle-income countries at 36% and low-income countries at 3.7%. Table 8 and Figure 12 show how long each group takes to reach 50% and 75% of the high-income level at advantages of one to four points a year.

Table 8 Years to reach half and three-quarters of the high-income level, by growth advantage

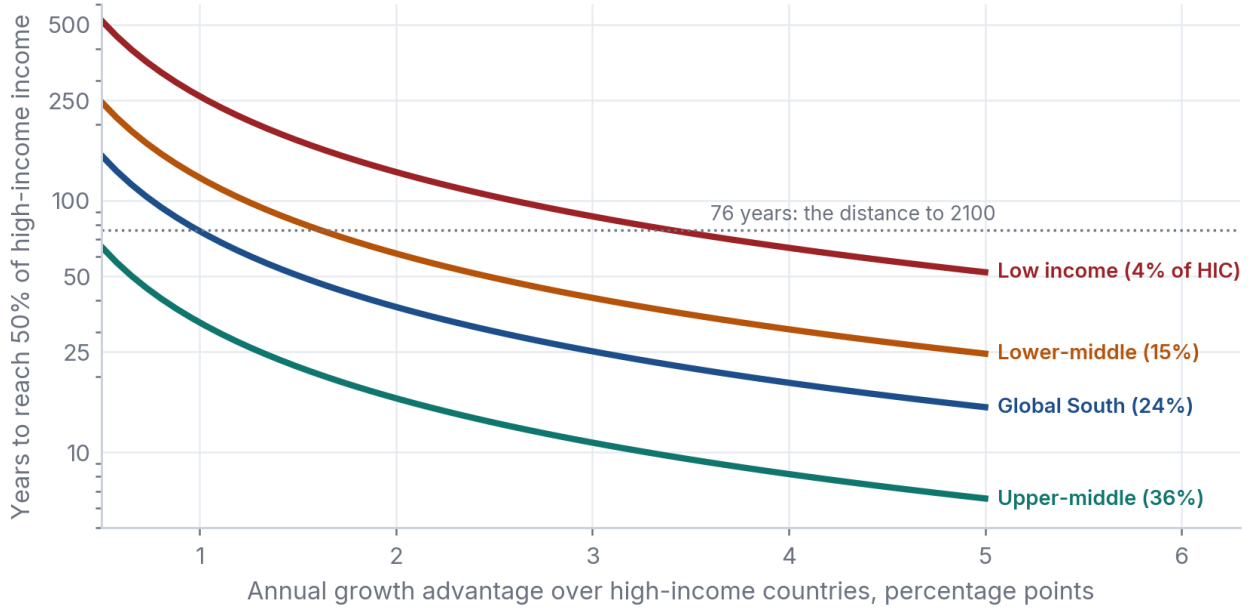
Group (current % of HIC)	1 pp	2 pp	3 pp	4 pp	1 pp	2 pp	3 pp	4 pp
Upper-middle income (36%)	33	16	11	8	73	37	24	18
Global South (all) (24%)	75	38	25	19	116	58	39	29
Lower-middle income (15%)	123	62	41	31	164	82	55	41
Low income (4%)	259	130	86	65	300	150	100	75

Source: H Heuristics calculations. Starting points are 2024 income per person at PPP, population-weighted, as a share of the high-income average; the advantage is assumed constant. Left block: years to 50%; right block: years to 75%.

The numbers are sobering at the bottom. A low-income country growing two points faster than the rich world every year for 130 years would reach half the high-income level. Even at four points, a pace achieved over 25 years by only a few economies, it would take 65 years. For lower-middle-income countries the corresponding figures are 62 and 31; for upper-middle-income, 16 and 8. Two things follow. Speed dominates every other variable, and the poorest economies have the most to gain from every added fraction of a point.

Figure 12 A small gain in annual growth advantage shortens the journey by decades

Years to reach 50% of the high-income level against the annual growth advantage



Source: H Heuristics calculations. Years for each group to reach 50% of the high-income level at a constant annual growth advantage, from the current starting ratio; logarithmic vertical axis. The dotted line marks the 76 years from 2024 to 2100.

12.2 What speeds have been achieved?

The Maddison data give a benchmark. Across all 25-year windows for economies that began below half of US income, the median growth advantage was 0.1 points a year, the 75th percentile 1.6 and the 90th 3.0 (6,211 economy-windows). A sustained advantage of one point or more occurred in 34% of windows, two points in 20%, three points in 10%. In 2000–19 the Global South as a whole achieved 2.6 points, but this was 0.6 points without China and India, and in 2019–24 it was 1.4 (-0.2 without them). A 'proven pace', the 75th percentile of what peer economies have sustained, is therefore about 1.6 points a year; a 'frontier pace' at the 90th percentile is about 3.

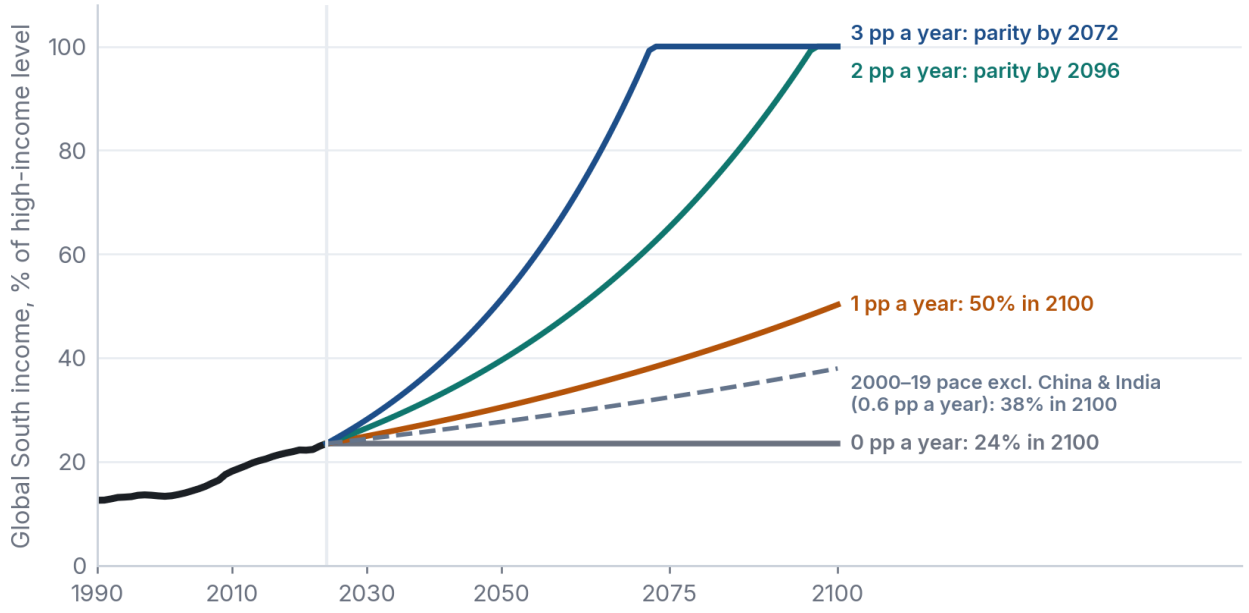
12.3 Scenarios to 2100

The scenarios below apply constant growth advantages to the Global South's current starting point. They are illustrations of arithmetic, not forecasts: they assume that a single average economy can sustain a constant advantage, and that high-income growth continues as before. Real convergence paths slow as economies approach the frontier, as in the middle-income slowdown, so figures near parity should be read as upper bounds (World Bank, 2024).

- **No advantage (0 points):** the Global South stays at 24% of the high-income level.
- **One point a year:** 30% by 2050 and 50% by 2100.
- **Proven pace (about 1.6 points):** 35% by 2050 and 77% by 2100.
- **Two points a year:** 40% by 2050 and parity by about 2096.
- **Three points a year:** 51% by 2050 and parity by about 2072.
- **The 2000–19 pace without China and India (0.6 points):** 28% by 2050 and 38% by 2100.

Figure 13 **At the pace of 2000–19 without China and India, the Global South does not converge this century**

Global South income as % of the high-income level, 1990–2100



Source: H Heuristics calculations; scenarios are illustrative. Population-weighted Global South income as % of the high-income average (PPP). Constant annual growth advantages from 2024 to 2100, capped at parity. Not comparable to the speed-of-closure scenarios in earlier H Heuristics reports, which close a fraction of the remaining log gap each year (Hughes, 2026c; Hughes, 2026d).

READING THE CLOCK

The paired reading of the clock

Each harm number has a lever. For low-income countries, a gap that takes 259 years to half-close at a one-point advantage takes 86 at three. The difference is the gap between the pace of the typical economy and the pace of the fastest tenth, which is what convergence policy aims to move. Because time to any target is inversely proportional to the advantage, moving from two points to two and a half cuts it by a fifth, and every year gained matters more as the population that needs the income grows (Section 13).

SECTION 13

Sustainability, Demography and Systemic Risk

Three conditions decide the feasibility and the quality of convergence: the environmental route, the number of people who must be employed, and the shocks that can reverse gains.

IN BRIEF

- The Global South now emits 1.4 times as much CO_2 per dollar of output as high-income economies, against parity in 2000.
- The Global South's population is projected to grow from 6.7 billion in 2025 to 8.0 billion in 2050; the high-income economies' stays near 1.4 billion.
- Setbacks, years in which income per person falls, hit 43% of low-income country-years in 2020–24 against 26% in 2010–19.

13.1 The environmental route

The seventh convergence asks whether catch-up can occur alongside decarbonization, environmental improvement and reduced systemic vulnerability. The record so far is mixed. Carbon intensity has fallen in every income group, but it has fallen faster in rich economies, so the gap has widened: the Global South emitted about 0.41 kg of CO_2 per dollar of GDP in 2000, the same as rich economies (0.41), and 0.31 in 2022 against 0.23 (Our World in Data, 2025). Low-income countries emit far less per dollar (0.14 kg in 2022), because they burn little fossil fuel, but this is the lack of industry as much as cleanliness. The central question for sustainable economic convergence is whether the middle-income economies, which will account for most of the next decades' growth, can industrialise on a cleaner path than their predecessors.

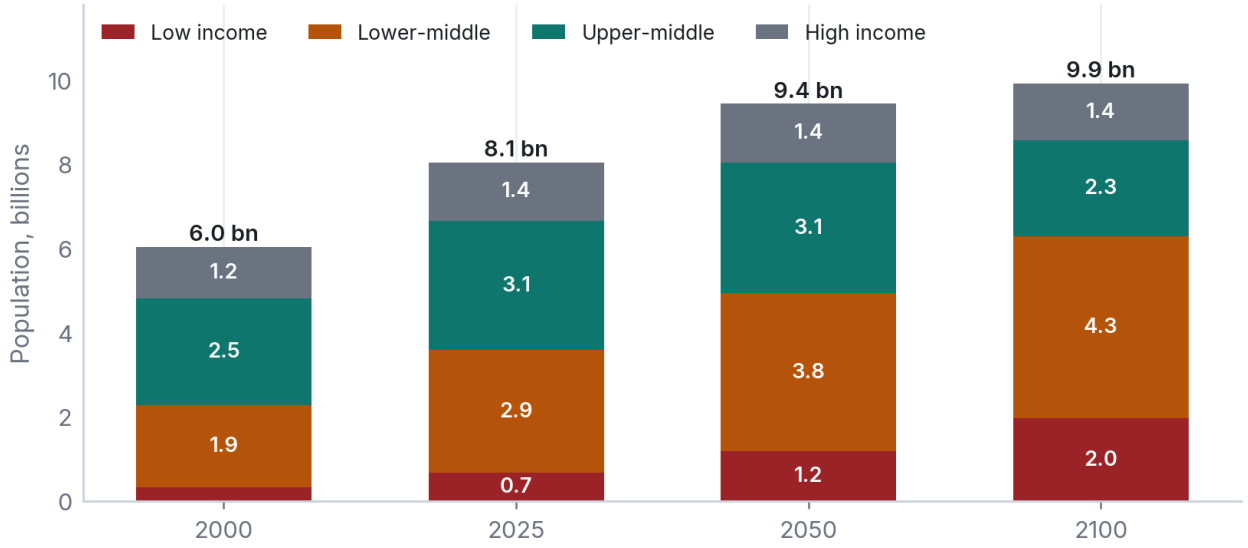
The latecomer advantage is real. Economies that first reached $10,000 of income per person after 2000 emitted a median 2.9 tonnes of CO_2 per person at that point, against 4.4 tonnes for those that got there before 1970 (Hughes, 2026b). Solar modules cost about 1,101 times less than in 1975, and clean power is now the cheapest new generation in most markets (Our World in Data, 2025b; IRENA, 2025). The problem is cost of capital, not cost of technology: where borrowing is expensive, capital-intensive clean assets lose their advantage (IEA, 2024a). The field's task is to establish when sustainability is a complement to convergence, as in cheaper clean power, and when it is a cost, as in the early years of costly climate adaptation.

13.2 Demography

The population that convergence must serve is growing in the poorest economies and not in the richest. On UN projections, the Global South grows from 6.7 billion in 2025 to 8.0 billion in 2050 and 8.6 billion in 2100, low-income countries from 0.7 to 1.2 to 2.0 billion, Sub-Saharan Africa from 1.3 to 2.1 to 3.4 billion, while high-income economies stay near 1.4 billion (Figure 14) (United Nations, 2024). The Global South's share of the population of the sample grows from 83% in 2025 to 86% in 2100. Whether this is a dividend or a burden depends on whether the economy can employ the entrants productively: East Asia's rapid growth was helped by a rising share of working-age people and the policies that put them to work (Bloom and Williamson, 1998). The working-age share in 2024 was 55% in low-income countries, 64% in lower-middle-income and 65% in high-income economies.

Figure 14 Nearly all of the world's population growth to 2100 is in the economies that most need to converge

Population by income group, billions, 2000–2100



Source: H Heuristics calculations from UN World Population Prospects 2024, medium variant (United Nations, 2024), through Our World in Data. Economies with at least one million people in 2000 (148 economies), grouped by current World Bank income class.

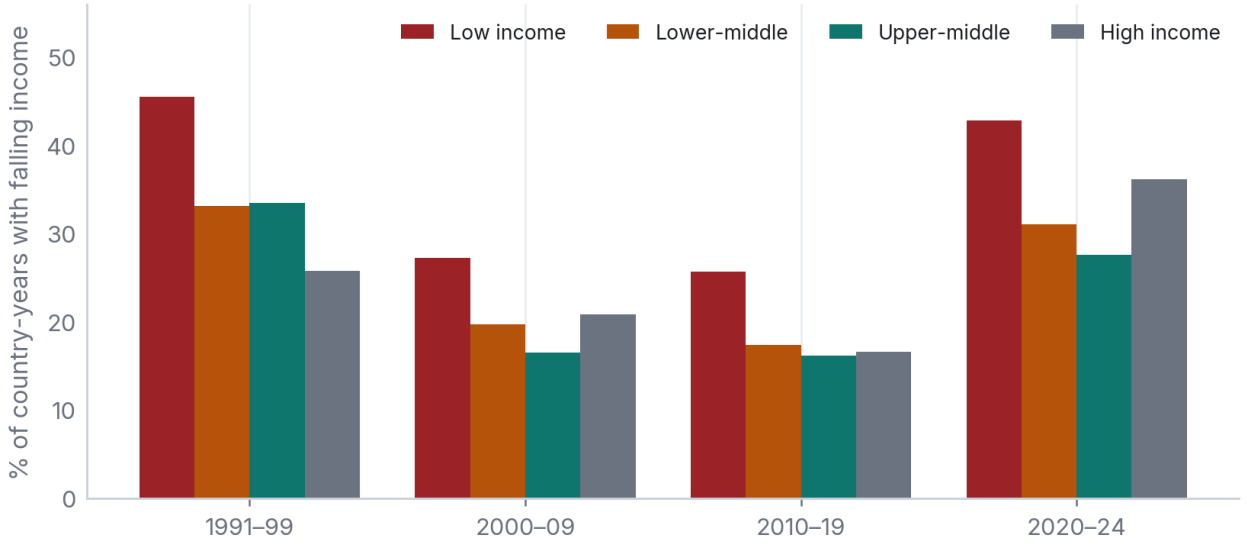
Two implications follow. First, convergence in income per person understates what must be built: aggregate output, housing, power and jobs must grow with the population. Second, the choices of the next two decades, when most Global South cities and power systems are built, will lock in patterns for the rest of the century. Time is therefore part of the case for acting early, which links this report to the logic of preventive investment (Hughes, 2026h).

13.3 Systemic risk

Convergence can reverse. Cerra and Saxena found that output losses after financial and political crises are largely permanent (Cerra and Saxena, 2008), and Hsiang and Jina found that large tropical cyclones depress income for more than a decade (Hsiang and Jina, 2014). A simple indicator is the share of country-years in which income per person falls (Figure 15). In low-income countries it was 46% in the 1990s, 27% in the 2000s, 26% in the 2010s and 43% in 2020–24. The rich world's rose too, to 36%, which is why the Global South's average ratio was little changed by 2020 (22.0% in 2019, 22.3% in 2020) even as low-income countries slipped from 4.3% to 3.7% by 2024.

Figure 15 Setbacks fell in the 2000s and 2010s and returned in the 2020s

% of country-years with falling income per person, by income group and period



Source: H Heuristics calculations from World Development Indicators, GDP per capita (constant US$) (World Bank, 2026). Share of country-years, within each income group, in which income per person fell; 2020–24 includes the pandemic years.

In the H Heuristics framework, Polycrisis Resilience is the capacity to withstand and reduce cascading, interconnected crises, and Sustainable Convergence is the development path that closes the gaps while pursuing environmentally sustainable, inclusive and resilient routes (Hughes, 2026e; Hughes, 2026a). Within Convergence Economics, they enter as conditions: sustainability and resilience determine the quality and durability of catch-up, and convergence in turn reduces the vulnerability that crises exploit. That two-way link is a hypothesis to be tested, and one of the propositions in Section 14.

SECTION 14

A Research Programme

A field earns its place by the questions it can answer. This section sets out ten testable propositions, the data and methods needed, and a route from concept to use.

IN BRIEF

- Ten propositions, each with what would count against it: five find first support in this report's data, four are partly supported or mixed, and one is untested.
- Priorities include quality-adjusted human capital, firm-level technology data, cost-of-capital data and open dashboards.
- The field grows through teaching, shared data and annual review.

14.1 Ten propositions

Table 9 states ten propositions that follow from the framework, with the evidence in this report and what would count against each. Where this report's data say little, the status is 'untested'.

14.2 Data and methods

- **Quality-adjusted human capital.** Learning outcomes and workforce skills for more countries and years, to test P4.
- **Firm-level technology adoption.** Harmonised surveys of what firms use and how, beyond access, to measure technological convergence directly.
- **Cost-of-capital data.** Country-level risk premia and project-level financing costs, to test P6.
- **An open convergence dashboard.** The seven convergences, in relative and absolute terms, updated each year with code and data open for replication.

14.3 From concept to use

A field grows when its ideas are taught, tested and used. Three routes are open. **Teaching**: a twelve-week course could treat convergence as an integrated subject, running from the record and theory through the eight mechanisms, conditions and policy to speed, sustainability and risk. **Shared data**: an open dashboard would give a common reference. **Annual review**: a yearly assessment of the propositions, with nulls reported as prominently as confirmations. These are proposals that depend on others taking them up.

14.4 Conclusion

For two centuries economists have asked whether poorer countries will catch up. The answers have changed with the data: no, then conditionally, then unconditionally, then perhaps not. The record in this report shows why a single answer will not do. Convergence is plural, conditional and slow; it happens through combinations of mechanisms, within limits set by finance, capacity, power, population and climate, and through incentives that can be aligned or not.

Table 9 Ten propositions of Convergence Economics

Proposition	Statement	What would count against it	Status in this report
P1 Plurality	The seven convergences are weakly correlated across economies; a single index hides more than it shows	Average rank correlation above 0.6 after controlling for income	Supported: mean 0.20
P2 Insufficiency	No single mechanism reliably predicts convergence; combinations do	A single mechanism with a hit rate above 90%	Supported: top-third hit rates 42–77%; stacks 32% to 90%
P3 Complementarity	Mechanisms work better where specific complements are strong	Interaction terms null across pairings	Mixed: 2 of 10 significant, one reversed
P4 Absorption	Skills quality, not years of schooling, predicts gains from technology and capital	Years of schooling predict catch-up as well as test scores	Partly: years not associated; quality untested
P5 Route	Among converging latecomers, tradable services and agro-industry carry more of the structural shift	Converging economies still follow the manufacturing hump	Partly: the hump has flattened
P6 Finance	A lower cost of capital and debt service raise the growth return to investment	No relation between borrowing cost and investment returns	Untested here
P7 Rarity	A 25-year advantage of 2 points a year stays rare (under a quarter of windows)	Share of windows rising above a quarter	Supported: 20% of windows
P8 Fragility	The 2000s catch-up was exceptional and depended on external conditions	Catch-up persists at 2000s rates after 2019	Supported so far: 90% outgrew the US in 2000–10, 64% after
P9 Quality	Income convergence runs ahead of carbon-intensity convergence unless clean technology is financed	Carbon-intensity gaps close as fast as income gaps	Supported so far: intensity gap widened
P10 Resilience	Shocks erase more of the gains in low-income economies, and protection preserves convergence	Equal proportional losses across income groups	Partly: setbacks more frequent in low-income countries

Source: H Heuristics. Each proposition is open to testing with the data and methods in the text.

The picture is not bleak. Technology has converged fast. A growth advantage of three points, which about one in ten 25-year windows achieved, would bring the Global South to parity within about 48 years. The lesson for policy is to build the bundles that make convergence likelier: skills with technology, finance with infrastructure, institutions with investment.

> *"Convergence Economics asks how economies at different stages of development can progressively narrow their disparities and achieve higher levels of productive capacity and prosperity, and what enables some to catch up while others do not."*
>
> Hunter Hughes, Founder of H Heuristics

DATA AND METHODS

Data and Methods

All data are public. This note lists the sources, the definitions and the limits of the calculations, so that every number in the report can be checked and challenged.

Sources

The report uses only public data. Table 10 lists the sources and what each is used for.

Table 10 Data used

Source	Series	Used for
World Bank, World Development Indicators (World Bank, 2026)	GDP per capita (PPP, constant); output per worker; population; internet use; manufacturing and agriculture; investment, trade, FDI; electricity; working-age share; interest payments	Income ratios, dashboard, mechanism audit, constraints
World Bank, Worldwide Governance Indicators (World Bank, 2025a)	Government effectiveness	Institutional convergence, audit, constraints
Penn World Table 11.0 (Groningen Growth and Development Centre, 2025)	Capital stock, employment	Capital convergence
Maddison Project Database 2023 (Bolt and van Zanden, 2024)	GDP per capita, 1950–2022	Long-run record, 25-year windows, mobility
UNDP Human Development Report 2025 (UNDP, 2025)	Mean years of schooling	Human capital convergence, audit
Our World in Data / Global Carbon Project (Our World in Data, 2025)	CO_2 per unit of GDP	Sustainable convergence
UN World Population Prospects 2024 (United Nations, 2024)	Population, medium variant	Demography
World Bank country classifications (World Bank, 2025b)	Income groups and regions	Grouping

Source: as listed.

Definitions and methods

- **Sample.** 148 economies with at least one million people in 2000, in the four World Bank income groups: 101 low-, lower-middle- and upper-middle-income (the 'Global South') and 47 high-income. Groups follow current classifications, so some economies moved group over the period.
- **Averages.** Population-weighted, except carbon intensity (GDP-weighted) and the medians of interest payments. The frontier is the population-weighted average of high-income economies in the same year.

- **Latest year.** 2024 for income, internet, electricity and manufacturing; 2023 for schooling and capital; 2022 for carbon intensity. The World Bank's 2025 values were not used because coverage is incomplete.
- **Growth advantage.** Annual difference in log income per person (PPP) between a developing economy and the high-income average. 'Converged' means at least one point a year, 2000–19.
- **Convergence changes (Section 5).** For each indicator, the change since 2000 in the economy's position relative to the frontier, in standard deviations of the 2000 cross-section, with sign set so that positive means catching up. Levels use logs where indicators are strictly positive.
- **Mechanism audit (Section 7).** 76 developing economies with complete data. Investment, FDI and trade are averages over 2000–19; internet, schooling, non-agricultural employment and electricity are gains; institutions are average government effectiveness. FDI is trimmed at the 2nd and 98th percentiles. Standard errors are heteroskedasticity-robust (HC3). The 'top third' is by rank within the sample.
- **Maddison calculations (Section 4).** Lagging economies are those below half of US income at the start of each window. Decade windows are 1950–60 to 2010–22; 25-year windows start in each year from 1950 to 1997.
- **Manufacturing hump (Section 8).** Quadratic regression of manufacturing value added (% of GDP) on log income, with five-year averages for 1995–99 and 2015–19.
- **Clocks and scenarios (Section 12).** Constant annual growth advantage applied to the 2024 ratio; ratios capped at parity.

Limits

- **Association, not causation.** The mechanism audit uses contemporaneous measures over one period and a small sample; results are descriptive.
- **Measurement.** Years of schooling, internet users and investment rates do not capture quality. PPP comparisons depend on price surveys. Electricity use and CO_2 per dollar are affected by economic structure as well as policy.
- **Sample.** Excluding economies under one million people leaves out many small islands and some resource economies; the Maddison windows are not restricted by population.
- **Comparison with earlier H Heuristics reports.** Convergence figures use the same World Bank PPP series as earlier reports and agree on levels (Global South at about 23–24% of the high-income level in 2024; 20% without China and India). Beta-convergence coefficients differ slightly because the sample and definitions differ. Growth-accounting shares are sensitive to how capital is measured and are not repeated here.
- **Scenarios.** Constant-advantage scenarios are arithmetic illustrations, not forecasts.
- **Concept status.** Convergence Economics is a proposed framework. The phrase has appeared in earlier literature in a narrower sense (De Grauwe, 1996); this report does not claim novelty for the underlying ideas, which come from the literatures cited.

REFERENCES

References

Abramovitz, M. (1986). Catching up, forging ahead, and falling behind. *Journal of Economic History*, 46(2), 385–406. doi.org/10.1017/S0022050700046209

Acemoglu, D., Johnson, S. and Robinson, J. A. (2001). The colonial origins of comparative development: an empirical investigation. *American Economic Review*, 91(5), 1369–1401. doi.org/10.1257/aer.91.5.1369

Aghion, P. and Howitt, P. (1992). A model of growth through creative destruction. *Econometrica*, 60(2), 323–351. doi.org/10.2307/2951599

Aghion, P., Cai, J., Dewatripont, M., Du, L., Harrison, A. and Legros, P. (2015). Industrial policy and competition. *American Economic Journal: Macroeconomics*, 7(4), 1–32. doi.org/10.1257/mac.20120103

Andrews, M., Pritchett, L. and Woolcock, M. (2013). Escaping capability traps through problem driven iterative adaptation (PDIA). *World Development*, 51, 234–244. doi.org/10.1016/j.worlddev.2013.05.011

Atkin, D., Khandelwal, A. K. and Osman, A. (2017). Exporting and firm performance: evidence from a randomized experiment. *Quarterly Journal of Economics*, 132(2), 551–615. doi.org/10.1093/qje/qjx002

Barro, R. J. (1991). Economic growth in a cross section of countries. *Quarterly Journal of Economics*, 106(2), 407–443. doi.org/10.2307/2937943

Barro, R. J. and Sala-i-Martin, X. (1992). Convergence. *Journal of Political Economy*, 100(2), 223–251. doi.org/10.1086/261816

Baumol, W. J. (1986). Productivity growth, convergence, and welfare: what the long-run data show. *American Economic Review*, 76(5), 1072–1085. jstor.org/stable/1816469

Becker, S. O., Egger, P. H. and von Ehrlich, M. (2010). Going NUTS: the effect of EU Structural Funds on regional performance. *Journal of Public Economics*, 94(9–10), 578–590. doi.org/10.1016/j.jpubeco.2010.06.006

Bloom, D. E. and Williamson, J. G. (1998). Demographic transitions and economic miracles in emerging Asia. *World Bank Economic Review*, 12(3), 419–455. doi.org/10.1093/wber/12.3.419

Bloom, N., Eifert, B., Mahajan, A., McKenzie, D. and Roberts, J. (2013). Does management matter? Evidence from India. *Quarterly Journal of Economics*, 128(1), 1–51. doi.org/10.1093/qje/qjs044

Bolt, J. and van Zanden, J. L. (2024). Maddison-style estimates of the evolution of the world economy: a new 2023 update. *Journal of Economic Surveys*. Maddison Project Database 2023, accessed via Our World in Data. rug.nl/ggdc/historicaldevelopment/maddison/releases/maddison-project-database-2023

Borensztein, E., De Gregorio, J. and Lee, J.-W. (1998). How does foreign direct investment affect economic growth? *Journal of International Economics*, 45(1), 115–135. doi.org/10.1016/S0022-1996(97)00033-0

Boston University Global Development Policy Center (2025). *The Cost of Inaction: Explaining Africa's Debt Distress in 10 Charts and Five Fixes for the G20*. Boston, MA: BU GDP Center. bu.edu/gdp/2025/06/18/the-cost-of-inaction-explaining-africas-debt-distress-in-10-chart...

Caselli, F. (2005). Accounting for cross-country income differences. In P. Aghion and S. Durlauf (eds.), *Handbook of Economic Growth*, vol. 1A, 679–741. Amsterdam: Elsevier. doi.org/10.1016/S1574-0684(05)01009-9

Cerra, V. and Saxena, S. C. (2008). Growth dynamics: the myth of economic recovery. *American Economic Review*, 98(1), 439–457. doi.org/10.1257/aer.98.1.439

Comin, D. and Hobijn, B. (2010). An exploration of technology diffusion. *American Economic Review*, 100(5), 2031–2059. doi.org/10.1257/aer.100.5.2031

Commission on Growth and Development (2008). *The Growth Report: Strategies for Sustained Growth and Inclusive Development*. Washington, DC: World Bank. openknowledge.worldbank.org/handle/10986/6507

De Grauwe, P. (1996). Monetary union and convergence economics. *European Economic Review*, 40(3–5), 1091–1101. doi.org/10.1016/0014-2921(95)00117-4

Donaldson, D. (2018). Railroads of the Raj: estimating the impact of transportation infrastructure. *American Economic Review*, 108(4–5), 899–934. doi.org/10.1257/aer.20101199

Forster, P. M., Smith, C., Walsh, T. et al. (2025). Indicators of Global Climate Change 2024: annual update of key indicators of the state of the climate system and human influence. *Earth System Science Data*, 17, 2641–2680.

doi.org/10.5194/essd-17-2641-2025

Frankel, J. A. and Romer, D. (1999). Does trade cause growth? *American Economic Review*, 89(3), 379–399. doi.org/10.1257/aer.89.3.379

Gerschenkron, A. (1962). *Economic Backwardness in Historical Perspective*. Cambridge, MA: Harvard University Press.

Gollin, D., Lagakos, D. and Waugh, M. E. (2014). The agricultural productivity gap. *Quarterly Journal of Economics*, 129(2), 939–993. doi.org/10.1093/qje/qjt056

Groningen Growth and Development Centre (2025). *Penn World Table version 11.0*. University of Groningen, Dataverse NL. https://doi.org/10.34894/FABVLR doi.org/10.34894/FABVLR

Hanushek, E. A. and Woessmann, L. (2012). Do better schools lead to more growth? Cognitive skills, economic outcomes, and causation. *Journal of Economic Growth*, 17(4), 267–321. doi.org/10.1007/s10887-012-9081-x

Hausmann, R. and Rodrik, D. (2003). Economic development as self-discovery. *Journal of Development Economics*, 72(2), 603–633. doi.org/10.1016/S0304-3878(03)00124-X

Hausmann, R., Hwang, J. and Rodrik, D. (2007). What you export matters. *Journal of Economic Growth*, 12(1), 1–25. doi.org/10.1007/s10887-006-9009-4

Hidalgo, C. A. and Hausmann, R. (2009). The building blocks of economic complexity. *Proceedings of the National Academy of Sciences*, 106(26), 10570–10575. doi.org/10.1073/pnas.0900943106

Hirschman, A. O. (1958). *The Strategy of Economic Development*. New Haven, CT: Yale University Press. yalebooks.yale.edu/book/9780300001358/the-strategy-of-economic-development/

Hsiang, S. M. and Jina, A. S. (2014). *The Causal Effect of Environmental Catastrophe on Long-Run Economic Growth: Evidence from 6,700 Cyclones*. NBER Working Paper 20352. nber.org/papers/w20352

Hsieh, C.-T. and Klenow, P. J. (2009). Misallocation and manufacturing TFP in China and India. *Quarterly Journal of Economics*, 124(4), 1403–1448. doi.org/10.1162/qjec.2009.124.4.1403

Hughes, H. (2026a). *Sustainable Development & Economic Convergence: Sustainable Convergence*. Figshare preprint, November 2026. https://doi.org/10.6084/m9.figshare.34977568. doi.org/10.6084/m9.figshare.34977568

Hughes, H. (2026b). *Sustainable Global Economic Convergence: A Framework for Advancing Prosperity, Environmental Quality and Systemic Resilience Together*. H Heuristics Research Report, November 2026. researchreports.hheuristics.com

Hughes, H. (2026c). *Global Economic Convergence as a Polycrisis Resilience Strategy*. H Heuristics Research Report, November 2026. researchreports.hheuristics.com

Hughes, H. (2026d). *Closing the Global Productivity Gap Through Technology Adoption*. H Heuristics Research Report, November 2026. researchreports.hheuristics.com

Hughes, H. (2026e). *Polycrisis Resilience: A General Definition and the H Heuristics Framework*. H Heuristics Research Report, November 2026. researchreports.hheuristics.com

Hughes, H. (2026h). *Preventive Development Economics*. H Heuristics Research Report, November 2026. researchreports.hheuristics.com

International Energy Agency (2024a). *Reducing the Cost of Capital: Strategies to Unlock Clean Energy Investment in Emerging and Developing Economies*. Paris: IEA. iea.org/reports/reducing-the-cost-of-capital

International Monetary Fund (2025). *Resilience and Sustainability Trust*. Washington, DC: IMF. imf.org/en/Topics/Resilience-and-Sustainability-Trust

International Renewable Energy Agency (2025). *Renewable Power Generation Costs in 2024*. Abu Dhabi: IRENA, July. irena.org/Publications/2025/Jun/Renewable-Power-Generation-Costs-in-2024

Johnson, P. and Papageorgiou, C. (2020). What remains of cross-country convergence? *Journal of Economic Literature*, 58(1), 129–175. doi.org/10.1257/jel.20181207

Juhász, R. (2018). Temporary protection and technology adoption: evidence from the Napoleonic blockade. *American Economic Review*, 108(11), 3339–3376. doi.org/10.1257/aer.20151730

Kremer, M., Willis, J. and You, Y. (2022). Converging to convergence. *NBER Macroeconomics Annual*, 36, 337–412. doi.org/10.1086/718672

Lewis, W. A. (1954). Economic development with unlimited supplies of labour. *The Manchester School*, 22(2), 139–191. doi.org/10.1111/j.1467-9957.1954.tb00021.x

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, 22(1), 3–42. doi.org/10.1016/0304-3932(88)90168-7

Mankiw, N. G., Romer, D. and Weil, D. N. (1992). A contribution to the empirics of economic growth. *Quarterly Journal of Economics*, 107(2), 407–437. doi.org/10.2307/2118477

McMillan, M., Rodrik, D. and Verduzco-Gallo, Í. (2014). Globalization, structural change, and productivity growth, with an update on Africa. *World Development*, 63, 11–32. doi.org/10.1016/j.worlddev.2013.10.012

Nelson, R. R. and Phelps, E. S. (1966). Investment in humans, technological diffusion, and economic growth. *American Economic Review*, 56(1/2), 69–75. jstor.org/stable/1821269

North, D. C. (1990). *Institutions, Institutional Change and Economic Performance*. Cambridge: Cambridge University Press. doi.org/10.1017/CBO9780511808678

Our World in Data (2025). *CO_2 and Greenhouse Gas Emissions dataset*, based on the Global Carbon Project. Oxford: Our World in Data. github.com/owid/co2-data

Our World in Data (2025b). *Solar photovoltaic module prices*, based on Nemet (2009), Farmer and Lafond (2016) and IRENA. Oxford: Our World in Data. ourworldindata.org/grapher/solar-pv-prices

Patel, D., Sandefur, J. and Subramanian, A. (2021). The new era of unconditional convergence. *Journal of Development Economics*, 152, 102687. doi.org/10.1016/j.jdeveco.2021.102687

Pomeranz, K. (2000). *The Great Divergence: China, Europe, and the Making of the Modern World Economy*. Princeton, NJ: Princeton University Press. press.princeton.edu/books/paperback/9780691090108/the-great-divergence

Pritchett, L. (1997). Divergence, big time. *Journal of Economic Perspectives*, 11(3), 3–17. doi.org/10.1257/jep.11.3.3

Pritchett, L. (2001). Where has all the education gone? *World Bank Economic Review*, 15(3), 367–391. doi.org/10.1093/wber/15.3.367

Pritchett, L. and Summers, L. H. (2014). *Asiaphoria Meets Regression to the Mean*. NBER Working Paper 20573. Cambridge, MA: National Bureau of Economic Research. doi.org/10.3386/w20573

Rodrik, D. (2004). *Industrial Policy for the Twenty-First Century*. Faculty Research Working Paper, Harvard Kennedy School. drodrik.scholar.harvard.edu/publications/industrial-policy-twenty-first-century

Rodrik, D. (2013). Unconditional convergence in manufacturing. *Quarterly Journal of Economics*, 128(1), 165–204. doi.org/10.1093/qje/qjs047

Rodrik, D. (2016). Premature deindustrialization. *Journal of Economic Growth*, 21, 1–33. doi.org/10.1007/s10887-015-9122-3

Rodrik, D. (2018). *New Technologies, Global Value Chains, and Developing Economies*. NBER Working Paper 25164. Cambridge, MA: National Bureau of Economic Research. doi.org/10.3386/w25164

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5), S71–S102. doi.org/10.1086/261725

Rosenstein-Rodan, P. N. (1943). Problems of industrialisation of Eastern and South-Eastern Europe. *Economic Journal*, 53(210/211), 202–211. doi.org/10.2307/2226317

Solow, R. M. (1956). A contribution to the theory of economic growth. *Quarterly Journal of Economics*, 70(1), 65–94. doi.org/10.2307/1884513

United Nations Development Programme (2025). *Human Development Report 2025: A Matter of Choice: People and Possibilities in the Age of AI*. New York: UNDP. Composite indices time series used for the HDI and schooling. hdr.undp.org/content/human-development-report-2025

United Nations, Department of Economic and Social Affairs (2024). *World Population Prospects 2024*. New York: United Nations. population.un.org/wpp/

World Bank (2024). *World Development Report 2024: The Middle-Income Trap* (press release: middle-income trap hinders progress in 108 developing countries). Washington, DC: World Bank, 1 August. worldbank.org/en/news/press-release/2024/07/22/middle-income-trap-hinders-progress-in-1…

World Bank (2025a). *Worldwide Governance Indicators*, 2025 update. Washington, DC: World Bank. worldbank.org/en/publication/worldwide-governance-indicators

World Bank (2025b). *World Bank Country and Lending Groups*. Washington, DC: World Bank. datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending…

World Bank (2026). *World Development Indicators*. Washington, DC: World Bank. databank.worldbank.org/source/world-development-indicators

About the author. Hunter Hughes is the Founder of H Heuristics. He developed the concepts of Sustainable Convergence and Polycrisis Resilience and the H Heuristics Polycrisis Resilience Framework.

About H Heuristics. H Heuristics is an independent research practice founded by Hunter Hughes, publishing research on development, resilience, the clean transition and interconnected global risks at researchreports.hheuristics.com.

Disclaimer. The views are the author's. Statistical results describe associations in public data and are not causal estimates. Scenario results are illustrative, not forecasts. Corrections are welcome.