

Human Capital, Unequal Opportunities and Productivity Convergence: A Global Historical Perspective, 1800-2100

Nitin Bharti, Amory Gethin, Thanasak Jenmana,
Zhexun Mo, Thomas Piketty, Li Yang

WIL Seminar, March 5 2025

What We Do in this Research

(1) We build a new historical database on public expenditure and its components, and particularly human capital expenditure (% GDP) covering 57 core territories (48 main countries + 9 residual regions) over the 1800-2025 period

Including public and private education and health expenditure

+ other human and social capital expenditure

(general public services (justice, police, administration, roads, etc.)

+ research/culture/ community services/environmental protect./etc.)

(this presentation mostly focus on education + health)

(2) We find a large rise of education and health expenditure (as % GDP) in every world region in the long run

We also find very large and persistent inequality in access to education and health between poor and rich countries, with little improvement in recent decades

E.g. per-school-age-individual public education expenditure in Sub-Saharan Africa $\approx$ 3% of Europe/North America level in 2025 in PPP terms (vs 6% in 1980 and 4% in 1950) (gap is even worst in MER)

(3) We also discuss the implications of our historical findings for the future

We find a large impact of education/health on productivity growth 1800-2025 (especially for public education, and especially for poor countries) and we show that increased expenditure could lead to global productivity convergence by 2100 (around 100€/hour in all world regions)

See forthcoming GJP scenarios for more detailed analysis of future trajectories (taking into account within-country inequality, structural transformation between sectors, etc.)

Relation to the Literature

(i) Large literature on public expenditure in the long run

Mostly focuses on Western countries

Lindert 1994, 2004, 2021 on rich countries since 1800

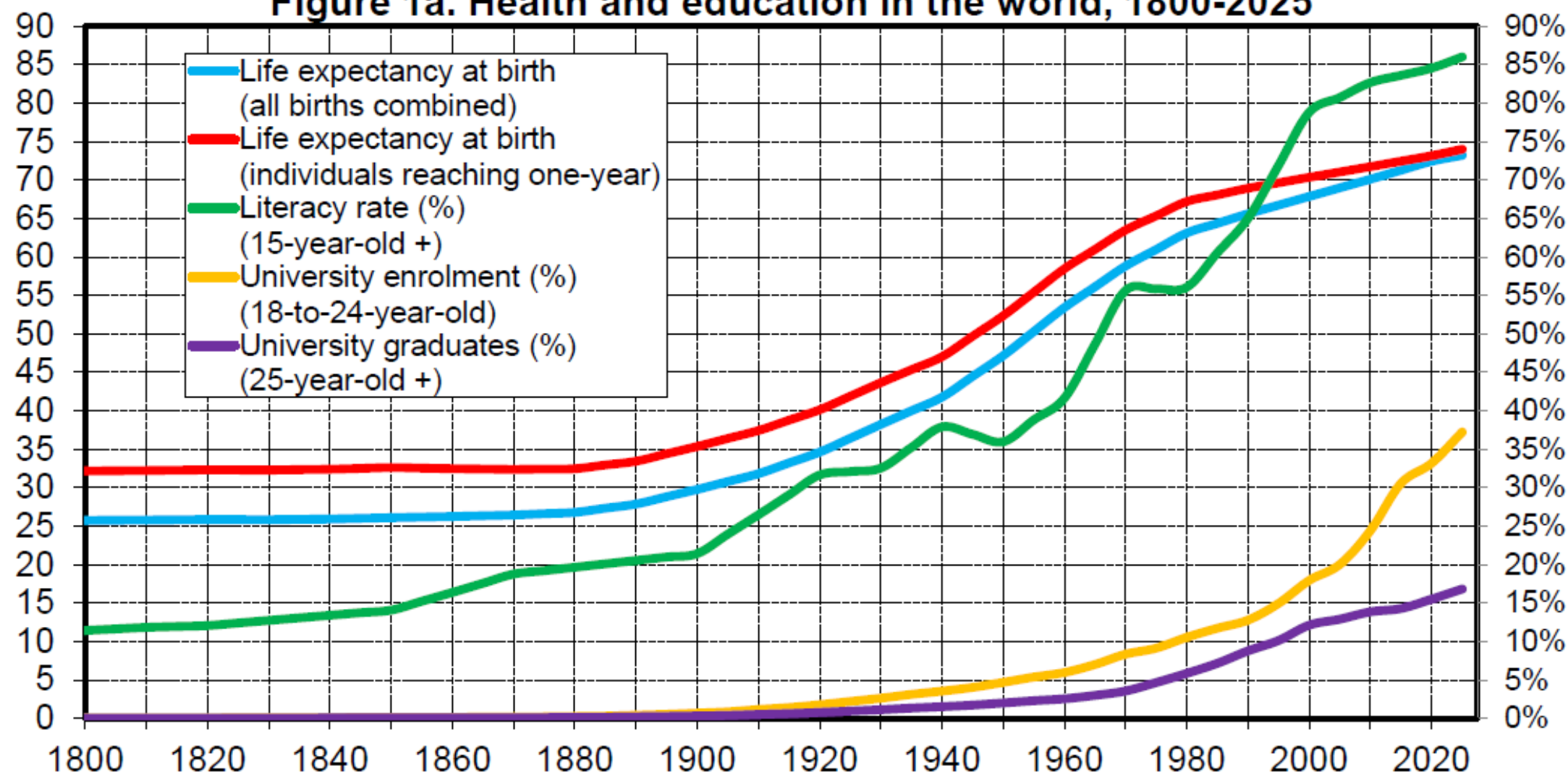
(ii) Recent historical work covering more & more countries in & outside the West

Bharti and Yang 2024 on China and India since late 19c

Gethin 2024 at global level since 1980

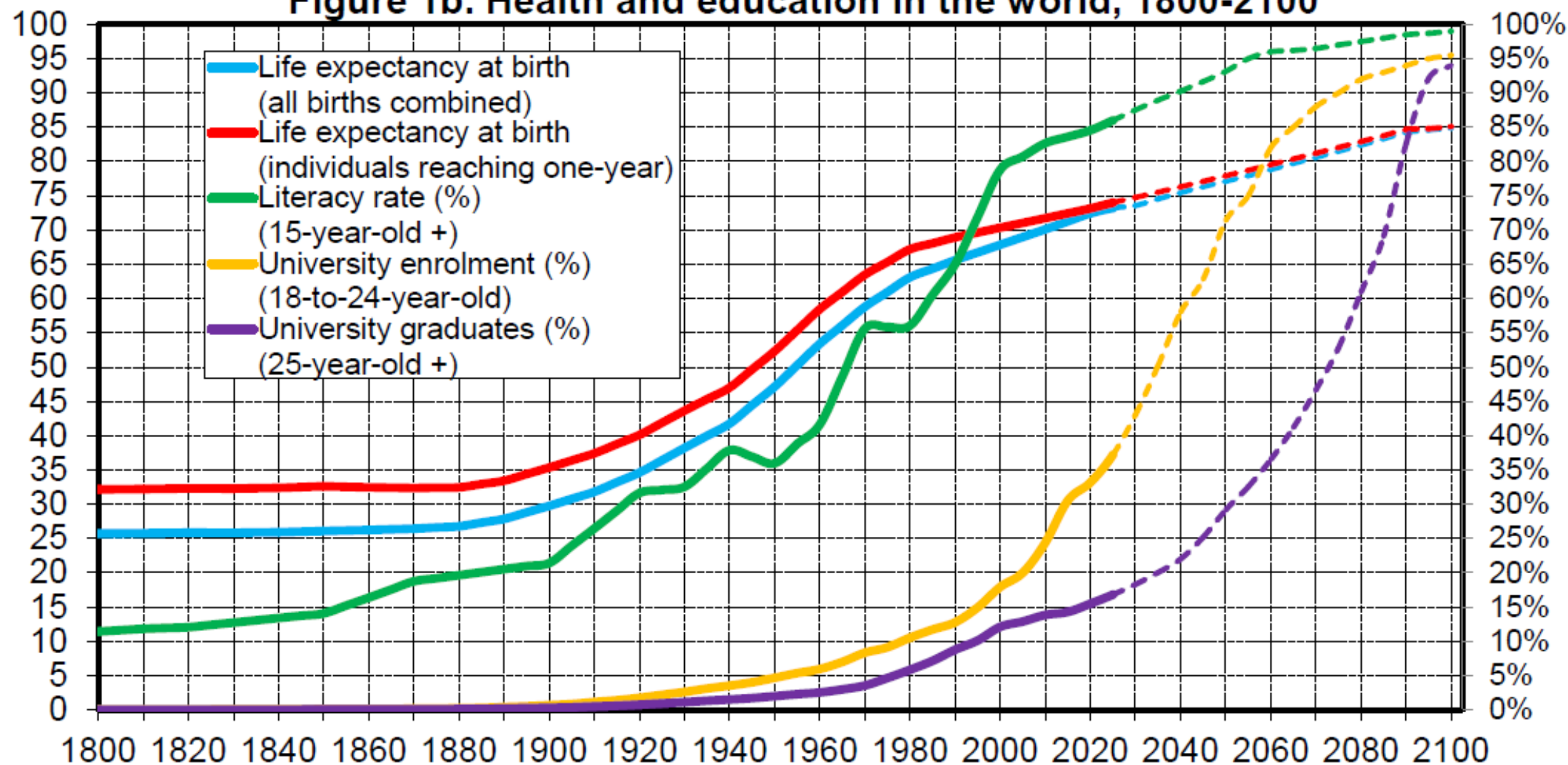
But no attempt so far to provide consistent historical estimates at the global level: key contribution of this paper, using new budgetary sources and archival material

Figure 1a. Health and education in the world, 1800-2025



Interpretation. Life expectancy increased from an average of 26 years in the world in 1800 to 73 years in 2025. Life expectancy for those living to age 1 rose from 32 years to 74 years (because infant mortality before age 1 decreased from 20% in 1800 to less than 1% in 2025). The literacy rate for the 15-year-olds-and-over rose from 12% to 86%. University enrolment for the 18-to-24-year-olds rose from less than 1% to 37%. The proportion of university graduates for the 25-year-olds-and-over rise from less than 1% to 17%. **Sources and series:** wid.world

Figure 1b. Health and education in the world, 1800-2100



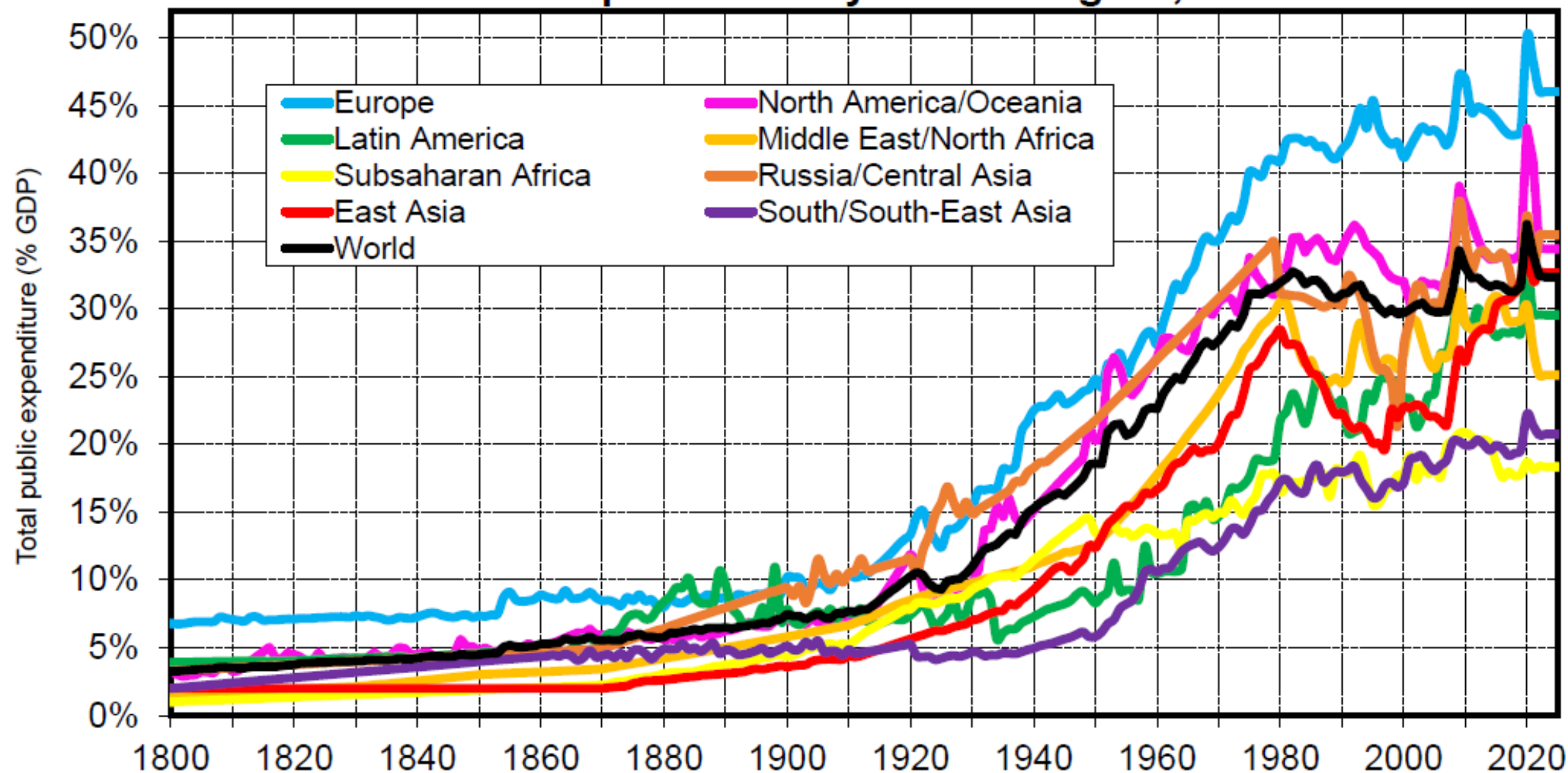
Interpretation. Assuming that past trends continue in the future, life expectancy could reach about 85 years worldwide by 2100, while literacy rates, university enrolments rates and proportions of university graduates could reach 95% or more. As time passes and quantitative improvements continue, the key question will increasingly become the quality of health care and education provision. **Sources and series:**

Table 1. A New Global Human Capital Database: Geographical Coverage
(57 core territories = 48 main countries + 9 residual regions)

East Asia (5)	China, Japan, South Korea, Taiwan Other EASA
Europe (11)	Britain, Denmark, France, Germany, Italy, Netherlands, Norway, Spain, Sweden, Other W.EUR, Other E.EUR
Latin America (6)	Argentina, Brasil, Chile, Colombia Mexico, Other LATAM
Middle East/ North Africa (8)	Algeria, Egypt, Iran, Morocco, Saudi Arabia, Turkey, UAE, Other MENA
North America/ Oceania (5)	USA, Canada, Australia, New Zealand Other NAOC
Russia/ Central Asia (2)	Russia Other RUCA
South/South-East Asia (9)	Bengladesh, India, Indonesia, Myanmar, Pakistan, Philippines, Thailand, Vietnam, Other SSEA
Sub-Saharan Africa (11)	DR Congo, Ethiopia, Kenya, Ivory Coast, Mali, Niger, Nigeria, Rwanda, Sudan, South Africa, Other SSAF

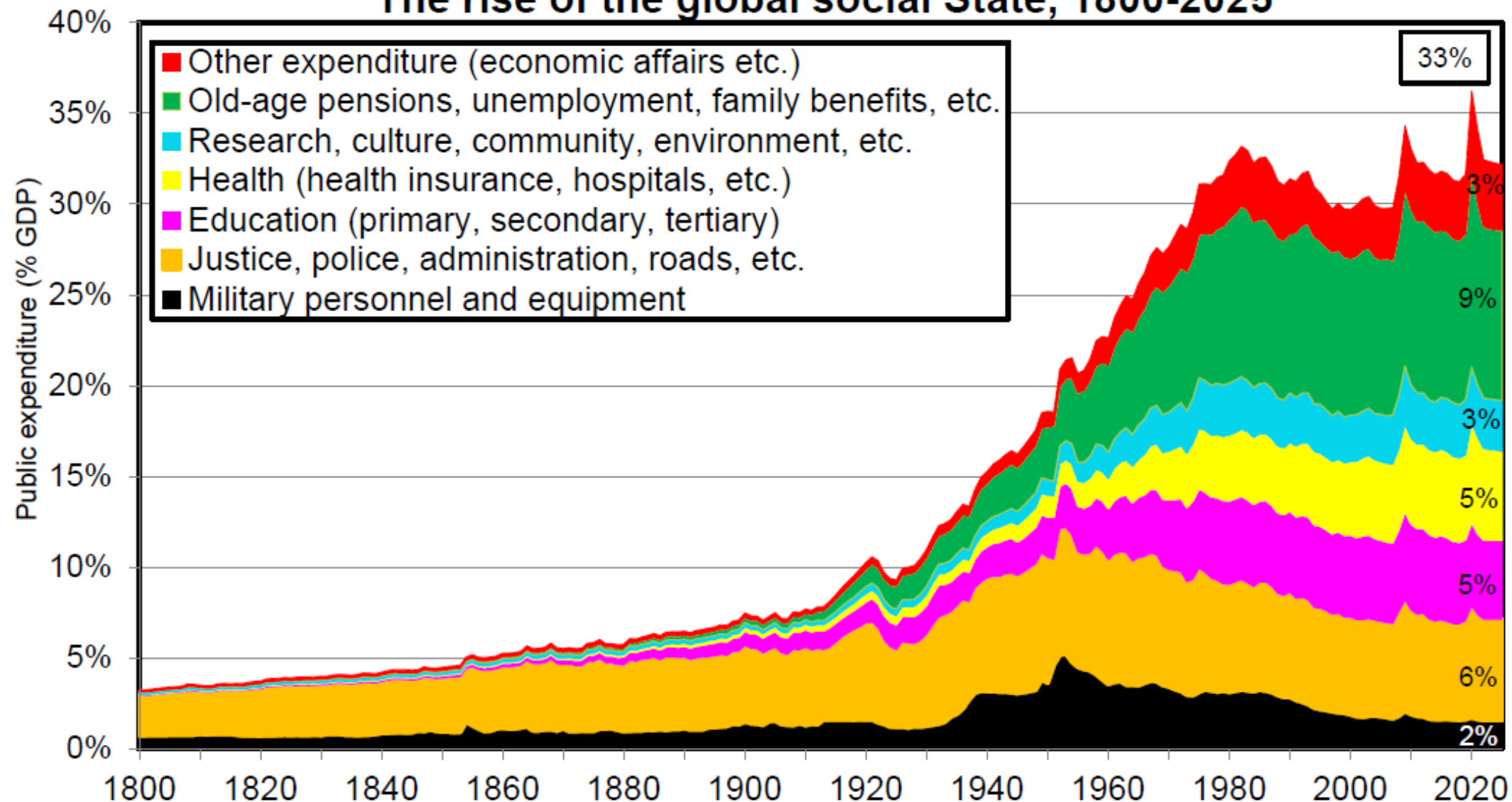
Interpretation. Our global historical database on human capital expenditure aims to cover 57 core territories (48 main countries + 9 residual regions) over the 1800-2025 period. Whenever possible, we provide estimates for public and private education and health expenditure, as well as for other human and social capital expenditure (research, culture, basic public services: justice, police, roads, etc.), i.e. expenditure contributing to the accumulation of human and social capital and to long term sustainable productivity growth (over and beyond the accumulation of non-human capital assets included in national accounts balance sheets).

Total Public Expenditure by World Region, 1800-2025



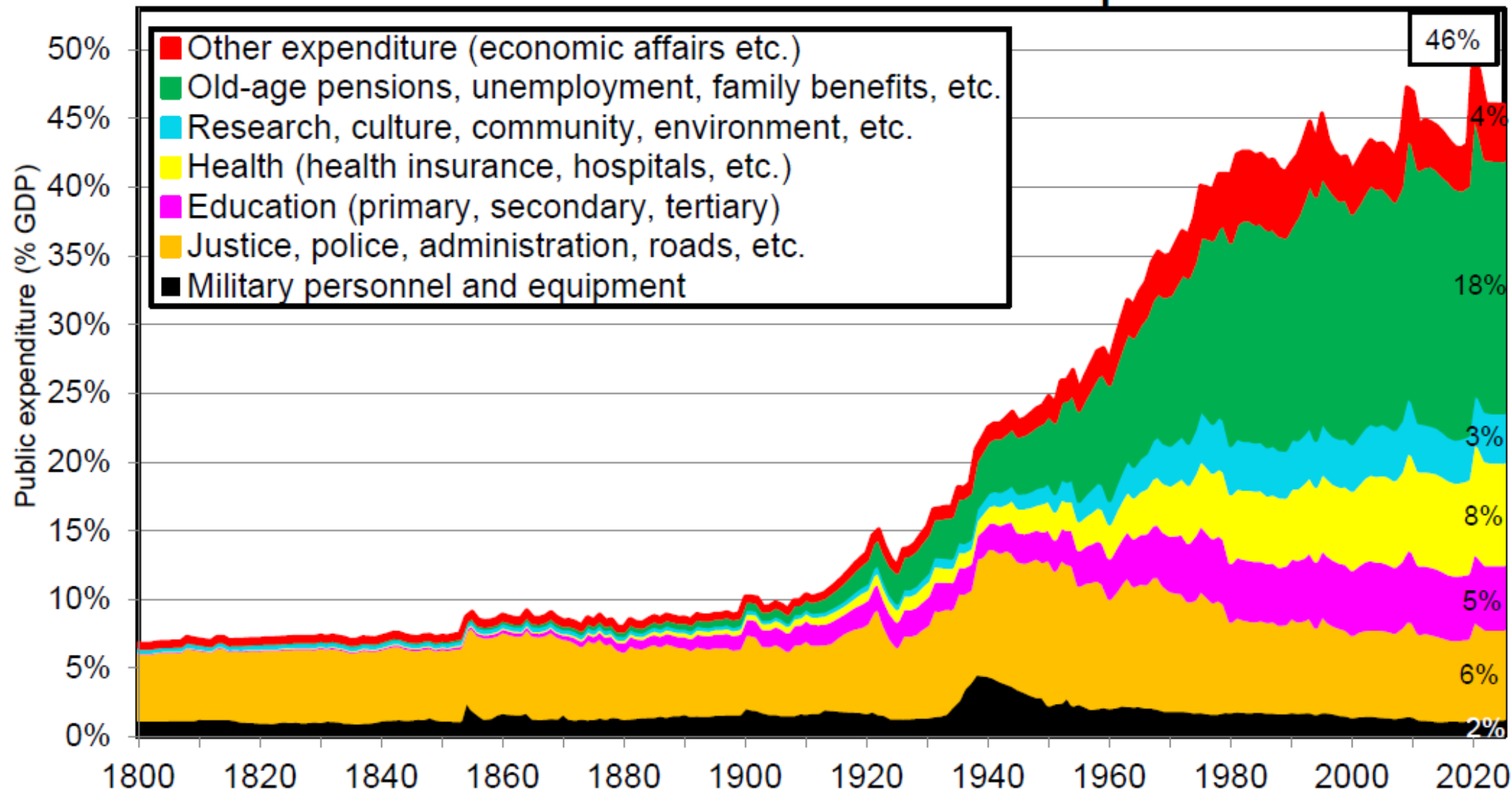
Interpretation. Total public expenditure rose from about 3% of global GDP in 1800 to about 33% in 2025, with large regional variations. Total public expenditure includes all expenditures by all public administrations (including central and local government, social security funds, etc.), except interest payments (and except exceptional expenditure during world wars). **Sources and series:** wid.world

The rise of the global social State, 1800-2025



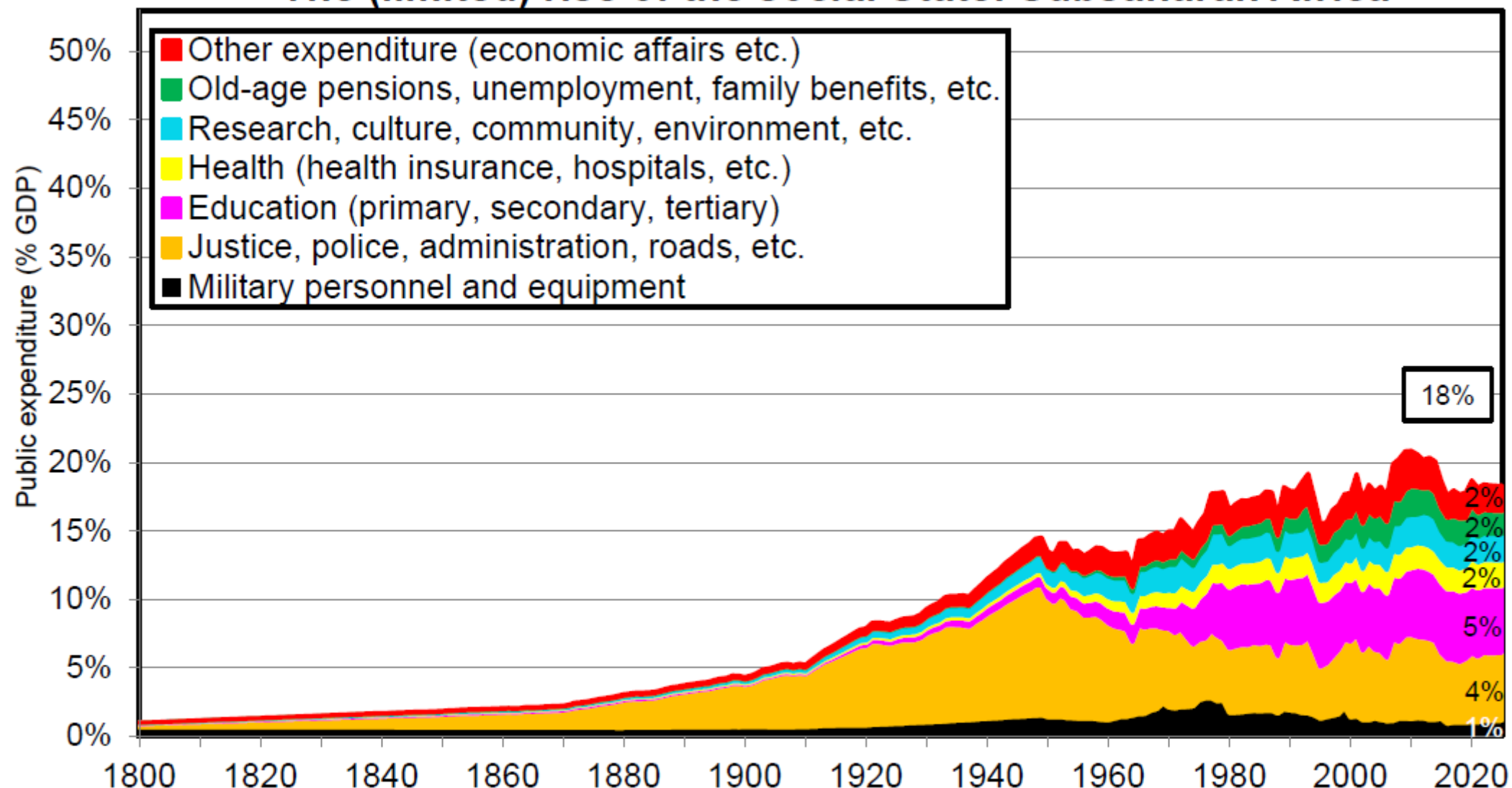
Interpretation. In 2025, total public expenditure amounts to about 33% of global GDP (PPP), including about 2% for military expenditure, 6% for general public services (justice, police, general administration, roads, etc.), 5% for education, 5% for health, 3% for research, culture/recreation/religion, community services (water, light, etc.), environmental protection (waste, biodiversity, etc.), 9% for social protection (old-age pensions, unemployment, family benefits, maternity, sick-leave, safety nets, etc.) and 3% for other expenditures (economic affairs excluding roads and basic infrastructures included in general public services). **Sources and series:** wid.world

The rise of the social State: Europe



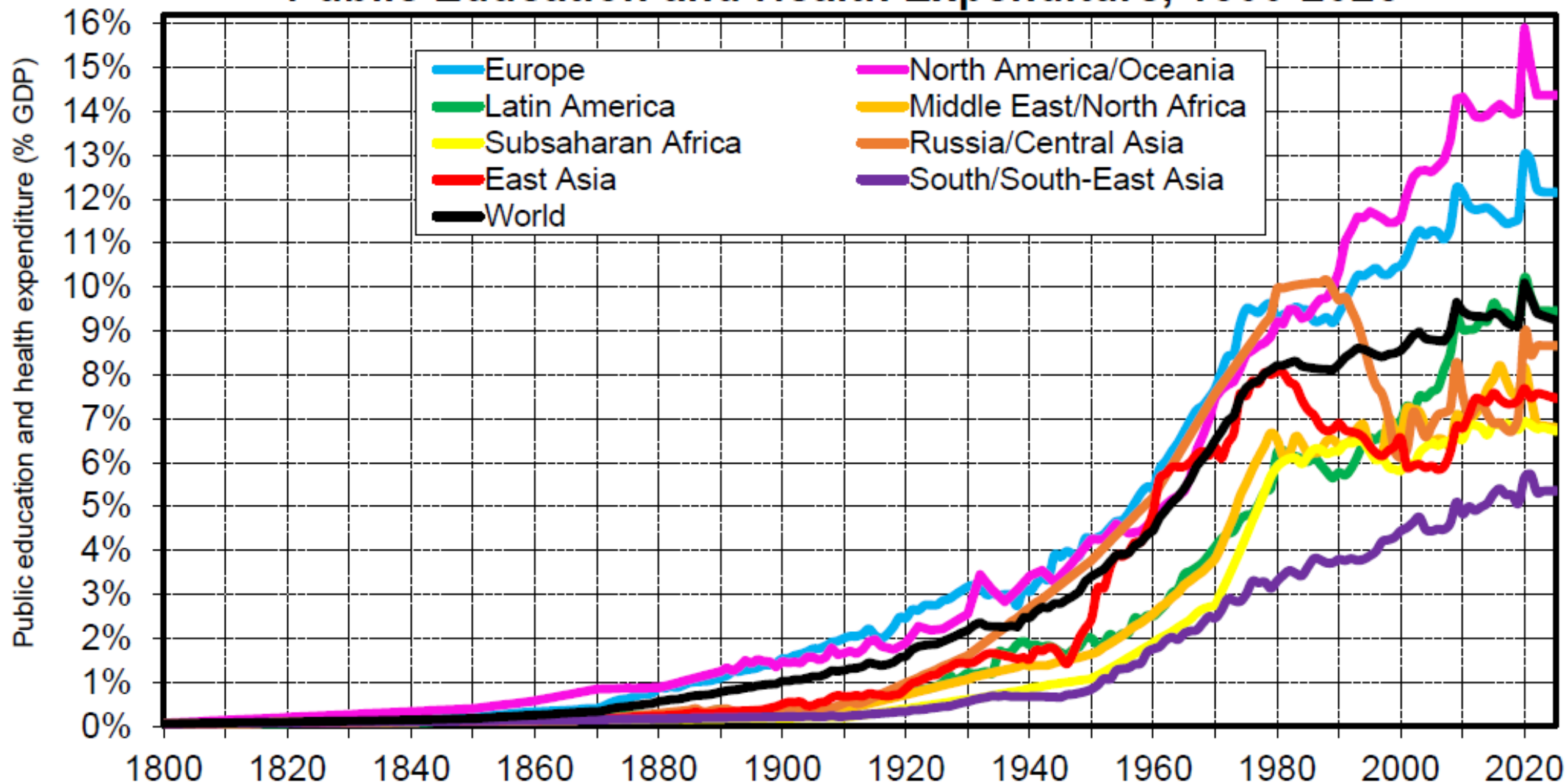
Interpretation. In 2025, total public expenditure amounts to about 46% of GDP in Europe, including about 2% for military expenditure, 6% for general public services (justice, police, general administration, roads, etc.), 5% for education, 8% for health, 3% for research, culture/recreation/religion, community services (water, light, etc.), environmental protection (waste, biodiversity, etc.), 18% for social protection (old-age pensions, unemployment, family benefits, maternity, sick-leave, safety nets, etc.) and 4% for other expenditures (economic affairs excluding roads and basic infrastructures included in general public services). **Sources and series:** wid.world

The (limited) rise of the social State: Subsaharan Africa



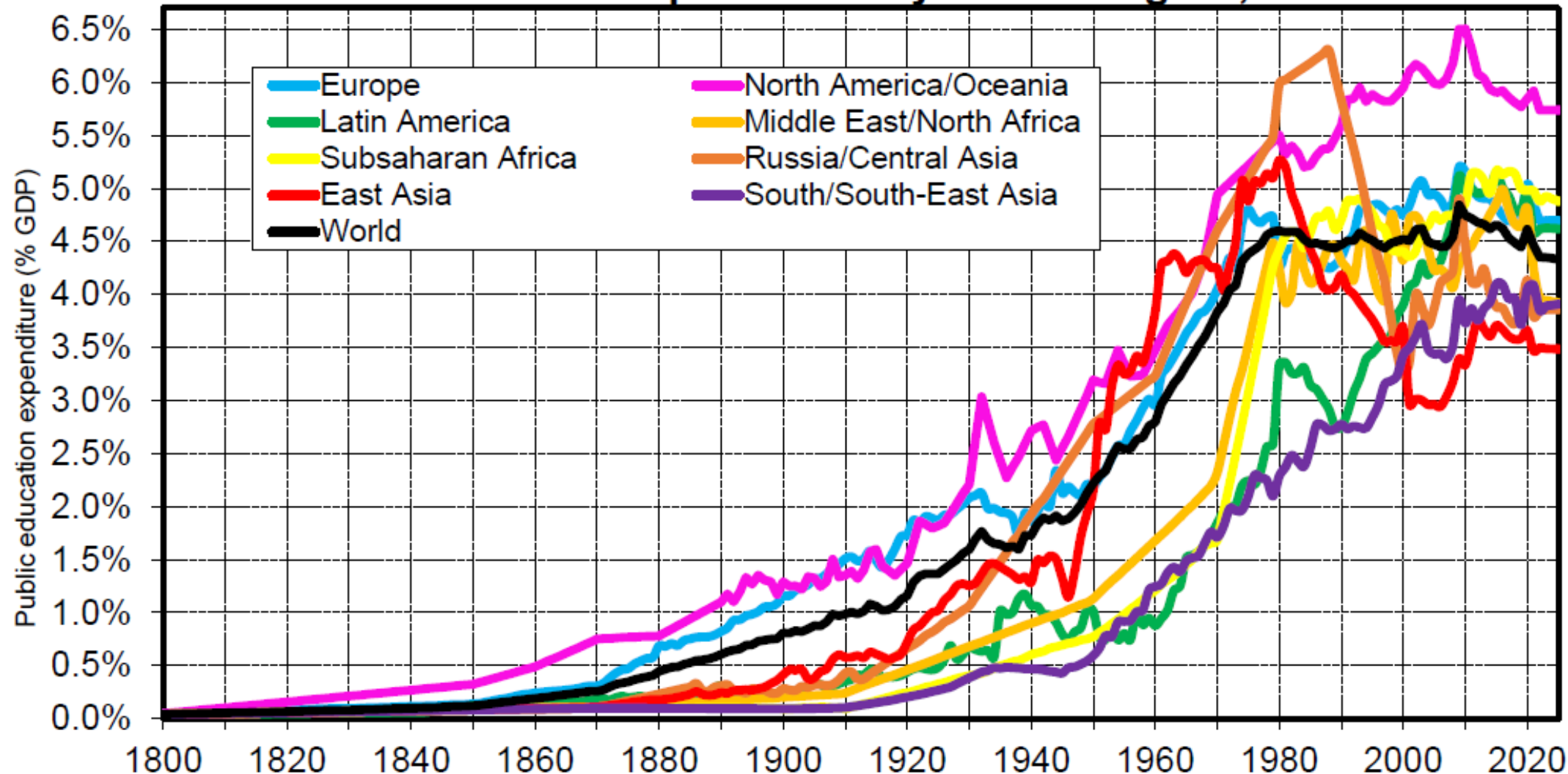
Interpretation. In 2025, total public expenditure amounts to about 18% of GDP in Subsaharan, including about 1% for military expenditure, 4% for general public services (justice, police, general administration, roads, etc.), 5% for education, 2% for health, 2% for research, culture/recreation/religion, community services (water, light, etc.), environmental protection (waste, biodiversity, etc.), 2% for social protection (old-age pensions, unemployment, family benefits, maternity, sick-leave, safety nets, etc.) and 2% for other expenditures (economic affairs excluding roads and basic infrastructures included in general public services). **Sources and series:** wid.world

Public Education and Health Expenditure, 1800-2025



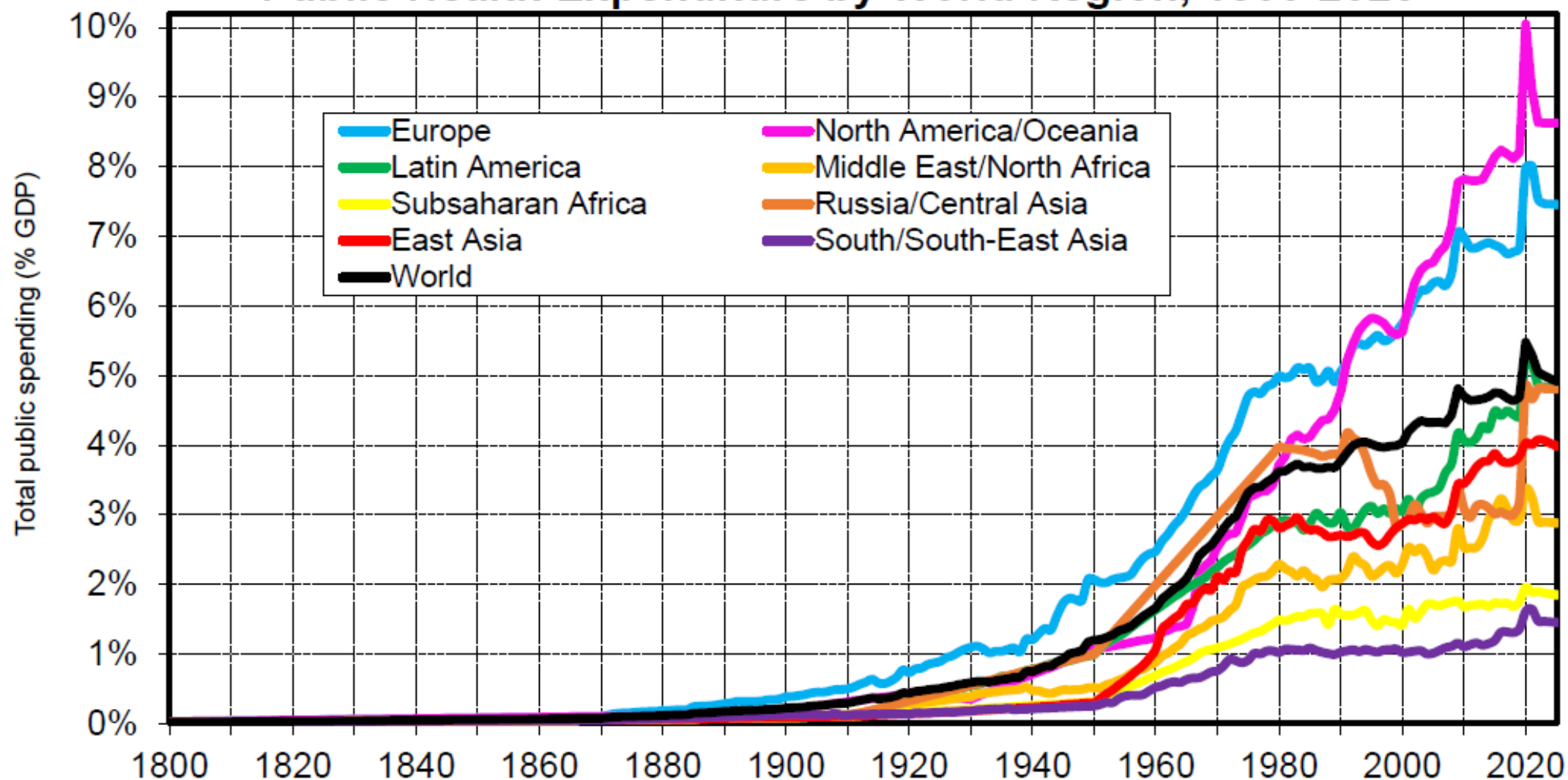
Interpretation. Public education and health expenditure rose from less than 1% of GDP before 1900 to about 9-10% of GDP in 2025 at the global level, with large regional variations (from about 5-7% of GDP in South & South East Asia and Subsaharan Africa to 12-15% of GDP in Europe and North America/Oceania). **Sources and series:** wid.world

Public Education Expenditure by World Region, 1800-2025



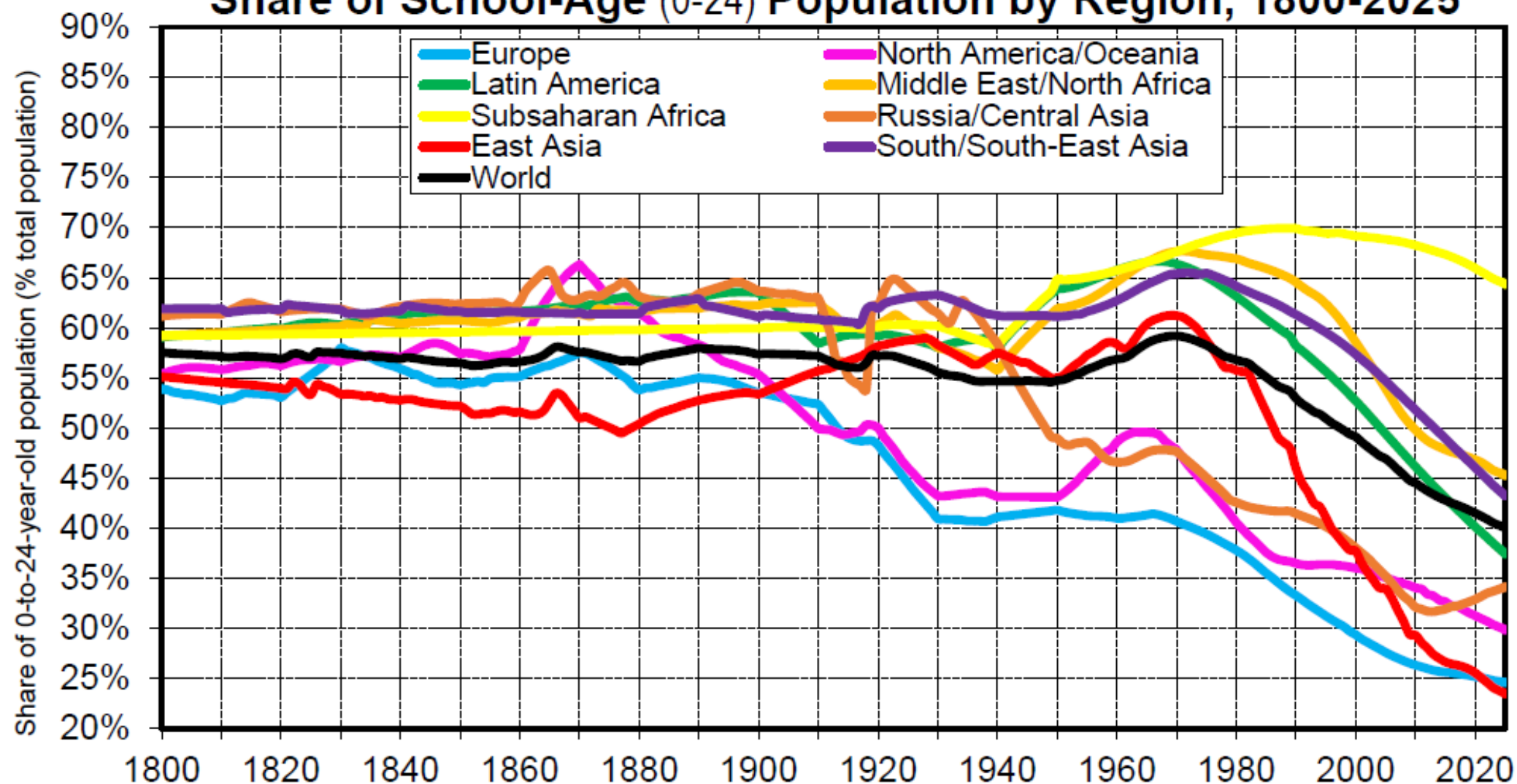
Interpretation. Public education expenditure rose from less 1% of GDP before 1900 to about 4.5-5% of GDP at the global level in 2025, with surprisingly similar levels in many world regions, including Europe and Subsaharan Africa. However the share of school-age population in total population varies widely across regions (e.g. it is more than 2.5 times as large in SSAF than in Europe). It is therefore critical to look at age-corrected education expenditures in order to make meaningful comparisons. **Sources and series:** wid.world

Public Health Expenditure by World Region, 1800-2025



Interpretation. Public health expenditure was less than 0.5% before 1900 and is about 5% of GDP in 2025, with enormous variations across world regions, from 1-2% of GDP in South & South-East Asia and Subsaharan Africa to 8-9% of GDP in Europe and North America/Oceania. These very large gaps are partly due to different age structures (with a much larger old-age population share in richer countries). Like for education, one needs to analyze age-corrected health expenditure in order to make proper comparisons. **Sources and series:** wid.world

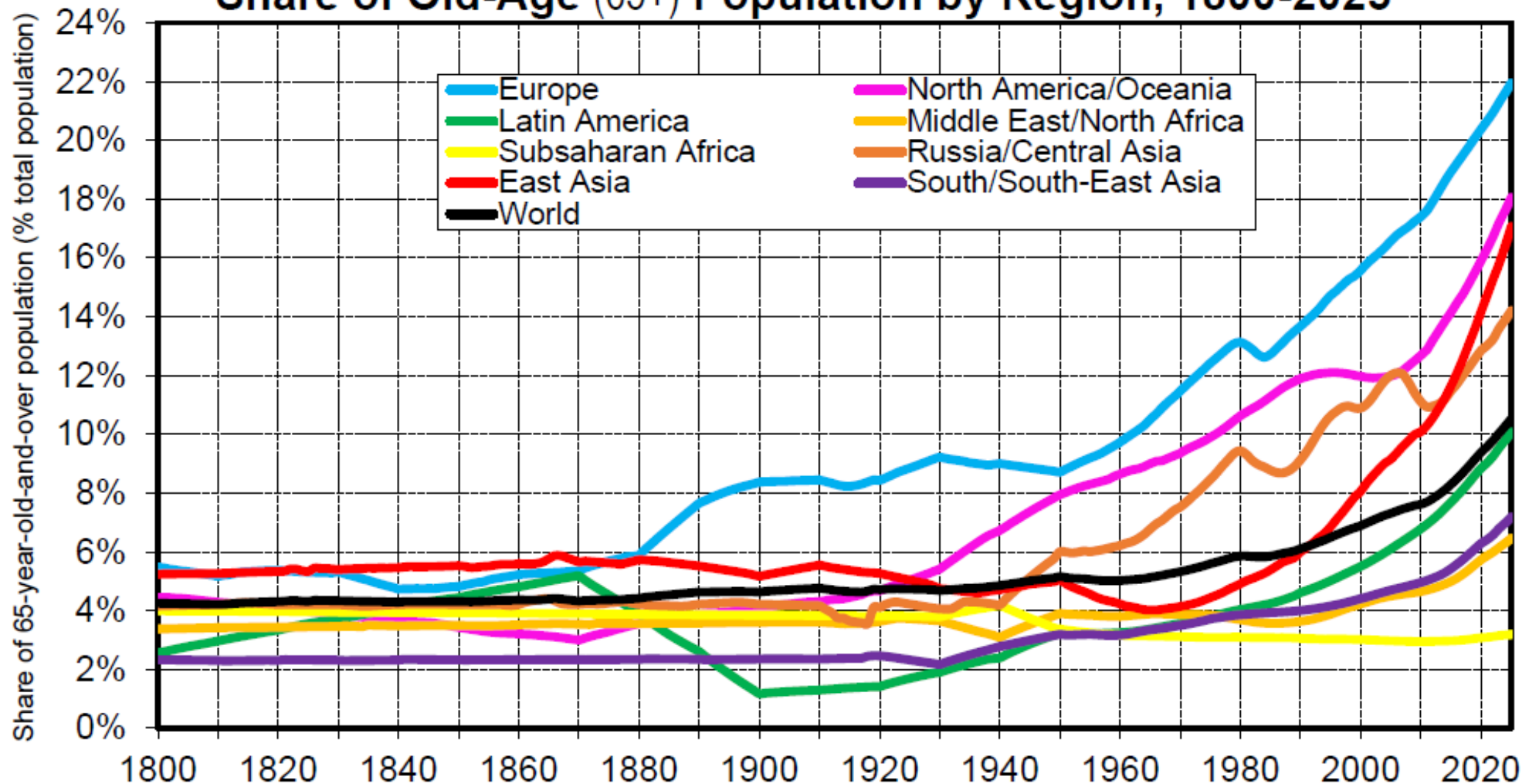
Share of School-Age (0-24) Population by Region, 1800-2025



Interpretation. The share of school-age population (0-to-24 year-old) varies enormously across world regions in 2025, from 23% in East Asia and 25% in Europe to 64% in Subsaharan Africa. Given that most of education expenditures are devoted to this age group, critical to include some age adjustment in order to evaluate the impact of education expenditure.

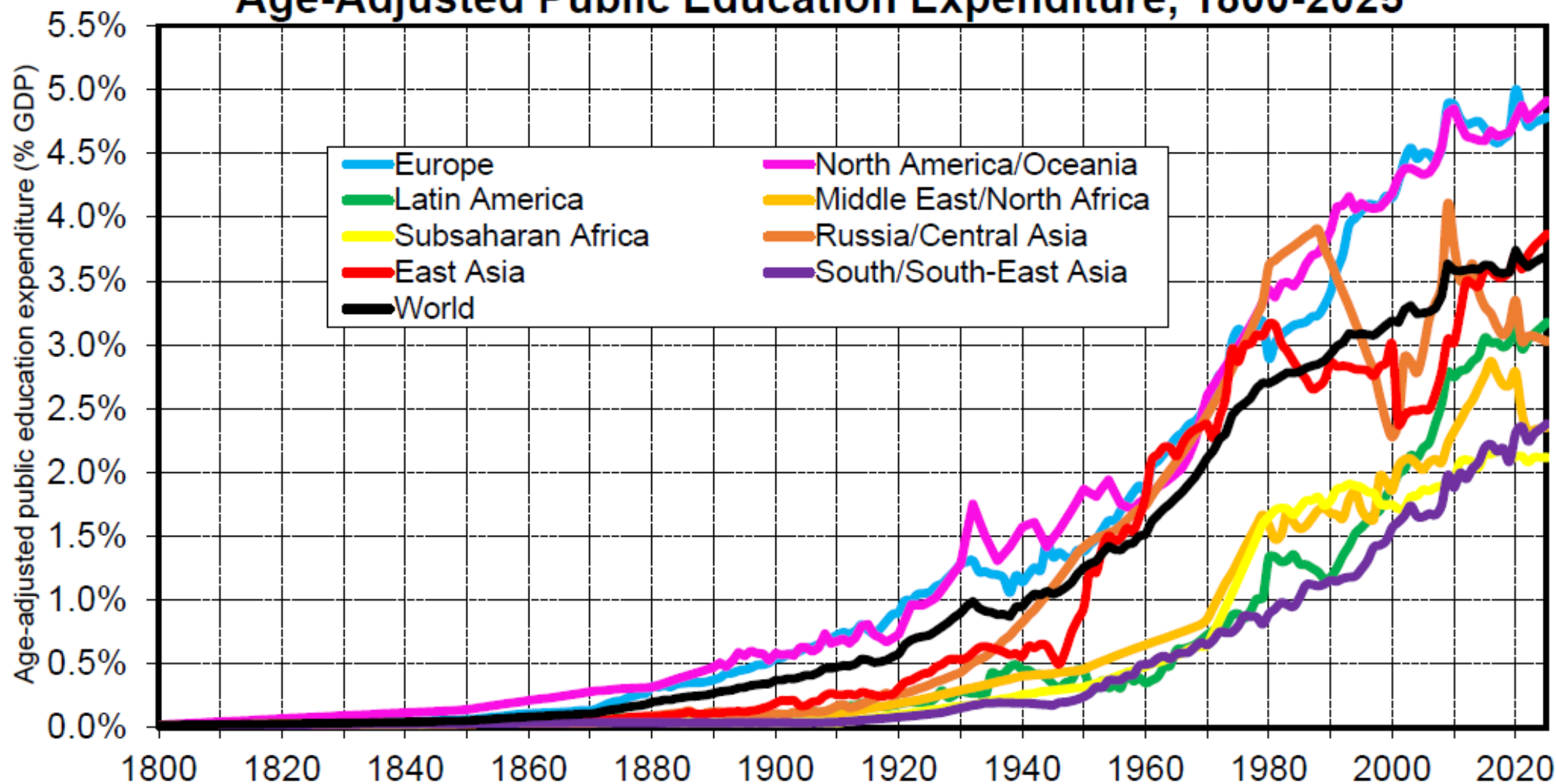
Sources and series: see wid.world

Share of Old-Age (65+) Population by Region, 1800-2025



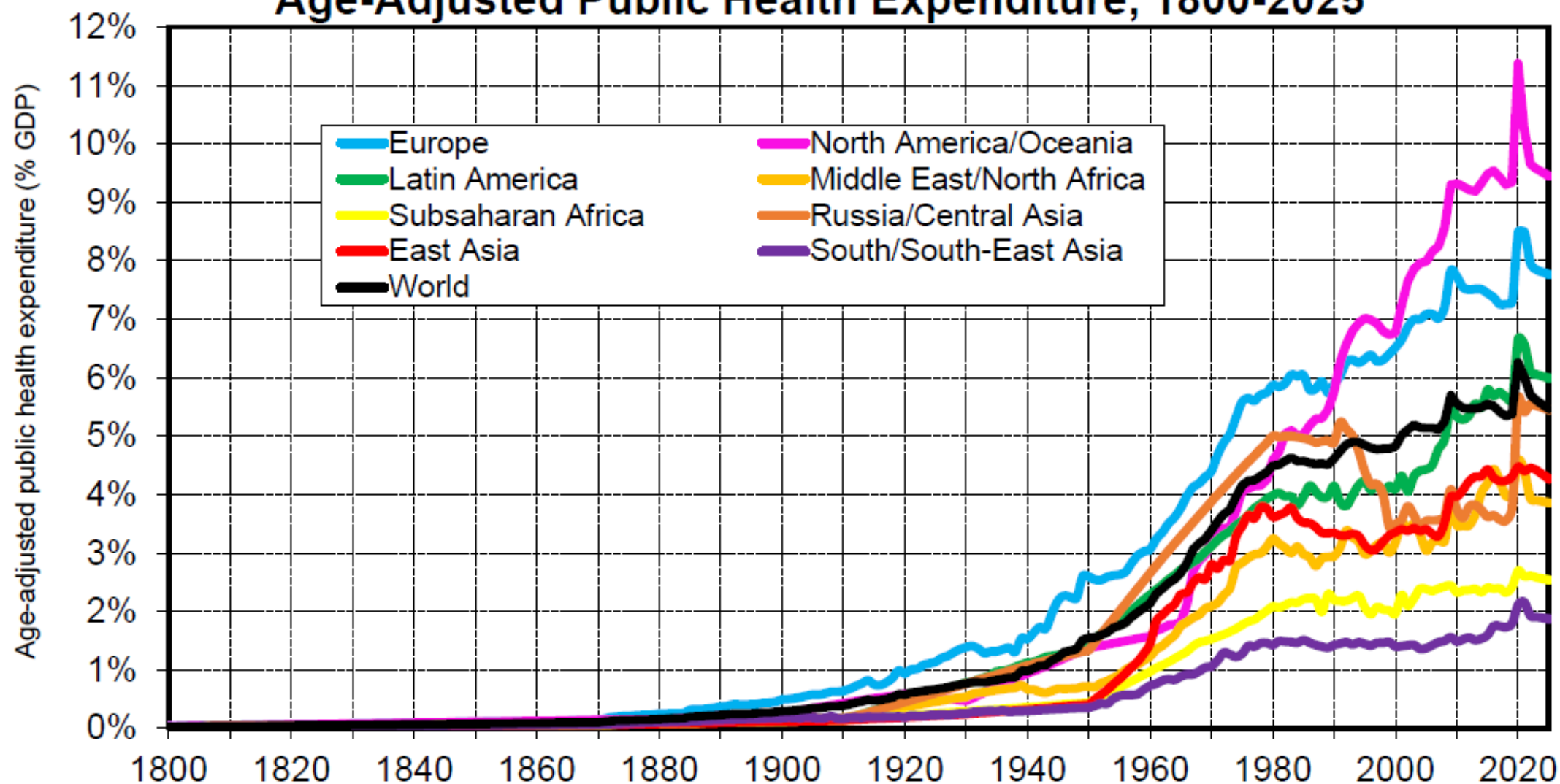
Interpretation. The share of old-age population (65-year-old-and-over) varies enormously across world regions in 2025, from 3% in Subsaharan Africa to 22% in Europe. Given that the per capita health expenditure received by this age group is substantially larger than that received by individuals aged 0-to-64 (on average about 3 times larger in recent decades) is critical to include some age adjustment in order to evaluate the impact of health expenditure. **Sources and series:** see wid.world

Age-Adjusted Public Education Expenditure, 1800-2025



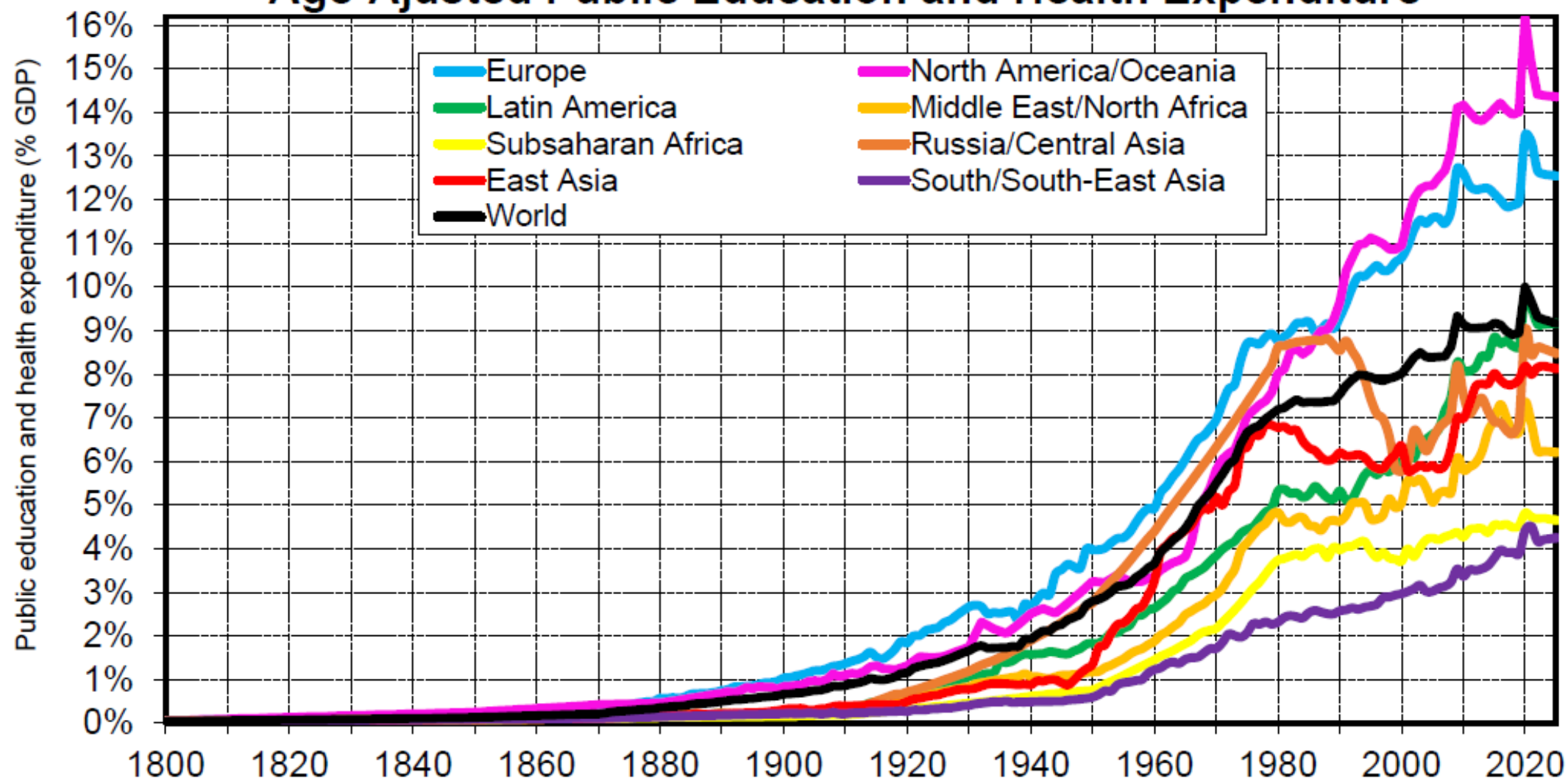
Interpretation. Adjusting for the age structure, i.e. assuming that the share of school-age population (0-to-24-year-old) is equal to 25% in all countries-years ($\approx$ Europe 2025) and keeping the same per-school-age-individual expenditure as in observed country-year, we find that public education expenditure varies from about 2% of GDP in Subsaharan Africa and South & South-East Asia to about 5% of GDP in Europe and North America/Oceania. **Sources and series:** wid.world

Age-Adjusted Public Health Expenditure, 1800-2025



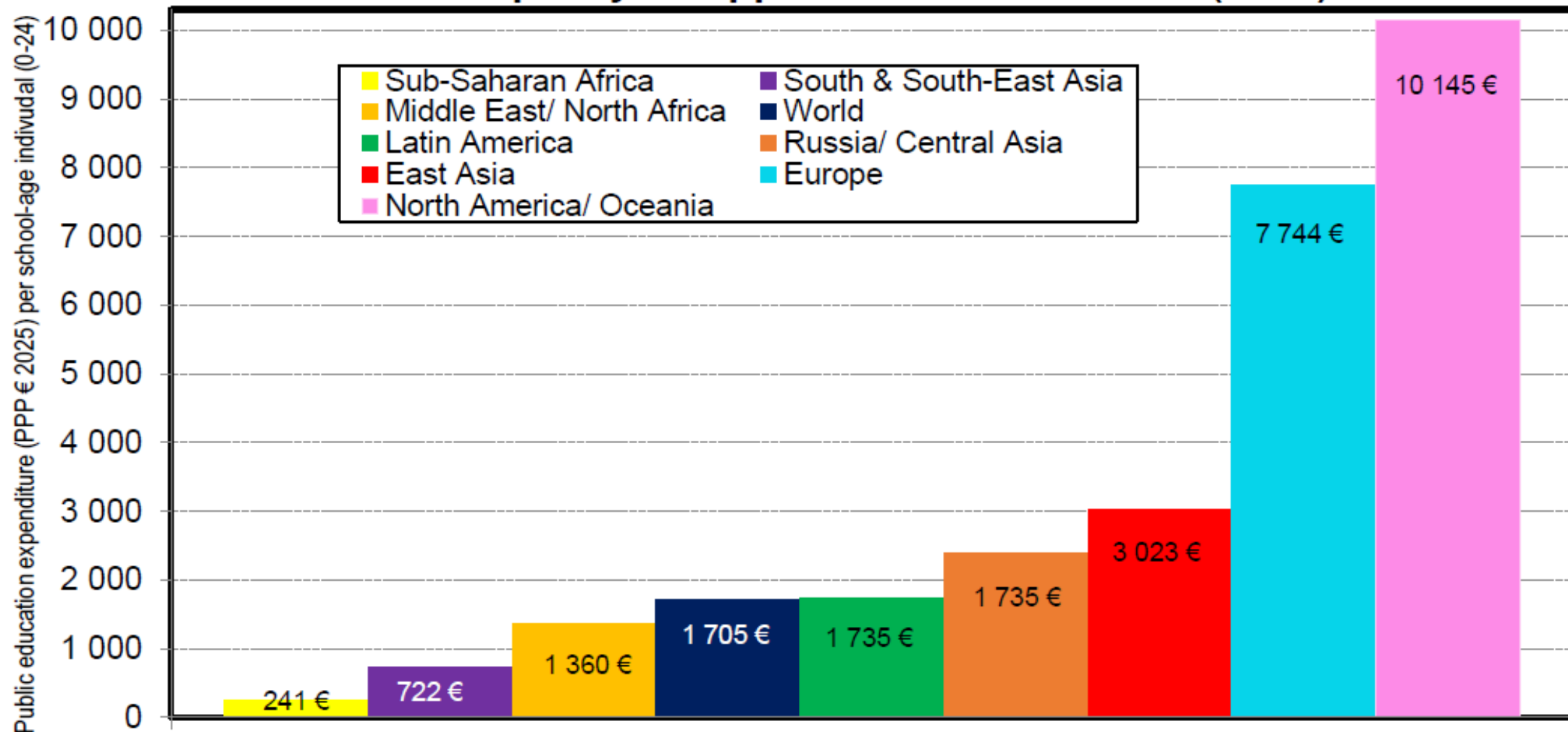
Interpretation. Adjusting for the age structure, i.e. assuming that the share of old-age population (65-year-old+) is equal to 25% in all countries ($\approx$ Europe 2030) and taking into account that average per capita health expenditure is on average about 3 times larger for old-age individuals than for the rest of the population, we find that public health expenditure varies from about 2% of GDP in Subsaharan Africa and South & South-East Asia to about 8-10% of GDP in Europe and North America/Oceania. **Sources and series:** wid.world

Age-Ajusted Public Education and Health Expenditure



Interpretation. Total age-adjusted public education and health expenditure has increased from less than 1% of GDP before 1900 to 9-10% of GDP in 2025 at the global level, with very large gaps between regions, from 4-5% of GDP in South & South-East Asia and Subsaharan Africa to 13-15% in Europe and North America/Oceania. The gaps are somewhat larger after age adjustment, as the unequalizing impact of education adjustment more than counterbalances the equalizing impact of health adjustment (especially for SSAF). **Sources and series:** wid.world

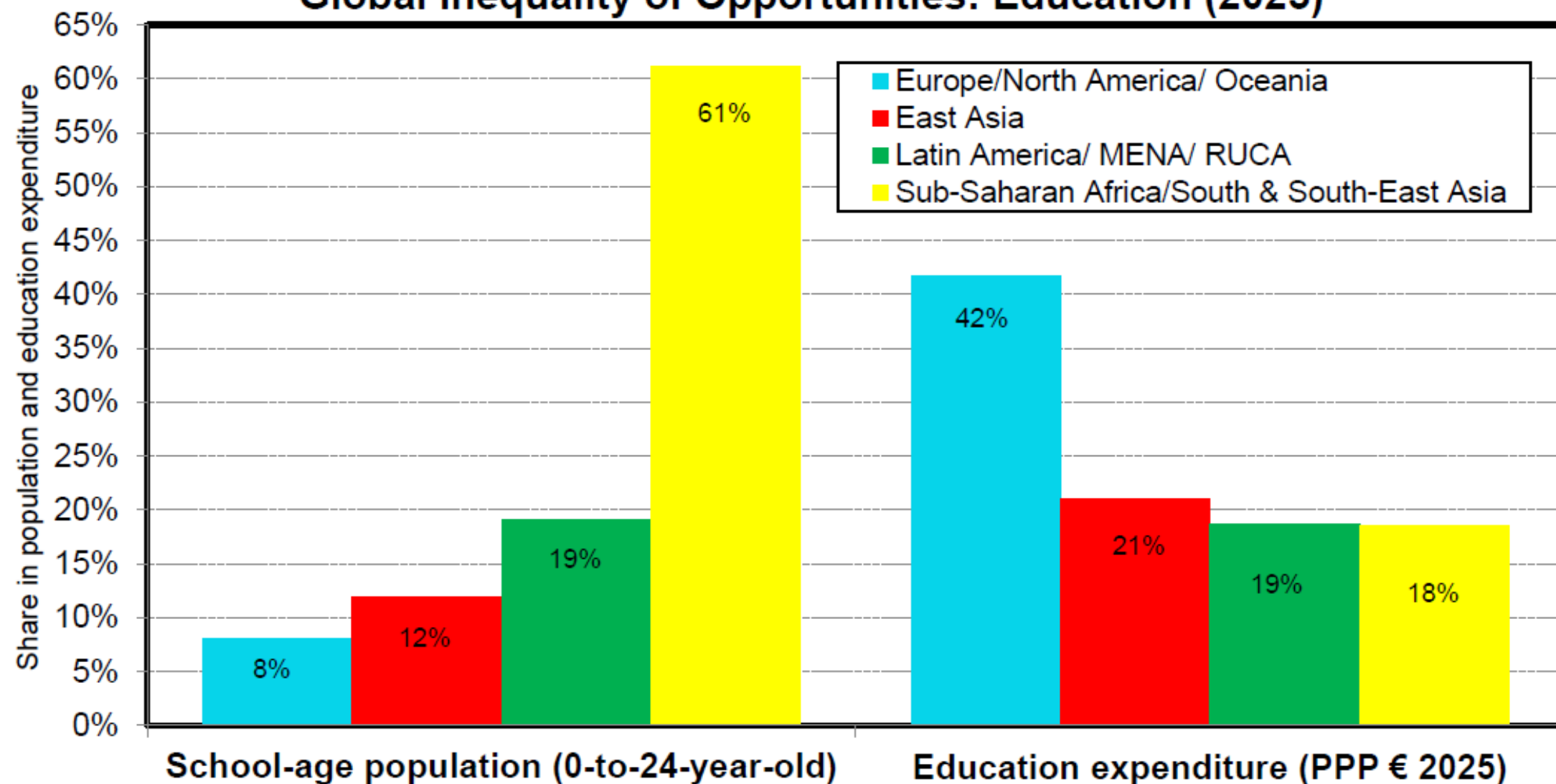
Global Inequality of Opportunities: Education (2025)



Public education expenditure (PPP € 2025) per school-age individual (0-24)

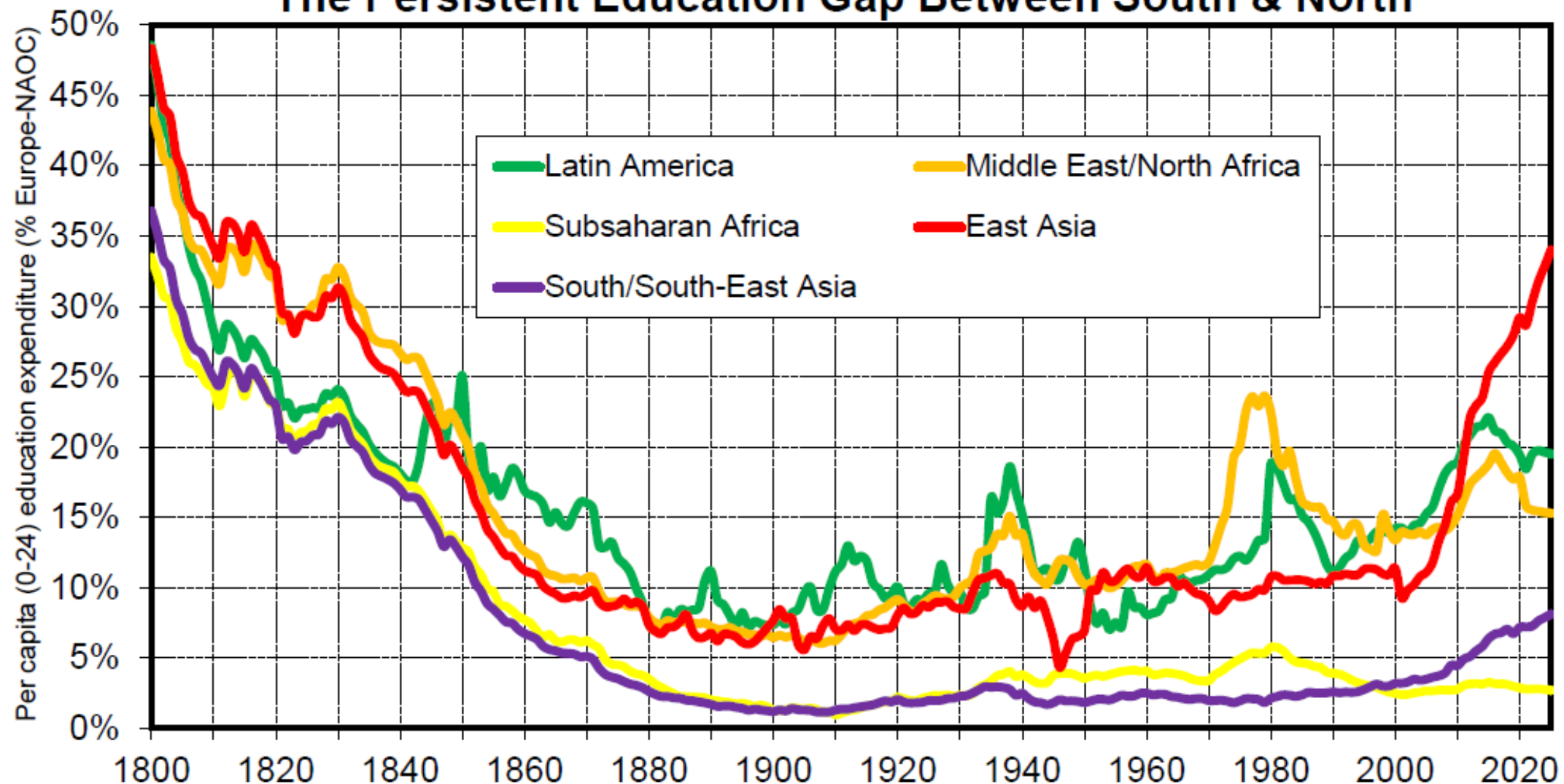
Interpretation. In 2025, average public education expenditure per school-age individual (0-to-24-year-old) varies enormously across world regions, from 241€ in Subsaharan Africa to 10 145€ in North America/Oceania (PPP € 2025), i.e. a gap of about 1 to 50. If we were using MERs (market exchange rates) rather than PPPs (purchasing power parities), the gaps would be 2-3 times larger. **Sources & series:** wid.world

Global Inequality of Opportunities: Education (2025)



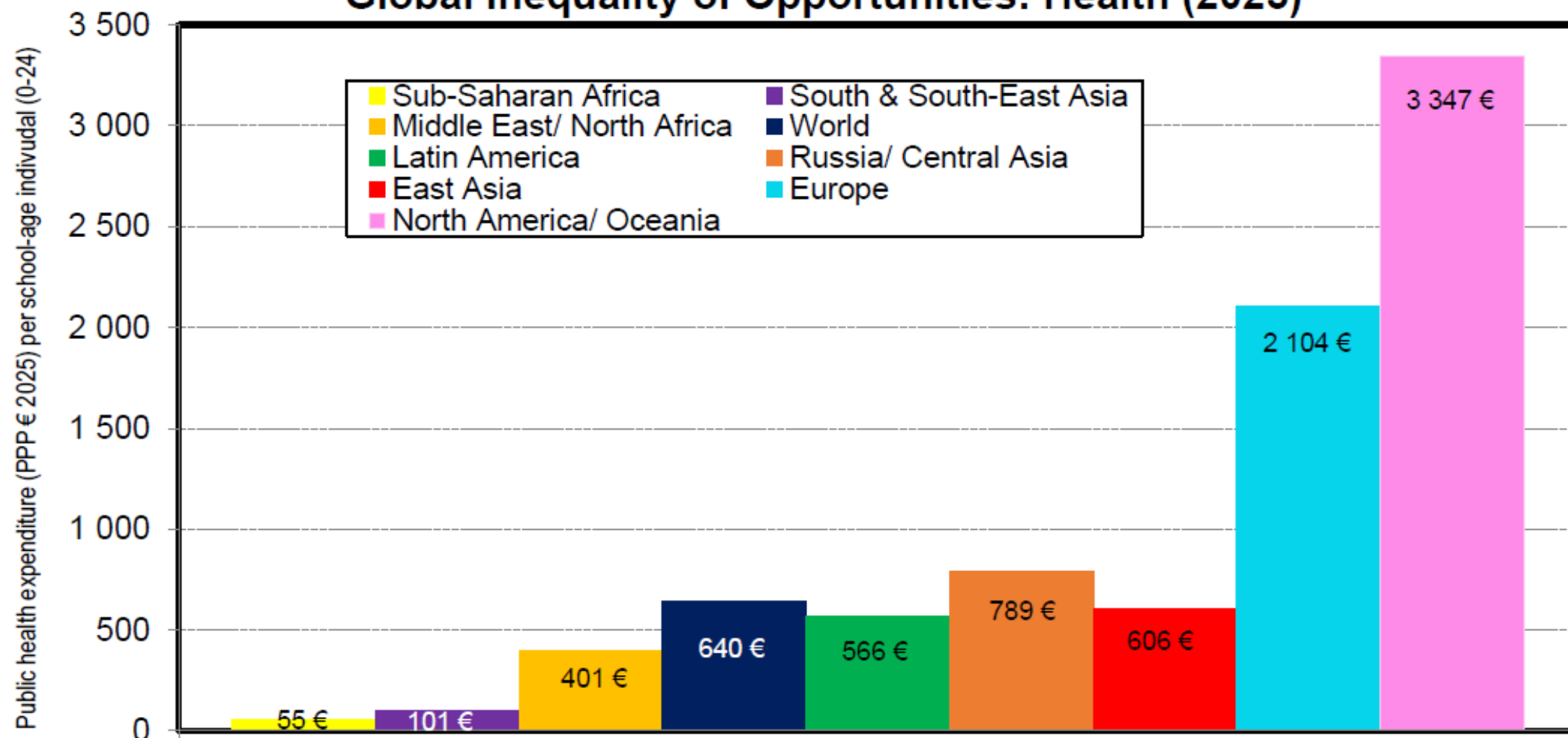
Interpretation. In 2025, Europe and North America/Oceania host 8% of the world school-age population (0-to-24-year-old) and benefit from 42% of the world education expenditure (measured in PPP € 2025). In contrast, Sub-Saharan Africa and South & South-East Asia host 61% of the global school-age population and benefit from 18% of the global education expenditure. **Sources & series:** wid.world

The Persistent Education Gap Between South & North



Interpretation. Except in early 19th century (when education expenditure was very small everywhere), average public education expenditure per school-age individual (0-to-24-year-old) has always been much smaller in most world regions as compared to Europe/North America Oceania average (PPP). The situation improved in East Asia in recent decades, but the gap remains very large for Subsaharan Africa (with average expenditure equal to 3% of Europe/NAOC average in 2025) and South/South-East Asia (8%). **Sources and series:** wid.world

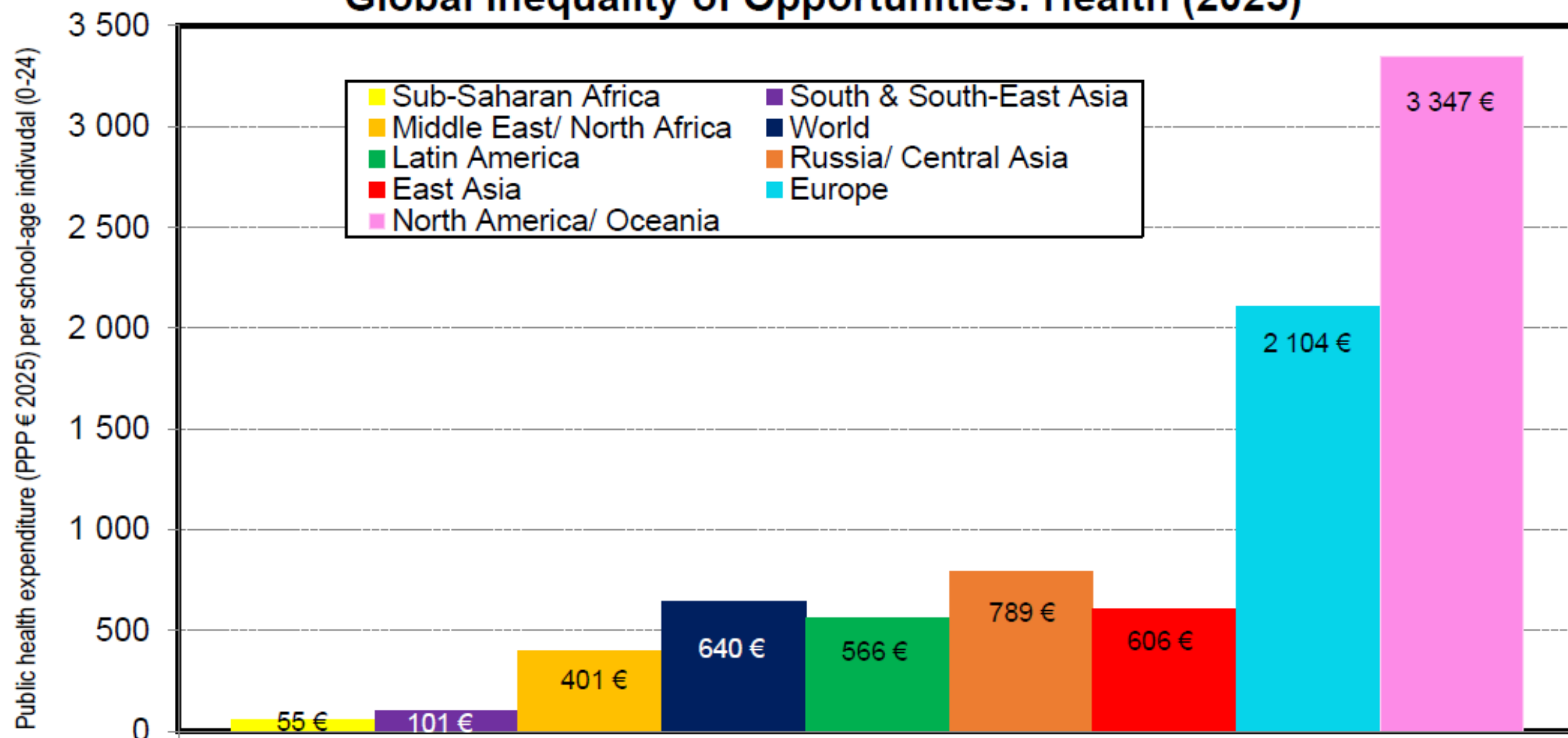
Global Inequality of Opportunities: Health (2025)



Public health expenditure (PPP € 2025) per individual (0-64)

Interpretation. In 2025, average public health expenditure per individual aged 0-to-64-year-old) (assuming that older individuals receive 3 times this amount) varies enormously across world regions, from 55€ in Subsaharan Africa to 3 347€ in North America/Oceania (PPP € 2025), i.e. a gap of about 1 to 60. If we were using MERs (market exchange rates) rather than PPPs (purchasing power parities), the gaps would be 2-3 times larger. The gaps would also be also larger in the absence of an age correction. **Sources & series:** wid.world

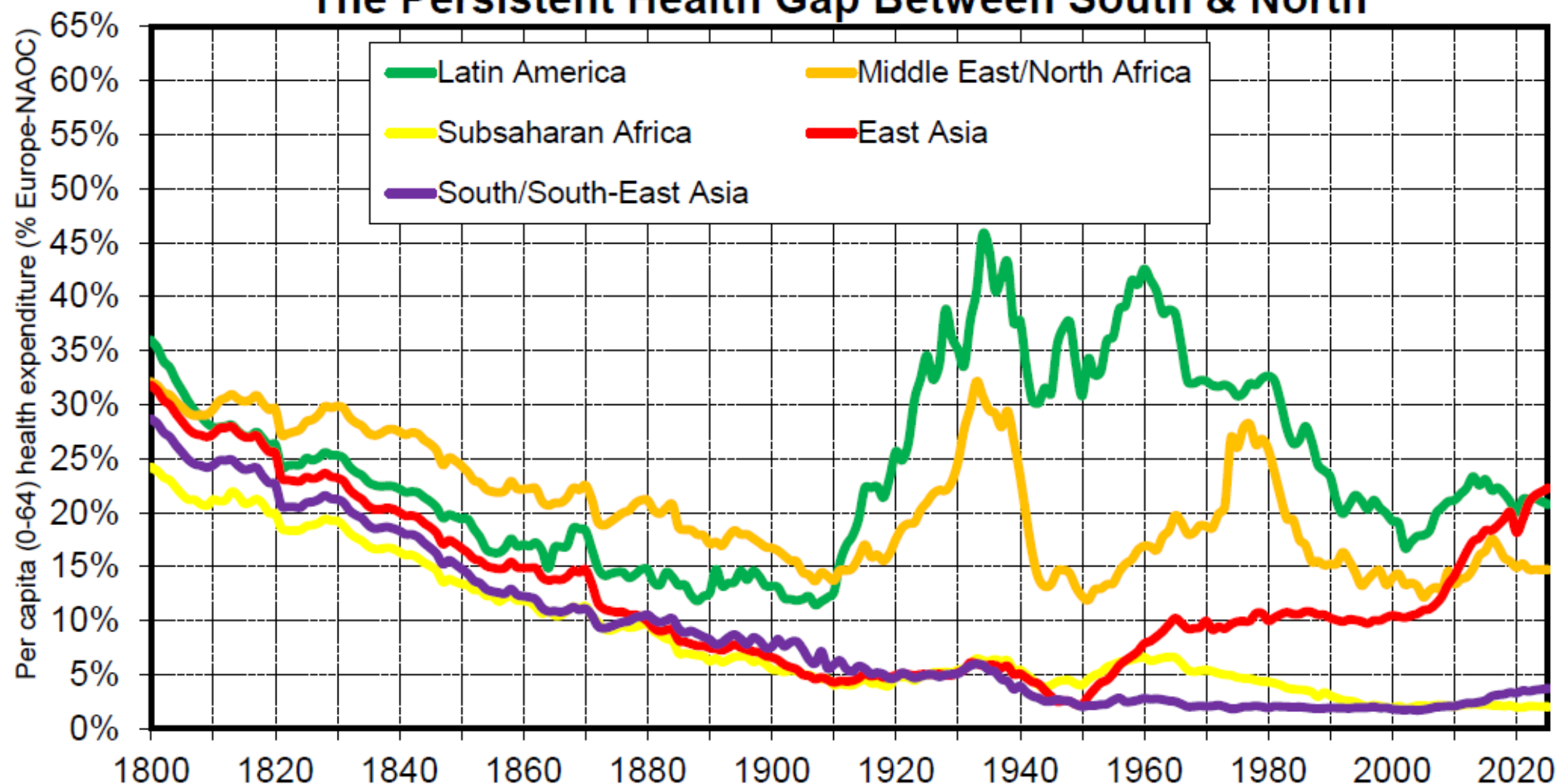
Global Inequality of Opportunities: Health (2025)



Public health expenditure (PPP € 2025) per individual (0-64)

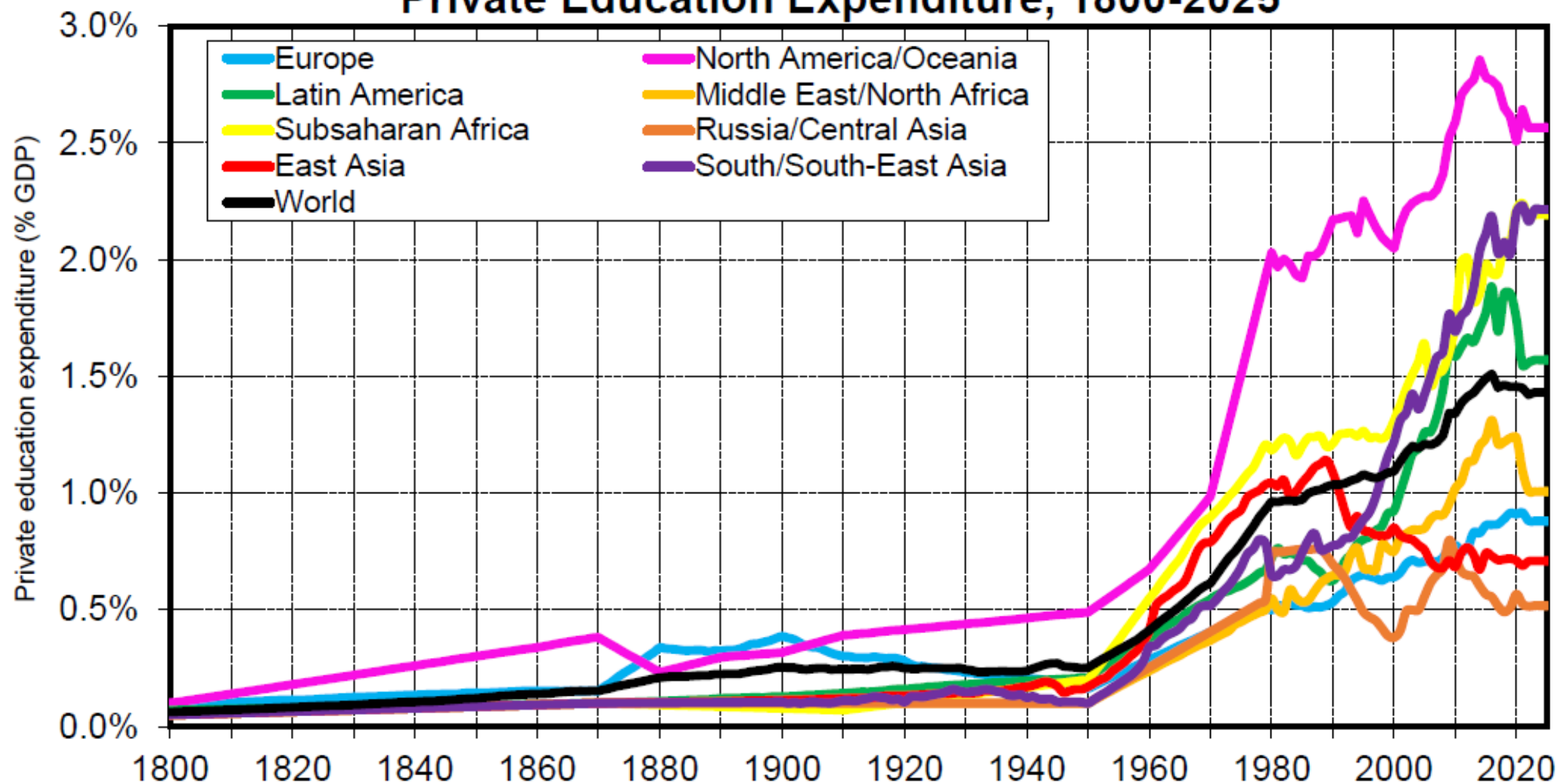
Interpretation. In 2025, average public health expenditure per individual aged 0-to-64-year-old) (assuming that older individuals receive 3 times this amount) varies enormously across world regions, from 55€ in Subsaharan Africa to 3 347€ in North America/Oceania (PPP € 2025), i.e. a gap of about 1 to 60. If we were using MERs (market exchange rates) rather than PPPs (purchasing power parities), the gaps would be 2-3 times larger. The gaps would also be also larger in the absence of an age correction. **Sources & series:** wid.world

The Persistent Health Gap Between South & North



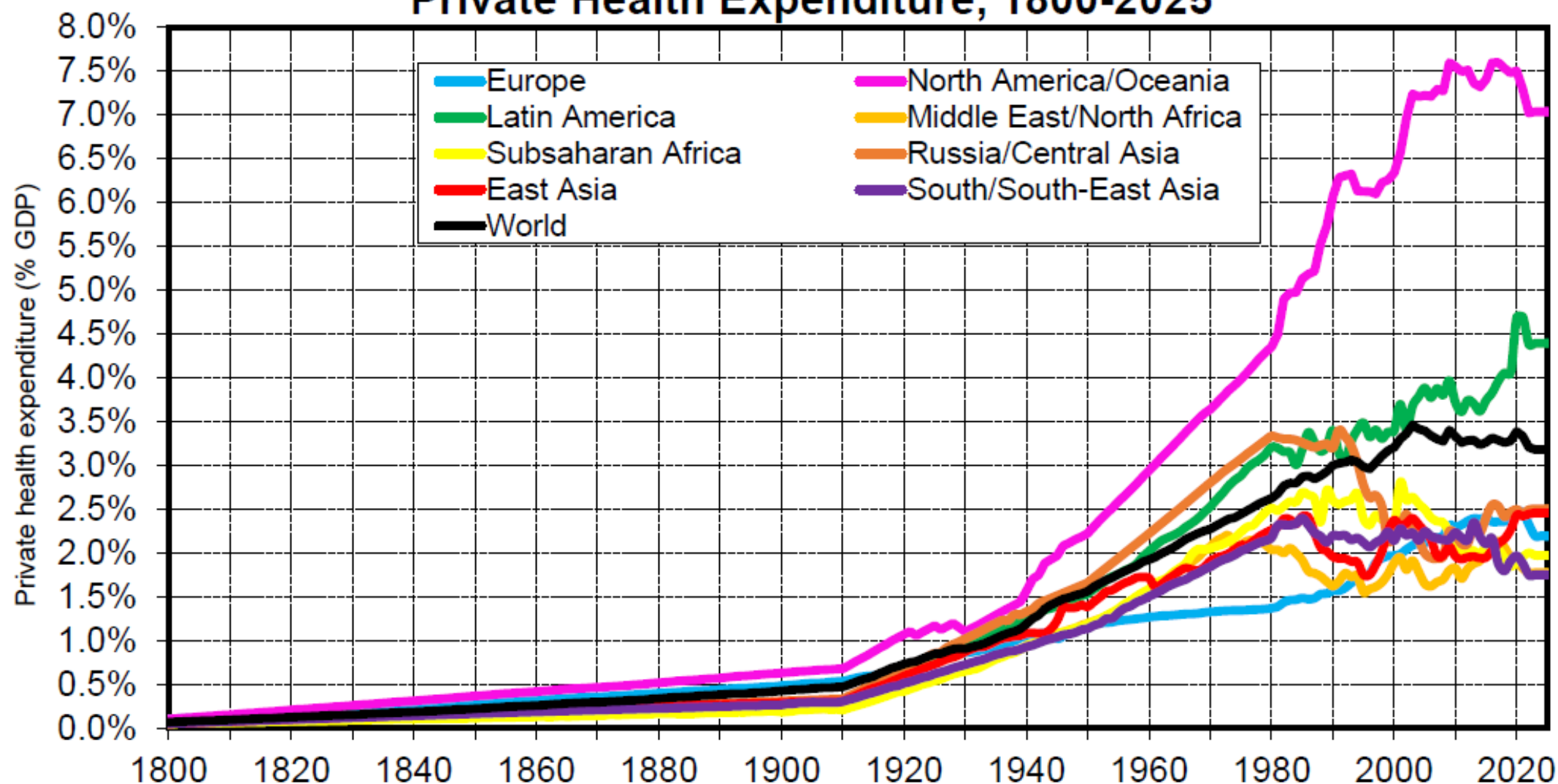
Interpretation. Average public health expenditure per capita (0-to-64-year-old) (assuming older individuals receive 3 times this level) has always been much smaller in most world regions as compared to the Europe/North America/Oceania average (PPP). The situation has improved in East Asia in recent decades (and the gap has always been smaller in Latin America and MENA), but the gap remains enormous for Subsaharan Africa (2% of Europe-NAOC average in 2025) and South/South-East Asia (4%). **Sources and series:** wid.world

Private Education Expenditure, 1800-2025



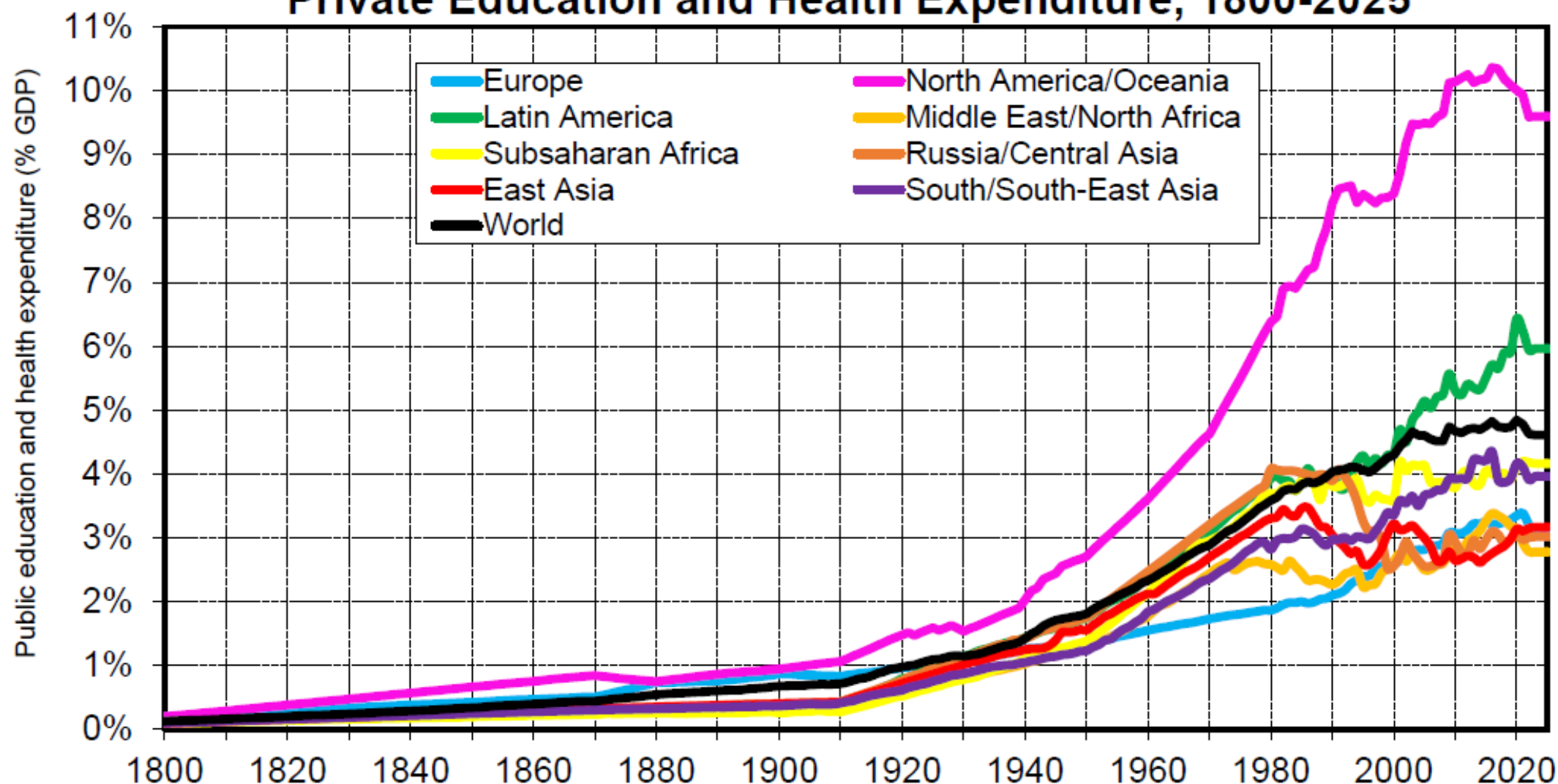
Interpretation. Private education expenditure has increased substantially in recent decades, particularly in North America/Oceania, South & South East Asia, Subsaharan Africa and Latin America. At the global level, they represent 1.4% of GDP in 2025, i.e. about 25% of total public + private education expenditure (5.8% of GDP). **Sources and series:** wid.world

Private Health Expenditure, 1800-2025



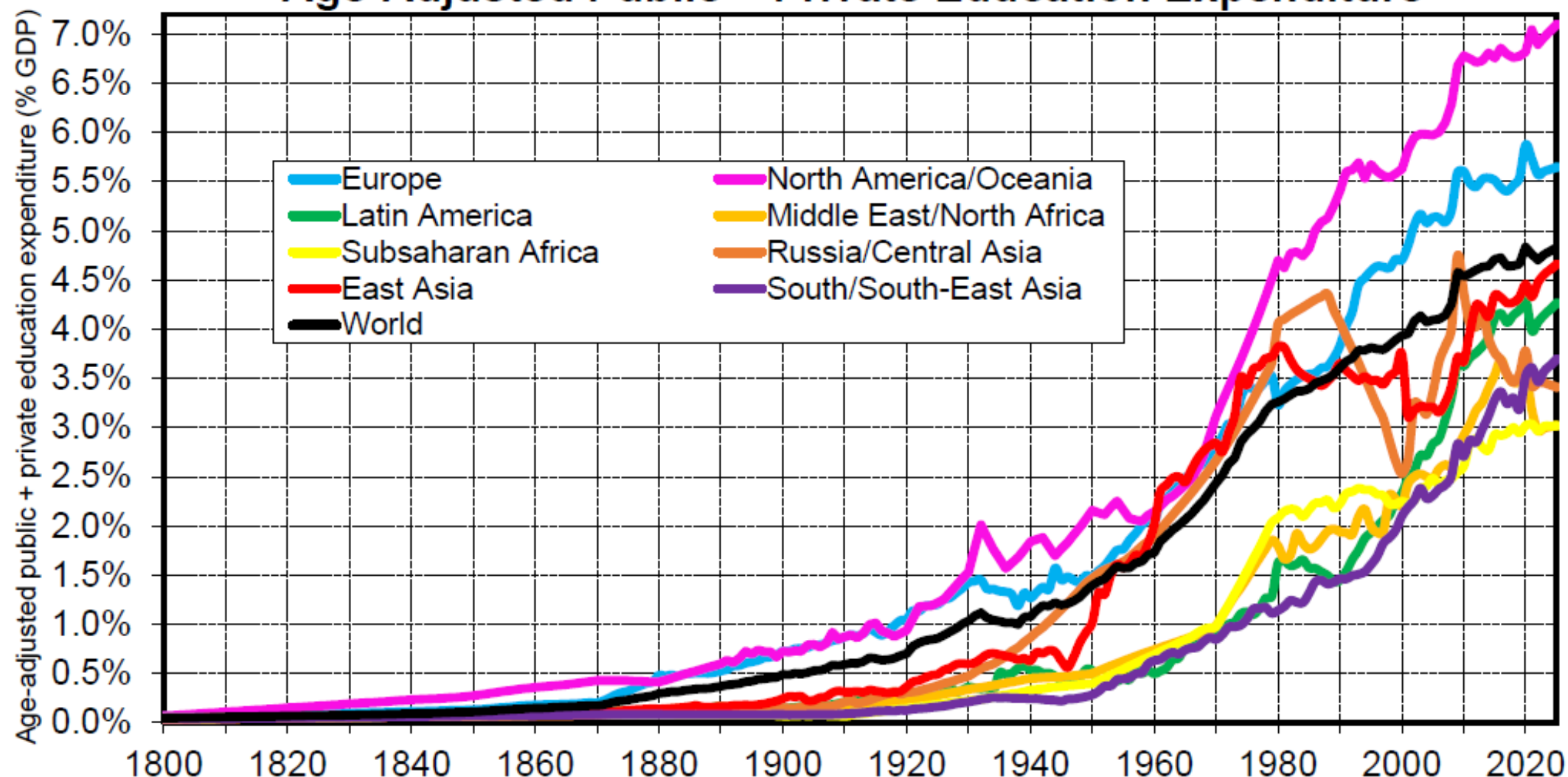
Interpretation. Private health expenditure has increased substantially in recent decades in North America/Oceania, and to a lesser extent in Latin America. At the global level, they represent 3.2% of GDP in 2025, i.e. about 39% of total public + private education expenditure (8.1% of GDP). **Sources and series:** wid.world

Private Education and Health Expenditure, 1800-2025



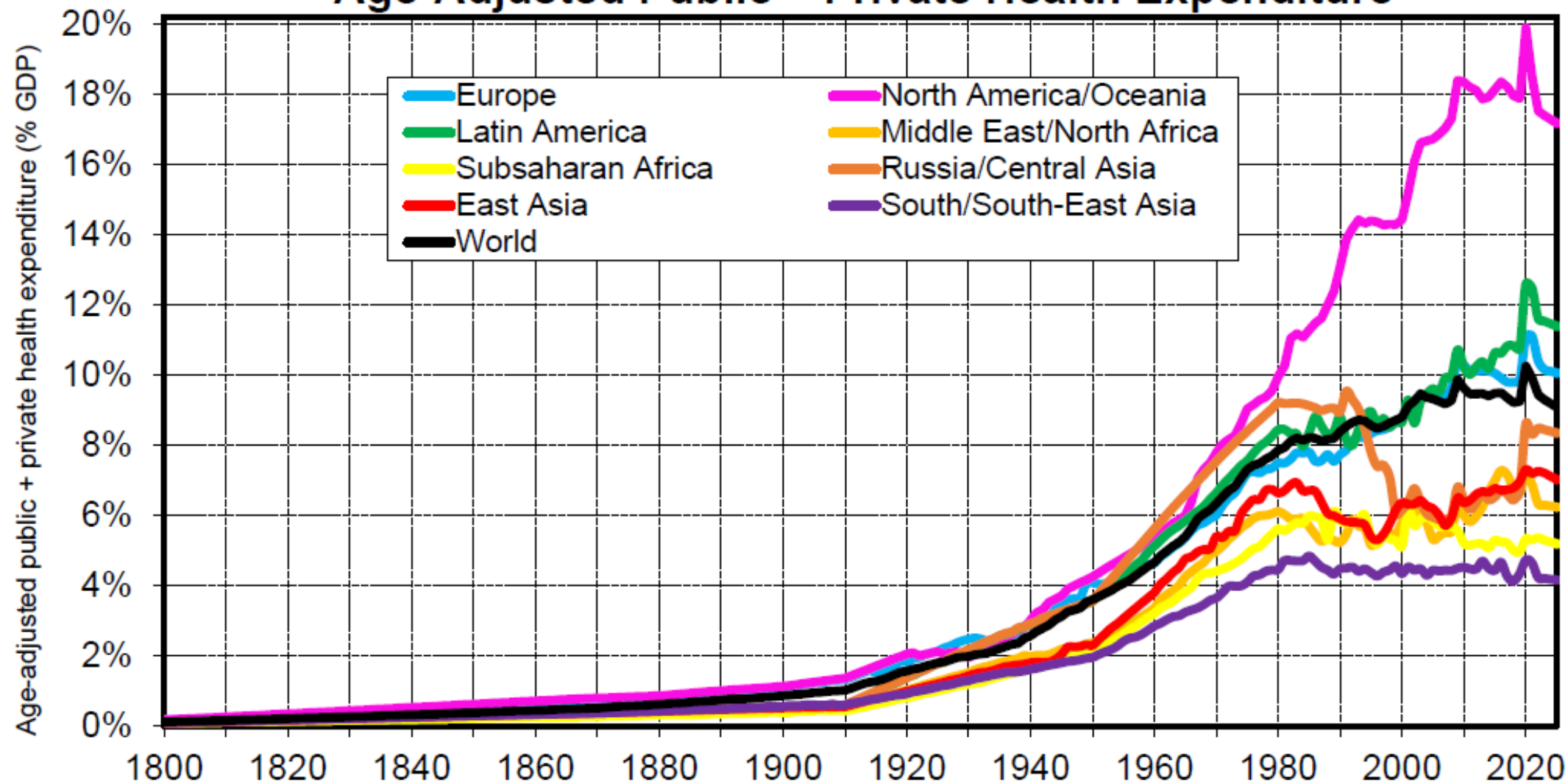
Interpretation. Private education and health expenditure has increased substantially in recent decades and represents over 4.5% of GDP at the global level in 2025, with enormous variations across world regions, from about 10% in North America/Oceania to 6% in Latin America, 4% in South & South-East Asia and Subsaharan Africa and 3% in Europe, East Asia, Russia/Central Asia and Middle East/North Africa. **Sources and series:** wid.world

Age-Adjusted Public + Private Education Expenditure



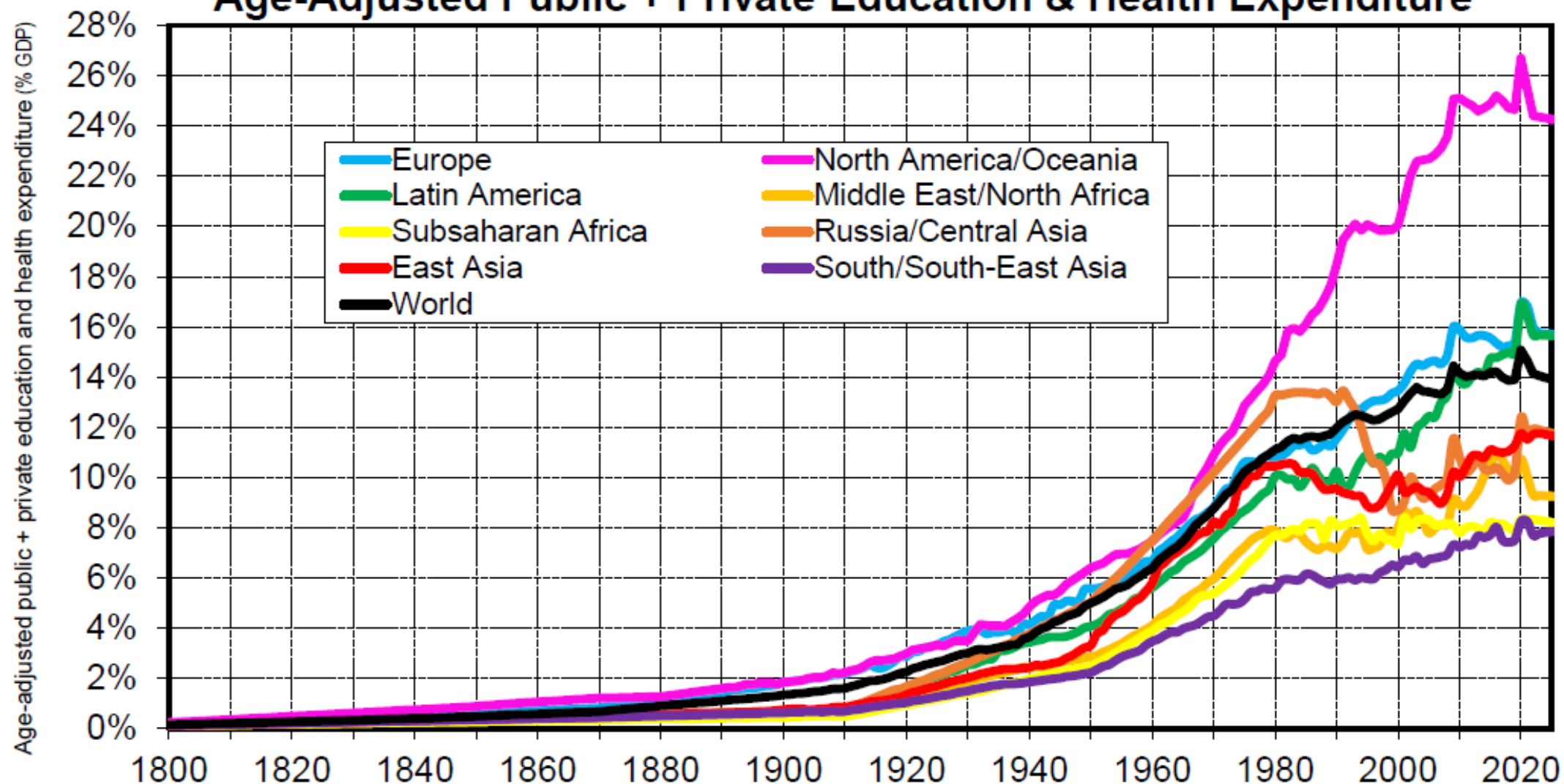
Interpretation. Total age-adjusted public and private education expenditure has increased from less than 1% of GDP before 1900 to about 5% of GDP in 2025 at the global level, with large gaps between regions, from about 3-3.5% of GDP in South & South-East Asia and Subsaharan Africa to about 7% in North America/Oceania. **Sources and series:** wid.world

Age-Adjusted Public + Private Health Expenditure



Interpretation. Total age-adjusted public and private health expenditure has increased from less than 1% of GDP before 1900 to about 9-10% of GDP in 2025 at the global level, with large gaps between regions, from about 4-5% of GDP in South & South-East Asia and Subsaharan Africa to about 18% in North America/Oceania. **Sources and series:** wid.world

Age-Adjusted Public + Private Education & Health Expenditure



Interpretation. Total age-adjusted public and private education and health expenditure has increased from less than 1% of GDP before 1900 to about 14% of GDP in 2025 at the global level, with large gaps between regions, from about 8% of GDP in South & South-East Asia and Subsaharan Africa to about 25% in North America/Oceania. **Sources and series:** wid.world

Human capital h_{it} : key driver of productivity growth g_{it}

Simple linear specification 1800-2025: $g_{it} = g_0 + a h_{it} + \epsilon_{it}$

with: $g_{it} = (y_{it} - y_{it-1})/y_{it-1}$ = growth rate of labor productivity y_{it}
 h_{it} = human capital expenditure as a fraction of GDP

(public + private education and health expenditure)

Non-linear equation varying with the productivity bracket:

$$g_{it} = [g_1 + a (h_{it} - h_1)] 1_{y_{it} \in I_1} + \dots + [g_s + a (h_{it} - h_s)] 1_{y_{it} \in I_s} + \epsilon_{it}$$

With: $I_1, \dots, I_s$: intervals of labor productivity

h_s = average human capital expenditure in bracket I_s

→ $a \approx 0,1$ (highly significant, with $R^2 \approx 30-40\%$)

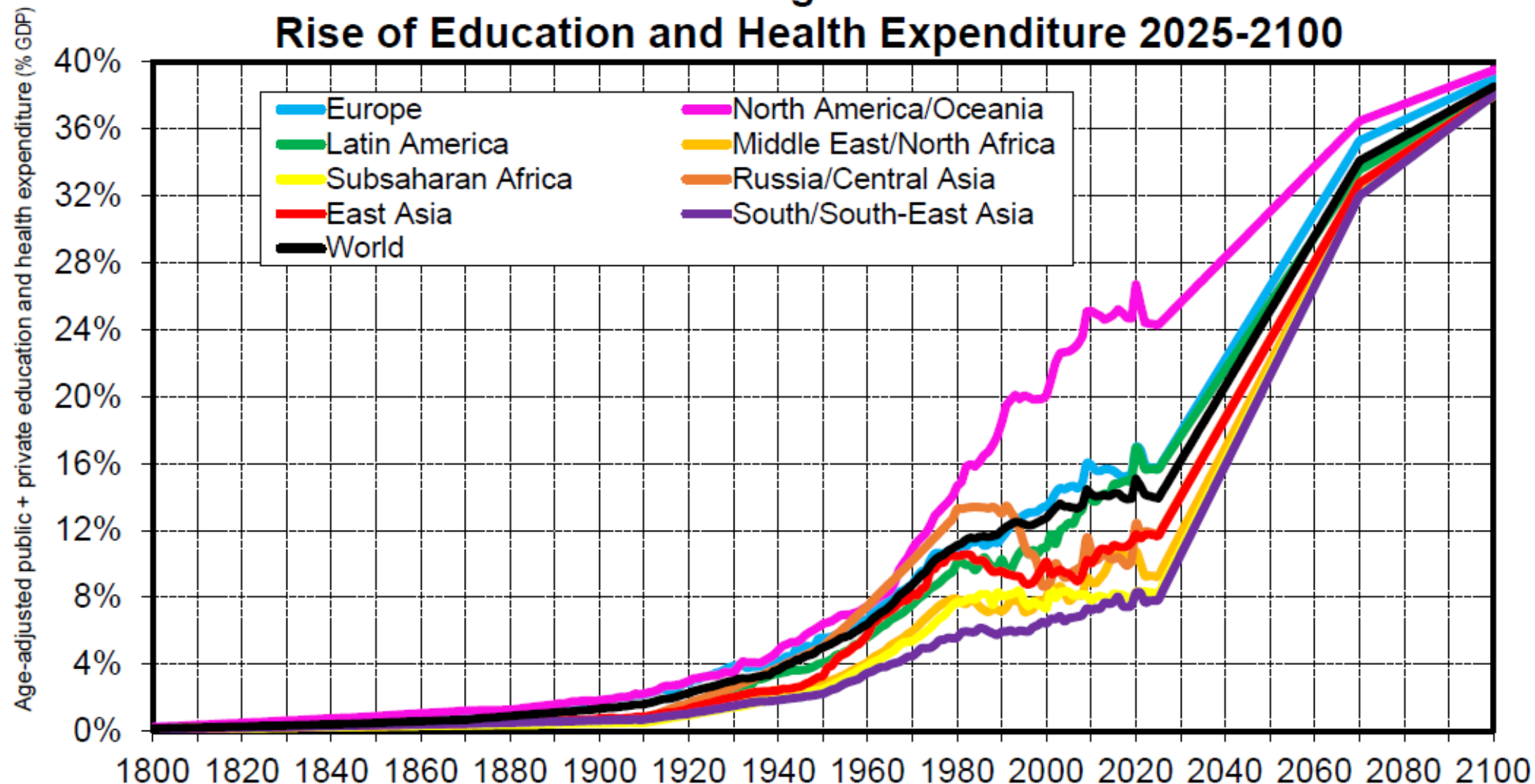
E.g. if $h \uparrow$ from 10% to 20%, then $g \uparrow$ by 1% (say from 1% to 2%/year)

Table 2. The Impact of Human Capital Expenditure on Productivity Growth

	Annual Growth Rate of Hourly Productivity (net domestic product per work hour)						
Total Human Capital Expenditure (s.e.)	0.084*** (0.004)	0.105*** (0.008)	0.201*** (0.008)				
Education (s.e.)				0.132*** (0.021)			
Health (s.e.)				0.095*** (0.012)			
Public Expenditure (s.e.)					0.132*** (0.017)		
Private Expenditure (s.e.)					0.078*** (0.016)		
Public Education (s.e.)						0.279*** (0.098)	0.478*** (0.134)
Country Fixed Effects	NO	YES	YES	YES	YES	YES	YES
Productivity Level	NO	YES	YES	YES	YES	YES	YES
Capital-Output Ratio	NO	YES	YES	YES	YES	YES	YES
Countries Covered	ALL	ALL	POOR	ALL	ALL	ALL	POOR
Period Covered	1800-2025	1800-2025	1800-2025	1800-2025	1800-2025	1980-2025	1980-2025
R2	0.19	0.32	0.33	0.35	0.34	0.47	0.49
N.obs	12882	12882	8213	12882	12882	2622	1022

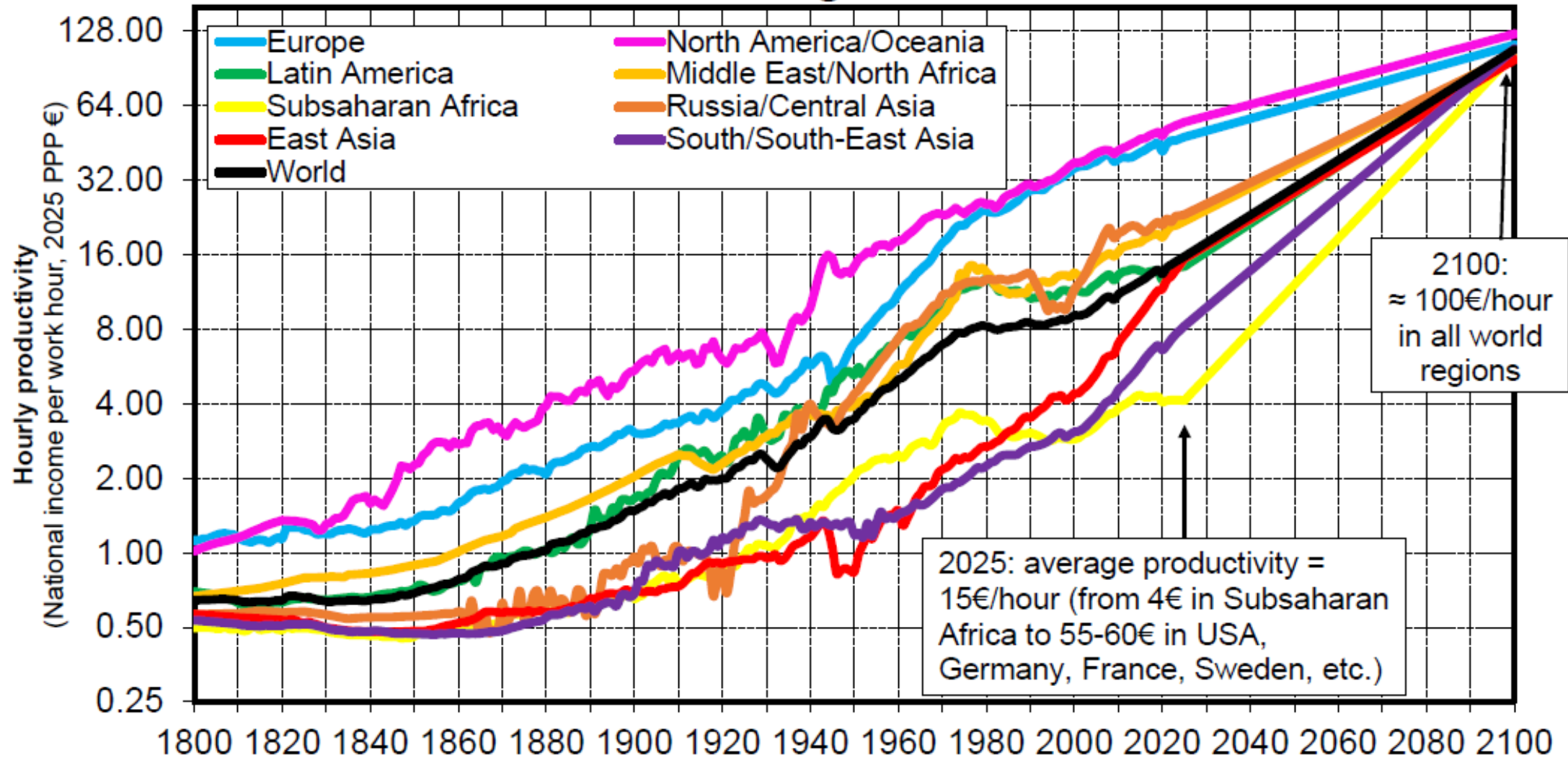
Interpretation. When (age-adjusted) human capital expenditure (public and private education and health expenditure) expressed as % of GDP increases by 10% (e.g. from 10% to 20% of GDP), annual productivity growth increases by about 1% (e.g. from 1% to 2% per year). I.e. the annual rate of return to human capital investment is about 10% (consistent with micro studies). The return is higher for education than for health and for public expenditure than for private expenditure. It is even larger for poor countries (productivity < 10€ PPP 2025/hour, i.e. mostly countries in Sub-Saharan Africa and South & South East Asia) and for public education in the post-1980 period.

Global Convergence Scenario: Rise of Education and Health Expenditure 2025-2100



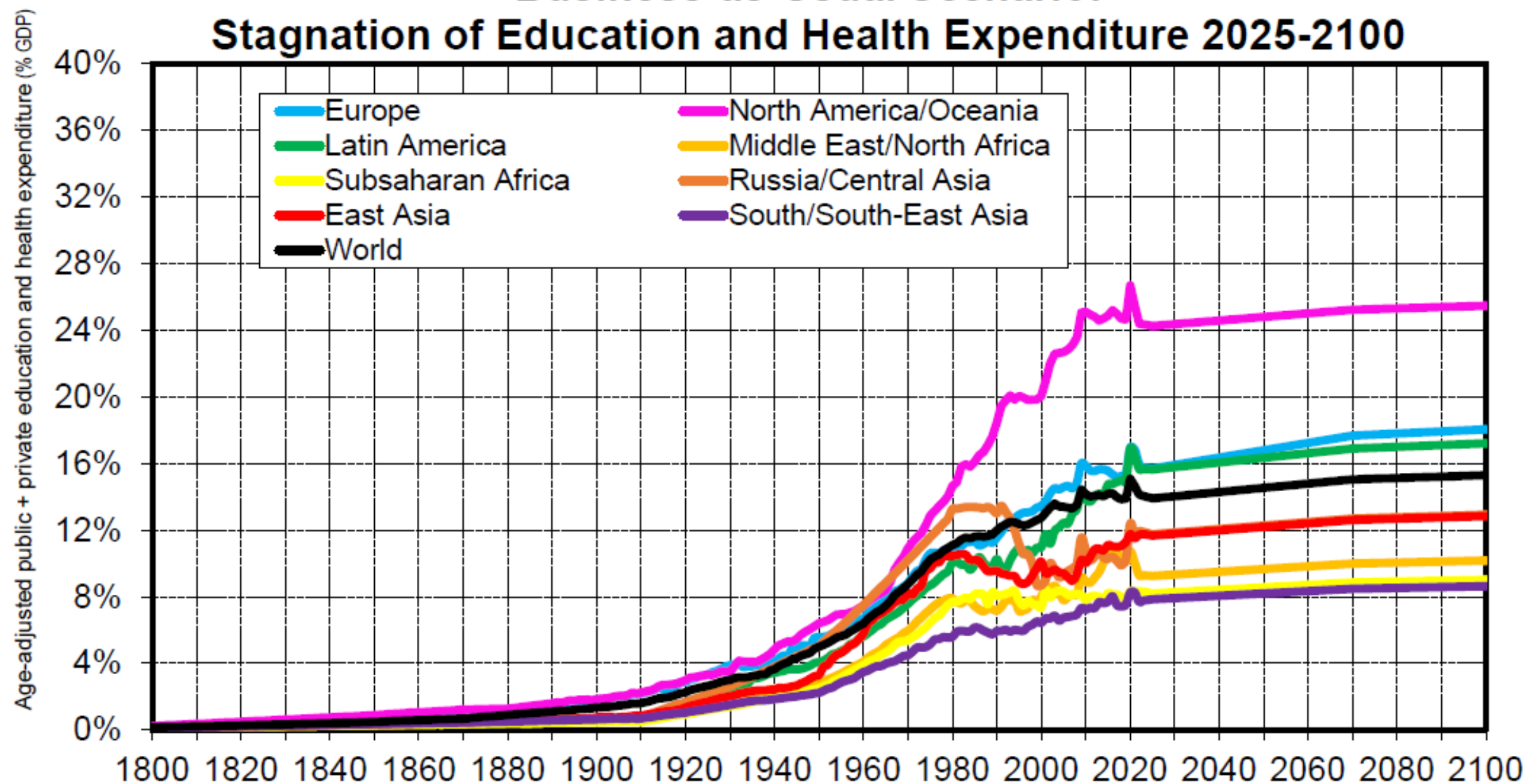
Interpretation. In the global-convergence scenario, total age-adjusted public and private education and health expenditure is projected to converge toward about 40% of GDP in all world regions by 2100. **Sources and series:** wid.world

World Productivity Trends 2025-2100: Global Convergence Scenario



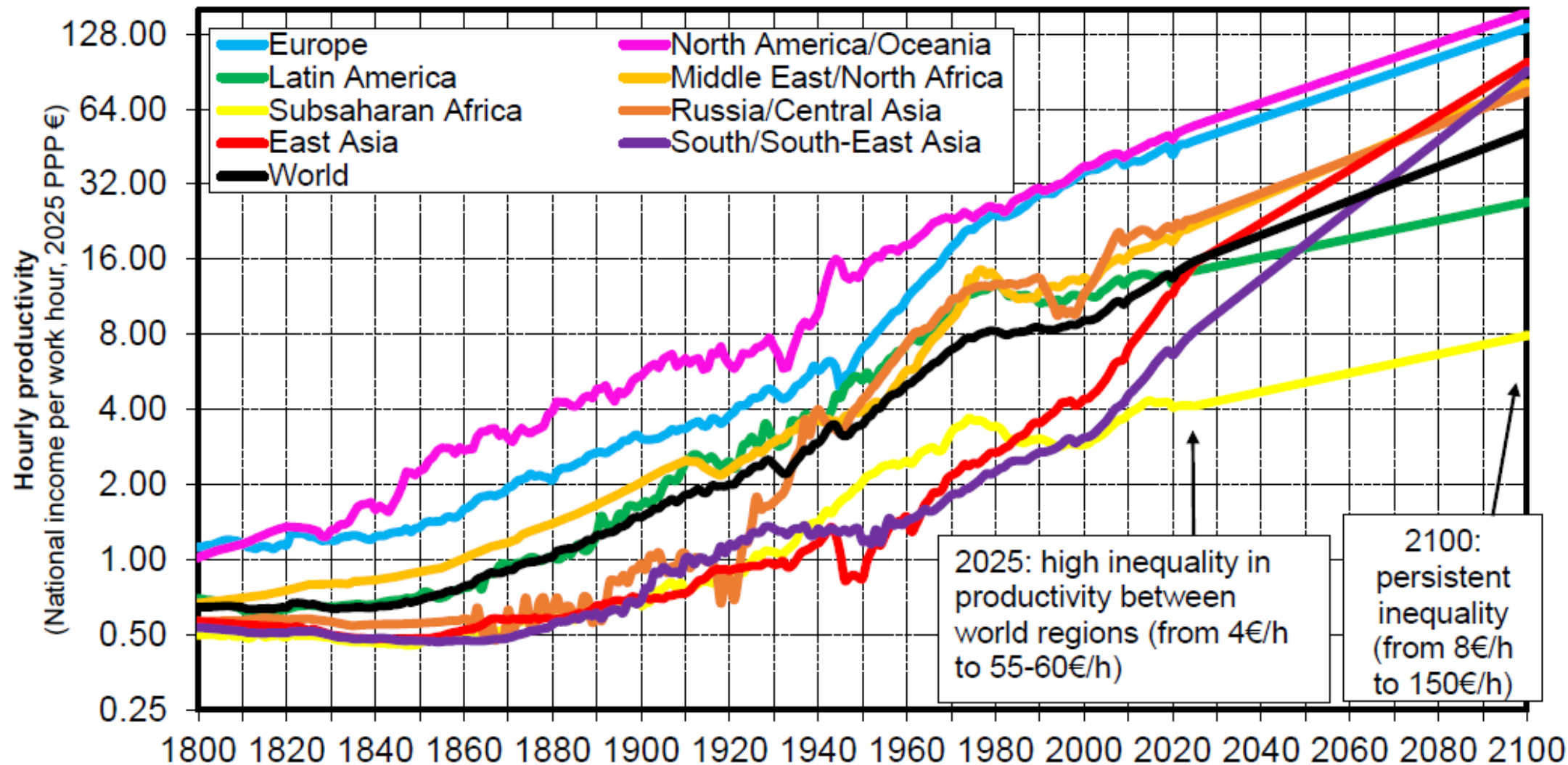
Interpretation. Under the "global convergence" scenario, productivity growth rates are projected to rise substantially in 2025-210, so that all regions converge to about 100-120€/hour by 2100. This requires in particular a large acceleration of productivity growth in Subsaharan Africa (4.4% per year over 2025-2100 period, i.e. the same as in East Asia 1990-2025). **Sources and series:** see wid.world

Business-as-Usual Scenario: Stagnation of Education and Health Expenditure 2025-2100



Interpretation. In the global-convergence scenario, total age-adjusted public and private education and health expenditure is projected to stabilize (as a share of GDP) in all world regions during the 2025-2100 period. **Sources and series:** wid.world

World Productivity Trends 2025-2100: Business-As-Usual Scenario



Interpretation. Under the "business-as-usual" scenario (stagnation of education and health expenditure, same productivity growth rates as in 1900-2025, with minor changes), inequality in hourly productivity is projected to remain very high between world regions by 2100. In particular, productivity in 2100 would be only 8€/hour in Subsaharan Africa. **Sources and series:** see wid.world

Conclusion & research perspectives

- In spite of large historical increase in education and health expenditure, access to education and health remains extremely unequal between South and North
- E.g. per-school-age-individual public education expenditure in Sub-Saharan Africa $\approx$ 3% of Europe/North America level in 2025 in PPP terms (vs 6% in 1980 and 4% in 1950)
- **To be added:** retrospective counterfactual simulations. I.e. with higher human capital expenditure in global South since 1900 or 1950, global productivity convergence already achieved in 2025

- Human capital expenditure has a huge a positive impact on productivity growth, especially public education, and especially in the poorest countries
- **Real-world governments may not be perfect, but as they stand they appear to be more efficient in the South than in the North** in order to transform human capital expenditure into productivity
- A large global justice fund aimed at financing human capital expenditure can deliver global productivity convergence, with productivity around 100€/hour in all world regions by 2100
- **To be further analyzed in GJP scenarios, together with within-country inequality of income and wealth, structural transformation across sectors, planetary habitability etc.**