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

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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 Subsaharan Africa ≈ 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.)

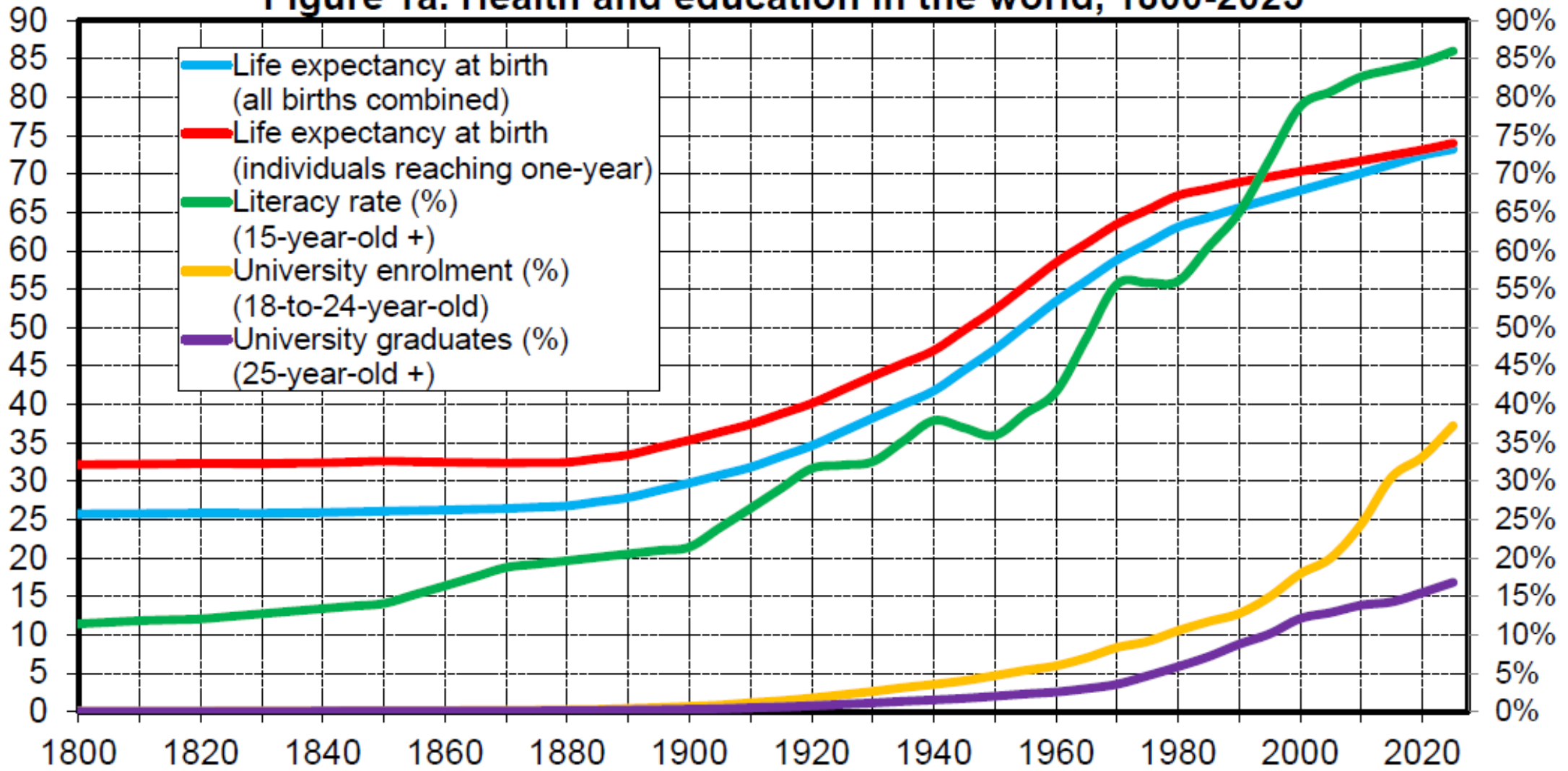
Relation to the Literature

(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

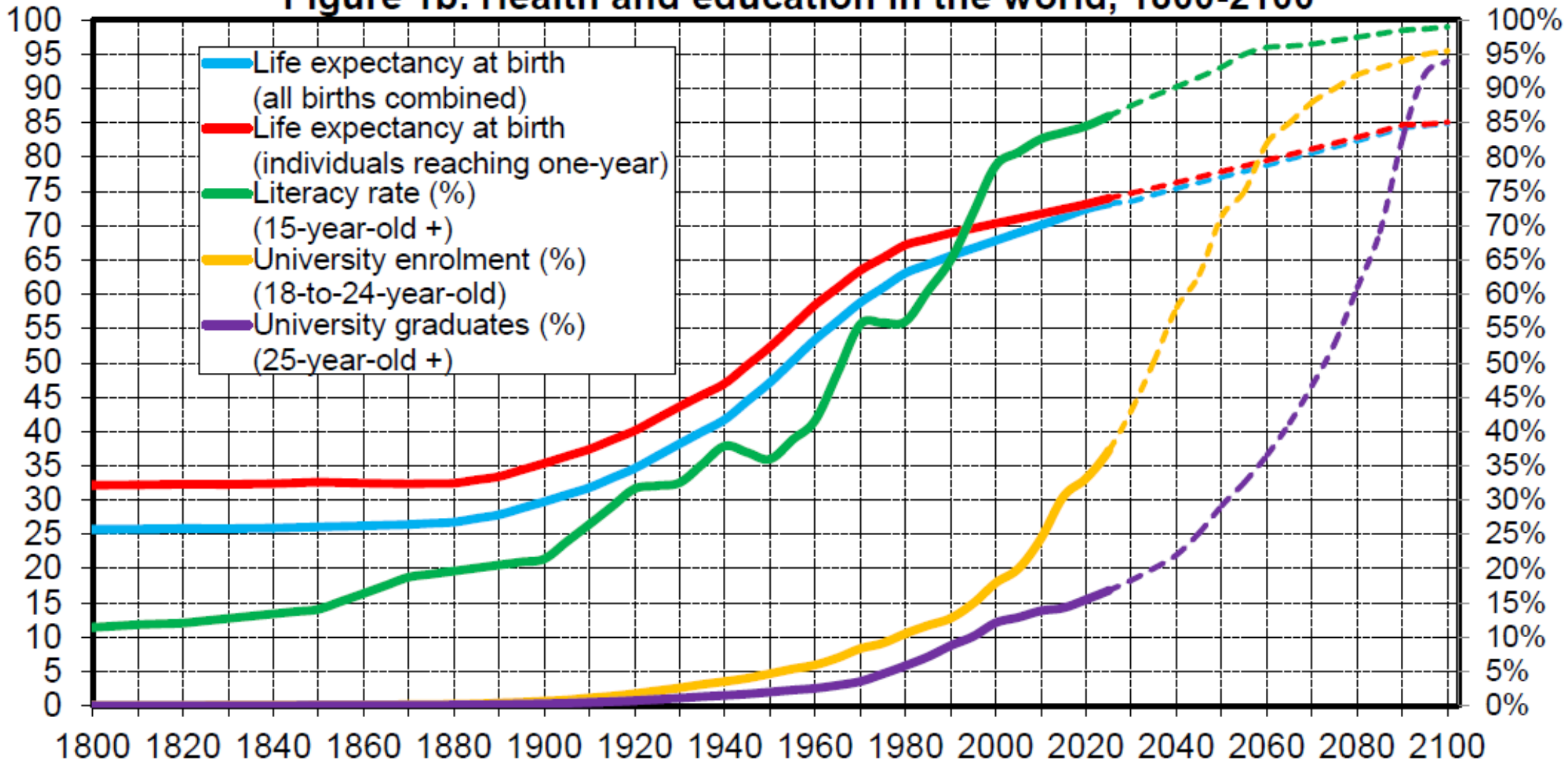
But no attempt so far to provide consistent historical estimates at the global level: key contribution of this paper, using new budgetary sources and archival material

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

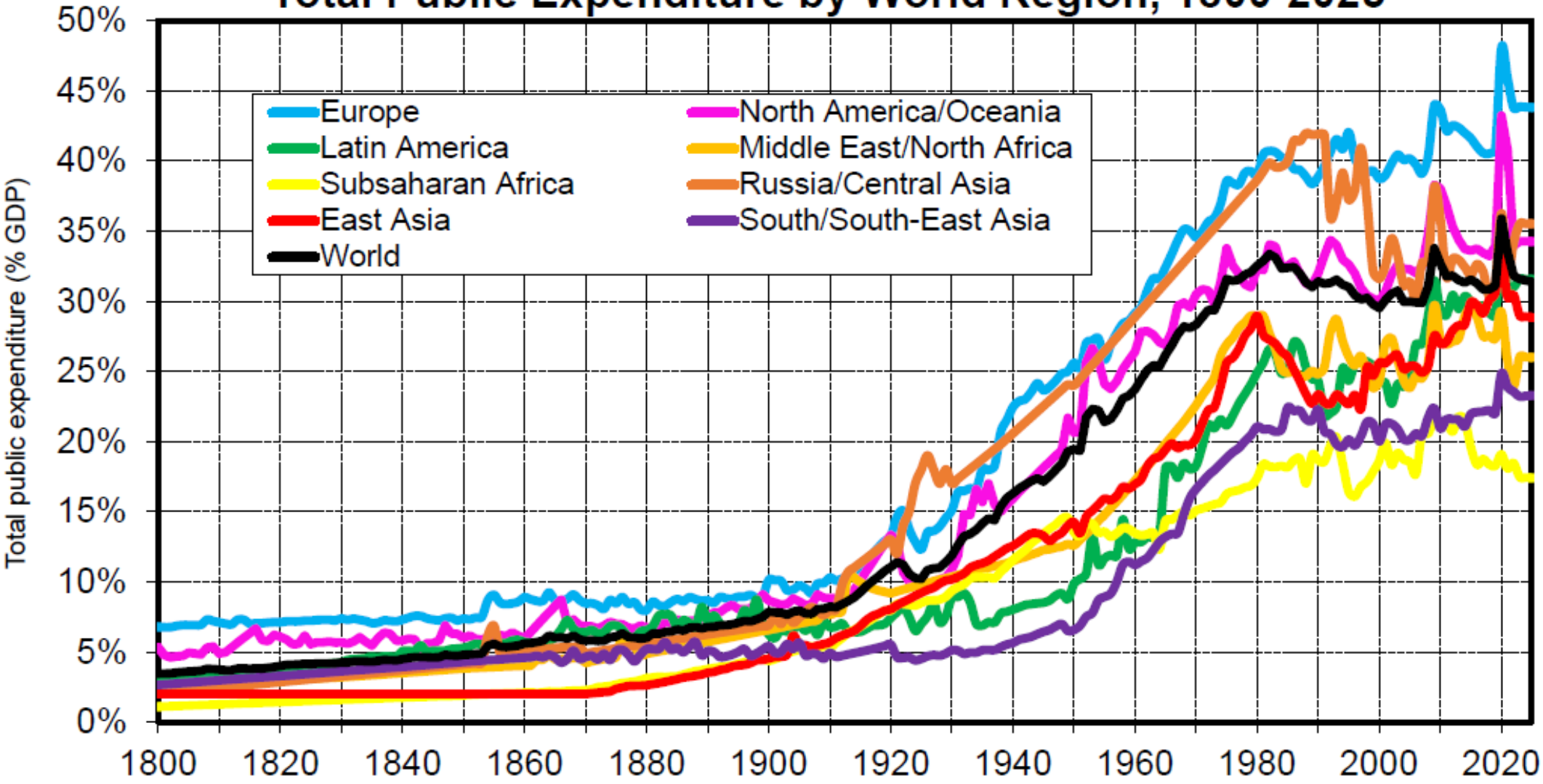
Figure 1b. Health and education in the world, 1800-2100



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**: wid.world

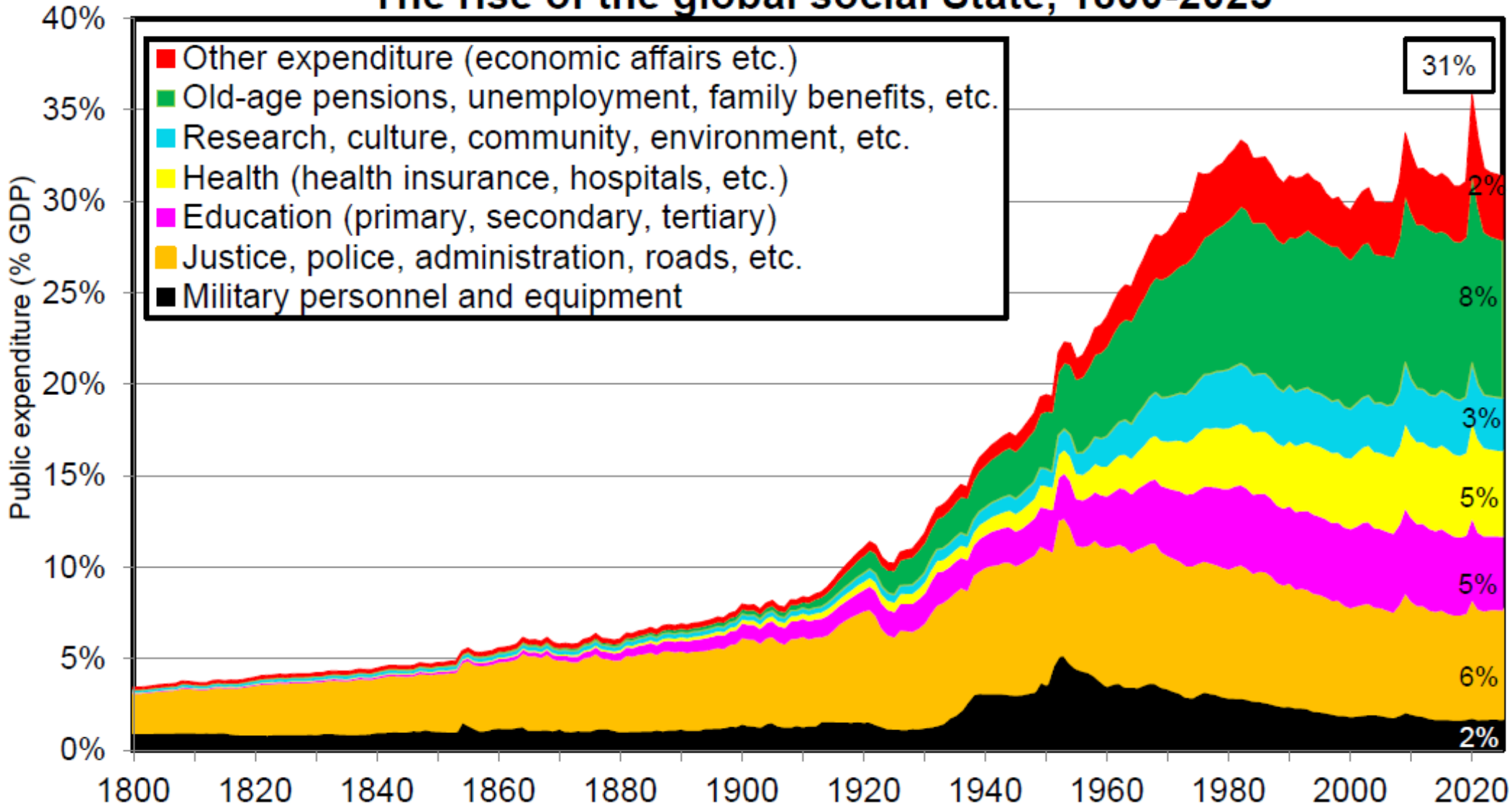
The World Human Capital Expenditure Database (WHCE): Geographical Coverage (57 core territories = 48 main countries + 9 residual regions)	
East Asia (5)	China, Japan, South Korea, Taïwan Other EASA
Europe (11)	Britain, Denmark, France, Germany, Italy, Netherlands, Norway, Spain, Sweden, Other W.EUR, 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, Canana, Australia, New Zealand Other NAOC
Russia/ Central Asia (2)	Russia Other RUCA
South/South-East Asia (9)	Bengladesh, India, Indonesia, Myanmar, Pakistan, Philipinnes, Thailand, Vietnam, Other SSEA
Sub-Saharan Africa (11)	DR Congo, Ethiopa, Kenya, Ivory Coast, Mali, Niger, Nigeria, Rwanda, Sudan, South Africa, Other SSAF
Interpretation. The World Human Capital Expenditure Database (WHCE) provides data series for 57 core territories (48 main countries + 9 residual regions, which we define using fixed 2025 borders) covering the entire world over the 1800-2025 period. The database includes series on public expenditure and revenue and their components, expressed as % of GDP. It also includes series on private education & health expenditure and age-adjusted education and health expenditure. Over the recent decades (1980-2025), we provide similar series for 216 core countries and jurisdictions (168 of which define the 9 residual regions), again with fixed 2025 borders, and with additional decompositions (e.g. for primary, secondary and tertiary education). All series are also available and will be regularly updated in the World Inequality Database (wid.world).	

Total Public Expenditure by World Region, 1800-2025



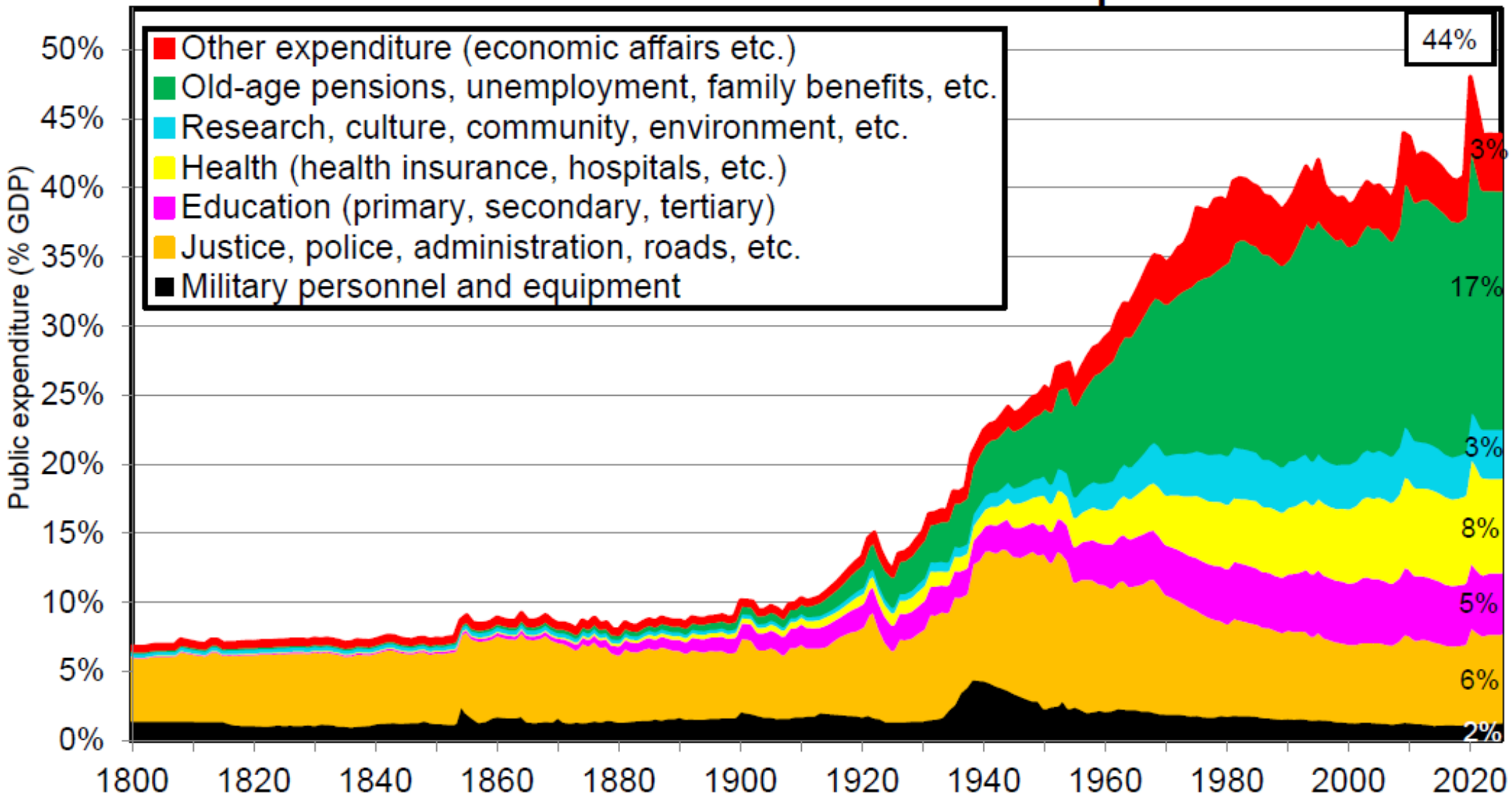
Interpretation. Total public expenditure rose from about 3% of global GDP in 1800 to about 31% in 2025, with large regional variations. Total public expenditure includes all expenditures by all public administrations (including central and local government, social security funds, etc.), except interest payments (and except exceptional expenditure during world wars). **Sources and series**: wid.world

The rise of the global social State, 1800-2025



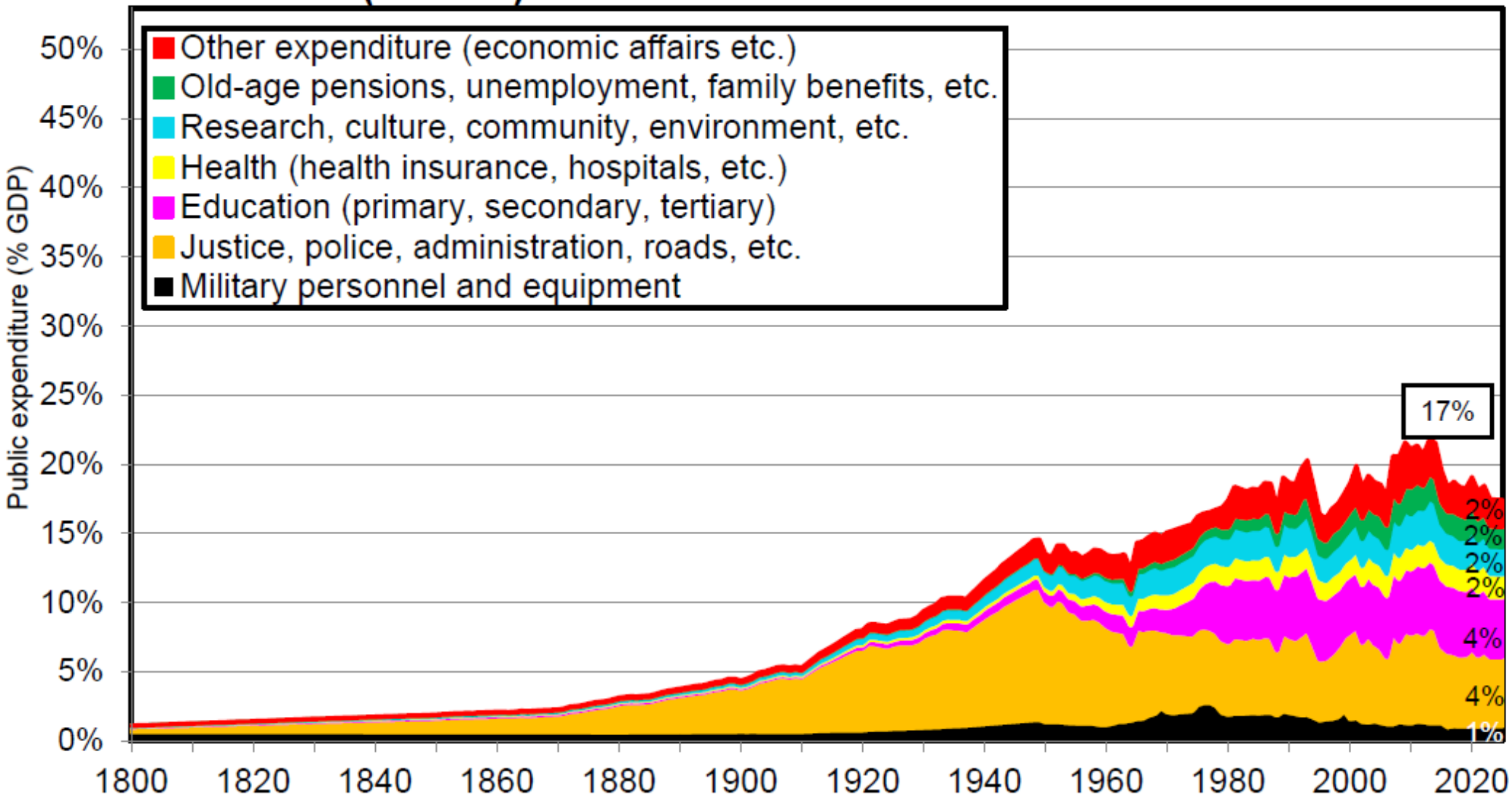
Interpretation. In 2025, total public expenditure amounts to about 31% of global GDP (PPP), including about 2% for military expenditure, 6% for general public services (justice, police, general administration, roads, etc.), 5% for education, 5% for health, 3% for research, culture/recreation/religion, community services (water, light, etc.), environmental protection (waste, biodiversity, etc.), 8% 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

The rise of the social State: Europe



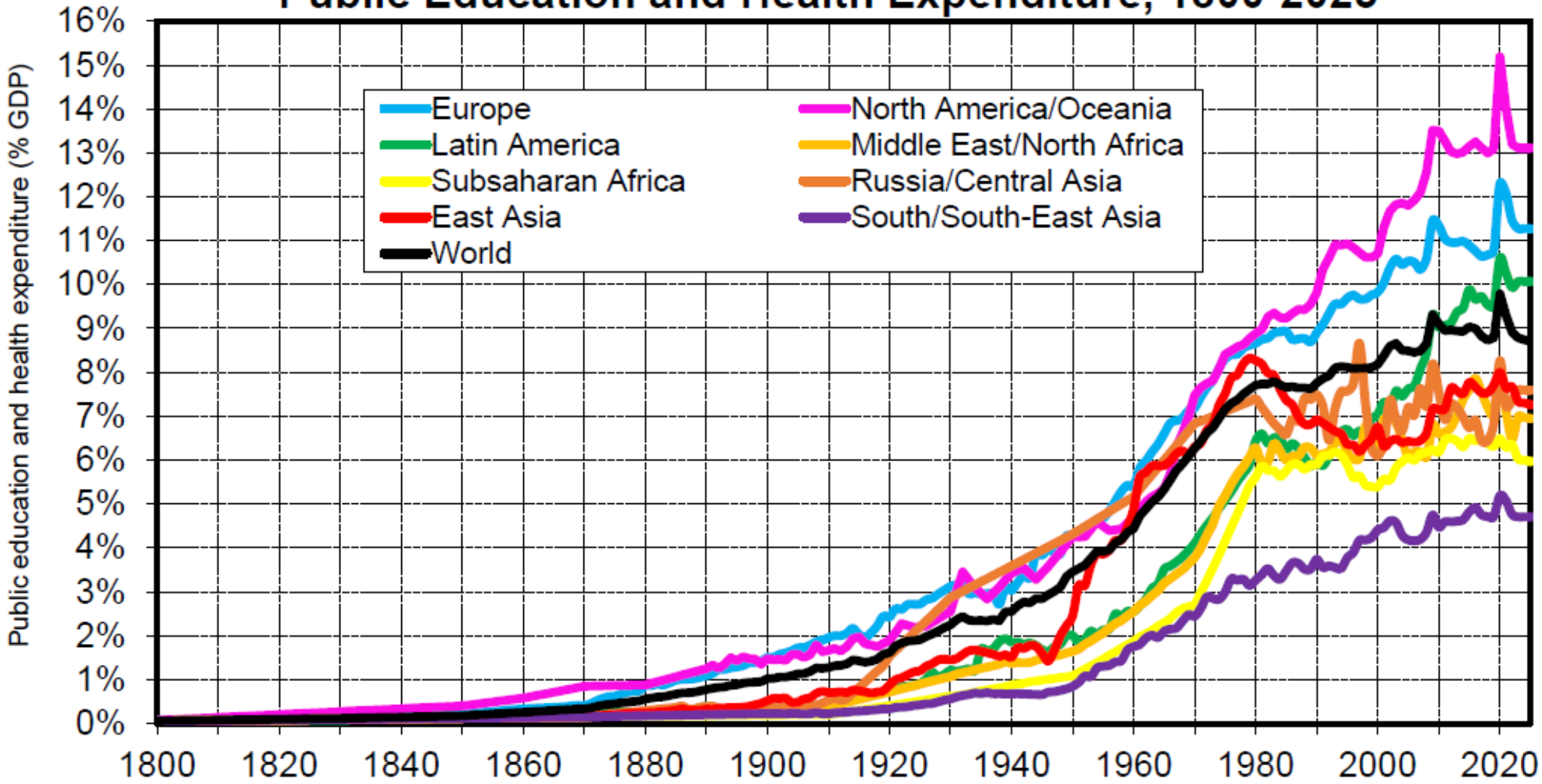
Interpretation. In 2025, total public expenditure amounts to about 44% of GDP in Europe, including about 2% for military expenditure, 6% for general public services (justice, police, general administration, roads, etc.), 5% for education, 8% for health, 3% for research, culture/recreation/religion, community services (water, light, etc.), environmental protection (waste, biodiversity, etc.), 17% 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 (limited) rise of the social State: Subsaharan Africa



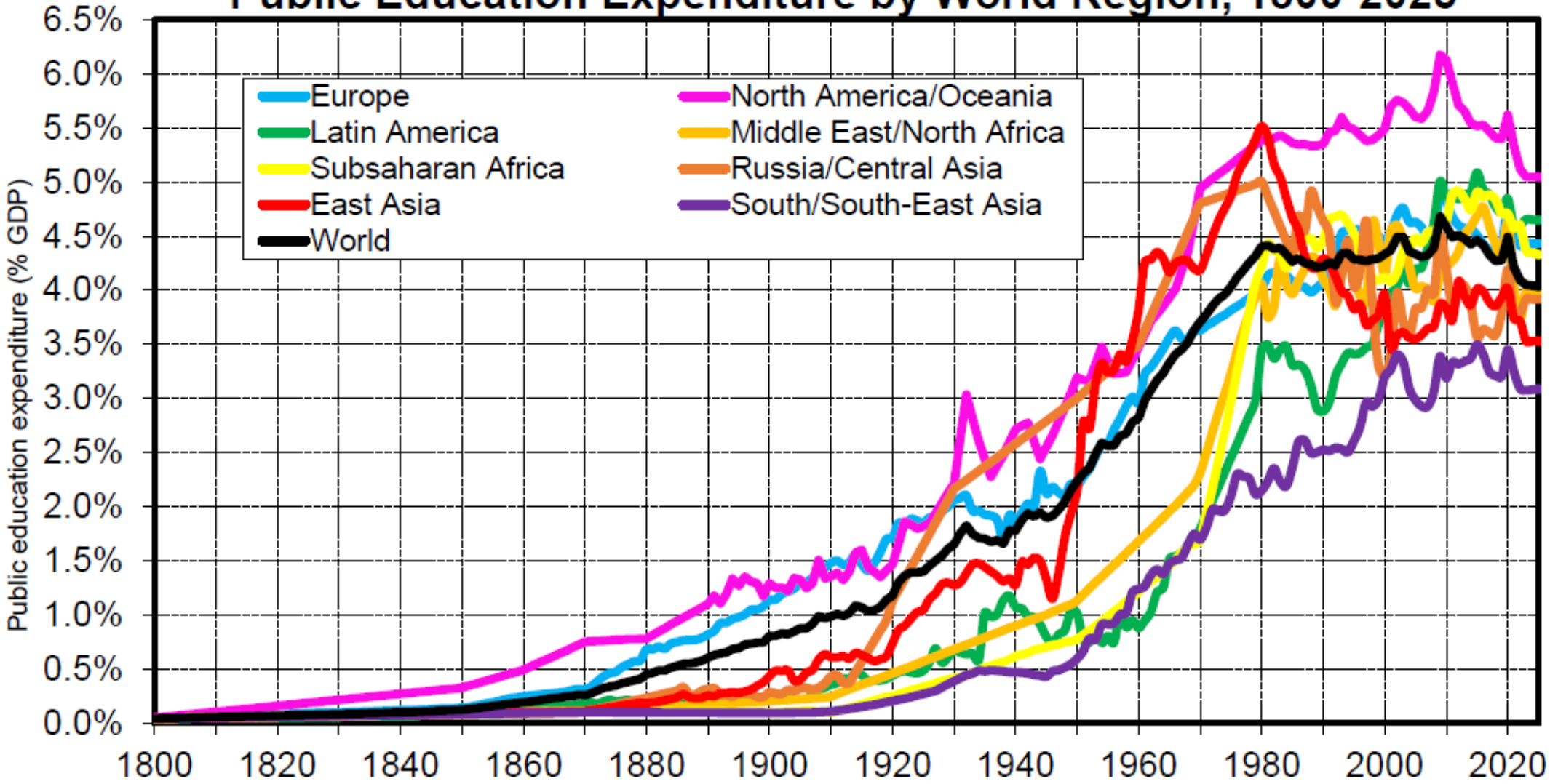
Interpretation. In 2025, total public expenditure amounts to about 17% of GDP in Subsaharan, including about 1% for military expenditure, 4% for general public services (justice, police, general administration, roads, etc.), 4% for education, 2% for health, 2% for research, culture/recreation/religion, 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



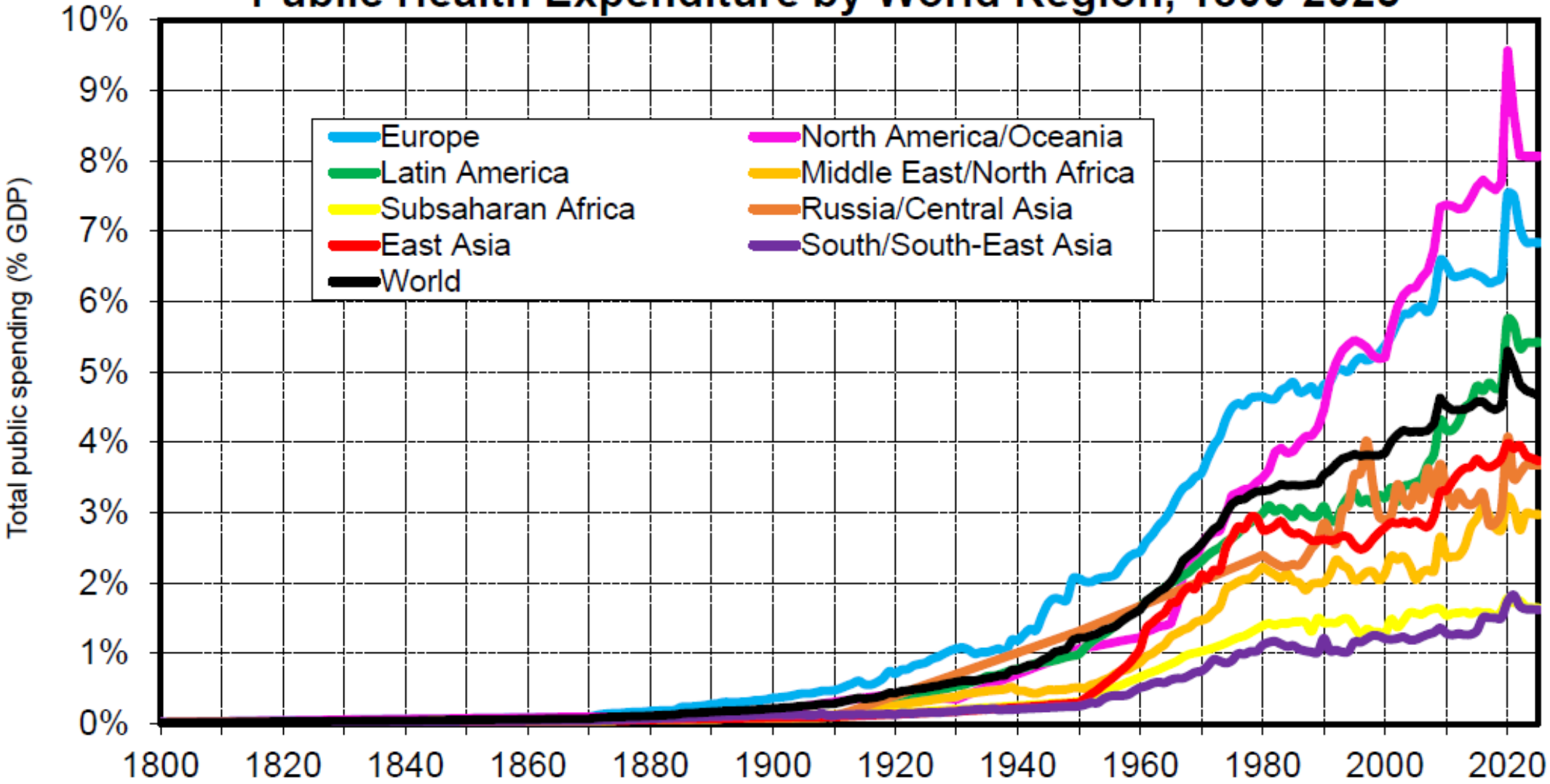
Interpretation. Public education and health expenditure rose from less than 1% of GDP before 1900 to about 9% of GDP in 2025 at the global level, with large regional variations (from about 5-6% of GDP in South & South East Asia and Subsaharan Africa to 11-14% of GDP in Europe and North America/Oceania). **Sources and series**: wid.world

Public Education Expenditure by World Region, 1800-2025



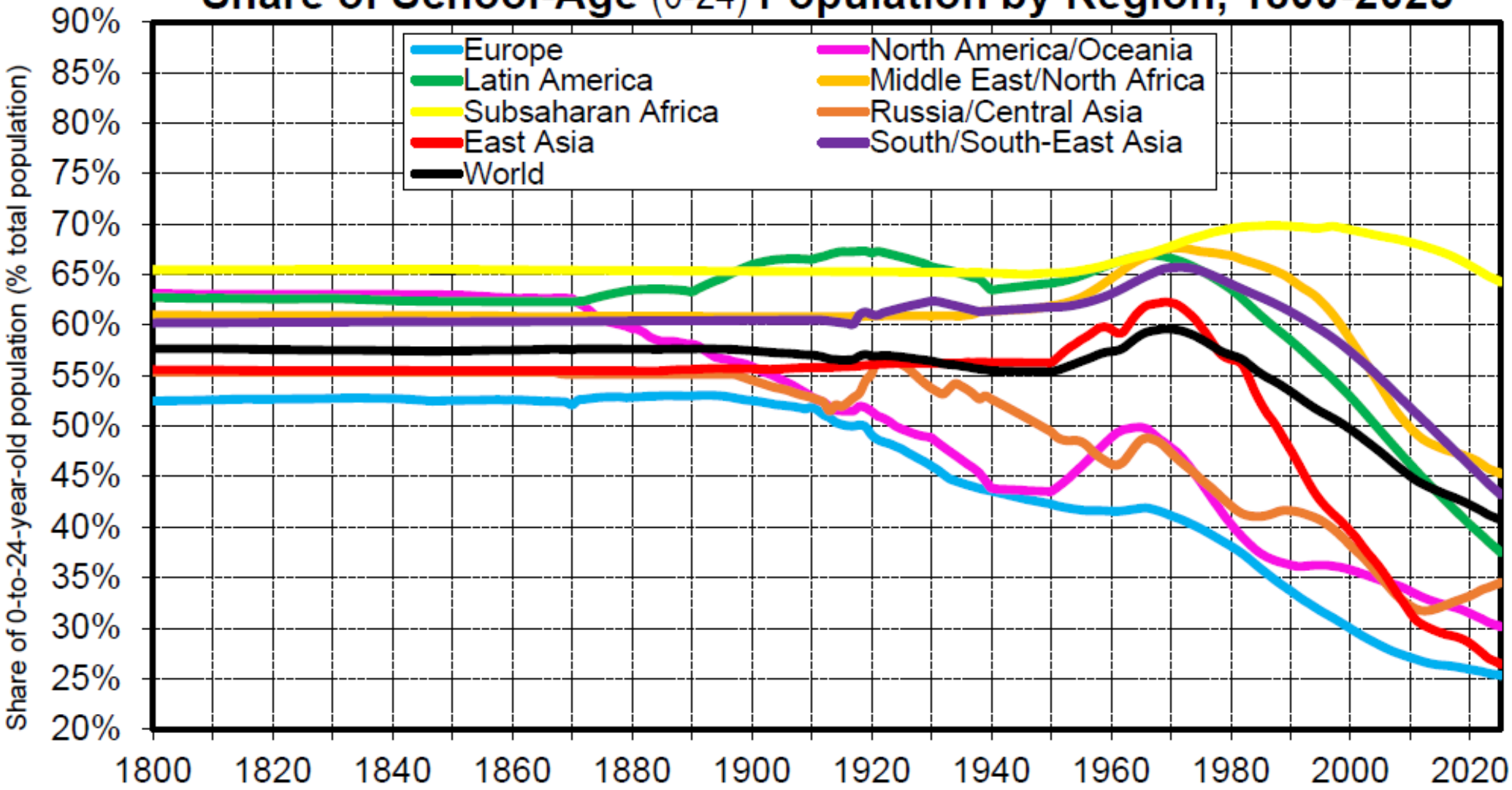
Interpretation. Public education expenditure rose from less 1% of GDP before 1900 to about 4-4.5% of GDP at the global level in 2025, with surprisingly similar levels in many world regions, including Europe and Subsaharan Africa. However the share of school-age population in total population varies widely 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 meaningul 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 7-8% 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

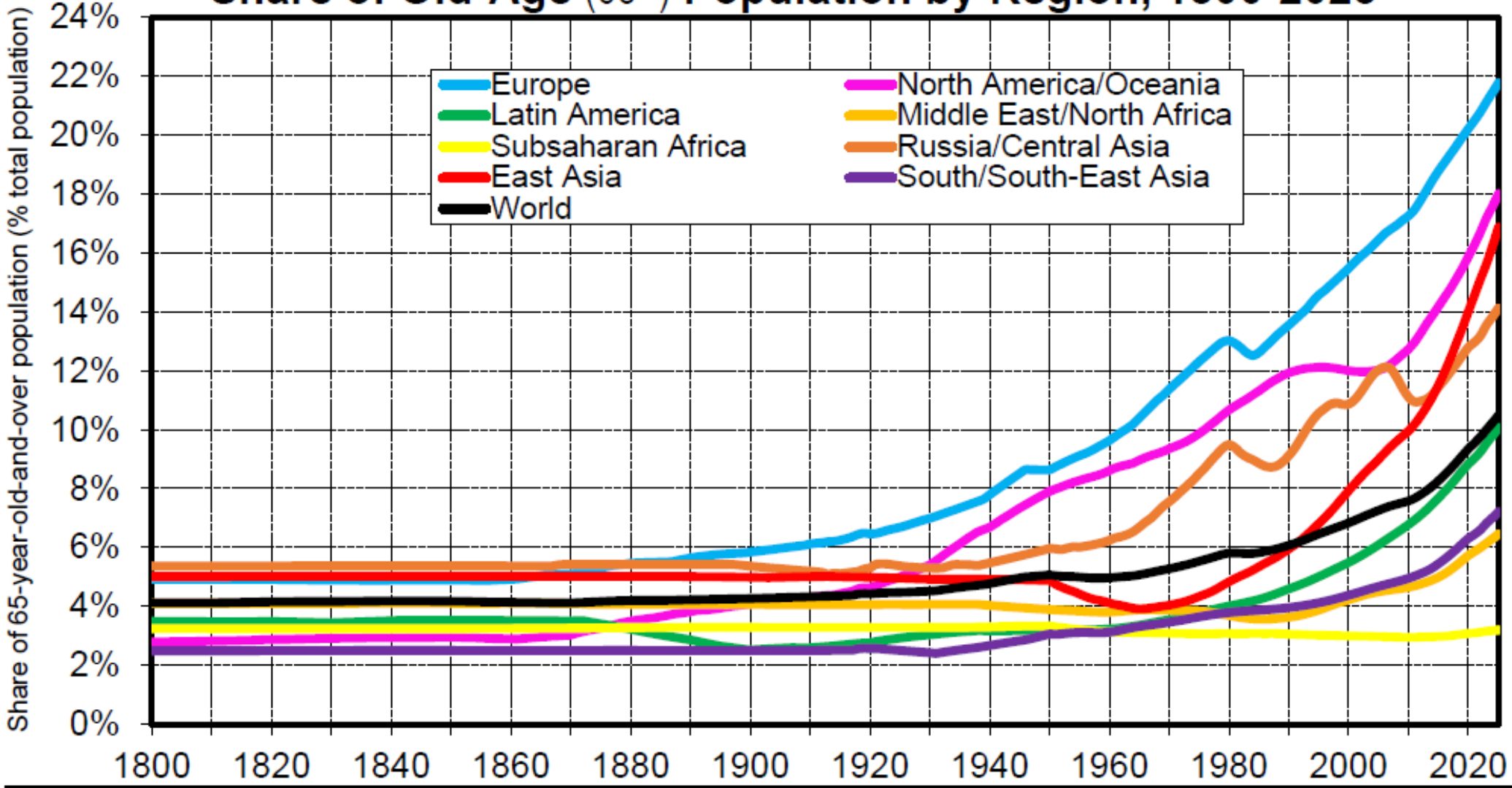
Share of School-Age (0-24) Population by Region, 1800-2025



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 adjustement in order to evaluate the impact of education expenditure.

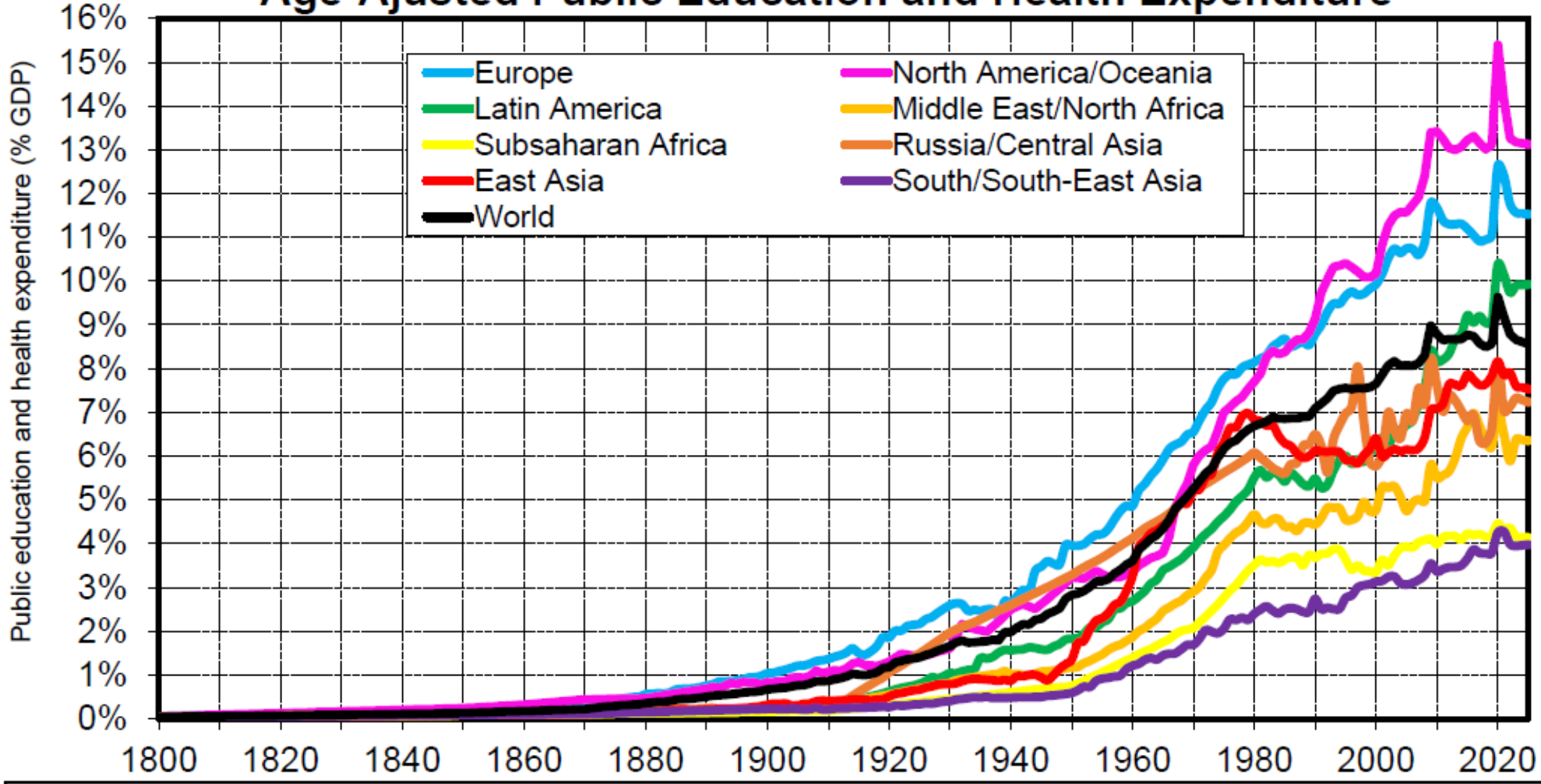
Sources and series: see wid.world

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



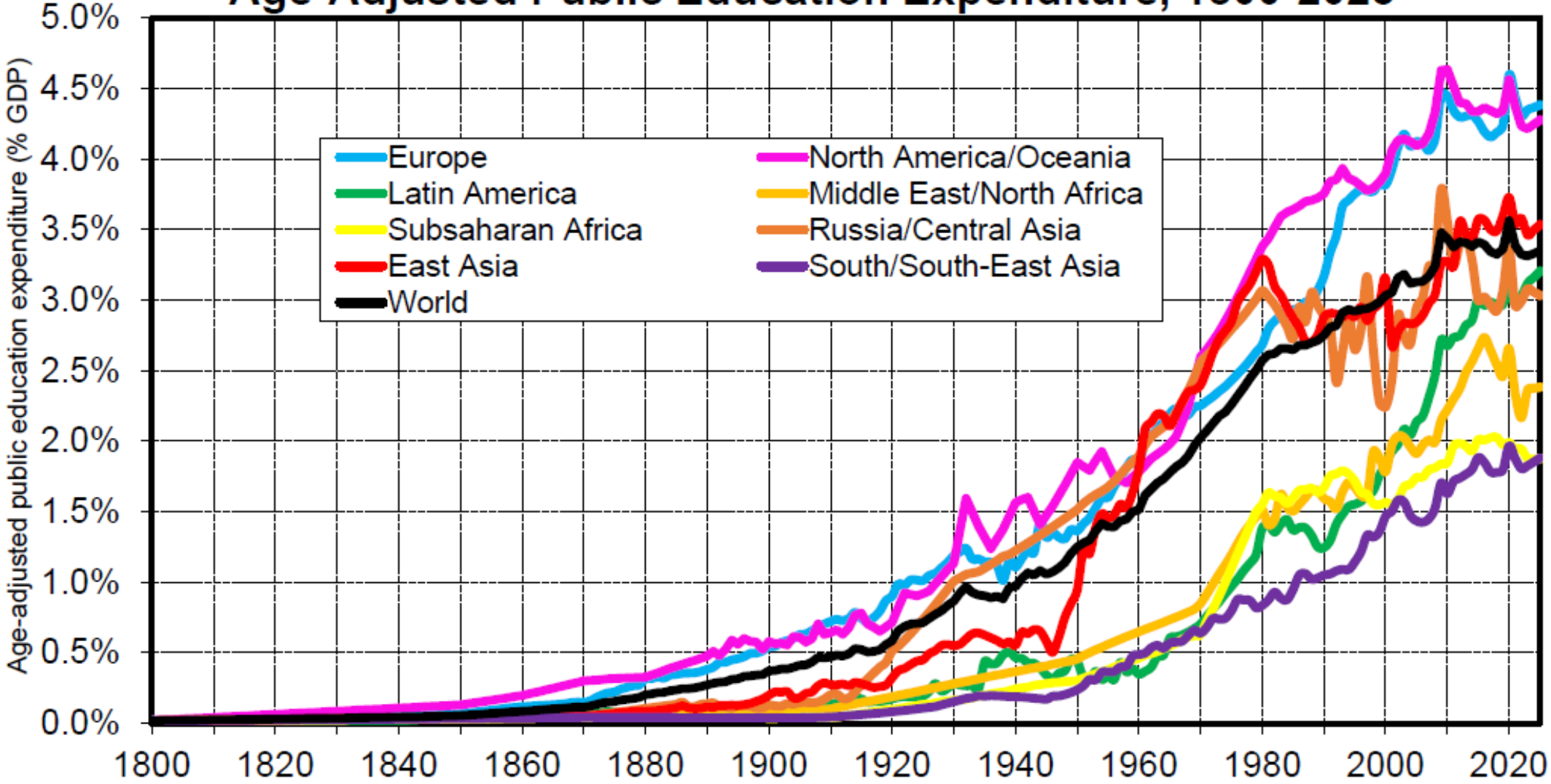
Interpretation. The share of old-age population (65-year-old-and-over) varies enormously across world regions in 2025, from 3% in Subsaharan Africa to 22% in Europe. Given that the per capita health expenditure received by this age group is substantially larger than that received by indiviuals aged 0-to-64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

Age-Ajusted Public Education and Health Expenditure



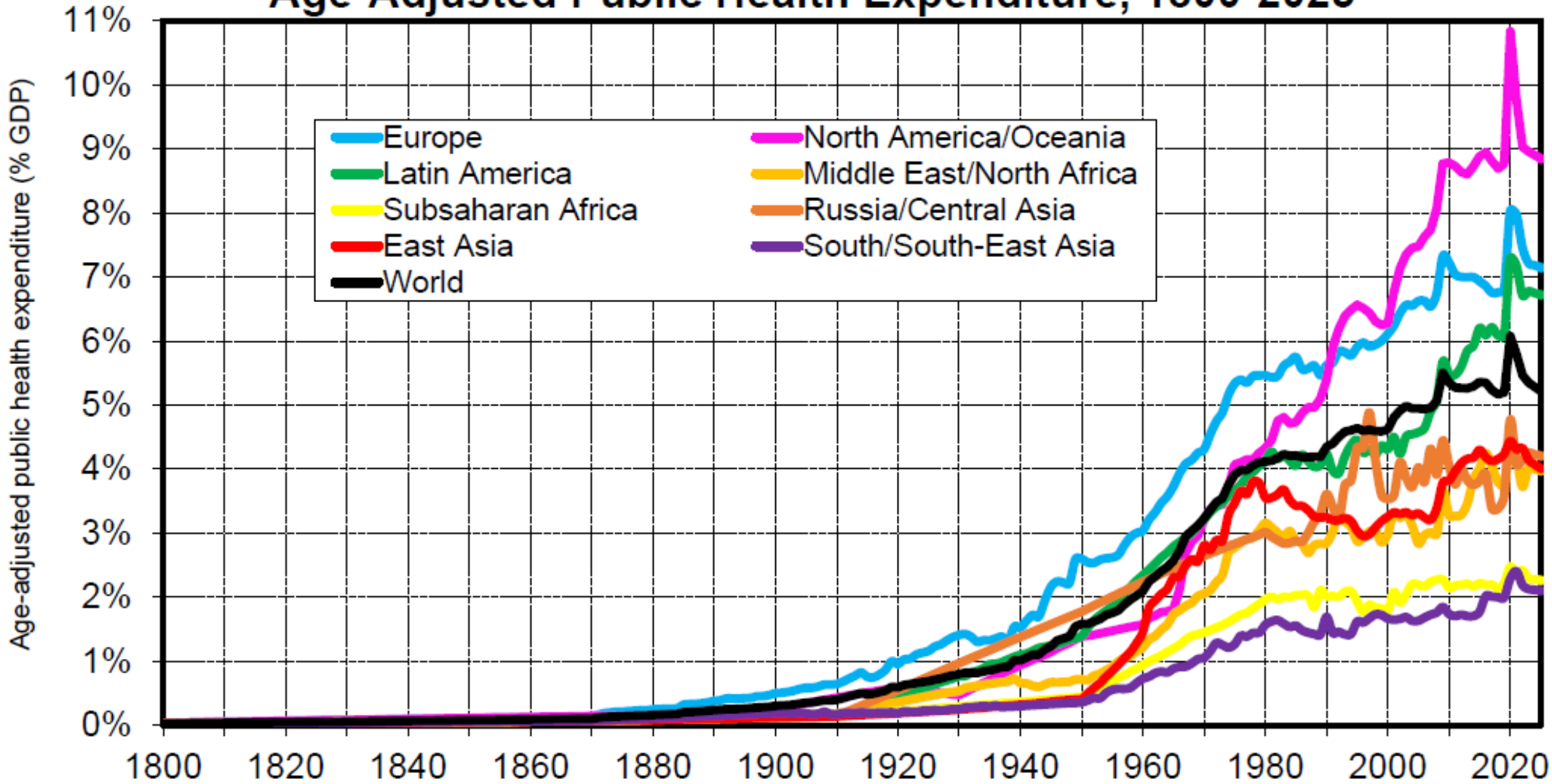
Interpretation. Total age-adjusted public education and health expenditure has increased from less than 1% of GDP before 1900 to 9% of GDP in 2025 at the global level, with very large gaps between regions, from 4% of GDP in South & South-East Asia and Subsaharan Africa to 12-13% in Europe and North America/Oceania. The gaps are somewhat larger after age adjustement, as the unequalizing impact of education adjustment more than counterbalances the equalizing impact of health adjustment (especially for SSAF). **Sources and series**: wid.world

Age-Adjusted Public Education Expenditure, 1800-2025



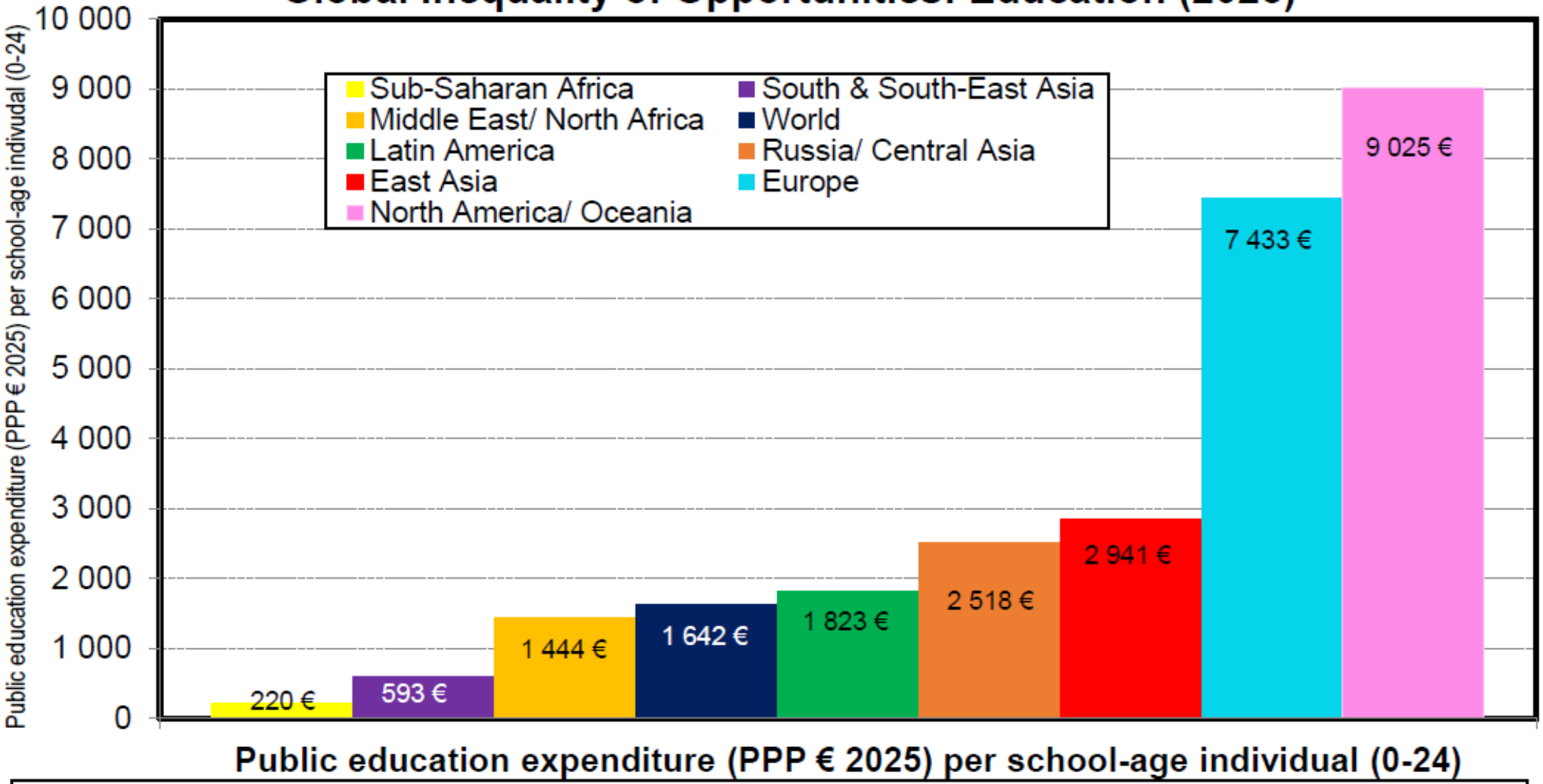
Interpretation. Adjusting for the age structure, i.e. assuming that the share of school-age population (0-to-24-year-old) is equal to 25% in all countries-years (≈ Europe 2025) and keeping the same per-school-age-individual expenditure as in observed country-year, we find that public education expenditure varies from about 2% of GDP in Subsaharan Africa and South & South-East Asia to about 4.5% of GDP in Europe and North America/Oceania. **Sources and series**: wid.world

Age-Adjusted Public Health Expenditure, 1800-2025



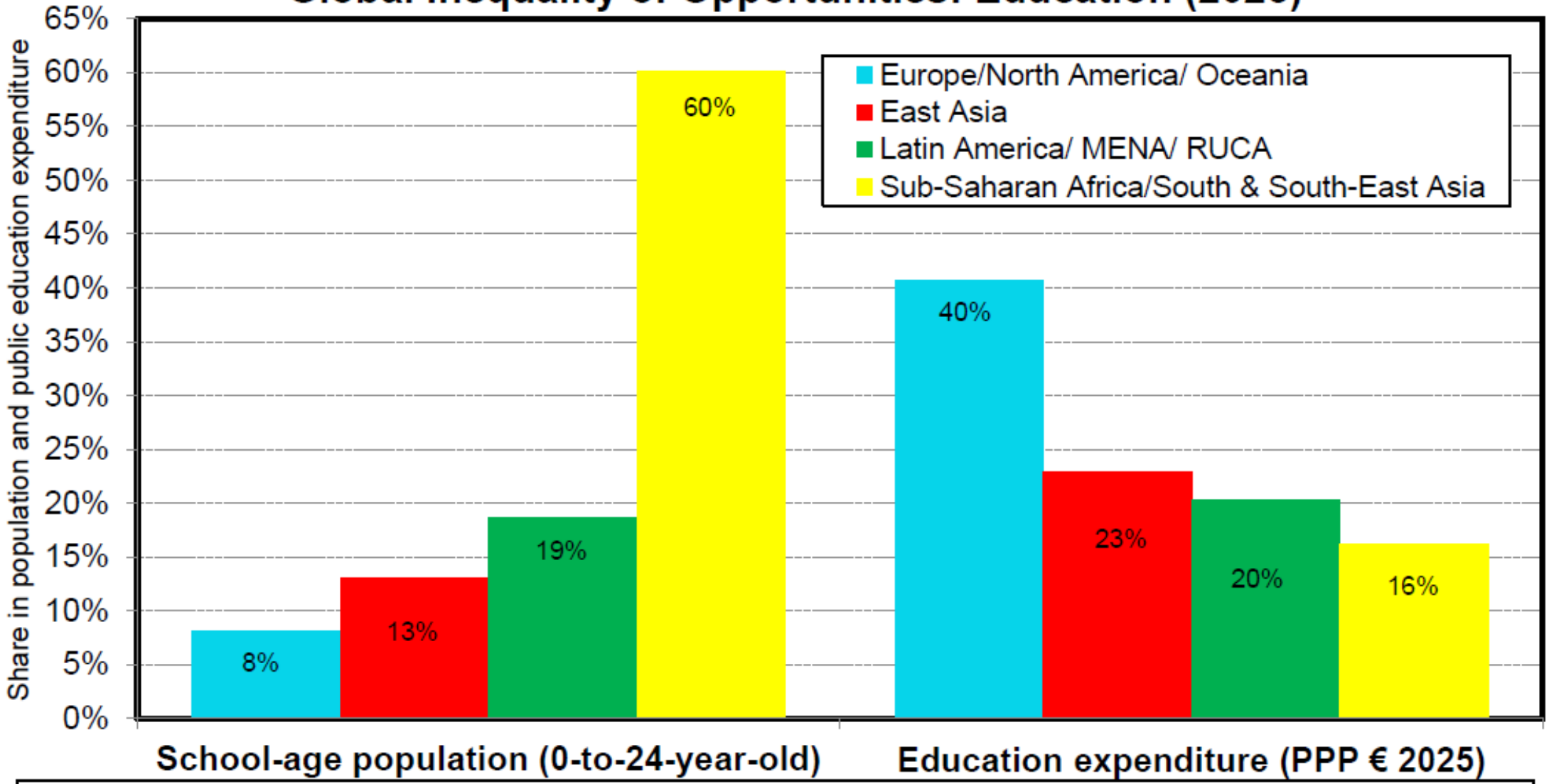
Interpretation. Adjusting for the age structure, i.e. assuming that the share of old-age population (65-year-old+) is equal to 25% in all countries (≈Europe 2030) and taking into account that average per capita health expenditure is on average about 3 times larger for old-age individuals than for the 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 8-9% of GDP in Europe and North America/Oceania. **Sources and series**: wid.world

Global Inequality of Opportunities: Education (2025)



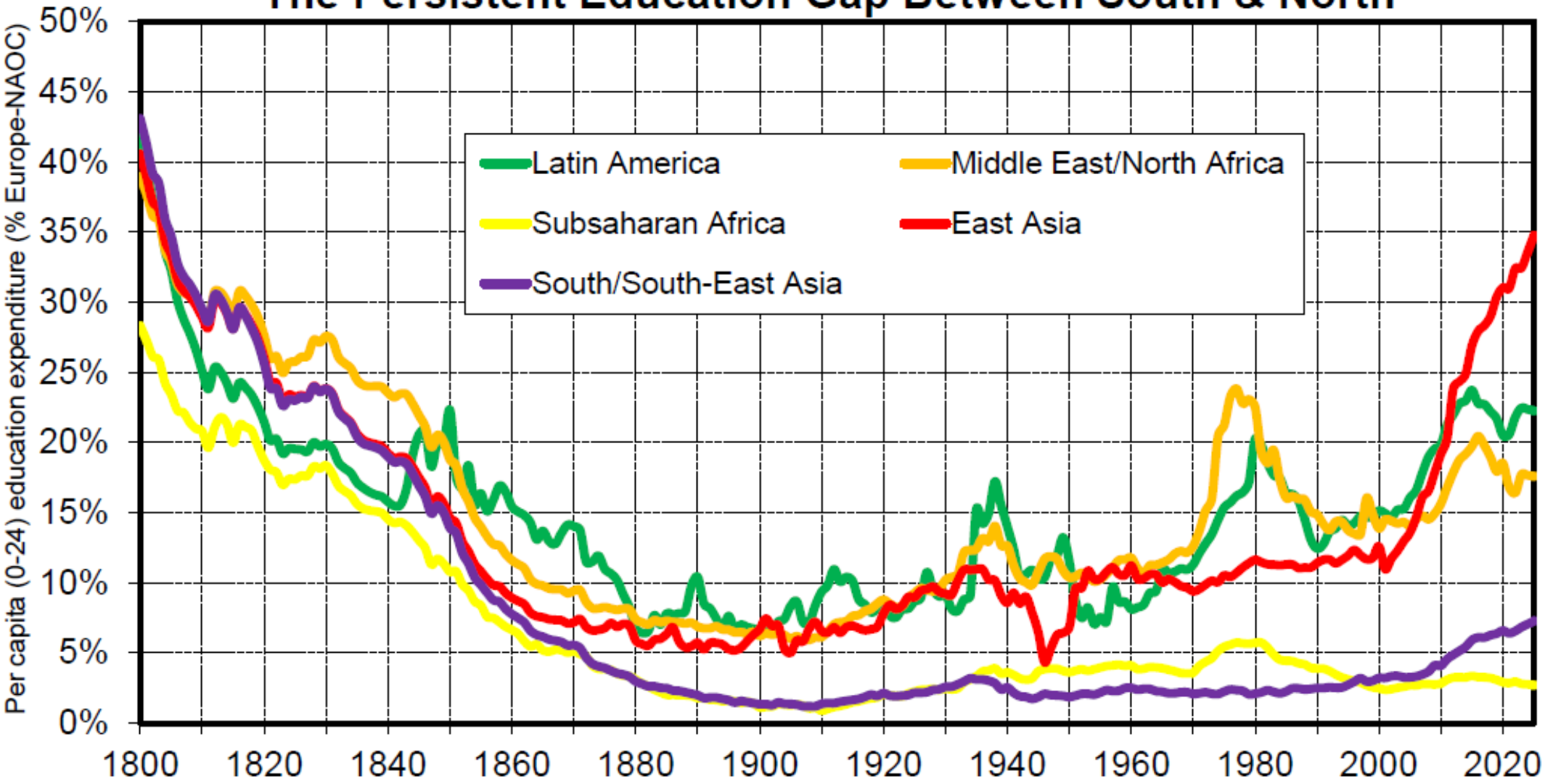
Interpretation. In 2025, average public education expenditure per school-age individual (0-to-24-year-old) varies enormously across world regions, from 220€ in Subsaharan Africa to 9025€ in North America/Oceania (PPP € 2025), i.e. a gap of almost1 to 50. If we were using MERs (maket exchange rates) rather than PPPs (purchasing power parities), the gaps would be 2-3 times larger. **Sources & series**: wid.world

Global Inequality of Opportunities: Education (2025)



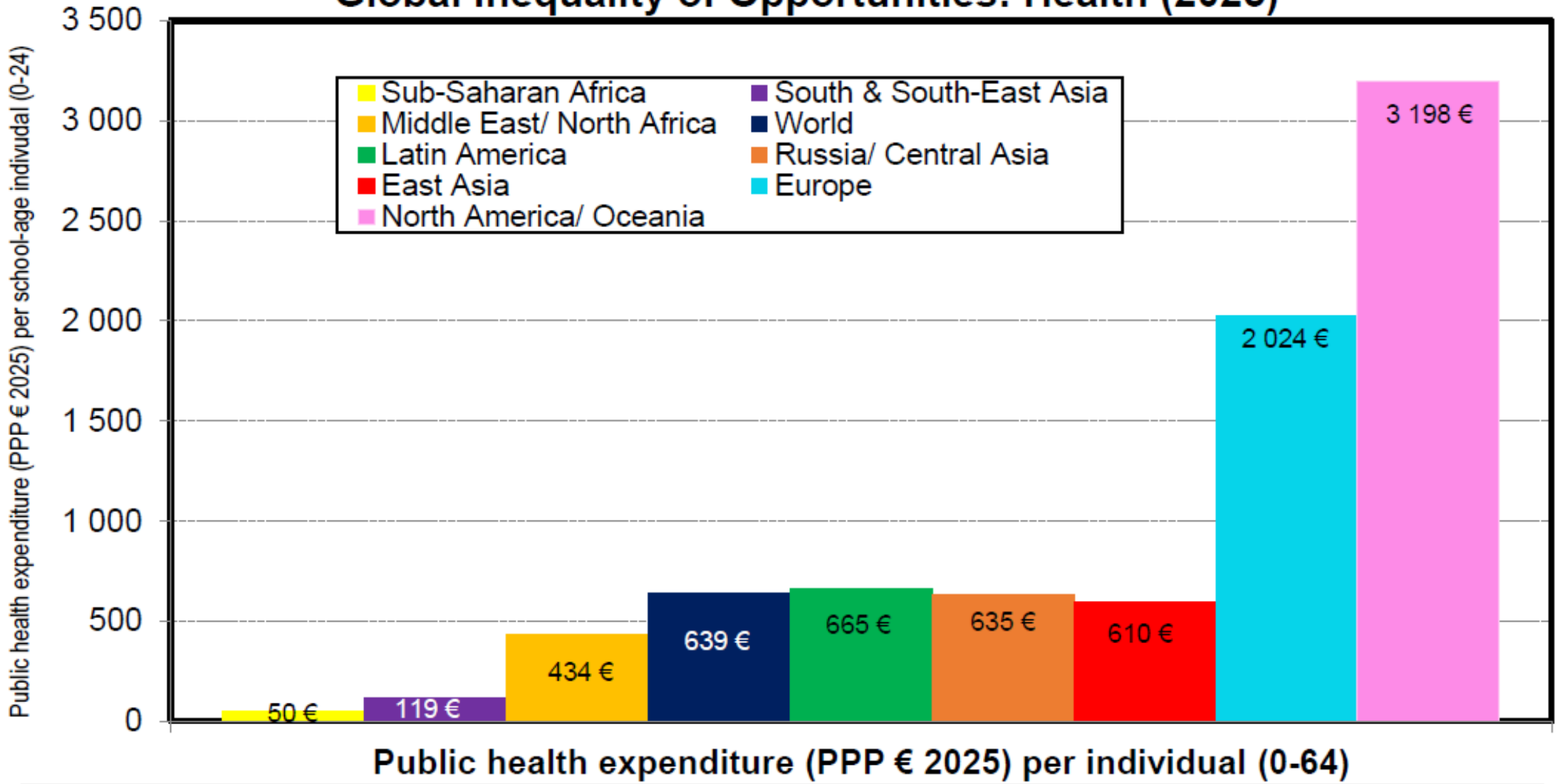
Interpretation. In 2025, Europe and North America/Oceania host 8% of the world school-age population (0-to-24-year-old) and benefit from 40% of the world public education expenditure (measured in PPP € 2025). In contrast, Subsaharan Africa and South & South-East Asia host 60% of the global school-age population and benefit from 16% of the global education expenditure. **Sources & series**: wid.world

The Persistent Education Gap Between South & North



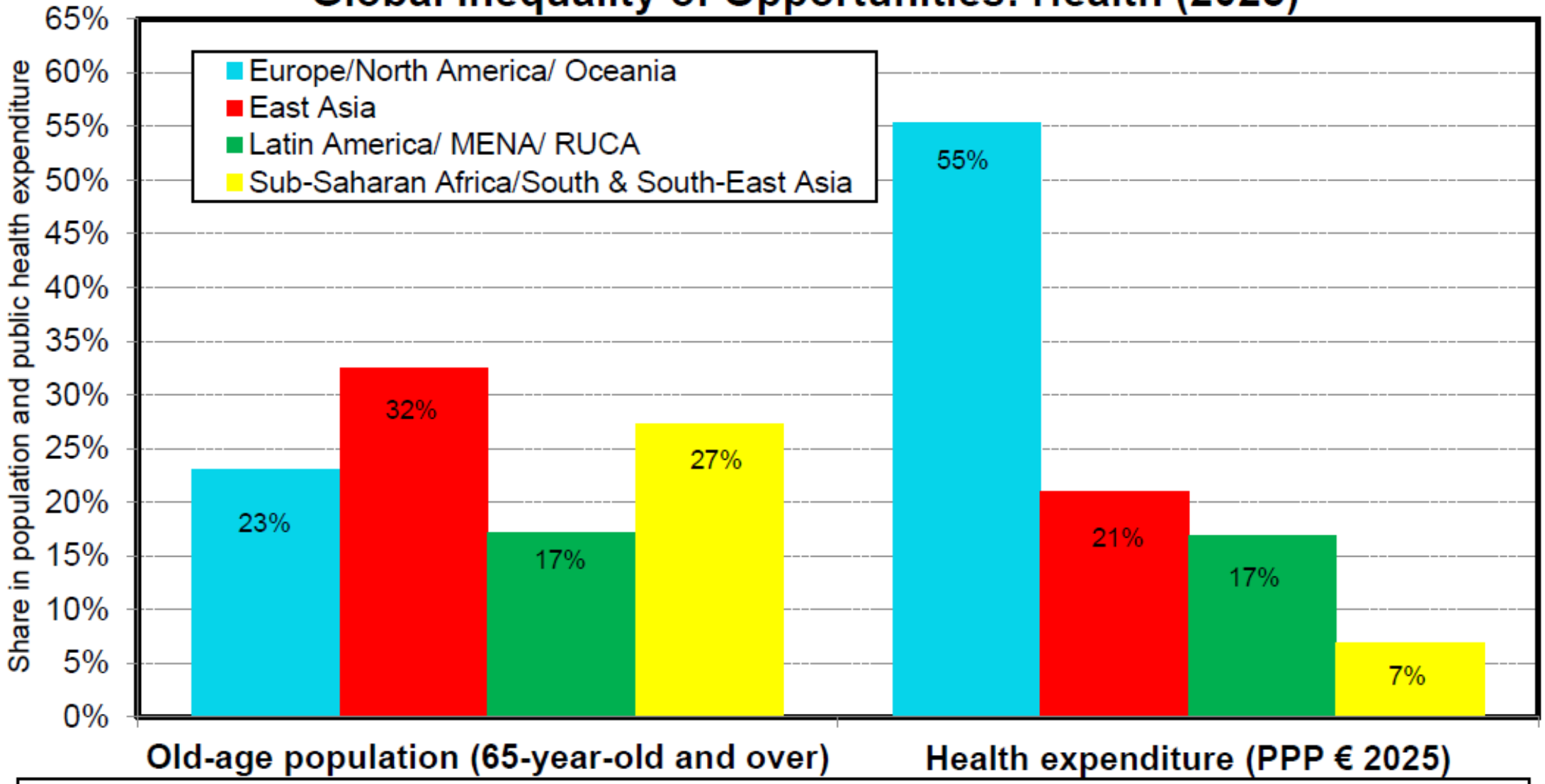
Interpretation. Except in early 19th century (when education expendiure was very small everywhere), average public education expenditure per school-age individual (0-to-24-year-old) has always been much smaller in most world regions as compared to Europe/North America Oceania average (PPP). The situation 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 (7%). **Sources and series**: wid.world

Global Inequality of Opportunities: Health (2025)



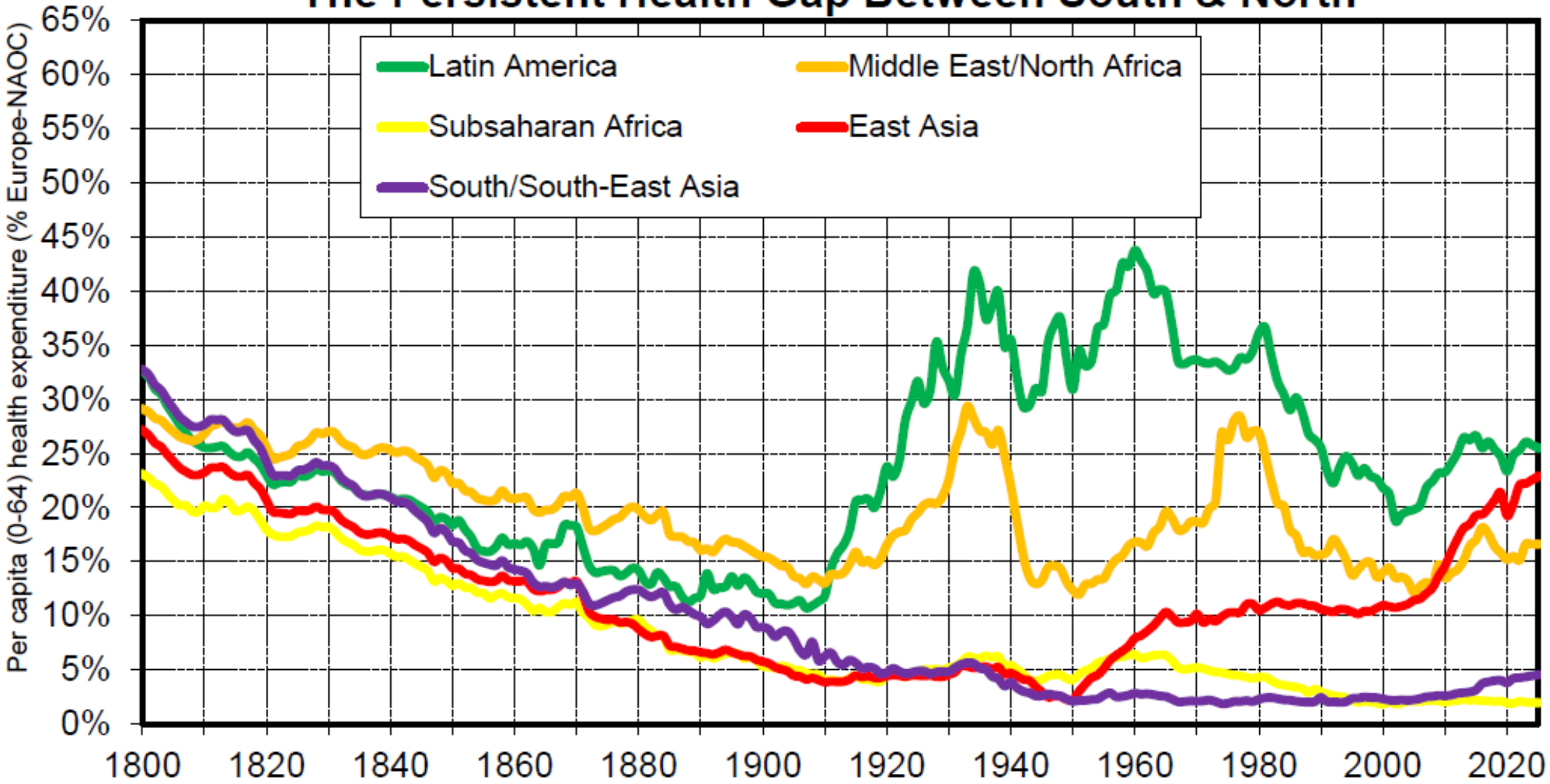
Interpretation. In 2025, average public health expenditure per individual aged 0-to-64-year-old) (assuming that older individuals receive 3 times this amount) varies enormously across world regions, from 50€ in Subsaharan Africa to 3 198€ in North America/Oceania (PPP € 2025), i.e. a gap of about 1 to 60. If we were using MERs (maket 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)



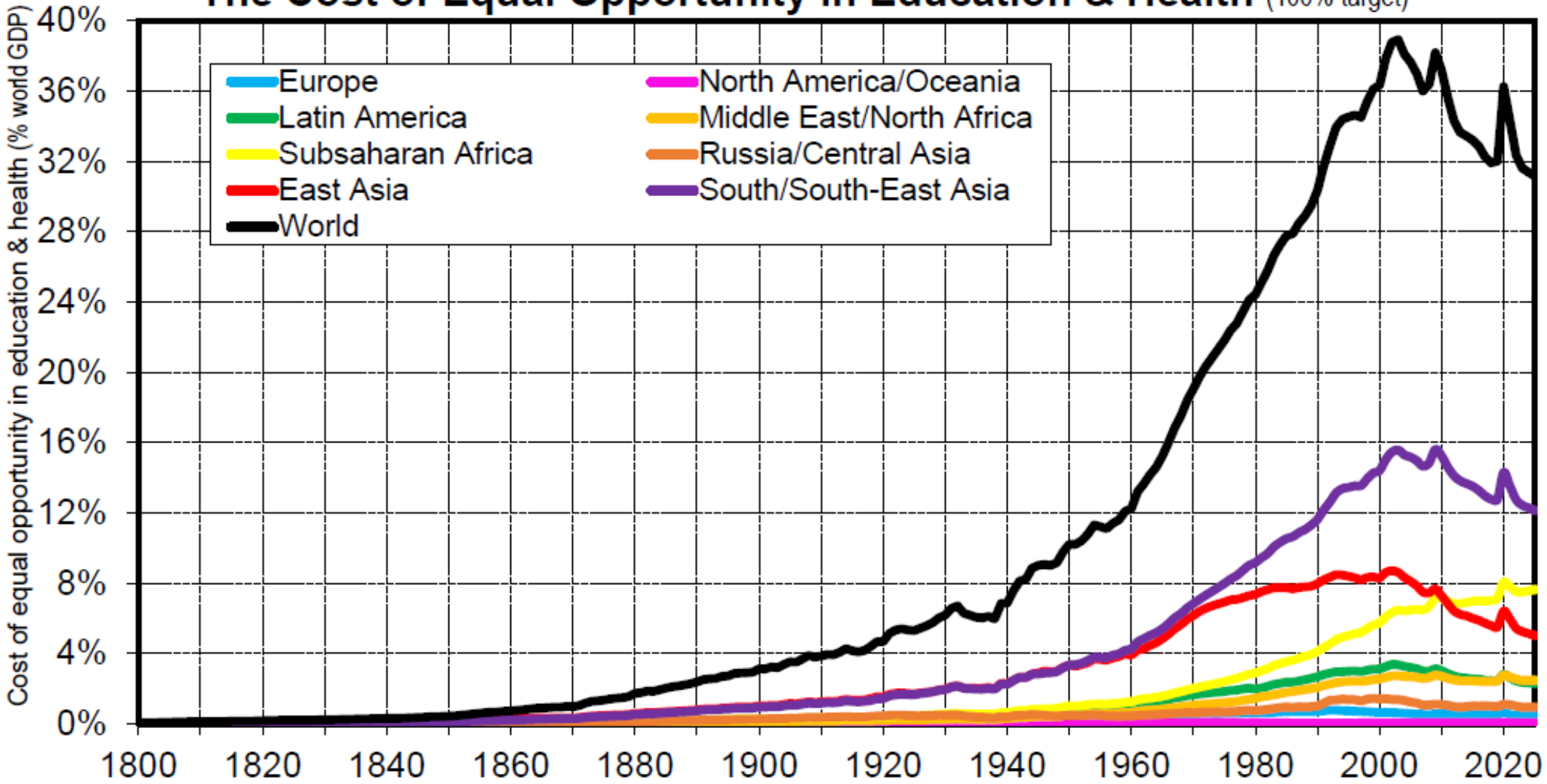
Interpretation. In 2025, Europe and North America/Oceania host 23% of the world old-age population (65-year-old +) and benefit from 55% of the world public health expenditure (measured in PPP € 2025). In contrast, Subsaharan Africa and South & South-East Asia host 27% of the global old-age population and benefit from 7% of the global health expenditure. **Sources & series**: wid.world

The Persistent Health Gap Between South & North



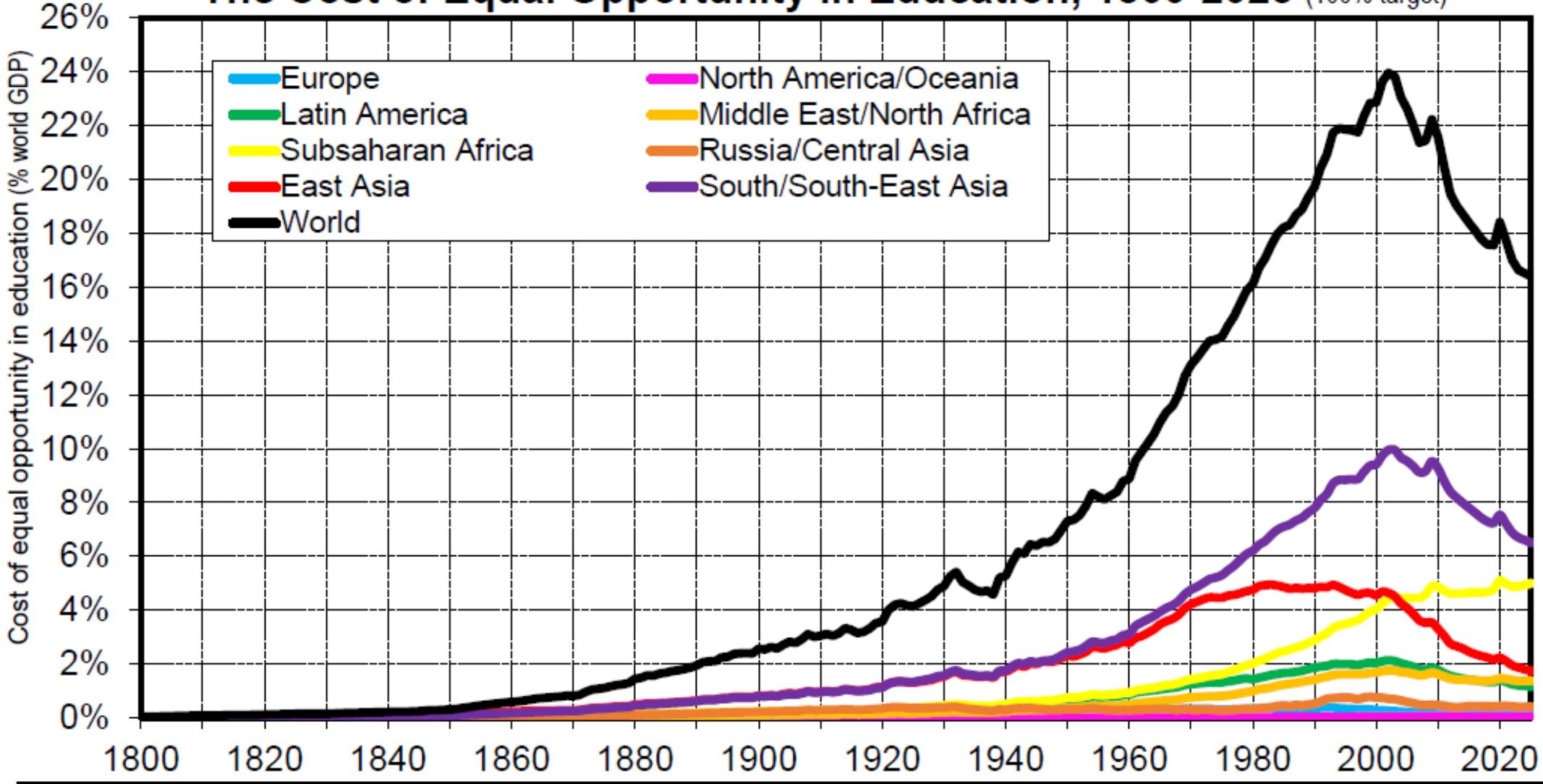
Interpretation. Average public health expenditure per capita (0-to-64-year-old) (assuming older individuals receive 3 times this level) has always been much smaller in most world regions as compared to the Europe/North America/Oceania averag (PPP). The situation has improved in East Asia in recent decades (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 (5%). **Sources and series**: wid.world

The Cost of Equal Opportunity in Education & Health (100% target)



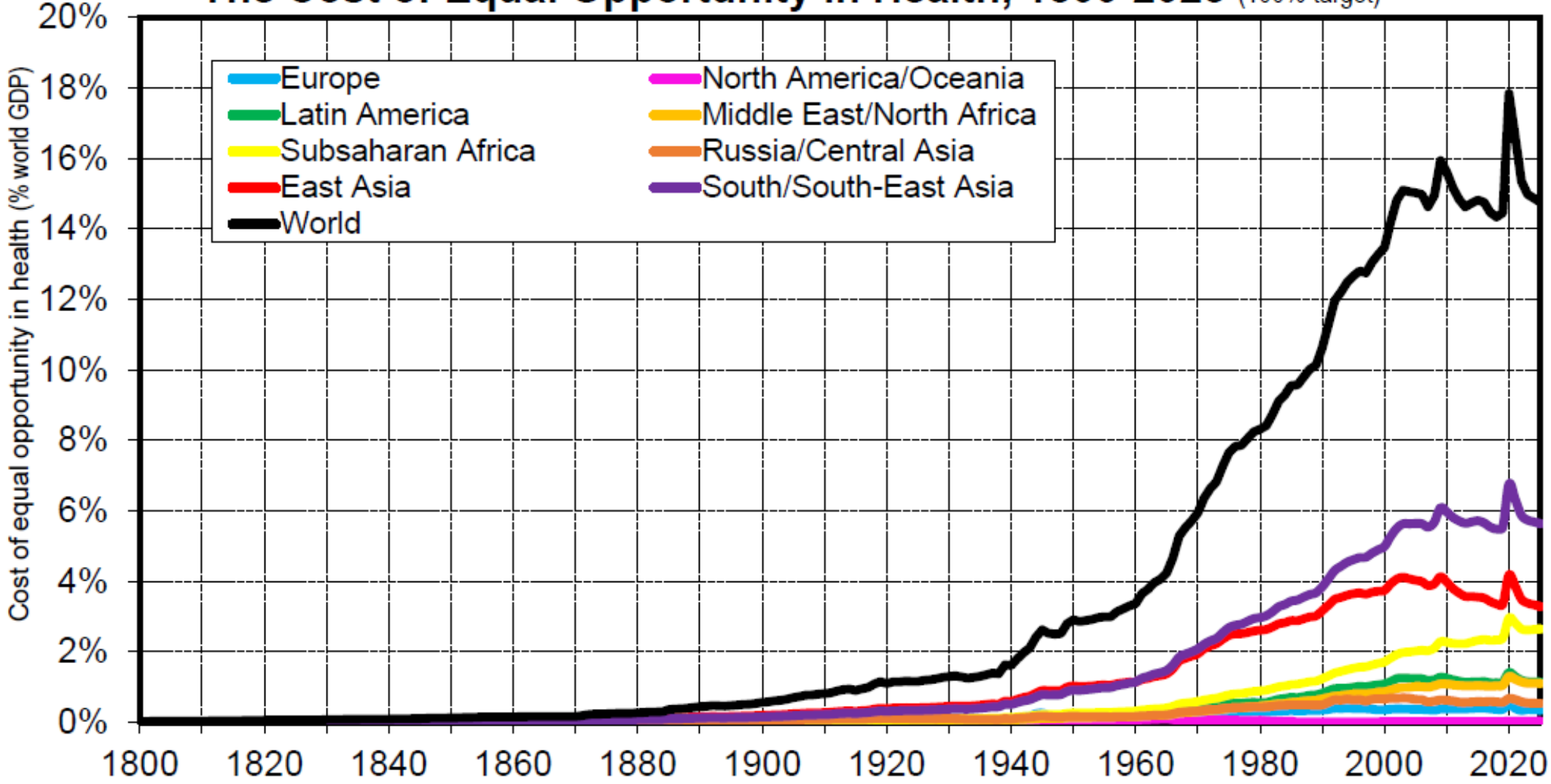
Interpretation. Assume that we raise per capita (age-adjusted) education and health expenditure to the same level as Europe/NAOC average (in PPP terms) in all countries where it is lower. In 2025, the cost would be 32% of world GDP, including 12% for South & South-East Asia, 5% in East Asia and 8% for Subsaharan Africa. The cost would have been much lower in the 19th century or in the early 20th century (as health expenditure was relatively lower at the time). **Sources and series**: wid.world

The Cost of Equal Opportunity in Education, 1800-2025 (100% target)



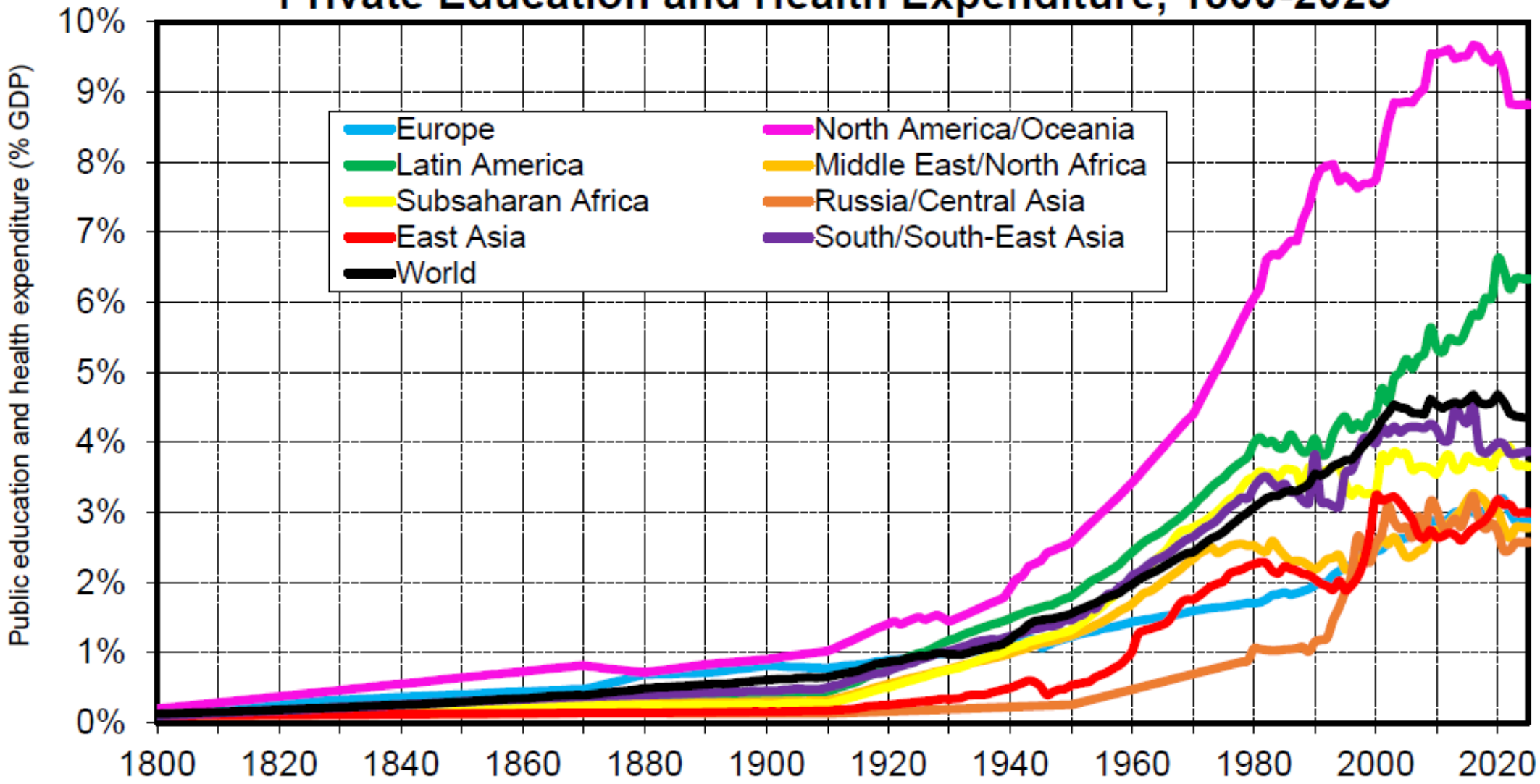
Interpretation. Assume that we raise average education expenditure per school-age individual (0-24) to the same level as Europe/NAOC average (in PPP terms) in all countries where it is lower. In 2025, the cost would be 16% of world GDP, including 7% for South & South-East Asia and 5% for Subsaharan Africa. The cost would have been much lower in the 19th century or in the early 20th century (as education expenditure was relatively lower at the time) and might have allowed for faster productivity convergence. **Sources and series**: wid.world

The Cost of Equal Opportunity in Health, 1800-2025 (100% target)



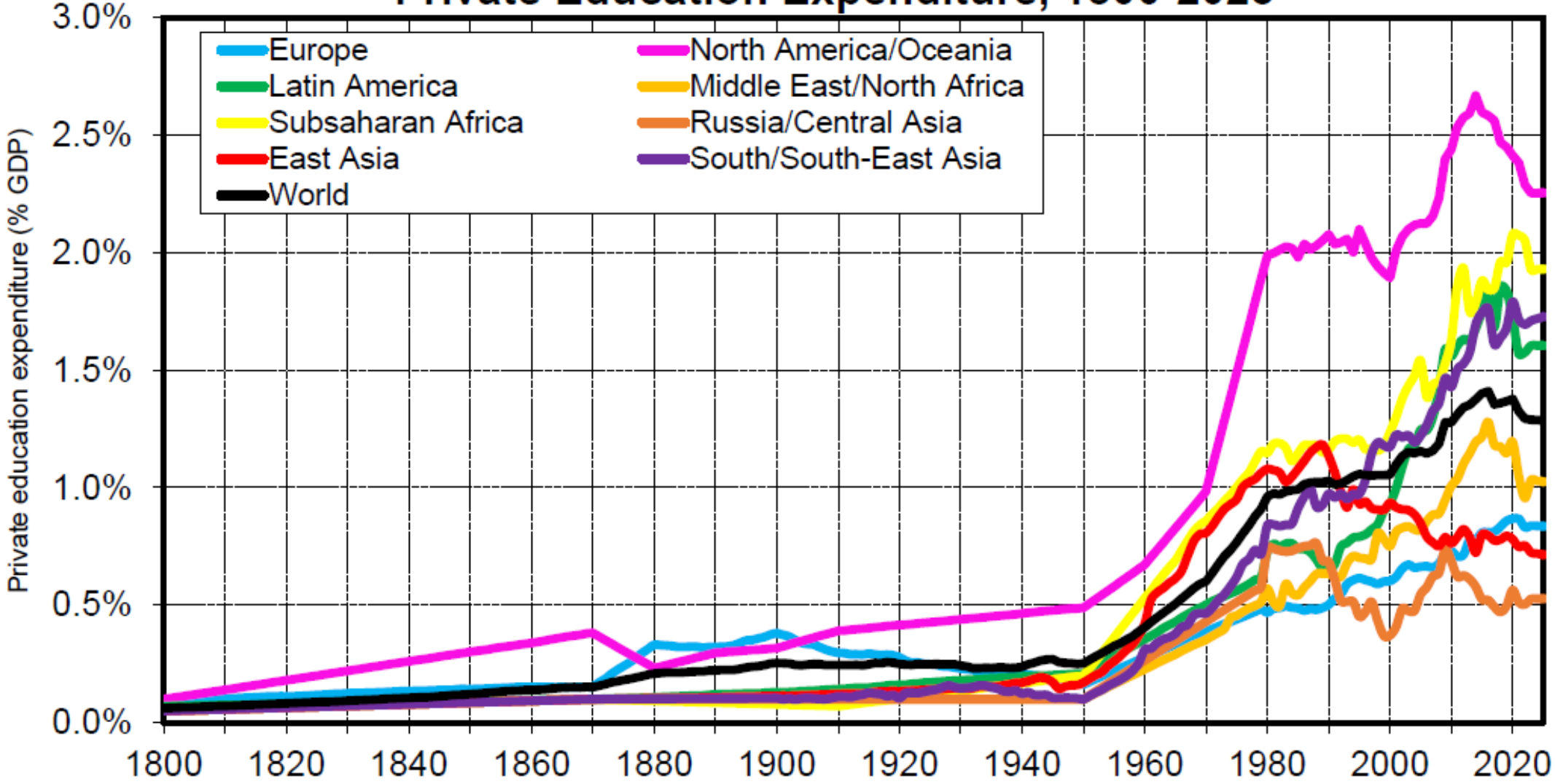
Interpretation. Assume that we raise average health expenditure per capita (0-to-64-year-old) to the same level as Europe/NAOC average (in PPP terms) in all countries where it is lower. In 2025, the cost would be 15% of world GDP, including 6% for South & South-East Asia, 3% in East Asia and 3% for Subsaharan Africa. The cost would have been much lower in the 19th century or in the early 20th century (as health expenditure was relatively lower at the time). **Sources and series**: wid.world

Private Education and Health Expenditure, 1800-2025



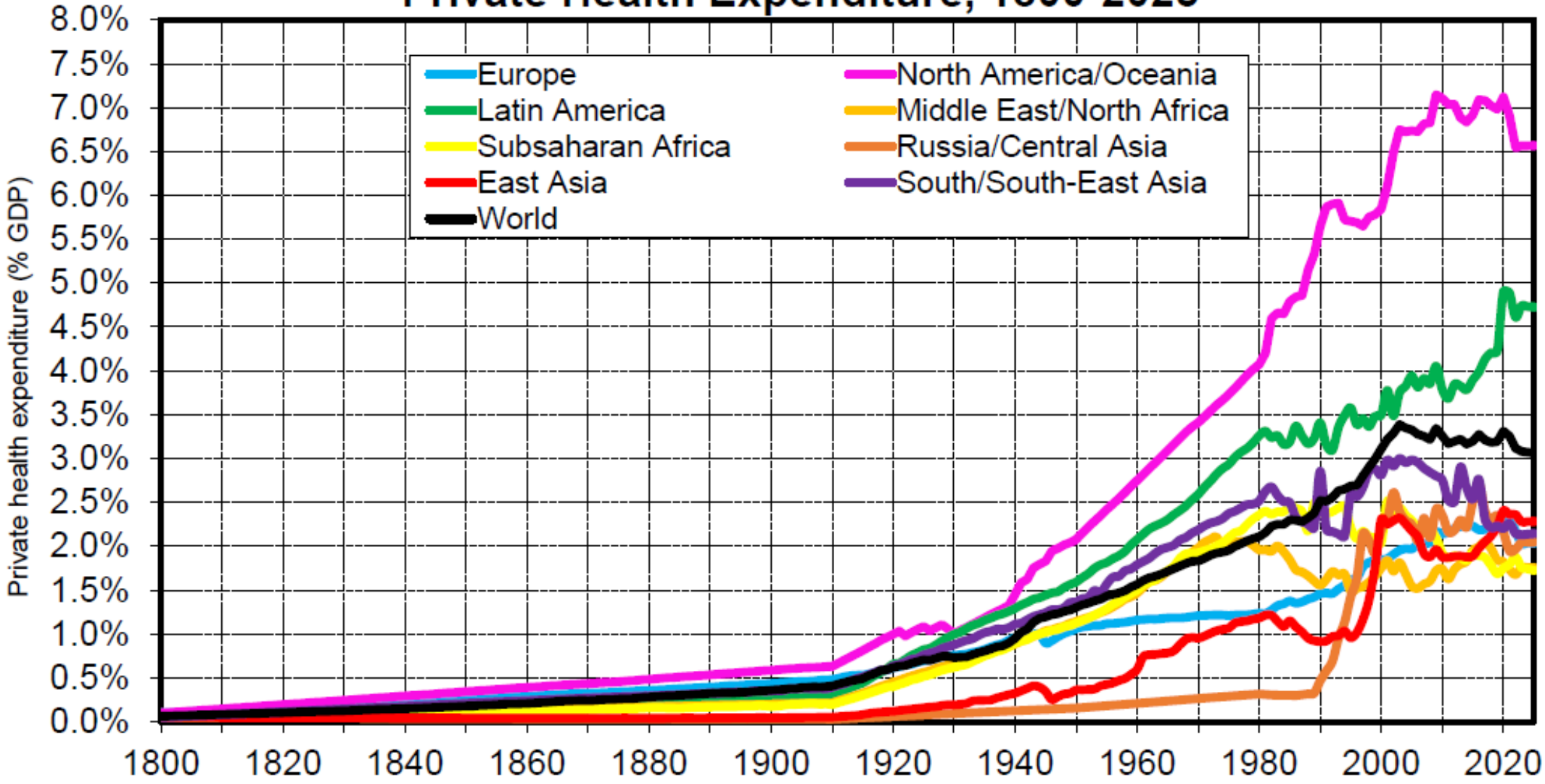
Interpretation. Private education and health expenditure has increased substantially in recent decades and represents about 4.5% of GDP at the global level in 2025, with enormous variations across world regions, from about 9% in North America/Oceania to 6% in Latin America, 4% in South & South-East Asia and Subsaharan Africa and 3% in Europe, East Asia, Russia/Central Asia and Middle East/North Africa. **Sources and series**: wid.world

Private Education Expenditure, 1800-2025



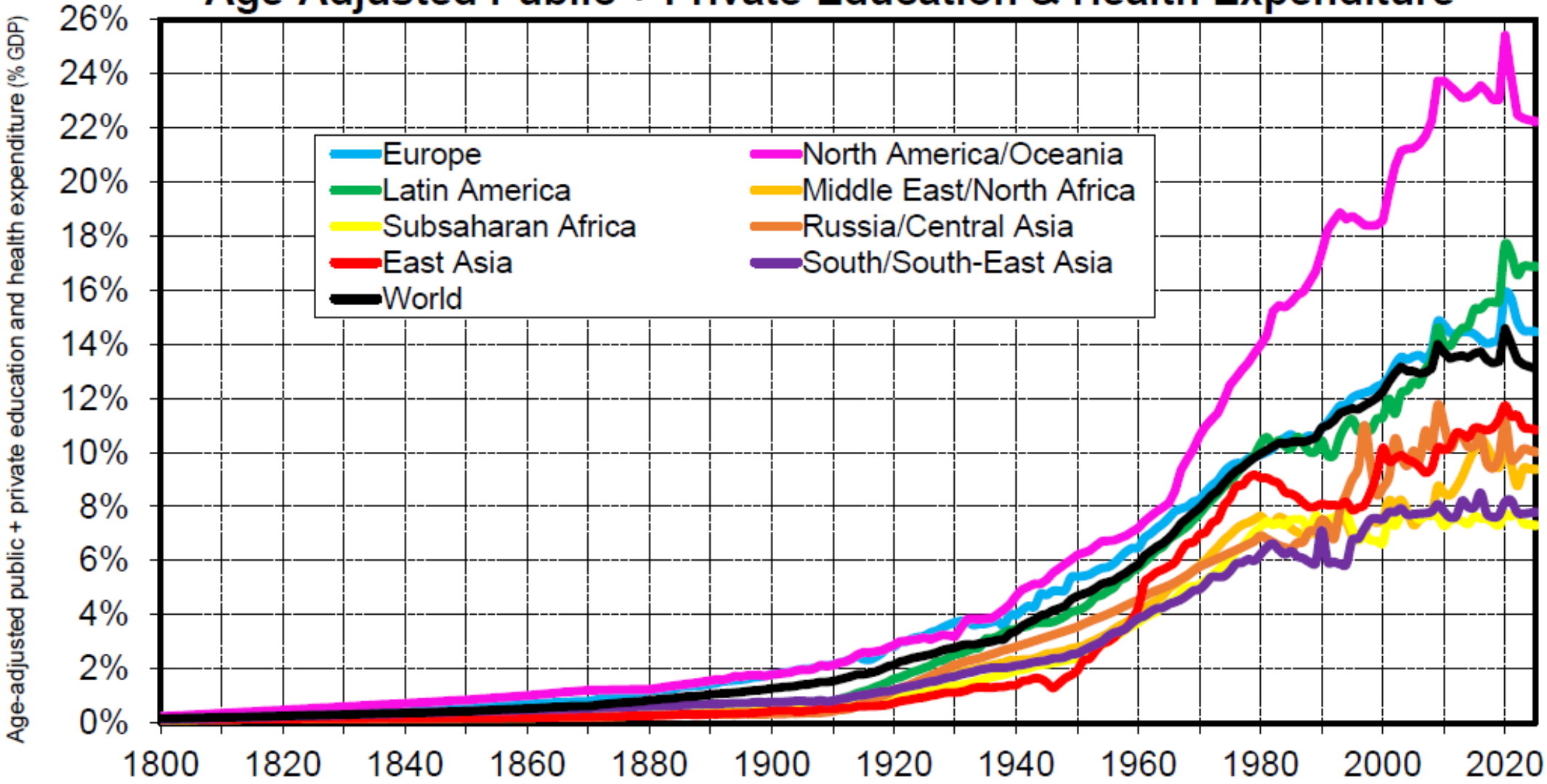
Interpretation. Private education expenditure has increased substantially in recent decades, particularly in North America/Oceania, South & South East Asia, Subsaharan Africa and Latin America. At the global level, they represent 1.3% of GDP in 2025, i.e. about 24% of total public + private education expenditure (5.3% of GDP). **Sources and series**: wid.world

Private Health Expenditure, 1800-2025



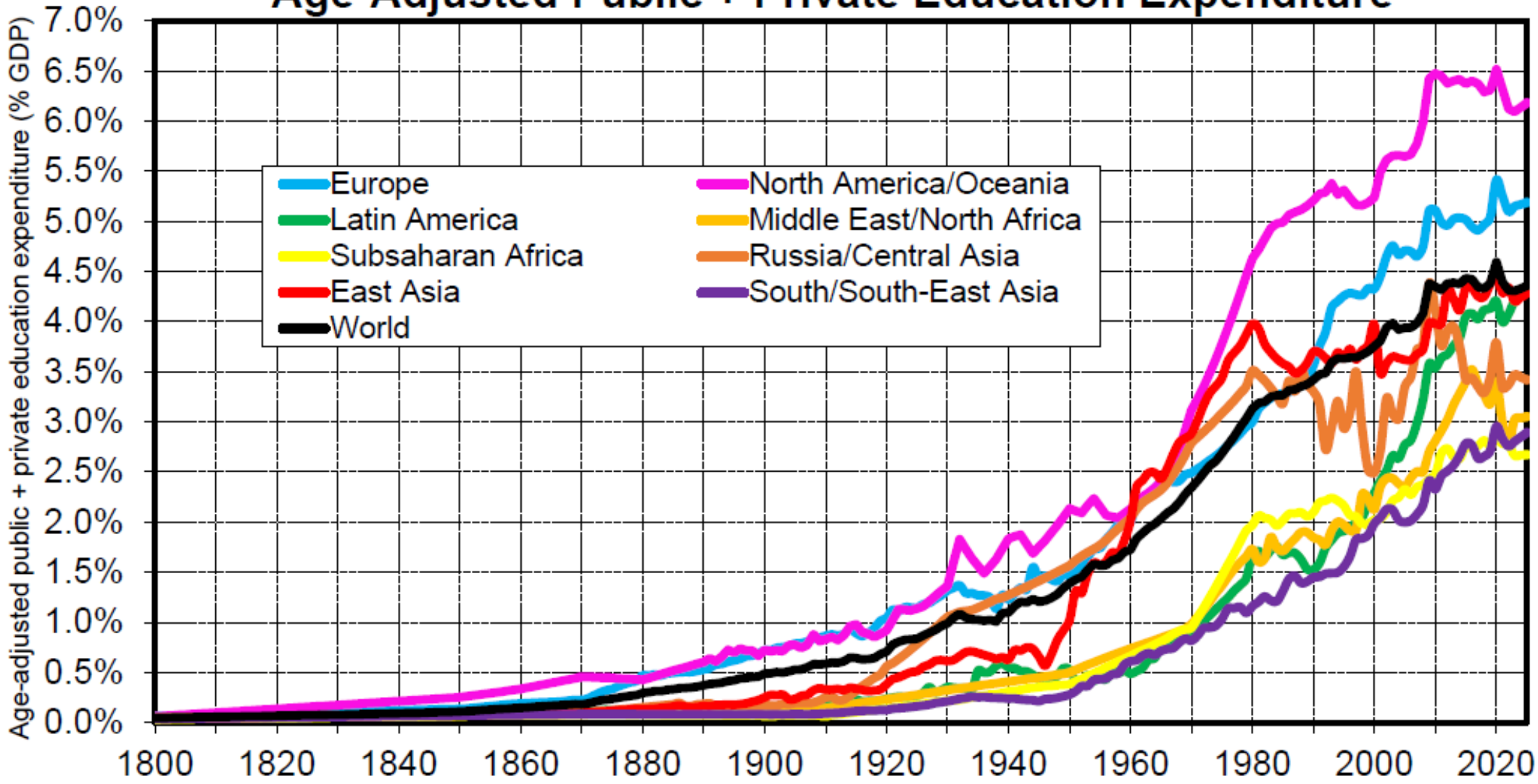
Interpretation. Private health expenditure has increased substantially in recent decades in North America/Oceania, and to allesser extent in Latin America. At the global level, they represent 3.1% of GDP in 2025, i.e. about 40% of total public + private education expenditure (7.8% of GDP). **Sources and series**: wid.world

Age-Adjusted Public + Private Education & Health Expenditure



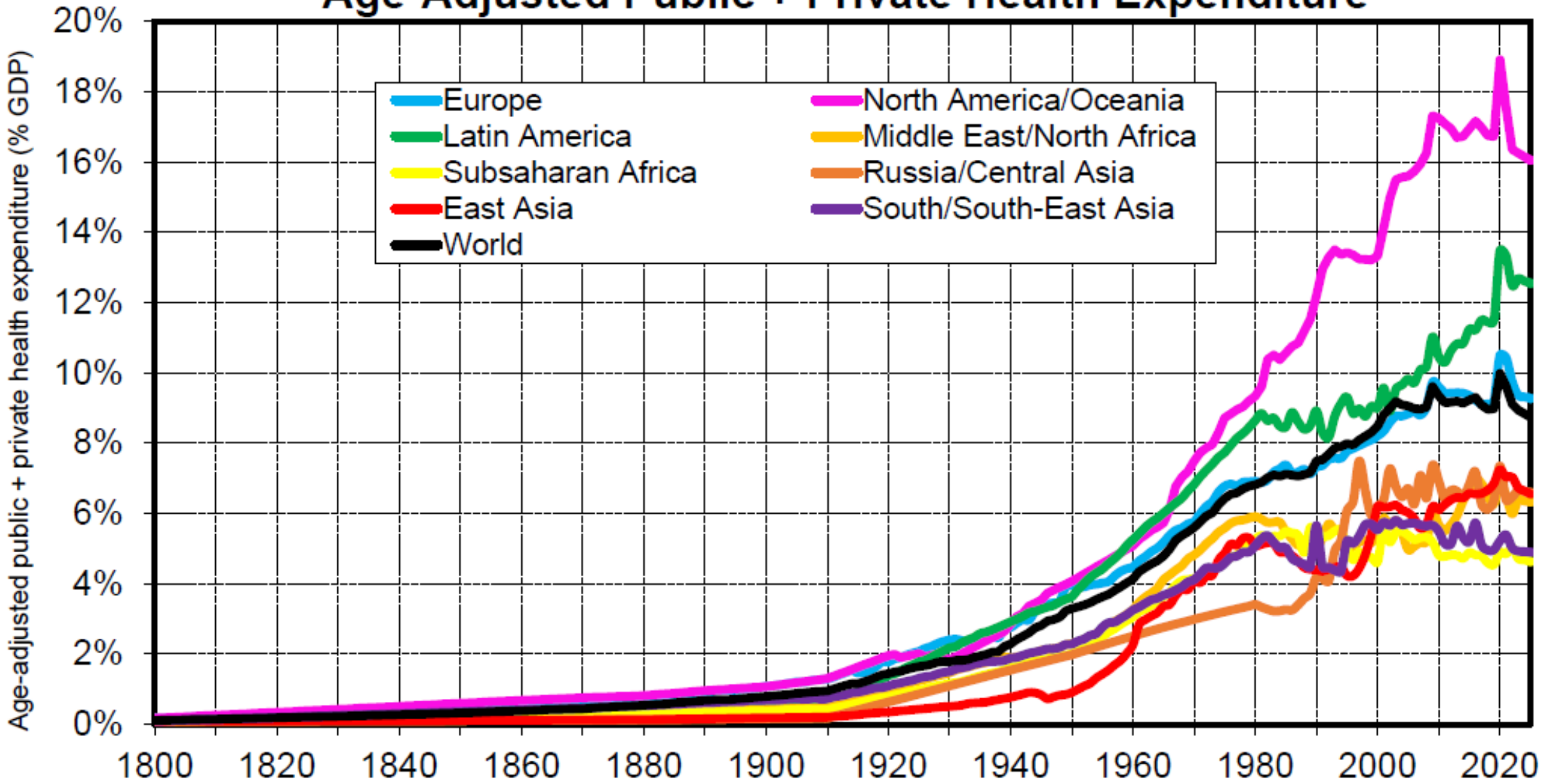
Interpretation. Total age-adjusted public and private education and health expenditure has increased from less than 1% of GDP before 1900 to about 14% of GDP in 2025 at the global level, with large gaps between regions, from about 8% of GDP in South & South-East Asia and Subsaharan Africa to about 23% in North America/Oceania. **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 4.5% of GDP in 2025 at the global level, with large gaps between regions, from about 2.5% of GDP in South & South-East Asia and Subsaharan Africa to about 6-6.5% 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% 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 16% 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: $\mathbf{g_{it} = g_0 + a\, h_{it} + \epsilon_{it}}$

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

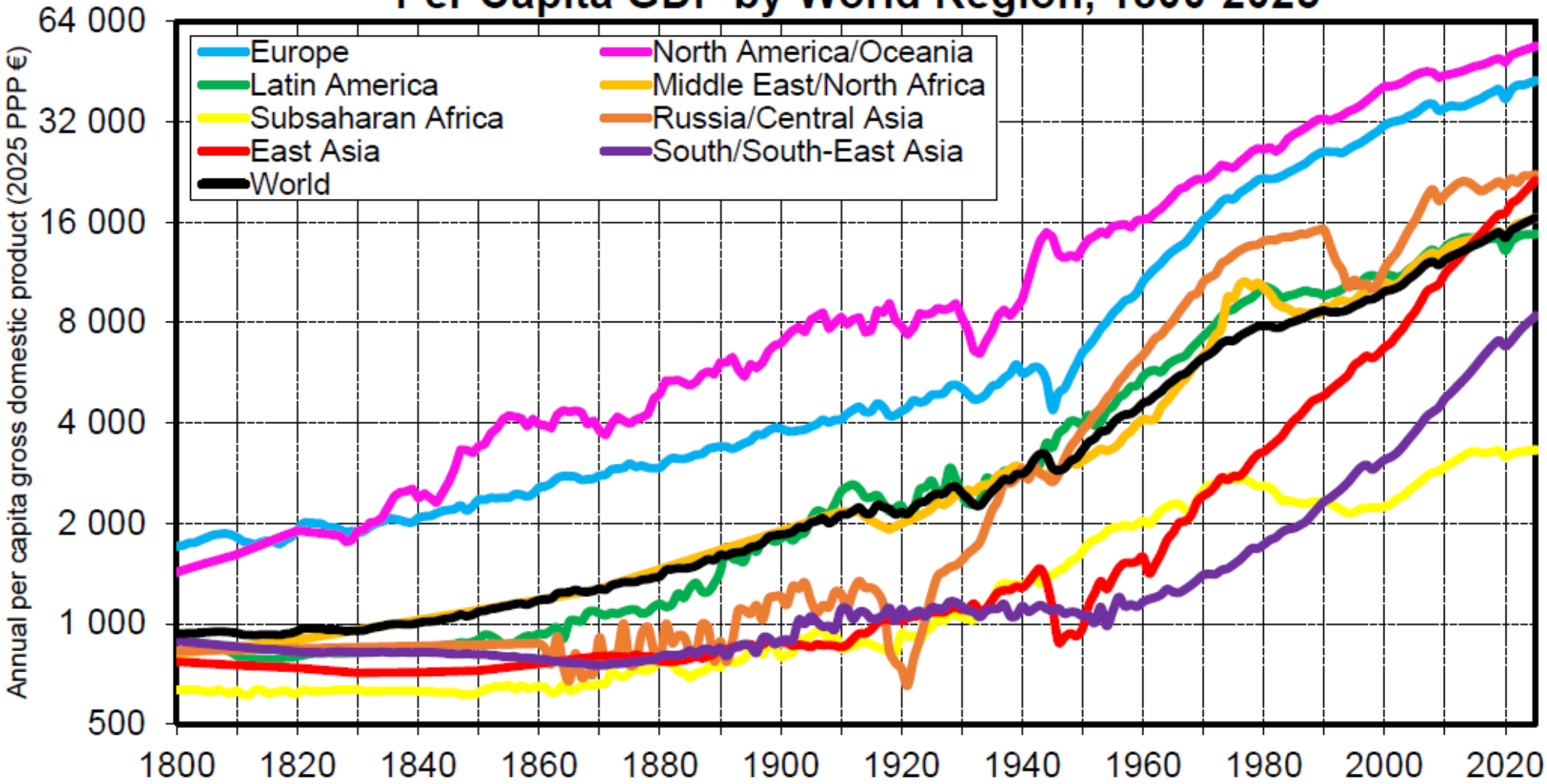
(public + private education and health expenditure)

→ **a≈0,1** (as high as 0.2+ for poor countries & public education)

E.g. if h↑ from 10% to 11%, then g ↑ by 0.1% (say from 1% to 1.1%/year).

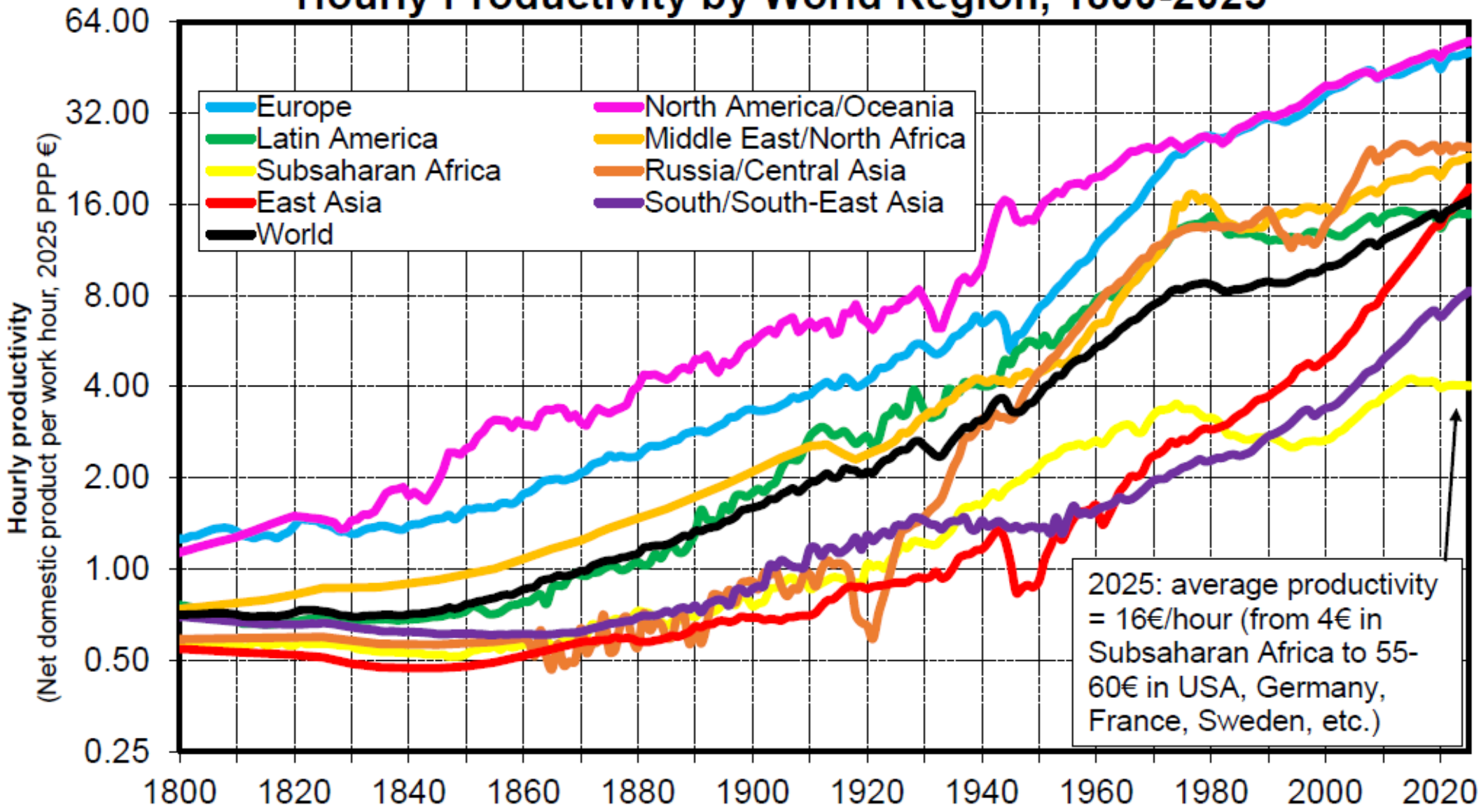
Consistent with micro studies: 10% return to education

Per Capita GDP by World Region, 1800-2025



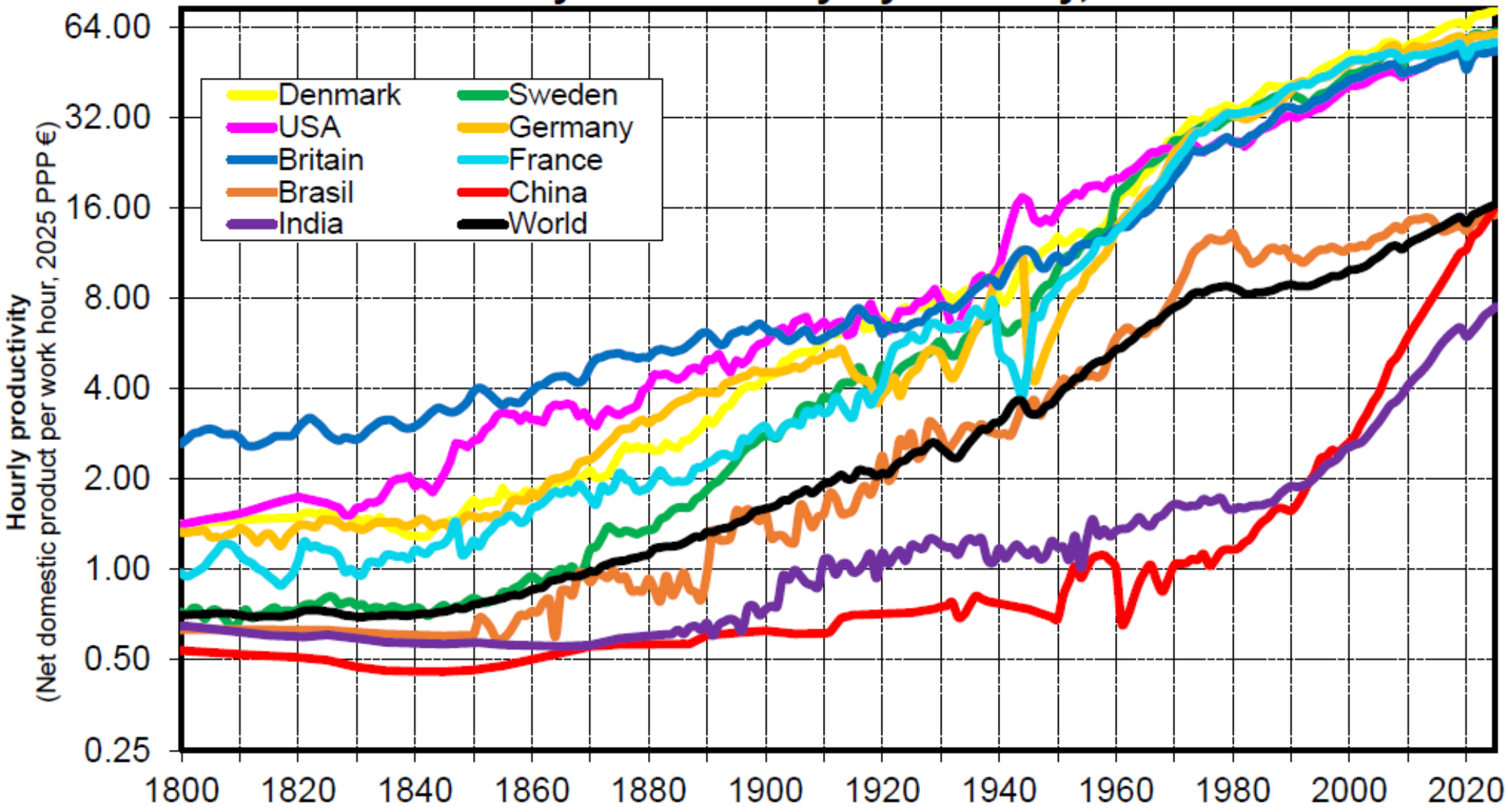
Interpretation. Expressed in 2025 PPP €, annual per capita gross domestic product (GDP) rose from about 900€ in 1800 to 16 000€ in 2025 at the global level. I.e. it was multiplied by about 18, which corresponds to average annual real growth rate of 1,3% per year, with large variations over time and across regions. In 2025, per capita GDP varies between about 3 000€ on average in Subsaharan Africa and about 40 000-50 000€ in Europe and North America/Oceania (i.e. a gap from 1 to 15). **Sources and series**: see wid.world

Hourly Productivity by World Region, 1800-2025



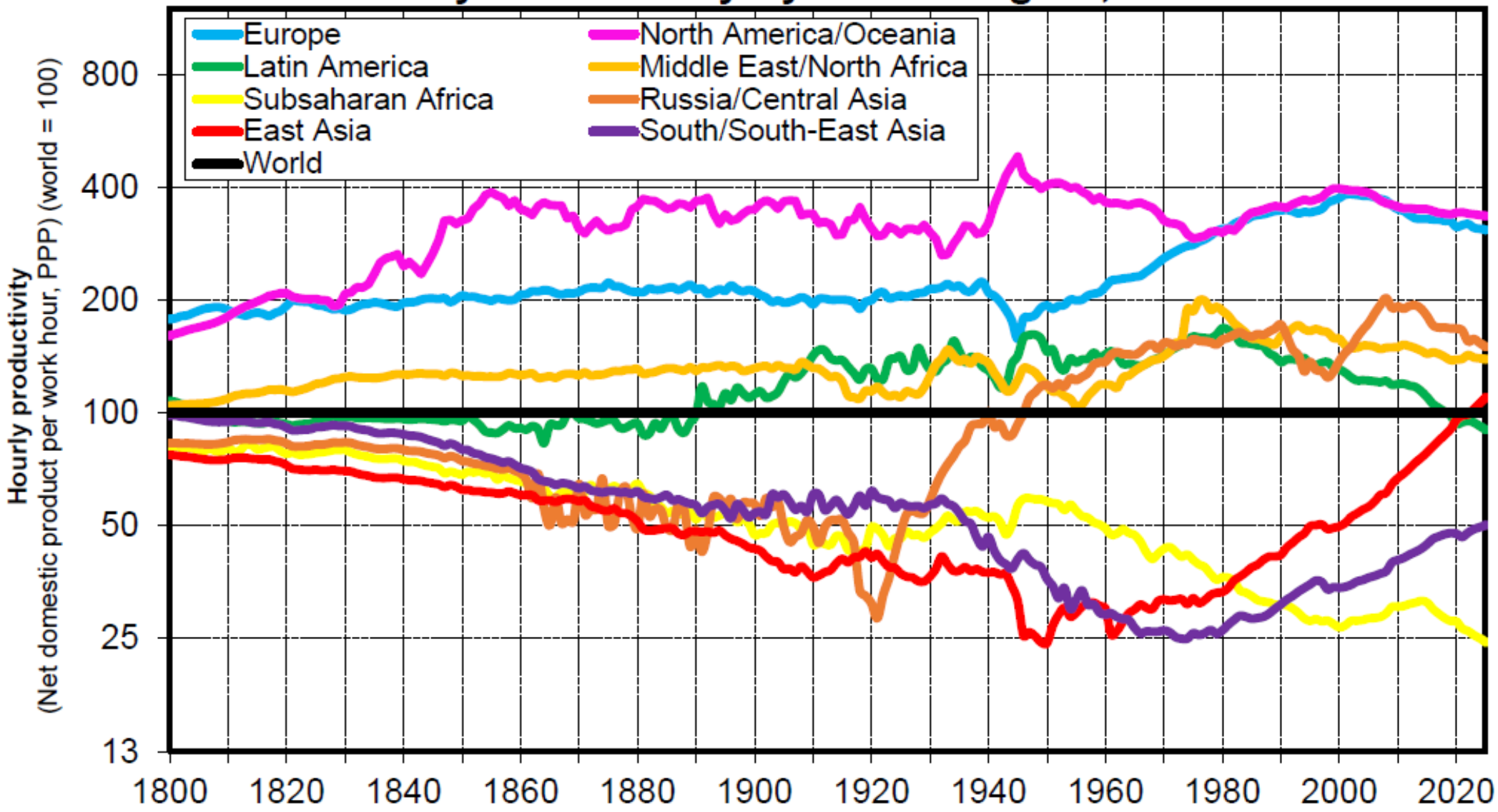
Interpretation. Expressed in 2025 PPP €, hourly productivity (as defined by net domestic product by economic labour hour) rose from about 0.7€ in 1800 to 16€ in 2025 at the global level. I.e. it was multiplied by about 24, which corresponds to average annual real growth rate of 1,4% per year, with large variations over time and across regions. **Sources and series**: see wid.world

Hourly Productivity by Country, 1800-2025



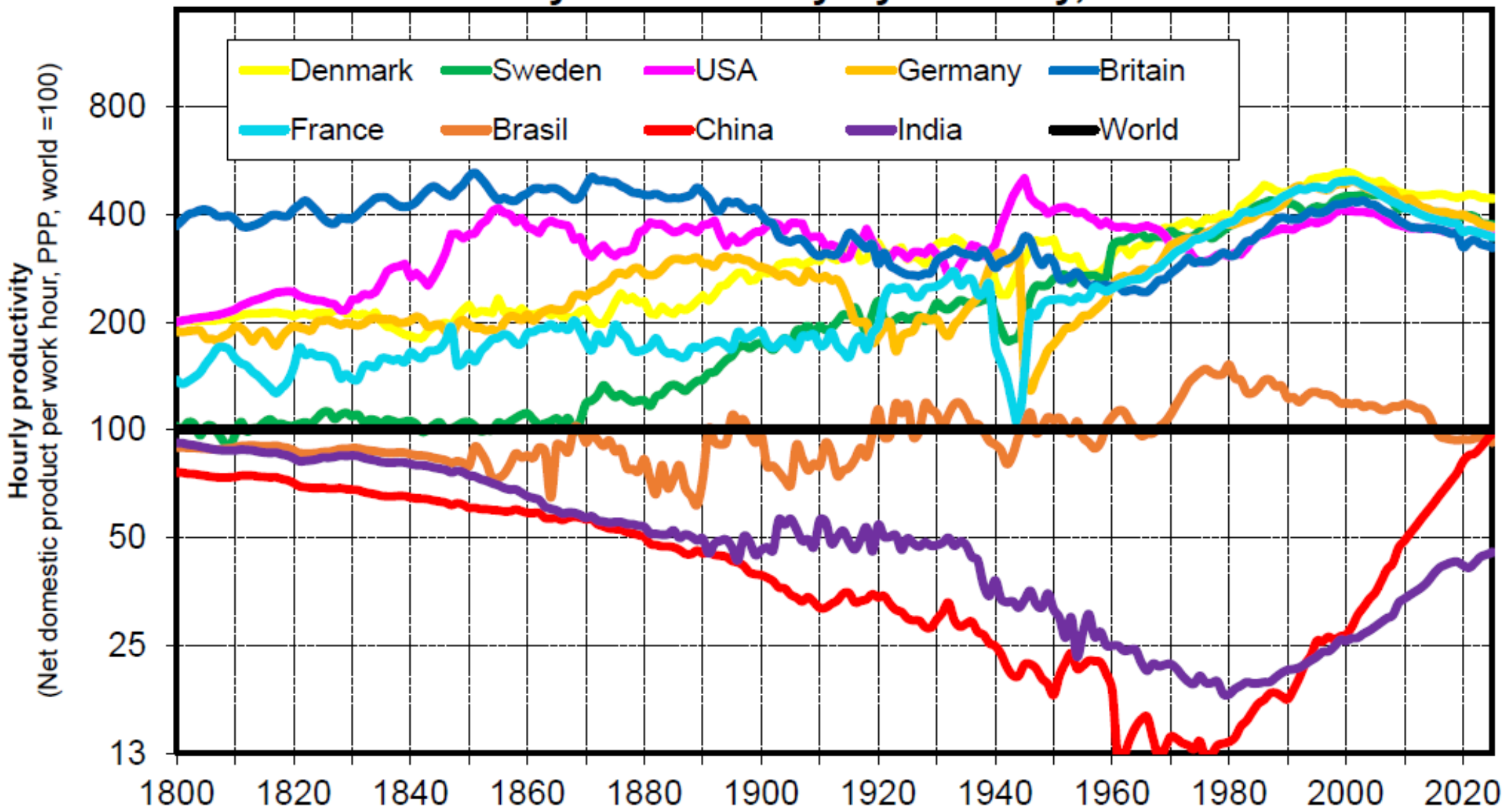
Interpretation. Between 1800 and 1900, Britain was the country in the world with the highest productivity (NDP per work hour), before being replaced by the USA between 1900 and 1970. Since 1970, Europe's highest productivity countries (incl. Denmark, Sweden, Germany, France, Britain) are on par with the USA (around 55-60€/hour, vs 16€ for world average and 7€ in India) . **Sources and series**: see wid.world

Hourly Productivity by World Region, 1800-2025



Interpretation. The inequality in hourly productivity (net domestic product per work hour) between world regions rose between 1800 and 1950 and has started to decline since 1950-1960, but with large geographical variations. In 2025, productivity is close to world average in East Asia but only 50% of world average in South & South-East Asia and 25% of world average in Subsaharan Africa. **Sources and series**: see wid.world

Hourly Productivity by Country, 1800-2025



Interpretation. Between 1800 and 1900, Britain was the country in the world with the highest productivity (NDP per work hour), before being replaced by the USA between 1900 and 1970. Since 1970, Europe's highest productivity countries (incl. Denmark, Sweden, Germany, France, Britain) are on par with the USA (around 400% of world average, vs less than 50% in India) . **Sources and series**: see wid.world

Productivity Growth by World Regions (1800-2025)

Annual real growth rate of productivity (hourly NDP)	1800-2025	1800-1910	1910-1950	1950-1990	1990-2025
East Asia	1.6%	0.2%	0.7%	3.6%	4.6%
Europe	1.7%	1.0%	1.7%	3.7%	1.4%
Latin America	1.3%	1.2%	1.7%	2.0%	0.6%
Middle East/ North Africa	1.5%	1.1%	1.4%	3.0%	1.4%
North America/ Oceania	1.7%	1.6%	2.1%	1.8%	1.6%
Russia/ Central Asia	1.7%	0.4%	3.9%	3.1%	1.4%
South/South-East Asia	1.1%	0.5%	0.4%	1.8%	3.2%
Sub Saharan Africa	0.9%	0.4%	2.4%	0.6%	1.1%
World	**1.4%**	**0.9%**	**1.7%**	**2.2%**	**1.8%**

Interpretation. Productivity (as defined by net domestic product per hour of economic labour) has been multiplied by about 24 at the global level between 1800 and 2025 (from about 0.7€/h in 1800 to about 16€/h in 2025) (PPP 2025 €). This corresponds to an average annual real growth rate of 1.4%. Productivity growth has increased from 0.9% over the 1800-1910 period to 1.6% over 1910-1950 and 2.3% and 1.8% over 1950-1990 and 1990-2025. **Sources and series**: wid.world

State Capacity and the Early Productivity Gap, 1800-1840

	Hourly Productivity 1800-1820 (net domestic product per work hour) (20-year-averages) (log)		Annual Growth Rate of Hourly Productivity 1800-1840 (computed over previous 20 years)	
Total Public Expenditure (% GDP) (averages over previous 20 years)	13.328***		0.032***	
(s.e.)	(0.751)		(0.011)	
Incl. Basic Public Services (Justice, Police, Administration, Roads, etc.)		17.303***		0.039***
(s.e.)		(0.936)		(0.014)
Incl. Military Expenditure		-4.020		-0.014
(s.e.)		(3.298)		(0.038)
R2	0.34	0.37	0.01	0.01
N.obs	627	627	627	627

Interpretation. In 1800-1820, countries with higher state capacity (as proxied by total public expenditure) also have higher productivity. A rise in public expenditure by 1% of GDP is associated with a 13.3% rise in GDP. Given that public expenditure varies at the time from 1-2% of GDP in the poorest world regions to about 7% in Europe, this implies that the state capacity gap can explain as much as 60-80% of the productivity gap (about 1 to 2 at the time). Higher state capacity is also associated to higher growth rates over the 1800-1840 period. Both effects seem to be driven by basic public services rather than by military expenditure.

The Impact of Human & Social Capital Expenditure on Productivity Growth, 1800-2025

	Annual Growth Rate of Hourly Productivity (net domestic product per work hour) (computed over previous 20 years)				
Total Public Expenditure (% GDP) (averages over previous 20 years)	0.054***	0.048***			
(s.e.)	(0.001)	(0.001)			
Incl. Human & Social Expenditure			0.113***	0.053***	0.046***
(s.e.)			(0.006)	(0.006)	(0.006)
Incl. Military Expenditure			0.029**	-0.047***	0.006
(s.e.)			(0.012)	(0.011)	(0.011)
Incl. Social Protection Expenditure			-0.037***	0.006	-0.021**
(s.e.)			(0.006)	(0.006)	(0.008)
Incl. Other Expenditure			-0.001	0.009	-0.014
(s.e.)			(0.015)	(0.016)	(0.014)
Country Fixed Effects	NO	YES	YES	YES	YES
Capital-Output Ratio	NO	YES	YES	YES	YES
Period Fixed Effects	NO	NO	NO	YES	YES
Region x Period Fixed Effects	NO	NO	NO	NO	YES
Countries Covered	ALL	ALL	ALL	ALL	ALL
R2	0.14	0.21	0.23	0.33	0.53
N.obs	10602	10602	10602	10602	10602

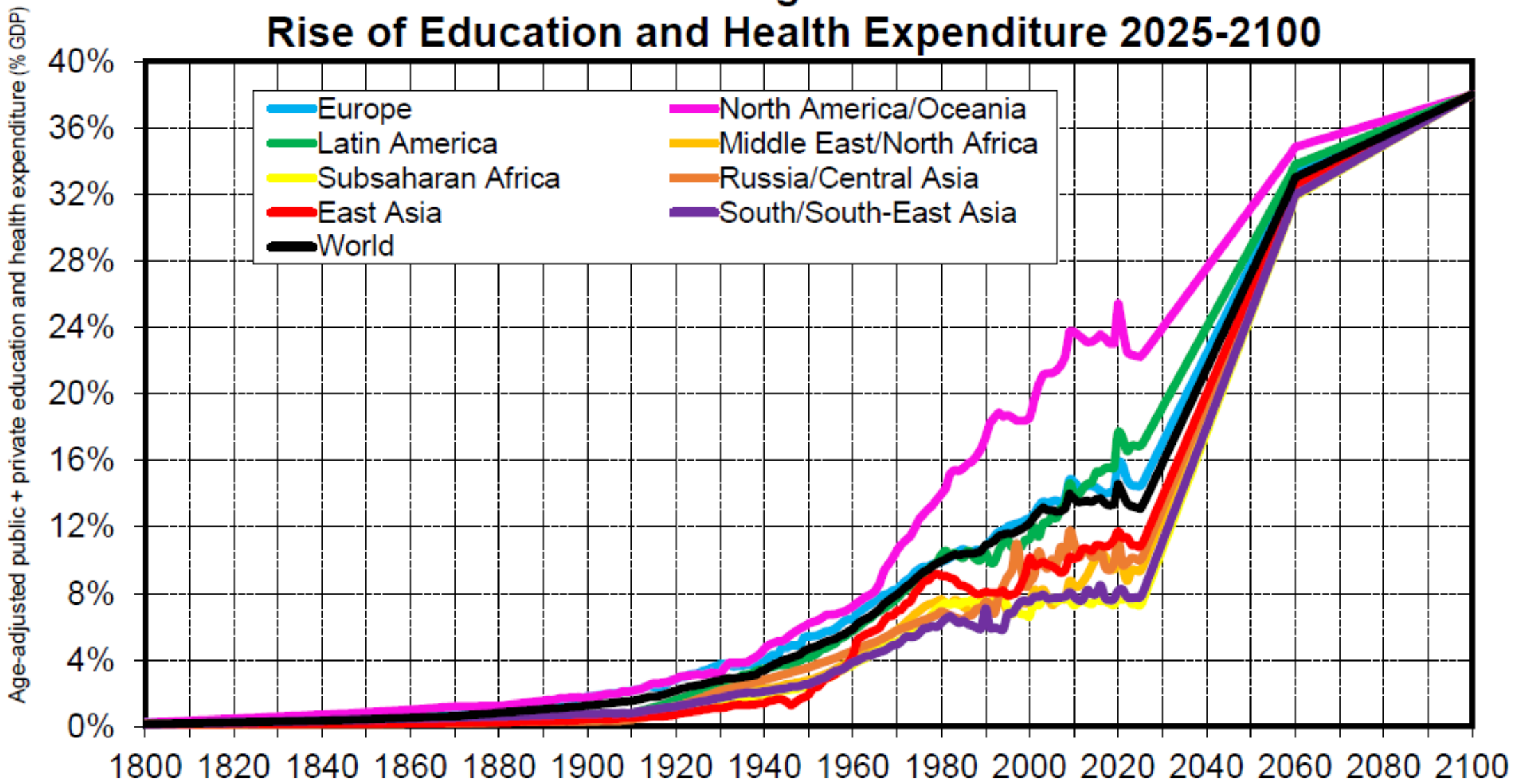
Interpretation. Over the 1800-2025 period, countries with higher public expenditure also have higher productivity growth. When public expenditure rises by 1% of GDP (e.g. from 10% to 11% of GDP), annual productivity growth increases by about 0.05% (e.g. from 1% to 1.05% per year). The effect is driven by human & social capital expenditure, including basic public services (justice, police, administration, roads, etc.), public human capital expenditure (education, health), and other human & social capital expenditure (research, culture, community, environment, etc.). It also holds after the inclusion of country fixed effects, capital-output ratio and region x period fixed effects (8 world regions interact 6 periods: 1800-1840, 1840-1880, 1880-1910, 1910-1950, 1950-1990, 1990-2025). Other categories of public expenditure have no robust significant impact on productivity growth.

The Impact of Human Capital Expenditure on Productivity Growth, 1800-2025: Education vs Health Expenditure, Public vs Private Expenditure

	Annual Growth Rate of Hourly Productivity (net domestic product per work hour) (computed over previous 20 years)								
Total Human Capital Expenditure (% GDP) (averages over previous 20 years) (s.e.)	0.099*** (0.004)	0.086*** (0.004)	0.166*** (0.005)						
Incl. Education (s.e.)				0.244*** (0.019)					
Incl. Health (s.e.)				0.040*** (0.008)					
Incl. Public Expenditure (s.e.)					0.159*** (0.006)				
Incl. Private Expenditure (s.e.)					0.017* (0.010)				
Incl. Public Education (s.e.)						0.420*** (0.013)	0.336*** (0.014)	0.850*** (0.025)	0.155*** (0.045)
Country Fixed Effects	NO	YES	YES	NO	NO	NO	YES	YES	YES
Capital-Output Ratio	NO	YES	YES	NO	NO	NO	YES	YES	YES
Region x Period Fixed Effects	NO	NO	NO	NO	NO	NO	NO	NO	YES
Countries Covered	ALL	ALL	POOR	ALL	ALL	ALL	ALL	POOR	POOR
R2	0.07	0.17	0.22	0.08	0.08	0.09	0.16	0.22	0.49
N.obs	10602	10602	8743	10602	10602	10602	10602	8743	8743

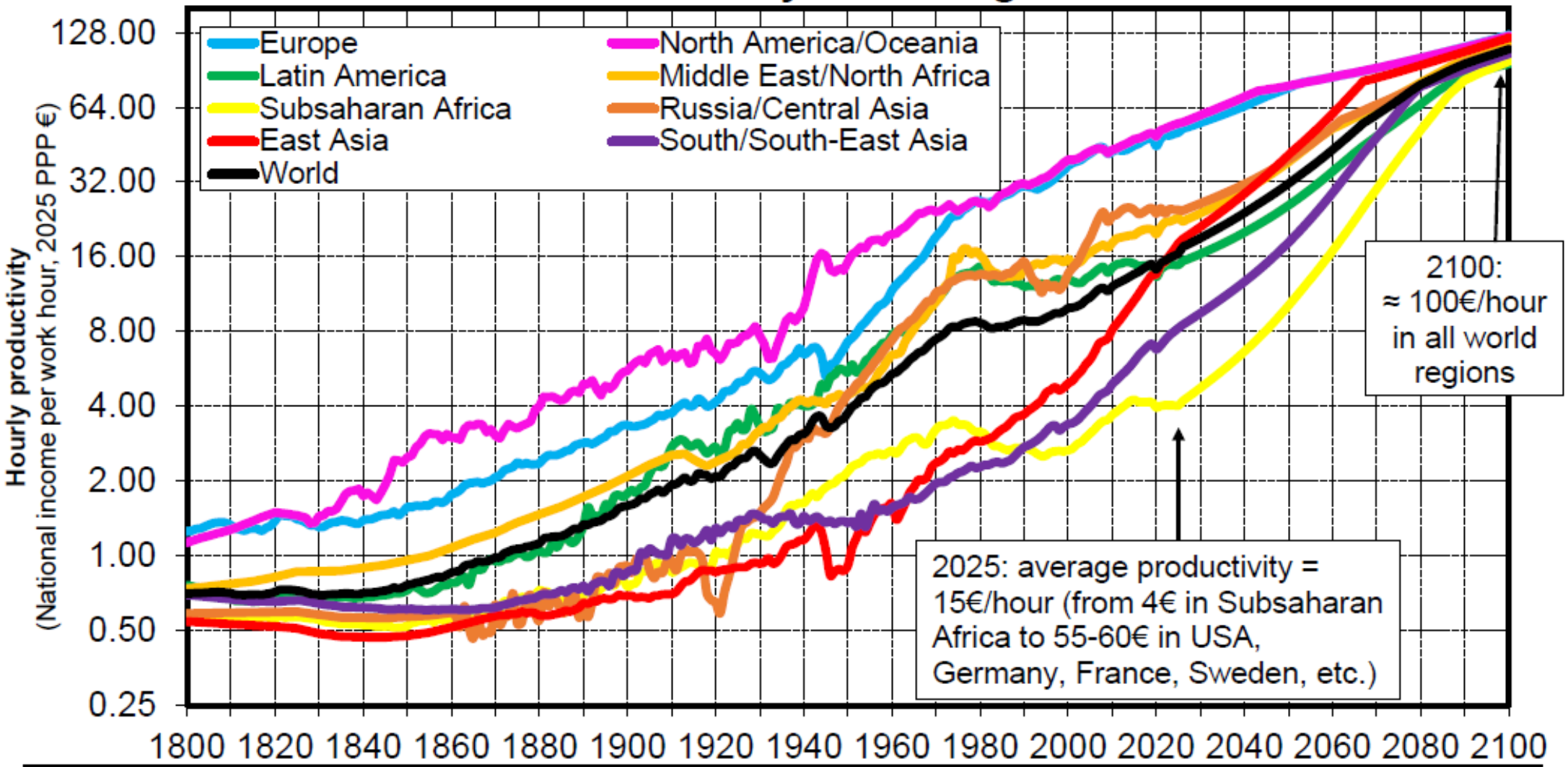
Interpretation. When (age-adjusted) human capital expenditure (public and private education and health expenditure) expressed as % of GDP increases by 1% (e.g. from 10% to 11% of GDP), annual productivity growth increases by about 0.1% (e.g. from 1% to 1.1% per year). I.e. the annual rate of return to 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) and for public education. This effect also holds after the inclusion of country fixed effects, capital-output ratio and region x period fixed effects (8 world regions interact 6 periods: 1800-1840, 1840-1880, 1880-1910, 1910-1950, 1950-1990, 1990-2025).

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



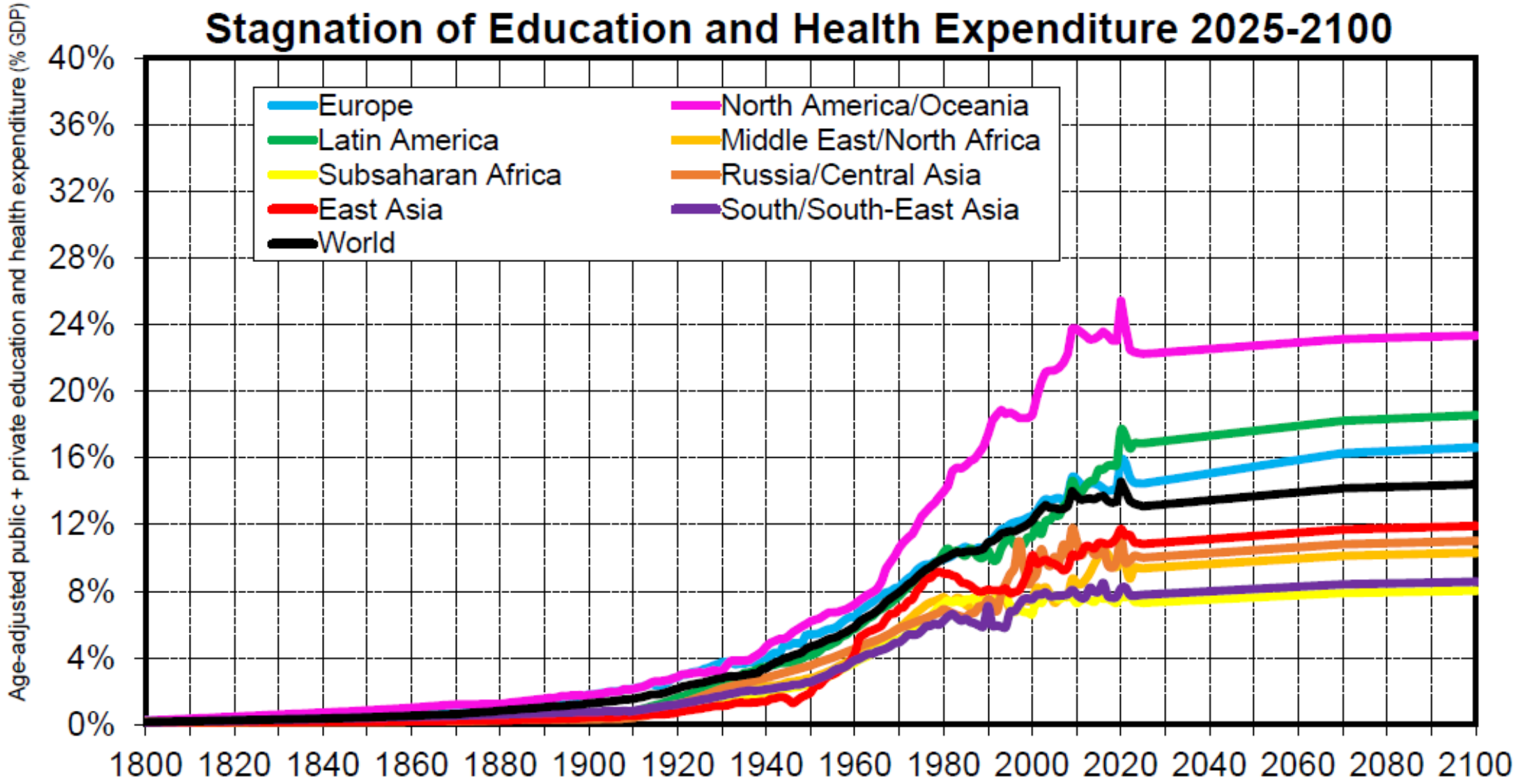
Interpretation. In the "global-convergence" scenario, total age-adjusted public and private education and health expenditure is projected to converge toward 38% of GDP in all world regions by 2100. **Sources and series**: wid.world

Global Convergence Scenario:
Rise of Productivity in All Regions 2025-2100



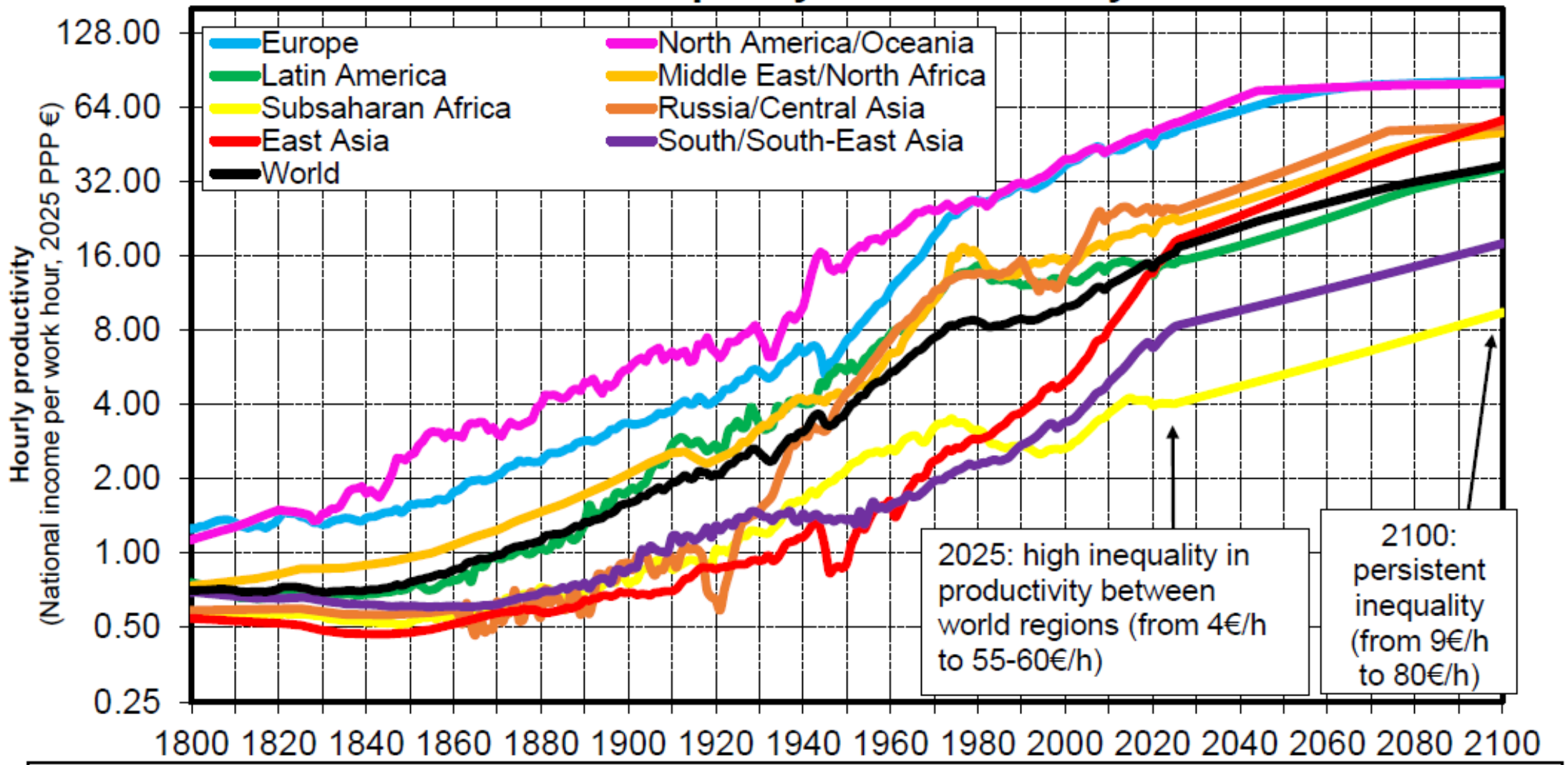
Interpretation. Under the "global convergence" scenario, productivity growth rates are projected to rise substantially in 2025-210, so that all regions converge to about 100-120€/hour by 2100. This involves in particular a large acceleration of productivity growth in Subsaharan Africa (4.4% per year 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 "business-as-usual" 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

Business-As-Usual Scenario: Persistent Inequality in Productivity 2025-2100



Interpretation. Under the "business-as-usual" scenario (stagnation of education and health expenditure), inequality in hourly productivity is projected to remain very high between world regions by 2100. In particular, productivity in 2100 would be only 9€/hour in Subsaharan Africa.
Sources and series: see wid.world

Simulations for Productivity Growth (2025-2100)

	Productivity 2025 (hourly NDP) (PPP € 2025)	Business-as-Usual Scenario		Global Convergence Scenario	
		Productivity growth rate 2025-2100	Productivity 2100 (PPP € 2025)	Productivity growth rate 2025-2100	Productivity 2100 (PPP € 2025)
East Asia	**18.1**	1.5%	**56.6**	2.6%	**121.8**
Europe	**50.6**	0.6%	**81.9**	1.2%	**124.9**
Latin America	**14.8**	1.2%	**36.2**	2.5%	**95.8**
Middle East/ North Africa	**22.9**	1.1%	**50.5**	2.1%	**112.6**
North America/ Oceania	**55.1**	0.5%	**79.6**	1.1%	**123.5**
Russia/ Central Asia	**24.7**	1.0%	**53.7**	2.0%	**109.5**
South/South-East Asia	**8.3**	1.0%	**17.9**	3.4%	**104.9**
Sub Saharan Africa	**4.0**	1.1%	**9.4**	4.4%	**98.1**
World	**16.5**	**1.1%**	**37.1**	**2.6%**	**109.6**

Interpretation. In the "business-as-usual" scenario (frozen human capital expenditure), productivity growth in 2025-2100 is projected to decline as compared to 1900-2025 (1.1% vs 1.8% at the world level). In the "global convergence" scenario (rising human capital expenditure), simulated productivity growth rates accelerate and all regions converge to about 100-120€ in hourly productivity by 2100.
Sources and series: 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 Subsaharan Africa ≈ 3% of Europe/North America level in 2025 in PPP terms (vs 6% in 1980 and 4% in 1950)

- With higher human capital expenditure in global South since 1900 or 1950, global productivity convergence would already be achieved in 2025. If we start now it can be achieved by 2100.

- 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.**