DISCUSSION PAPER

// NITIN BHARTI, AMORY GETHIN, THANASAK JENMANA, ZHEXUN MO, THOMAS PIKETTY, AND LI YANG

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

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

Nitin Bharti[1], Amory Gethin[2], Thanasak Jenmana[3]
Zhexun Mo[4], Thomas Piketty[3], Li Yang[5]

July 2, 2025

Abstract. This paper constructs a new global historical database on public expenditure and revenue and their components—particularly education and health expenditure—covering all world regions over the 1800-2025 period. We document a large rise of human capital expenditure (as % of GDP) in all parts of the world in the long run, but with enormous and persistent inequality between regions. Public education expenditure per school-age individual in Sub-Saharan Africa is about 3% of the level observed in Europe and North America in 2025 in PPP terms (versus 6% in 1980 and 4% in 1950). We also find a large impact of human capital expenditure on productivity growth over the 1800-2025 period, especially for public education and for poor countries. Estimated returns using our macro-historical database are around 10% or more, in line with micro studies. Finally, we present simulations based on alternative human capital expenditure trajectories over the 2025-2100 period. In particular, we analyze the conditions under which convergence in human capital expenditure could lead to global productivity convergence by 2100 (around 100€ per hour in all regions in our benchmark scenario).

JEL: E24, H5, I15, I25, N10
Keywords: Human Capital, Productivity, Education, Health, Global Inequality

[1]NYU Abu Dhabi & WIL. [2]World Bank & WIL. [3]PSE & WIL. [4]CUNY & WIL. [5]ZEW & WIL

* All series constructed in this research are available online in the World Human Capital Expenditure Database (whce.world), together with a detailed replication package and online appendix including raw data sources, methods and codes. All series are also available and will be regularly updated in the World Inequality Database (wid.world).

1. Introduction

Broad access to high-quality education and healthcare is widely viewed as a key condition for personal well-being, inclusive development, productivity growth, and socioeconomic convergence between world regions. But to what extent did access to education and health become more inclusive at the global level in recent decades? Are we already heading for global convergence in human capital, well-being and productivity, or do we need substantial increases in educational and health resources in order to achieve this ambitious goal over the course of the 21st century?

In order to bring new answers to these central questions, we construct a new global historical database on public expenditure and revenue and their components—particularly education and health expenditure—covering the entire planet (48 countries + 9 residual regions) over the 1800-2025 period. Our database also includes series on private education and health expenditure and age-adjusted expenditure.

Our analysis delivers a number of key findings. First, we document a large rise of human capital expenditure (as % of GDP) in all parts of the world in the long run, but with enormous and persistent inequality in access to education and healthcare between regions. For instance, per-school-age-individual public education expenditure in Sub-Saharan Africa is about 3% of Europe/North America levels in 2025 in PPP terms (versus 6% in 1980 and 4% in 1950). Hence, according to this indicator, global inequality in access to education did not decline at all in recent decades, quite the contrary. The gap is also about 2 to 3 times larger in MER terms (market exchange rates) than in PPP terms (purchasing power parities). We find similar results for health expenditure. Generally speaking, we observe a very large rise in global inequality in human capital expenditure between 1800 and 1950, followed by a stabilization at extremely high levels—and sometime a further deepening of the gaps—over the 1950-2025 period.

Next, we find a large impact of (age-adjusted) total human capital expenditure on productivity growth over the 1800-2025 period. We observe larger impacts for education than for healthcare and for public expenditure than for private expenditure. The impacts are especially large for public education and for poor countries. In effect, estimated returns using our macro-historical database are around 10% or more, in line with micro studies. There are of course many limitations associated with cross-country regressions, and we do not pretend that such results can directly be interpreted as causal. However, we find reinsuring that our estimates are consistent with micro

studies (including experimental and quasi-experimental research), which are much better identified but face other problems (in particular external validity issues). We also stress that our estimates of the impact of human capital on productivity growth rely on a much broader data set than previous work, both in terms of geographical coverage and time horizon, which allows us to exploit much larger historical variations. Our results are robust to the inclusion of many controls, including country fixed effects and interacted region-period fixed effects.

Finally, we present simulations based on alternative human capital expenditure trajectories over the 2025-2100 period. In particular, we analyze the conditions under which convergence in human capital expenditure could lead to global productivity convergence by 2100 (around 100€/hour in all regions). In comparison, average productivity is about 16€/hour at the global level in 2025, with enormous gaps between regions (from 4€/hour in Sub-Saharan Africa to 55-60€/hour in Europe and North America/Oceania). In our benchmark "global convergence" scenario, we assume that (age-adjusted) total human capital expenditure converges toward about 35-40% of GDP. While this may seem large to some readers, we argue that it is both desirable and plausible. In particular, we stress that human capital expenditure was less than 2% of GDP in all parts of world until 1910, and that it is close to 25% to GDP in the United States in 2020-2025. In other words, the rise of human capital expenditure that happened in the past is even larger than the one we envision for the future. Given the large projected rise in life expectancy and the growing needs in research and higher education in future decades, it is maybe not too surprising if the rise of human capital expenditure continues at a high pace in the future. We also look at a "business-as-usual" scenario, whereby human capital expenditure stops rising and stagnates over the 2025-2100 at the same level as that observed in 2010-2025. According to our simulations, this will lead not only to the perpetuation of huge productivity gaps but also to growth slowdown in rich countries.

To summarize, the main conclusion of this paper is that the human capital revolution is not over. Over the past two centuries, we have seen enormous progress in basic health and education indicators across the world. Life expectancy increased from an average of 26 years in the world in 1800 to 73 years in 2025, while the literacy rate for adults aged 15 and above rose from 12% to 86%. University enrolment for the 18-to-24-year-olds rose from less than 1% to 37%, and the proportion of university graduates for the 25-year-olds-and-over from less than 1% to 17% (see Figure 1a). 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 (see Figure 1b). As time passes and quantitative improvements continue, the key question will increasingly become the quality of healthcare and education provision, both from an investment perspective and from a consumption perspective. The stagnation of total human capital expenditure in recent decades—in spite of the continuous rise in the share of generation going for higher education—corresponds to a very paradoxical situation and has been suggested to be one of the main potential explanations behind growth slowdown.[1] Our estimates suggest the lost opportunities in terms of growth and welfare could be very large if we do not find a way to continue the historical rise of human capital expenditure in the 21st century.

The present work contributes to several strands in the vast literature on human capital and comparative development. First, our work is closely related to the literature on the measurement of human capital and its transformation at the global level. Our key contribution is to construct the first truly global historical database on human capital expenditure. The primary objective is to be able to compare the real resources that various societies have devoted to education and healthcare (as a fraction of their GDP) around the world since 1800. Generally speaking, existing global datasets on human capital tend to concentrate on recent decades and/or on rich countries. They also usually focus on outcomes, such as life expectancy, literacy rates, and years of education (see for instance the Barro-Lee (2013, 2015) education data set) rather than on expenditure. There does exists an important historical literature studying the evolution of social spending—and particularly human capital expenditure—since the late 18th century, but these works concentrate on Western countries (see in particular the work by Lindert 1994, 2004, 2021). More recently, a number of authors have started to collect and homogenize historical data from country-level budgetary documents and statistical yearbooks from other parts of the world, albeit in a less systematic manner so far than for Western countries.

In order to build our global historical database, we have carefully reviewed and compared all existing work and data series in this area. For missing countries-years, we rely on our own data collection in budgetary archives and statistical yearbooks. In addition to the pioneering work by Lindert, we rely extensively on the research by Bharti and Yang (2024)—who provide a comprehensive analysis of education expenditure in India and China since 1880-1900 until the present day—and Gethin (2024, 2025)— who offers a detailed global perspective on public expenditure for the post-1980

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[1] See e.g. Piketty (2020, Figures 10.15 & 11.13; 2022, Figures 19 & 23) and subsequent discussions.

period.[2] Despite our best efforts, we should make clear that the resulting series (now available online in the World Human Capital Expenditure Database) are not meant to be the final statement on the issue. The main trends and orders of magnitude appear to be very robust, but many series could still be improved for some of the older sub-periods. As new country research becomes available on human capital expenditure, WHCE series will be revised and updated accordingly. We are grateful in advance to all interested readers for their reactions and suggestions to help improve the database.

Next, our work is closely related to the vast literature on the impact of human capital on productivity and the returns to education (see e.g. Card (1999, 2001), Deming (2022), Duflo (2001, 2004), Montenegro (2021) and subsequent references). There also exists a number of research papers using estimated returns to education in order to simulate the impact of human capital policies on inequality and development (see e.g. Colin and Weil (2008) and Gethin (2023)). Our methods and findings are complementary to these works. The main difference is that we adopt a much broader time span, both from a retrospective viewpoint and from a prospective viewpoint.

The rest of the paper is organized as follows. We start by describing our sources, methods and concepts in section 2. We then present in section 3 our main results on the uneven rise of education and health expenditure across world regions and over the 1800-2025 period. In section 4 we use these series to analyze the interplay between productivity growth, state capacity and human capital expenditure in the long run. We then present in section 5 a number of counterfactual simulations in order to illustrate how different paths of human capital expenditure could lead to convergence in productivity. Finally we offer concluding comments and discuss research perspectives in section 6.

2. Sources, Methods and Concepts

This research relies on the construction of a new database, the World Human Capital Expenditure Database (WHCE). All WHCE series are available online on a dedicated website (whce.world), together with a detailed replication package and online appendix including raw data sources, methods and codes. All series are also available and will be regularly updated in the World Inequality Database (wid.world). We refer all

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[2] See also Tanzi and Schucknecht (2000) for a global perspective on public expenditure during the 20th century, van Leeuwen (2007) for a detailed analysis of public expenditure in Indonesia, India and Japan since the late 19th century and Cogneau et al (2021) for a comprehensive study of public revenue and expenditure in the French colonial empire in Africa and Indochina over the 1830-1962 period.

interested readers to the dedicated website and the replication package for all technical details about the construction of the series. In what follows, we describe the main steps of our methodology and focus on the most substantial issues.

2.1. Geographical Coverage and Conceptual Framework

We aim to provide series on public expenditure, public revenue and their components covering the whole world over the 1800-2025 period. We are primarily interested in public education and health expenditure, but we are also concerned with other forms of human and social capital expenditure, and we want to be able to put human capital expenditure into the broader context of public expenditure and revenue. Finally, the WHCE database also includes series on private education and health expenditure and age-adjusted expenditure.

The geographical coverage of our database is described in Table 1. We divide the world into 57 core territories (48 main countries and 9 residual regions) and provide annual series covering the entire 1800-2025 period for all 57 core territories. These 57 core territories are defined so as to cover 100% of world population and GDP over the entire period. Note that all countries, territories, and jurisdictions are defined throughout the 1800-2025 period on the basis of their 2025 territorial borders, i.e. all raw historical series were corrected accordingly so as to take territorial changes into account. Our 48 main countries represent about 85-90% of world population and world GDP (measured either using MER or PPP terms), while the 9 residual regions make up the remaining 10-15%.[3] All series are annual over the 1800-2025 period and cover all 57 core territories. Regarding the recent decades (1970-2025), we also provide the same annual series using the full set of 216 countries and jurisdictions used to define the world in the World Inequality Database,[4] together with some additional decompositions (see below). All series on GDP, population, and age structure are borrowed from the World Inequality Database (see Nievas and Piketty (2025) and Gomez-Carrera et al (2024)).

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[3] See Nievas and Piketty (2025, Figure 2).

[4] For the 1980-2025 period, all series covering the 9 residual regions described in Table 1 are constructed by adding up the series covering the 168 small countries and jurisdictions covered in WID and that are not part of the 48 main countries. Regarding the 1800-1980 period, we have full population series for all 216 countries, so we can compute the population of the 9 residual regions (see Gomez Carrera et al. (2024)). We also have GDP and public expenditure and revenue series for some of the 168 small countries (but not all), and we make plausible assumptions about the evolution of the relative positions of the missing countries with respect to the rest of the region. Given that the 9 residual regions together represent about 10-15% of world GDP, these assumptions have negligible impact on our results. See the online replication package for robustness checks.

The concepts that we use to define public expenditure and revenue throughout the 1800-2025 period follow very closely the latest international guidelines set by international organizations (UN, IMF, Eurostat, OECD, World Bank, etc.), with a few exceptions. First, when we refer to public expenditure and revenue, we always include in our series all levels of government, including the central government, local governments, social security funds, and all other entities included in the government sector according to SNA guidelines.[5] In some cases, especially for earlier periods (but also for recent years in a number of countries), the raw data sources cover only the central government. We always make corrections based on the best available information in order to ensure that all series cover all levels of government.

Next, in order to decompose public expenditure and revenue, we always use the latest concepts and definitions provided in the COFOG classification system (Classification of the Functions of Government) formulated by international organizations.[6] More precisely, regarding the recent decades (1980-2025), we provide the following decomposition of public expenditure and revenue for all countries-years, based on official COFOG categories (see Gethin (2024) and WID.world):

Total public expenditure = Military expenditure (defense) + General public services
+ Public order and safety + Education (primary, secondary, tertiary)[7]
+ Health (health insurance, hospitals, etc.) + Recreation, culture and religion
+ Housing and community amenities + Environmental protection
+ Social protection (social insurance & assistance: old-age pensions, unemployment & family benefits, etc.)[8]
+ Economic affairs   (1)

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[5] According to SNA (System of National Accounts 2008), the government sector is not defined by the ownership structure or legal status of the entities under consideration, but rather by the "production of non-market goods and services under control of the government". See UN (2009, p.73-74). Non-market producers are defined by the fact that they provide goods or services for free or at a price that is "not economically significant". Typically, "not economically significant" corresponds to situations where sales revenue cover less than half of the production costs, although this needs to be appreciated over several years. As a general rule, non-market production is then valued at production costs. "Government control" is defined by combining various criteria, including governance rules and the financing structure. For instance, a non-profit institution that is "mainly financed by government" may be considered to be "controlled by that government". As stressed by SNA, these criteria are multidimensional and require careful examination before a decision can be reached, i.e. the decision should be "based on the totality of all indicators" and "will necessarily be judgmental in nature". See UN (2009, p.73-74) and Dietrich et al (2025).

[6] See Eurostat 2019. See also IMF 2014.

[7] Over the 1980-2025 period we also provide homogeneous breakdown of public education expenditure into three components (primary, secondary, tertiary).

[8] Over the 1980-2025 period we also provide homogeneous breakdown of social protection expenditure into three components (social insurance, social assistance in cash, social assistance in kind).

Total public revenue = Indirect taxes + Property and wealth taxes

+ Personal income taxes + Corporate income taxes + Social contributions

+ Other taxes + Non-tax revenue (royalties, fines, etc.)   (2)

Note that our concept of public expenditure always refers to primary public expenditure, i.e. it excludes government interest payments.[9]

Regarding the full 1800-2025 period, the raw data sources at our disposal do not allow us to provide such a detailed decomposition. On the expenditure side, we use the following categories for our historical series:

Total public expenditure = Military expenditure (defense)

+ Basic public services (justice, police, administration, roads, etc.)

+ Education (primary, secondary, tertiary)

+ Health (health insurance, hospitals, etc.)

+ Other human & social capital (research, culture, community, environment, etc.)

+ Social Protection (social insurance & assistance: old-age pensions, unemployment & family benefits, etc.)

+ Other expenditure (economic affairs, etc.)   (3)

The categories used in equation (3) over the full 1800-2025 period are a simplified version of those defined in equation (1) over the 1980-2025 period.[10]

On the revenue side, we use the same categories as those described in equation (2), except that we put together "personal income taxes" and "corporate income taxes" into a single category "income taxes" for the historical series.

2.2. Sources and Methods

The main sources and methods used to construct WHCE series are the following. All details are available in the online replication package. Regarding the 1980-2025

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[9] Primary government surplus/deficit can be defined as (Public revenue – Public expenditure). Although this is not our main focus in the present work, we also provide series on Interest payments, so that one can also define Secondary government surplus/deficit as (Public revenue – Public expenditure – Interest payments).

[10] Namely, Basic public services (justice, police, administration, roads, etc.) are defined as the sum of 80% of General public services (in order to exclude basic research from the latter category), 100% of Public order and safety and 20% of Economic affairs (in order to extract roads and basic public infrastructures from the latter category). Other human and social expenditure (research, culture, community, environment, etc.) is defined as the sum of 20% of General public services and 100% of Recreation, culture and religion, Housing and community amenities and Environmental protection. Other expenditure is defined as 80% of Economic affairs.

period, we follow the methods described by Gethin (2024, 2025). Namely, we rely primarily on the official series on public expenditure and revenue released by the main international organizations (IMF, Eurostat, OECD, World Bank) on the basis of COFOG and other classifications. We use other additional sources – including series released by CEPAL, UNESCO and WHO – for specific countries-years and missing expenditure items. We refer to Gethin (2024, 2025) for additional information.

As compared to standard classifications, one of our main points of departure has to do with the treatment of private payments to public institutions. Namely we exclude government sales of goods and services – e.g. tuitions paid to public universities, partial payments made to public hospitals, etc. – from public revenue and public expenditure. In standard classifications, government sales of goods and services are included in non-tax public revenue, and the corresponding sums are also included in the public expenditure.[11] We feel that it makes more sense to exclude them from public revenue and expenditure and to include these items into private human capital expenditure. In practice, this does not make an enormous difference at the aggregate macroeconomic level, but this can make a significant difference regarding the split between public vs private education and health expenditure.[12]

Regarding the historical series (1800-1980), we proceed as follows. First, we have carefully reviewed and compared all existing historical series on public expenditure and revenue, including the work by Lindert (1994, 2004, 2021) on social spending in Western countries since the late 18th century and the research on public expenditure in large non-Western countries since the late 19th century by a large number of researchers (including Bharti and Yang (2024) on India and China, Cogneau et al (2021) on French Africa, Tanzi and Schucknecht (2000) on Latin America and a number of other non-Western countries, van Leeuwen (2007) on Indonesia, India and Japan, among many other research works). For missing countries-years, we rely on our own data collection in budgetary archives and statistical yearbooks. We do our best to homogenize all available historical series so as to fit the methods and concepts available over the 1980-2025 period. We also use country-level historical series on total public expenditure from the IMF "Public Finance in Modern History" database (see IMF (2023) and Mauro et al (2015)), as well as detailed historical series on military expenditure from Barnum et al (2024).

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[11] See e.g. IMF (2014).
[12] Government sales of goods and services represent about 1.5-2% of GDP over the 1980-2025 (including about one third of sales corresponding to market production and two thirds to non-market production, i.e. sales made at a price that is "not economically significant" according to SNA criteria, typically covering less than half of the costs), with large variations across regions. See Appendix Figures F3e-F3f and Gethin (2025) for further discussion of these conceptual and methodological issues.

By combining and homogenizing these different sources, we have relatively complete series on public expenditure and its components for most large Western countries from 1800 onward and for most large non-Western countries from 1880-1900 onward. We have a number of missing items for non-Western countries over the 1800-1880 period, which we complete on the basis of available evidence for similar countries. We should also point out that there is ample historical evidence demonstrating the relatively low levels of public expenditure and revenue in non-Western countries in 1800-1880 and in earlier periods as compared to Western countries (see e.g. Dincecco (2015, 2017), Genniaoli and Voth (2017), Hoffman (2011, 2013) and Karaman and Pamuk (2010, 2013)).[13] Therefore the simplifying assumptions that we make on the exact level of public expenditure and its components for non-Western countries before 1880-1900 cannot have a very large impact on the broad patterns and orders of magnitude.[14]

3. The Uneven Rise of Education and Health Expenditure, 1800-2025

We now present our main findings on the uneven global rise of human capital expenditure. We start with our results on total expenditure and its components. We then focus on education and health expenditure, including the role of age adjustments, the persistent inequality between regions, and the relative importance of public and private expenditure.

3.1. The Incomplete Rise of the Global Social State, 1800-2025

According to our estimates, total public expenditure rose from about 3% of global GDP in 1800 to about 31% in 2025, with large regional variations (see Figure 2). Two facts are particularly striking. First, we observe a rise of public expenditure in pretty much all regions and during most sub-periods. The largest part of the rise did happen between 1910 and 1980, but we also see a gradual increase in most world regions during the 1800-1910 period and again during the 1980-2025 period. In particular, the stabilization that we observe at the global level since 1980-1990 comes from the changing composition of global GDP (i.e. the decline of the Western share in global GDP). With the exception of Russia/Central Asia following the fall of USSR, public

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[13] See also Piketty (2020, Figures 9.1-9.2).

[14] Regarding the components of public revenue, we also have relatively detailed evidence for Western countries going back to the 19th century. See e.g. Piketty and Zucman (2014) and Piketty, Saez and Zucman (2018). We use these estimates to make similar assumptions for other countries. Given the low levels of public revenue in earlier periods, this again has very little impact on our main findings in the context of the present paper.

expenditure does keep rising in most world regions between 1980-1990 and 2025, albeit at a smaller pace than during the 1910-1980 period.

Next, it is striking to see that the world's richest regions – namely Europe and North America/Oceania – have always had larger public expenditure (not only in absolute terms, but also as a fraction of their GDP) than poorer regions. During the 19th century, public expenditure was pretty low everywhere – less than 10% of GDP in all world regions until World War 1 – but it was significantly higher in Europe and North America/Oceania than in other parts of the world. We will later return to this issue when we discuss the relation between development and early state capacity (see section 4 below). In the late 20th century and 21st century, we again see that Europe and North America/Oceania have the highest level of public expenditure in the world, followed by East Asia, Russia/Central Asia, Latin America and Middle East/North Africa. At the bottom of the distribution we see the poorest world regions, namely South & Southeast Asia and Sub-Saharan Africa (see Figure 2). Before we discuss the possible interpretation behind this finding (which we also do in section 4 below), it is critical to better understand the changing composition of public expenditure.

Note also that public expenditure expressed as a fraction of GDP does display very large short-run variations, e.g. large rise during the 2008 financial crisis or during the 2020 Covid crisis. These spikes are generally due to combination of rising numerator (expenditure) and falling denominator (GDP).[15] The point however is that these short-run variations are relatively secondary as compared to the long-run trends and the differences in levels across regions.

We now turn to the changing composition of public expenditure. The general finding is that the rise of public expenditure is mostly due to the rise of social spending (broadly defined). We therefore choose to refer to this structural transformation as the "rise of the global social state" (see Figure 3). In the 19th century, when public expenditure was less than 10% of GDP in all world regions, public spending largely consisted of military expenditure and basic public services (justice, police, administration, roads, etc.). There was not much left for anything else. In contrast, in the late 20th century and early 21st century, global public expenditure represents around 30-35% of world GDP, including three large spending items in education, health and social protection (social insurance and assistance), which almost did not exist in the early 20th century, and which together explain most of the rise. In effect, total public expenditure amounts to

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[15] Note that exceptional military expenditure during world wars were excluded from the series reported on Figure 2. All other spikes were left unchanged. For full series with and without exceptional military expenditure during world wars, see Online Appendix and especially Appendix Figures A1a-A1b.

about 31% of global GDP in 2025, including about 2% for military expenditure, 6% for general public services, 5% for education, 5% for health, 3% for other human and social capital expenditure (research, culture, recreation, community services, environmental protection, 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).

We observe the same general pattern in all world regions, but with different scales. At the top of the distribution, Europe's social state is by far the largest in the world, with total public expenditure reaching about 44% of GDP in 2025 (see Figure 4a). At the other extreme, total public expenditure is only 17% of GDP in 2025 in Sub-Saharan Africa: this looks more like a "mini-social state" than a true social state (see Figure 4b). All other world regions are in between these two extremes: South & Southeast Asia is around 23% of GDP in public expenditure in 2025, Middle East/North Africa stands at about 26% of GDP, while Latin America, Russia/Central Asia, East Asia, and North America/Oceania are all around 30-35% of GDP. Whatever the final level, the important point is that the general pattern has the same general shape in all regions. That is, military expenditure and basic public services almost did not increase since the early 20th century, and most of the long-run expansion of government was due to education, health and social protection (and to a lesser extent other human and social expenditure and other expenditure).[16]

Regarding the revenue side, we find that the rise of the global social state comes with the rise of global fiscal state, and more specifically with the rise of direct income taxes and social contributions. In the 19th century, when public revenue and expenditure were less than 10% of GDP, indirect taxes were the largest source of revenue, together with property and wealth taxes (especially in Europe and North America/Oceania). In the late 20th century and early 21st century, direct income taxes and social contributions have become major sources of revenue – each larger or comparable to indirect taxes – in regions with the largest social state (especially Europe and North America/Oceania).[17] On the contrary, in regions like Sub-Saharan Africa and South &

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[16] See Appendix Figures A1c-A1k. Note that military expenditure has generally oscillated around 1-2% of GDP in most countries and regions over the 1800-2025 period, with major spikes during wars, and structurally higher levels in USA and USSR during the cold war period (as much as 5-8% of GDP). See Appendix Figures A6b-A6c and Online Appendix for detailed country-level series.

[17] See Appendix Figures B1c-B1k. The rise of income taxes has been particularly large in North America/Oceania, while the rise of social contributions has been particularly important in Europe. However there are exceptions and the frontier between these two forms of tax revenue should not overestimated. E.g. Denmark has virtually no social contribution in the formal legal sense, and the generous social state (including social protection) is mostly financed by a very large income tax

Southeast Asia, where the historical rise of the social state was very limited, indirect taxes still remain a very large of total revenue.[18]

3.2. Human Capital Expenditure: the Role of Age Adjustments

We now look more closely at the evolution of human capital expenditure (education and health). At the world level, public education and health expenditure rose from less than 1% of GDP before 1900 to about 9% of GDP in 2025, again with large regional variations between poor and rich countries. In 2025, public human capital expenditure from about 5-6% of GDP in South & Southeast Asia and Sub-Saharan Africa to about 11-14% of GDP in Europe and North America/Oceania (see Figures 5a).

We also observe important differences regarding the historical trajectories of education and health spending. Public education expenditure rose from less than 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 Sub-Saharan Africa (see Figure 5b). 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 Sub-Saharan Africa as in Europe). It is therefore critical to look at age-corrected education expenditures to make meaningful comparisons. In contrast, 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 & Southeast Asia and Sub-Saharan Africa to 7-8% of GDP in Europe and North America/Oceania (see Figure 5c). These very large gaps are partly due to different age structures (with a much larger old-age population share in richer countries). As with education, one needs to analyze age-corrected health expenditure in order to make proper comparisons.

We proceed as follows. We first note that 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 Sub-Saharan Africa (see Figure 6a). On the other side of the

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(including various subcomponents earmarked for pensions, unemployment benefits, health insurance, etc.). See Online Appendix for detailed country series.

[18] It is also interesting to note that property and wealth taxes raise negligible revenue in Sub-Saharan Africa and South & Southeast Asia until the present day: about 0.1-0.3% of GDP in 2010-2025, vs about 2-3% of GDP in Europe, North America/Oceania and East Asia. Property and wealth taxes were already raising similarly high tax revenue in Europe and North America/Oceania in the 19th century. Available historical evidence suggests that property taxes played a very important historical role in Western countries in order to develop a system of property registration (cadaster), after which direct taxes and social contributions could develop. On the contrary, countries with underdeveloped property tax systems display very large informal sectors until the present day and faced major difficulties to develop modern income taxes and social contributions and raise total revenue. See Piketty (2020) for an analysis of the role of property taxes and proprietarian ideology in modern state construction.

age distribution, the share of old-age population (65-year-old-and-over) varies enormously across world regions in 2025, from 3% in Sub-Saharan Africa to 22% in Europe. We then apply the following age adjustment method. The simplest case is education. Given that most of education expenditures are devoted to the school-age population (0-to-24-year-old), we define age-adjusted public education expenditure as the expenditure that a country would have in a given year assuming that the share of school-age population (0-to-24-year-old) is equal to 25% in all countries-years (which corresponds approximately to the average level observed in Europe in 2025) and keeping the same per-school-age-individual expenditure as in the observed country-year. The case of health is more complicated, as all age groups benefit from health expenditure in a significant manner. However, in practice we observe that the average per capita health expenditure received by old-age individuals (65-year-old-and-over) is on average about three times than that received by individuals aged 0-to-64. This ratio appears to be relatively stable over time and across countries in recent decades.[19] Therefore we define age-adjusted public health expenditure as the expenditure that a country would have in a given year assuming that the share of old-age population (65-year-old-and-over) is equal to 25% in all countries-years (which corresponds approximately to the average level projected in Europe in 2030) and keeping the same per-age-group expenditure as in the observed country-year.

After making these adjustments, we find that 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, again with very large gaps between regions, from 4% of GDP in South & Southeast Asia and Sub-Saharan Africa to 12-13% in Europe and North America/Oceania (see Figure 7a). The gaps are somewhat larger after age adjustment than before age adjustment, as the unequalizing impact of education adjustment more than counterbalances the equalizing impact of health adjustment, especially for Sub-Saharan Africa (see Figures 7b-7c).

3.3. Persistent Global Inequality in Access to Education and Health

One of the most striking results emerging from our database is the magnitude of the opportunity gap between world regions in terms of access to education and expenditure, and most importantly the fact that this gap did not decrease at all during the recent decades. Regarding the sheer magnitude of the gap, we find that average public education expenditure per school-age individual (0-to-24-year-old) varies enormously across world regions, from 220€ in Sub-Saharan Africa to 9,025€ in North

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[19] See Morgan and Mueller (2023) and Online Appendix.

America/Oceania (PPP € 2025), i.e. a gap of almost 1 to 50 (see Figure 8a). Note that these gaps are not due to the fact that prices are higher in rich countries: we are using PPP values (purchasing power parities). If we were using MERs (market exchange rates) rather than PPPs, then the gaps would be 2-3 times larger.[20]

To put it another way, Europe and North America/Oceania host 8% of the world school-age population (0-to-24-year-old) in 2025 and benefit from 40% of the world public education expenditure (measured in PPP € 2025). In contrast, Sub-Saharan Africa and South & Southeast Asia host 60% of the global school-age population and benefit from 16% of the global education expenditure (see Figure 8b).

Even more strikingly, this gap did not reduce in recent decades. The education gap between the world's poorest and richest regions increase enormously over the 1800-1950 period, and since 1950 it stabilized at a very high inequality level, with little change over time. For instance, average public education expenditure per school-age individual in Sub-Saharan Africa was equal to 4% Europe/NAOC average in 1950, 6% in 1980 and 3% in 2025 (see Figure 8c)

We find approximately the same results for health. 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 Sub-Saharan Africa to 3,198€ in North America/Oceania (PPP € 2025), i.e. a gap of about 1 to 60 (see Figure 9a). In effect, Europe and North America/Oceania host 23% of the world old-age population (65-year-old +) in 2025 and benefit from 55% of the world public health expenditure (measured in PPP € 2025). In contrast, Sub-Saharan Africa and South & Southeast Asia host 27% of the global old-age population and benefit from 7% of the global health expenditure (see Figure 9b). Average public health expenditure per 0-to-64-year-old individual in Sub-Saharan Africa was equal to 4% of Europe-NAOC average in 1950 and 1980 and 2% in 2025 (see Figure 9c).

Another way to measure the magnitude of the gap is to ask the following question. How much would it cost to make available to all children of the world the same average expenditure in education and health than that available in Europe and North America/Oceania. The answer is that it would be very costly. More precisely, assume

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[20] MERs are on average about 2-3 times below PPPs for countries in Sub-Saharan Africa and South & Southeast Asia. See Nievas and Piketty (2025b, Figure 4a). Of course PPPs do not equalize all prices, but both theory and evidence from ICP surveys suggest that relative prices tend to be larger in poorer countries for more skill-intensive goods and services (like education and health). So if anything the true volume gap for education and health should be in between the PPP gap and the MER gap.

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 Sub-Saharan Africa (see Figure 10a). Out of these 32% of world GDP, about half would come from equal access to education and half from equal access to health (see Figures 10b-10c). The cost of equal opportunity would have been much lower in the 19th century or in the early 20th century (as education and health expenditure were much lower at the time).[21] But by now the gaps are so huge that an immediate equal-opportunity target – which one might consider to be desirable from a normative perspective – would require an enormous mobilization of resources.[22] It is also possible to move more gradually and to achieve convergence in human capital expenditure and productivity over a couple of decades, as we will later discuss when we analyze counterfactual scenarios for the future (see section 5 below).

3.4. Public vs Private Human Capital Expenditure

We now include private education and health expenditure into the analysis. Although the historical data sources are more limited than for public expenditure, we do have very detailed evidence for all world regions for the post-1980 period, and sufficient evidence to be confident about the orders of magnitude for the earlier periods.

We find that 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 & Southeast Asia and Sub-Saharan Africa and 3% in Europe, East Asia, Russia/Central Asia and Middle East/North Africa (See Figure 11a). Private education expenditure has increased substantially in recent decades, particularly in North America/Oceania, South & Southeast Asia, Sub-Saharan Africa, and Latin America (see Figure 11b). At the global level, private education expenditure represents 1.3% of GDP in 2025, i.e. about 24% of total public + private education expenditure (5.3% of GDP). Private health expenditure also increased substantially in recent decades in North America/Oceania, and to a lesser extent in Latin America (see Figure 11c). At the global level, private health expenditure represents 3.1% of GDP in 2025, i.e. about 40% of total public + private health expenditure (7.8% of GDP).

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[21] See Nievas and Piketty (2025a) for retrospective counterfactual scenarios along these lines.
[22] The costs associated to more modest targets (e.g. immediate convergence of all countries to 25% or 50% of education and health expenditure observed in rich countries) would also be very large, i.e. around 5% for world GDP for the 25% target and 14% of world GDP for the 50% target. See Online Figures A3m2-A3m3 and Online Appendix for detailed country series.

If the apply the same age adjustment method to both public and private human capital expenditure, we obtain the following results. 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 & Southeast Asia and Sub-Saharan Africa to about 23% in North America/Oceania (see Figure 12a). 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 & Southeast Asia and Sub-Saharan Africa to about 6-6.5% in North America/Oceania (see Figure 12b). Finally, 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 & Southeast Asia and Sub-Saharan Africa to about 16% in North America/Oceania (see Figure 12c).

It is very striking to see that the inclusion of private expenditure substantially modifies the ranking between countries and regions. In particular, due to the high private expenditure observed in the US (for education and especially for health), we find that total public and private human capital expenditure has become substantially larger in North America/Oceania than in Europe in recent decades. Whether this higher expenditure delivers the desired results is another issue. Health indicators are well-known to be better in Europe than in the US, which raises some serious doubts about the cost-effectiveness of high private health expenditure in the US.[23]

It is also interesting to see that Latin America reaches very high levels of human capital expenditure after the inclusion of private expenditure. For instance, according to our estimates, countries like Brazil, Colombia or Chile currently have total (age-adjusted) public and private education and health expenditure around 20% of GDP, as opposed to about 15-16% in Nordic European countries like Denmark, Sweden and the Netherlands.[24] This again raises questions about the cost-effectiveness of private human capital expenditure.

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[23]See e.g. Michaud et al (2011), Roser (2017) and Case and Deaton (2020).
[24] See Online Appendix for detailed country series.

4. Human Capital, Productivity and Comparative Development

We now analyze the relation between human capital expenditure, productivity growth, and comparative development. We first recapitulate the basic facts about productivity growth in the long run. We then discuss the role of state capacity in explaining the early productivity gap around 1800-1840. Finally, we look at the evolution of productivity over the entire 1800-2025 period and the impact of human capital expenditure.

4.1. The Uneven Rise of Productivity and the Phases in Productivity Leadership

We first recall the basic facts about the uneven rise of productivity and the phases in productivity leadership across the world over the 1800-2025 period. The story is not new, but it is important to start from here. At the global level, per capita GDP rose from about 900€ in 1800 to 16,000€ in 2025 (from now on, all money amounts are expressed in in 2025 PPP €), i.e. it has 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 Sub-Saharan Africa and about 40,000-50,000€ in Europe and North America/Oceania (i.e. a gap from 1 to 15) (see Figure 13).[25]

Labour hours have declined substantially in the long run and vary a lot across regions, so it is more meaningful from an economic viewpoint to look at hourly productivity, which we define as net domestic product divided by economic labour hour.[26] At the global level, hourly productivity rose from about 0.7€ in 1800 to 16€ in 2025, i.e. it has multiplied by 24, which corresponds to average annual real growth rate of 1.4% per year, with large variations over time and across regions. I.e. in 2025, productivity varies from about 4€ per hour in Sub-Saharan Africa to 55-60€ Europe and North America/Oceania (see Figure 14a). Between 1800 and 1900, Britain was the country in the world with the highest productivity, before being replaced by the USA between 1900 and 1970. Since 1970, Europe's highest productivity countries (incl. Denmark, Sweden, the Netherlands, Norway, Germany, France, Britain) have approximately the same productivity level as the USA, with productivity around 55-60€/hour, or even a bit more in some Nordic countries (see Figure 14b).

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[25] GDP and population series come for WID. For the recent period, they use the latest available official GDP series and PPP conversion factors from ICP surveys for PPP. For the historical series, they combine Maddison series with the latest available research. See Nievas and Piketty (2025b).

[26] Here we use the database on historical labour hours series constructed by Andreescu et al (2025) on the basis of labour force surveys and administrative sources. For recent decades the series are virtually identical to those available in standard official sources (OECD, ILO, BLS, etc.).

If we divide regional productivity by world average, we find that the inequality in hourly productivity between world regions rose between 1800 and 1950 and has started to decline since 1950-1960, again with large geographical variations. In 2025, productivity is close to world average in East Asia but only 50% of world average in South & Southeast Asia and 25% of world average in Sub-Saharan Africa (see Figures 15a-15b). At the global level, the average productivity growth rate increased from 0.9% between 1800 and 1910 to 1.6% between 1910 and 1950, 2.3% between 1950 and 1990 and 1.8% between 1990 and 2025. Annual growth rates can be as high as 3.5-4.5% per year in regions going through accelerated catch-up process with the world frontier, for instance in Europe in 1950-1990 or in East Asia in 1950-1990 (Japan) and again in 1990-2025 (China), but by definition this cannot last forever (see Table 2).

4.2. State Capacity and the Early Productivity Gap in the 19th Century

In 1800, the disparities in per capita GDP and hourly productivity between Europe and North America/Oceania and the rest of the world are already quite substantial (with a gap of about 1 to 2). This gap is then going to rise substantially over the 1800-1950 period, but it was already fairly significant in the early 19th century, and it is useful to start from there. Available evidence suggests that this gap did not exist at all around 1500 and that it developed during the 1500-1800, and particularly between 1650 and 1800.[27] It has long been suggested that this rising gap can be explained – at least in part – by the greater state capacity that Western countries developed over this period.[28] Two main explanatory mechanisms are usually considered: domestic and external. According to the domestic view, Europe's higher state capacity materialized into "better" domestic institutions, e.g., a more reliable legal system and police force, more protection to private property rights, better infrastructures (roads, etc.), and so on.[29] According to the external view, the key source of divergence is Europe's military domination of the rest of the world: European states were able to gradually take control of foreign territories and maritime roads, over the 1500-1800, which allowed them to

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[27] Standard GDP estimates by Maddison (2001) show a rising gap between 1500 and 1800 but are not very precise about the exact timing of divergence. Pomeranz (2000) argues that the most advanced regions of Europe and China are basically on par until 1750 and that divergence happens very late. According to Broadberry et al (2018), the divergence of per capita output and average wage between China and the United Kingdom is clear starting around 1700, which is a little earlier than Pomeranz finds but "later than prior Eurocentric arguments."

[28] According to available evidence, all states in the world for which we have data – including European states, the Ottoman Empire, the Chinese Empire, Indian states, etc. – had relatively small public revenue around 1500-1600 (around 1-2% of GDP), but European states rose to 6-8% of GDP between 1600-1650 and 1800-1850, while other states stagnated at the same level. The initial impetus seems to come from the particular form taken by interstate competition and military rivalry in the European context, but it has much wider implication. See e.g. Dincecco (2015, 2017), Genniaoli and Voth (2017), Hoffman (2011, 2012), Karaman and Pamuk (2010, 2013). See also Piketty (2020, Figures 9.1-9.2).

[29] See e.g. North and Weingast (1989) and Acemoglu et al (2001, 2005, 2012).

organize the world exploitation of natural resources and labour in order to fit their interests and development needs.[30]

Note that these two views are not mutually exclusive and could operate at the same time or sequentially. Western military domination might play a leading role to explain European territorial and economic expansion between 1500 and 1800, but it is also possible that starting around 1750-1800 domestic state capacity and institutions become equally important (or even more important). Given the data imperfections, and the fact that our public expenditure series start in 1800, it is very difficult to provide fully satisfactory answers to such questions.

To address these issues, we nevertheless run a couple of very simple regressions between average productivity in 1800-1820 and the level of public expenditure (see Table 3). We find that countries with higher state capacity (as proxied by total public expenditure) also have higher productivity in 1800-1820. Namely, 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. Interestingly, the effects seem to be driven by basic public services (justice, police, administration, roads, etc.) rather than by military expenditure. However, this does not mean that military expenditure did not play an important role in the past. This is simply saying that around 1800-1840, when the income gap between the West and the rest of the world is already solidly established, Western countries do not need to spend a particularly high fraction of their GDP on military expenditure: most of the gap in public expenditure (expressed a fraction of their GDP) is due to basic public services.[31]

4.2. Productivity Growth and Human Capital Expenditure 1800-2025

We now move to the study of productivity growth and human capital expenditure over the entire 1800-2025 period. To analyse the relation between productivity growth and human capital expenditure, the simplest way to proceed is to run a regression of the

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[30] See e.g. Pomeranz (2000), Parthasarati (2011) and Beckert (2014).
[31] In effect, given that their GDP is now much larger than other countries, Western countries can maintain military hegemony by spending the same fraction of their GDP on the military than other countries. But it is very likely that European states did spend a higher fraction of their GDP on military during most of the 1500-1800 period. See the references given above (synthetized by Piketty 2020, Figures 9.1-9.2), which unfortunately cover only a small number of countries-years before 1800.

following form over the past two centuries, together with the gradual introduction of various control variables and fixed effects:

$$\text{ProductivityGrowthRate}_{it} = a + b \text{ HumanCapitalExpenditure}_{it} + \text{Controls}_{it} + e_{it} \quad (4)$$

With:
ProductivityGrowthRate$_{it}$ = growth rate of hourly productivity (net domestic product per work hour) in country i and year t (growth rate computed over the previous 20 years)
HumanCapitalExpenditure$_{it}$ = human capital expenditure (as % GDP) in country i and year t (average over the previous 20 years)
Controls$_{it}$ = control variables and fixed effects

We start by running this regression with total public expenditure as a single explanatory variable, before moving on to more sophisticated specifications (see Table 4). We find a positive and statistically significant coefficient, i.e. 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 coefficient remains virtually the same – from 0.054 to 0.048 – when we introduce country fixed effects and controls for capital-output ratios.[32] Interestingly, the effect is driven by human & social capital expenditure, a broad category in which we include 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 (in particularly military expenditure and social protection) have no robust significant impact on productivity growth.

We then concentrate on human capital expenditure strictly speaking, i.e. education and health, including both public and private expenditure (see Table 5). We find that 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). This implies the annual rate of return to human capital investment is about 10%, which is consistent with the returns estimated in micro studies (including experimental and

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[32] We borrow the capital-output ratios from Bauluz et al (2025).

quasi-experimental studies).[33] We also find that the return is higher for education than for health and for public expenditure than for private expenditure. It is even larger for poor countries (defined as countries with productivity less than 10€ PPP 2025/hour) and for public education, with an annual return of 15-20% or more. 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).

We stress again that we are well aware of the limitations associated to cross-country regressions, and we do not pretend that such results can directly be interpreted as causal, even after the inclusion of country fixed effects and region x period fixed effects. However, we still find reassuring that our estimates are consistent with micro studies (including experimental and quasi-experimental research), which are better identified but face other problems (in particular external validity issues). One way to strengthen our estimates would be to use political discontinuities (e.g. the coming to power of Social-Democrats in Sweden in 1932) as instrumental variables to predict changes in human capital expenditure. One difficulty is that there are strong temporal correlations across countries in the timing of such political discontinuities, which given the long time lags involved in the returns to human capital expenditure can contribute to make identification challenging. We leave this to future work, and we very much hope that our findings and the database developed in this paper will contribute to stimulate more work in this area.

5. Counterfactual Simulations & Alternative Development Trajectories

We conclude this paper by discussing a number of counterfactual simulations and alternative development trajectories. We already pointed out that a policy reform based on equal access to education and health – whereby all children of the world would benefit immediately from the same average expenditure in education and health as that available in rich countries (average of Europe and North America/Oceania) - would require an enormous mobilization of resources (see Figure 12a–12b). Here we concentrate on a more gradual convergence scenario, where we attempt to achieve convergence in human capital expenditure and productivity over a couple of decades, namely over the 2025–2100 period. More specifically, we consider a global-convergence scenario whereby total (age-adjusted) public and private education and health expenditure is projected to converge toward 38% of GDP in all countries and

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[33] See e.g. Card (1999, 2001), Demmings (2022), Duflo (2001, 2004), Montenegro (2021) and subsequent references

world regions by 2100 (see Figure 16a). To a large extent, this would simply be the continuation of the evolution observed over the 1800-2025 period. In order to simulate the impact of this future human capital trajectory, we use the returns to education and health obtained in the historical regression framework – with annual returns assumed to decline from 20% for low-income countries to 10% for middle income and upper-middle-income countries and 5% for high-income countries, in line with the evidence. Under this scenario, we find that productivity growth rates are projected to rise substantially over the 2025–2100 period, so that all regions converge to about 100-120€/hour by 2100 (see Figure 16b). This involves in particular a large acceleration of productivity growth in Sub-Saharan Africa: 4.4% per year over 2025–2100 period, i.e. the same as in East Asia during the 1990-2025 period (see Table 6).

By comparison, 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 (see Figure 17a). This would correspond to a situation where countries are unable to find fiscal resources to raise public expenditure in education and health, in spite of the rising needs. In practice, if this happened, such a trajectory would probably involve a substantial rise of private expenditure in education and health – along the lines observed in the US and Latin America in recent decades –, which we do not try to take into account here for simplicity. Using the same returns to human capital as before, we find that under this "business-as-usual" scenario, the 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 Sub-Saharan Africa, vs about 80€ in Europe and North America/Oceania (see Figure 17b).

It is worth noting that all countries and regions would be better off in the global-convergence scenario than in the business-as-usual scenario, including the richest countries with the lower estimated returns to human capital, and even if we entirely ignore the consumption value of human capital. E.g. the US would be better off with an hourly productivity equal to 120€ rather than 80€, even though this requires to spend each year 38% of its GDP in human capital expenditure (vs 24% in the business-as-usual scenario). For poor countries with higher estimated returns to human capital, the long-run gains are even more obvious. E.g. for Sub-Saharan Africa the possibility of having a productivity equal to 100€ rather than 9€ is clearly worth spending 38% of its GDP in human capital expenditure rather than 8%. The problem is that these long-run gains take several decades to fully materialize, so that there is a serious risk that

without adequate financing mechanisms and political mobilizations the "business-as-usual" scenario might prevail.

6. Concluding Comments and Research Perspectives

In this paper we have constructed a new global historical database on public expenditure and revenue and their components - particularly education and health expenditure - covering all world regions over the 1800-2025 period. This has allowed us to re-address a number of key issues regarding the relation between human capital, unequal opportunities and global convergence.

Our general conclusion is that the human capital revolution is not over. In spite of substantial progress in absolute terms, we still live in a world with enormous inequalities in access in education and health. E.g. per-school-age-individual public education expenditure in Sub-Saharan Africa is about 3% of Europe/North America level in 2025 in PPP terms (vs 6% in 1980 and 4% in 1950). We have also found a large impact of human capital expenditure on productivity growth over the 1800-2025 period (especially for public education and for poor countries). Estimated returns using our macro-historical database are around 10% or more, in line with micro studies. Finally, we have shown with counterfactual simulations that convergence in human capital expenditure could lead to global productivity convergence by 2100 (around 100€/hour in all regions in our benchmark scenario). In this scenario, all countries and world regions would be better off in the long run than in the business-as-usual scenario based upon the perpetuation of current human capital expenditure.

Our findings raise very important issues which should be addressed in future research. First, the best way to finance the extra human capital expenditure would arguably be a global justice fund paid by the global rich (say the top 5% or top 1% of the world). It would be interesting to study more precisely the winners and loosers from such a system during the transition period. Next, we have entirely ignored in this research the ecological constraints and planetary boundaries associated to global economic convergence. The financing of decarbonation and alternative energy infrastructures would put very substantial extra pressure on the global justice fund. In addition one would need to describe more precisely the structural transformation and the combination of sectoral choices and labour hours reduction which could make global convergence viable. These are key challenges for future work, and we very much hope that the results presented in this paper will contribute to stimulate further research in this area.

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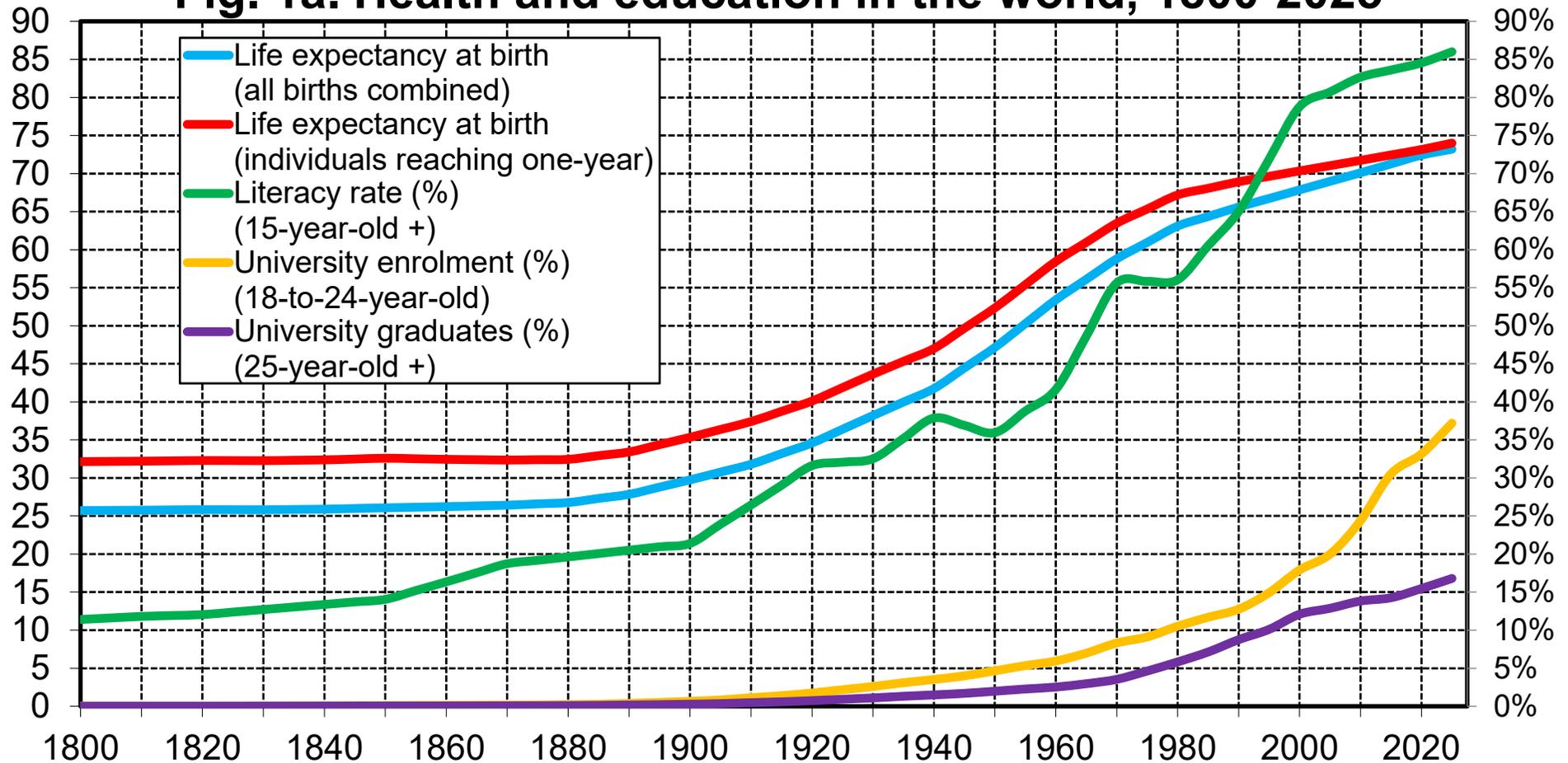
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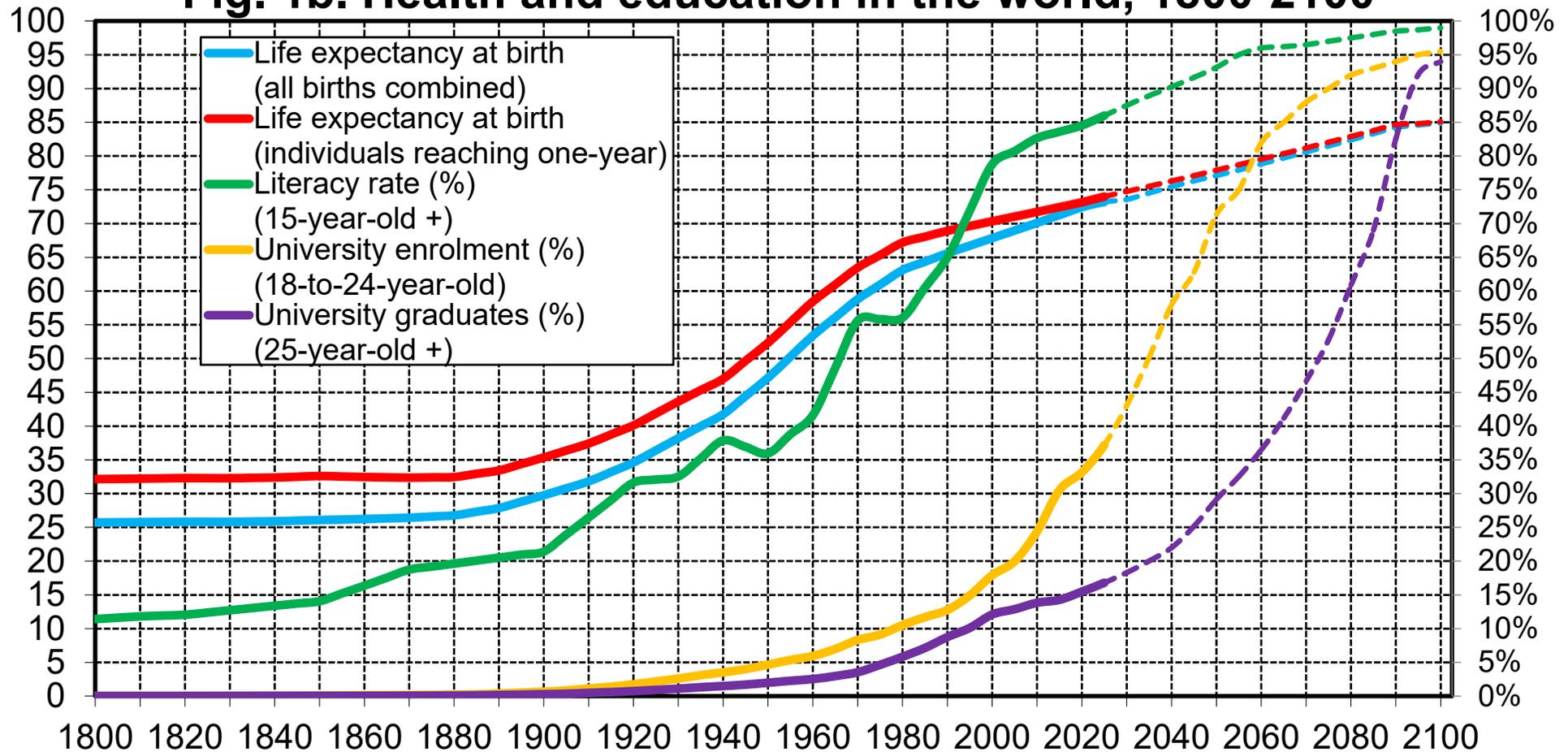
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Fig. 1a. Health and education in the world, 1800-2025

Legend:
- Life expectancy at birth (all births combined)
- Life expectancy at birth (individuals reaching one-year)
- Literacy rate (%) (15-year-old +)
- University enrolment (%) (18-to-24-year-old)
- University graduates (%) (25-year-old +)

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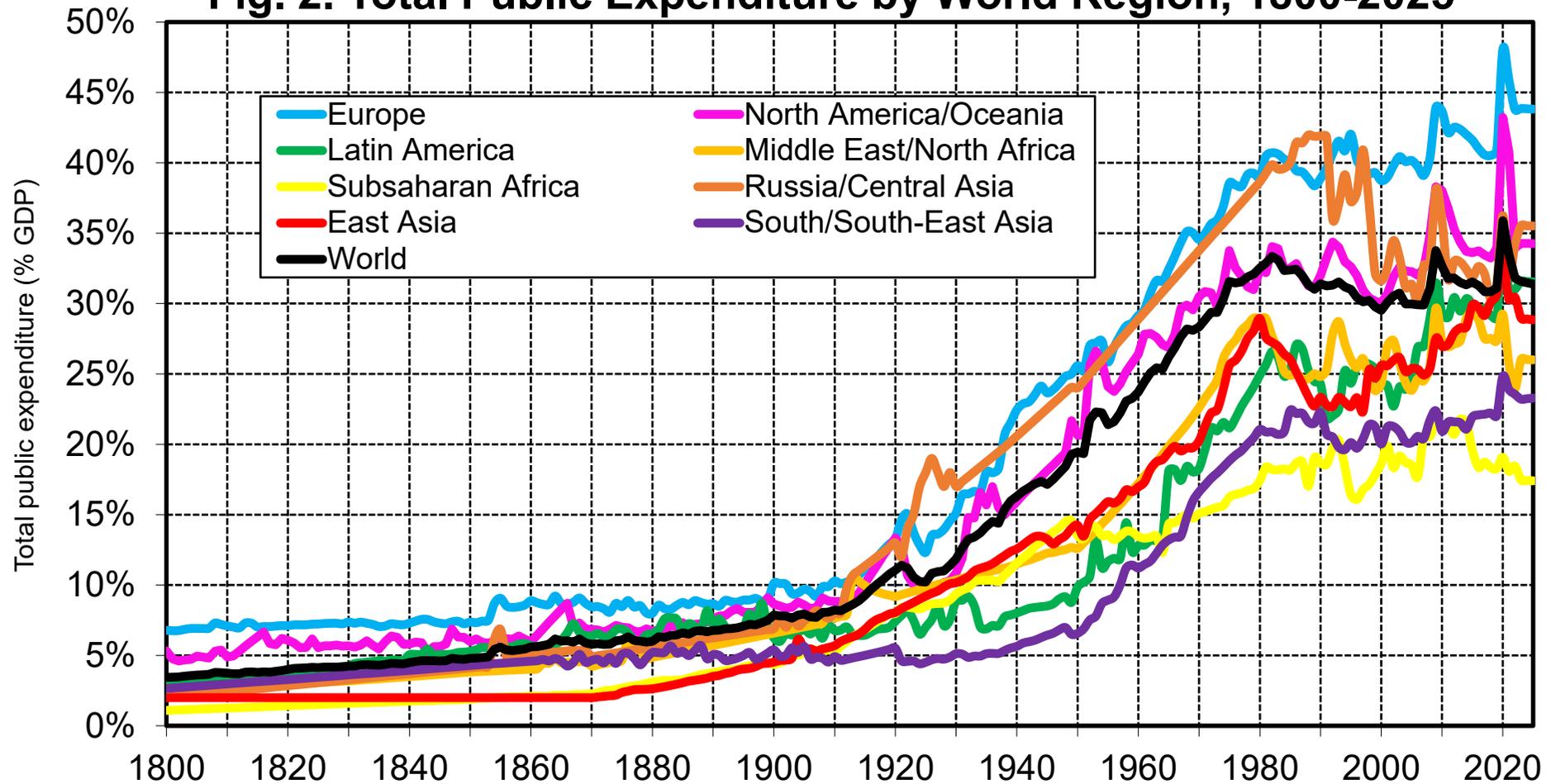
Fig. 1b. Health and education in the world, 1800-2100

Legend:
- Life expectancy at birth (all births combined)
- Life expectancy at birth (individuals reaching one-year)
- Literacy rate (%) (15-year-old +)
- University enrolment (%) (18-to-24-year-old)
- University graduates (%) (25-year-old +)

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 & proportions of university graduates could reach 95% or more. As time passes & quantitative improvements continue, the key question will increasingly become the quality of health care and education provision. **Sources and series**: wid.world
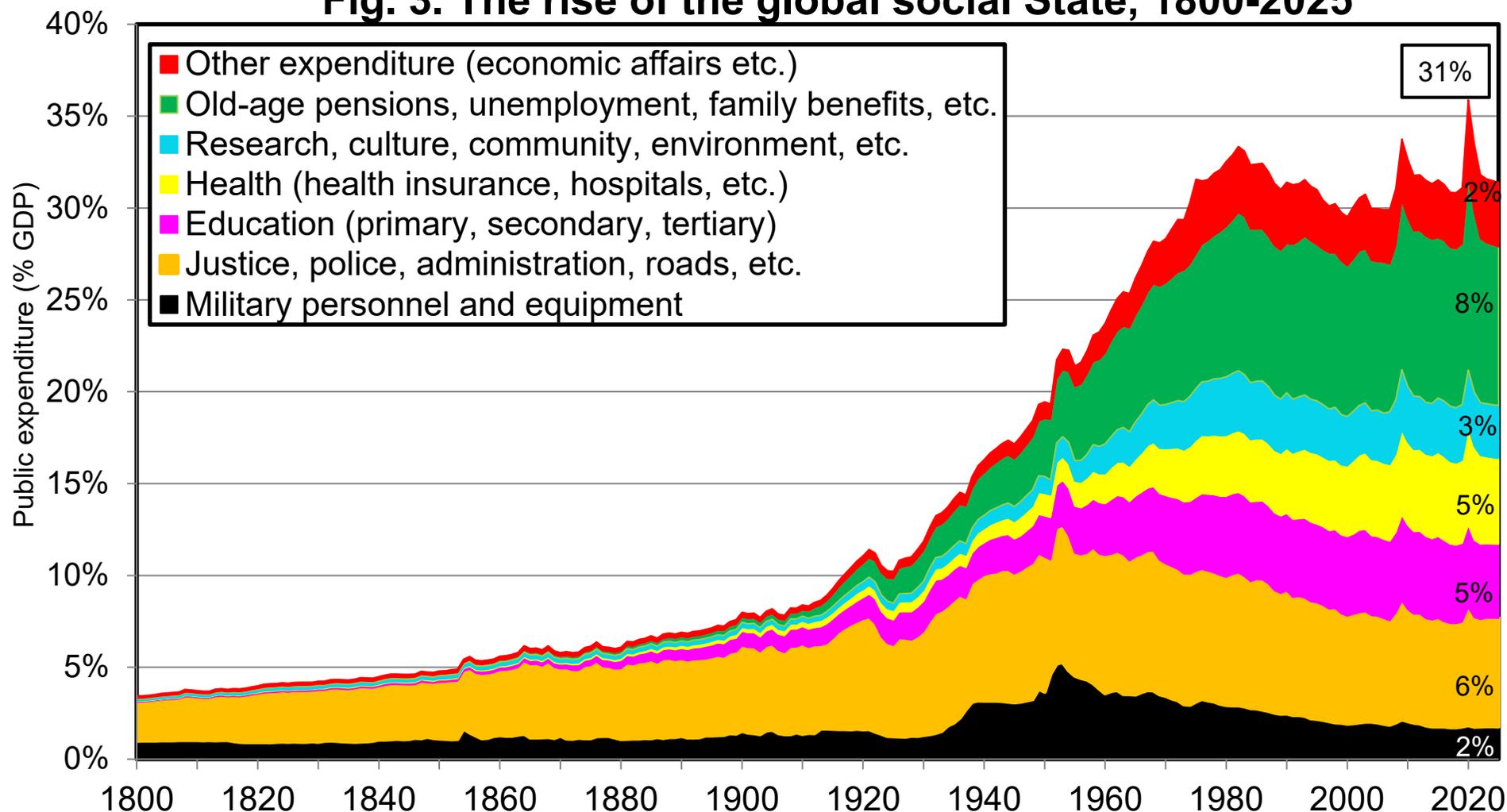
Table 1. The World Human Capital Expenditure Database (WHCE): Geographical Coverage (57 core territories = 48 main countries + 9 residual regions)	
East Asia (5)	China, Japan, South Korea, Taïwan Other EASA
Europe (11)	Britain, Denmark, France, Germany, Italy, Netherlands, Norway, Spain, Sweden, Other 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).

Fig. 2. Total Public Expenditure by World Region, 1800-2025

Legend:
- Europe
- Latin America
- Subsaharan Africa
- East Asia
- World
- North America/Oceania
- Middle East/North Africa
- Russia/Central Asia
- South/South-East Asia
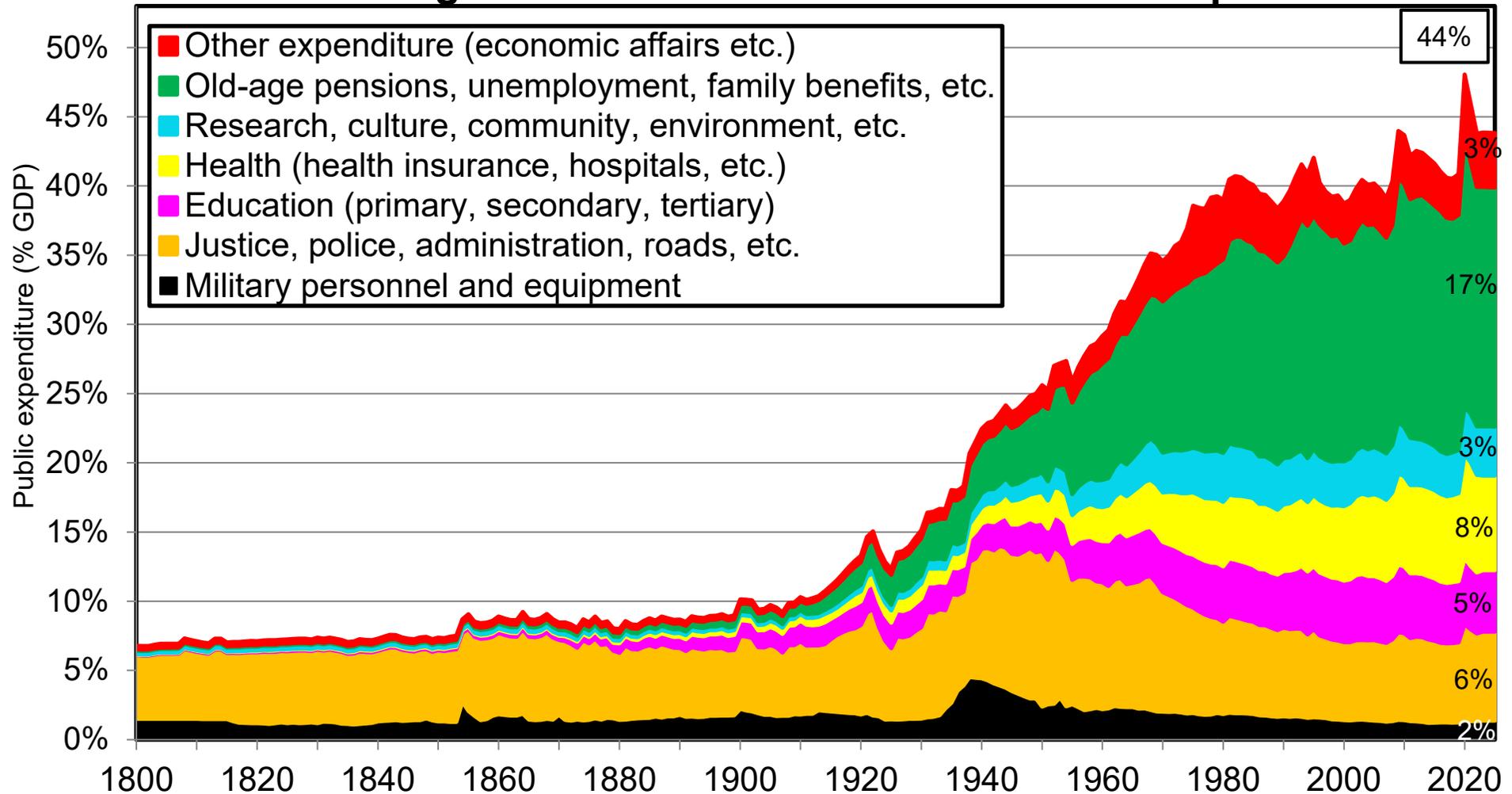
Y-axis: Total public expenditure (% GDP)

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

Fig. 3. The rise of the global social State, 1800-2025

Legend:
- Other expenditure (economic affairs etc.)
- Old-age pensions, unemployment, family benefits, etc.
- Research, culture, community, environment, etc.
- Health (health insurance, hospitals, etc.)
- Education (primary, secondary, tertiary)
- Justice, police, administration, roads, etc.
- Military personnel and equipment
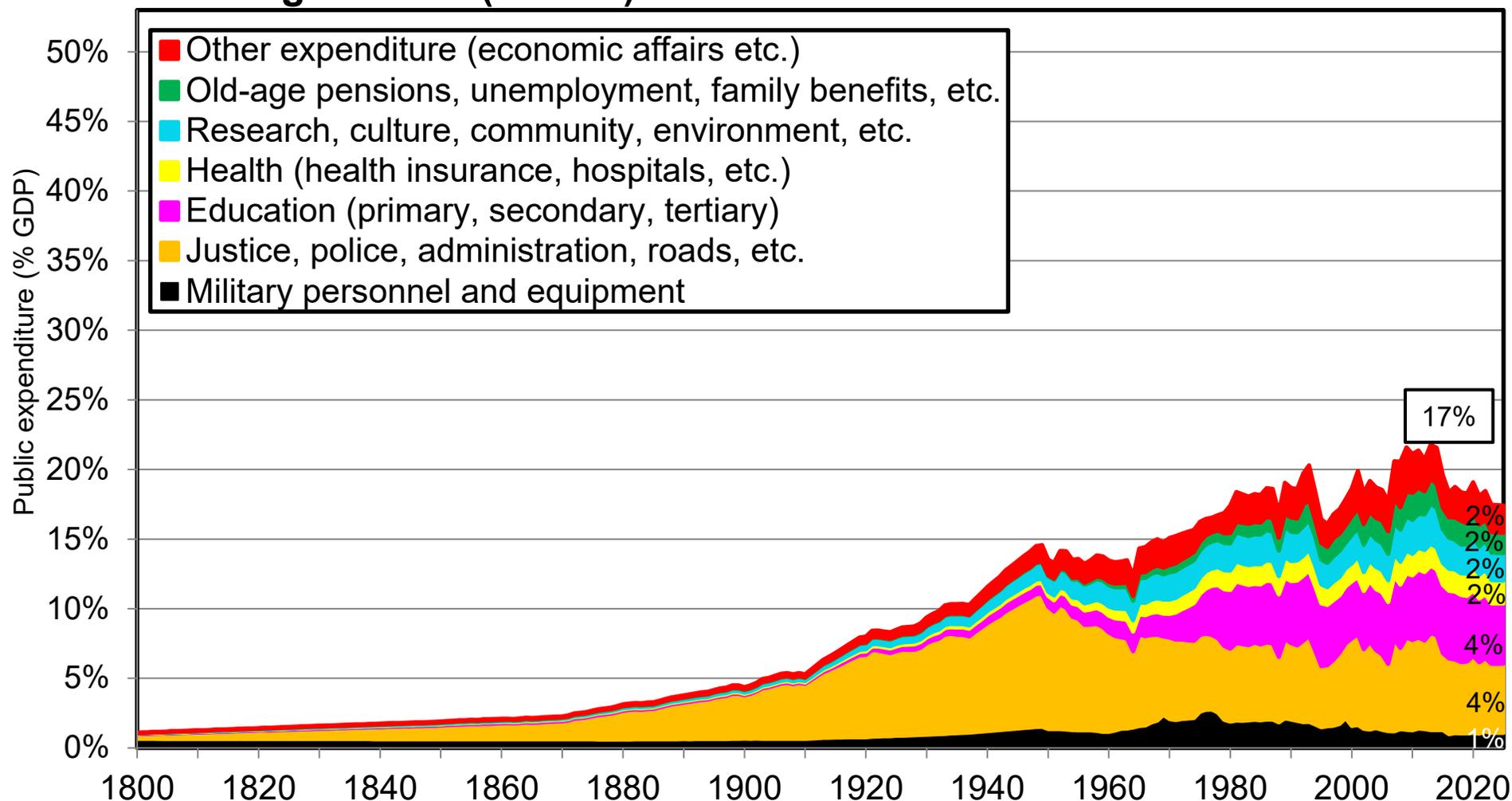
Y-axis: Public expenditure (% GDP)

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
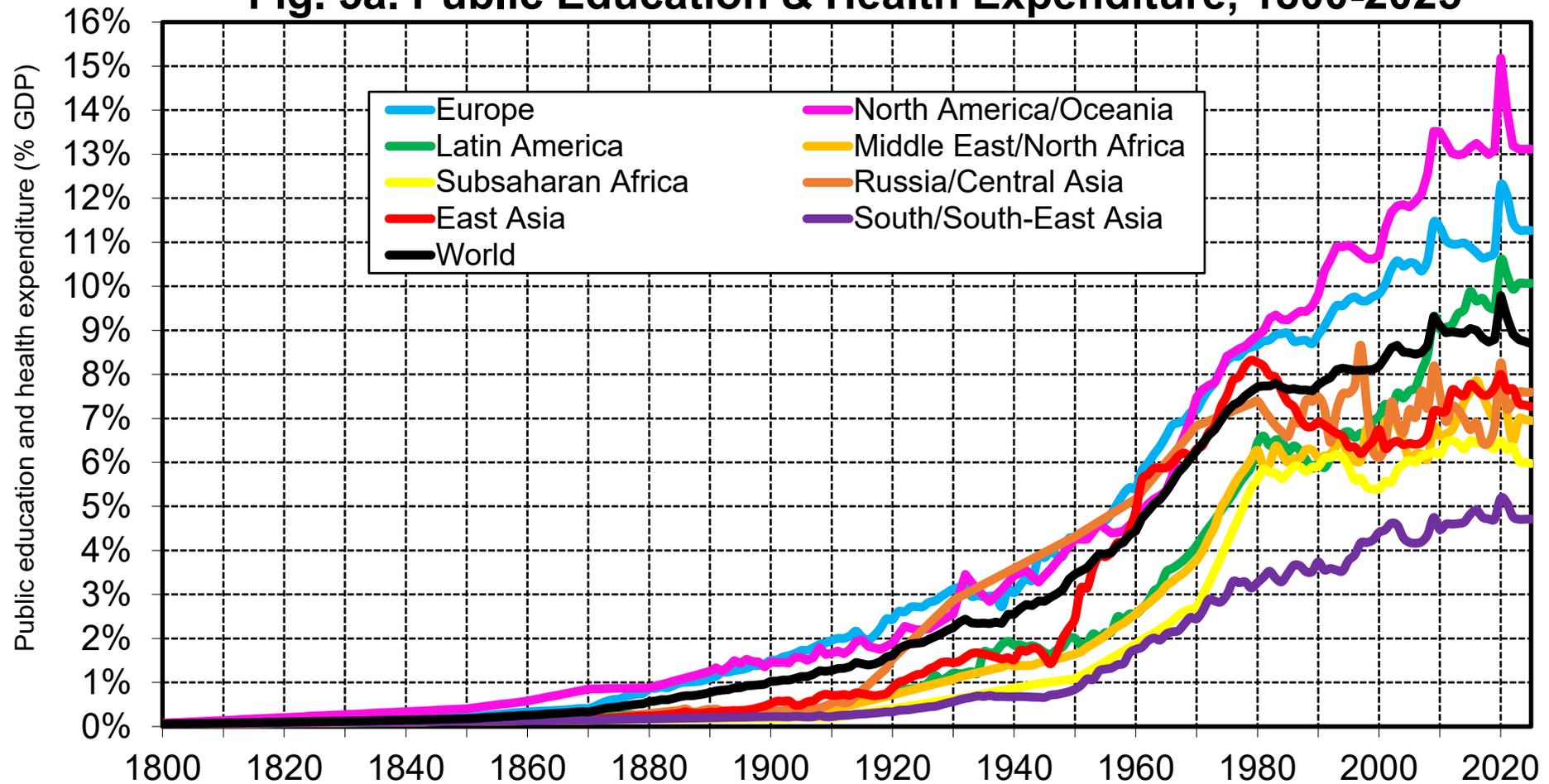
Fig. 4a. The rise of the social State: Europe

Legend:
- Other expenditure (economic affairs etc.)
- Old-age pensions, unemployment, family benefits, etc.
- Research, culture, community, environment, etc.
- Health (health insurance, hospitals, etc.)
- Education (primary, secondary, tertiary)
- Justice, police, administration, roads, etc.
- Military personnel and equipment

Y-axis: Public expenditure (% GDP), from 0% to 50%
X-axis: 1800 to 2020

Labels at right: 44%, 3%, 17%, 3%, 8%, 5%, 6%, 2%

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

Fig. 4b. The (limited) rise of the social State: Subsaharan Africa
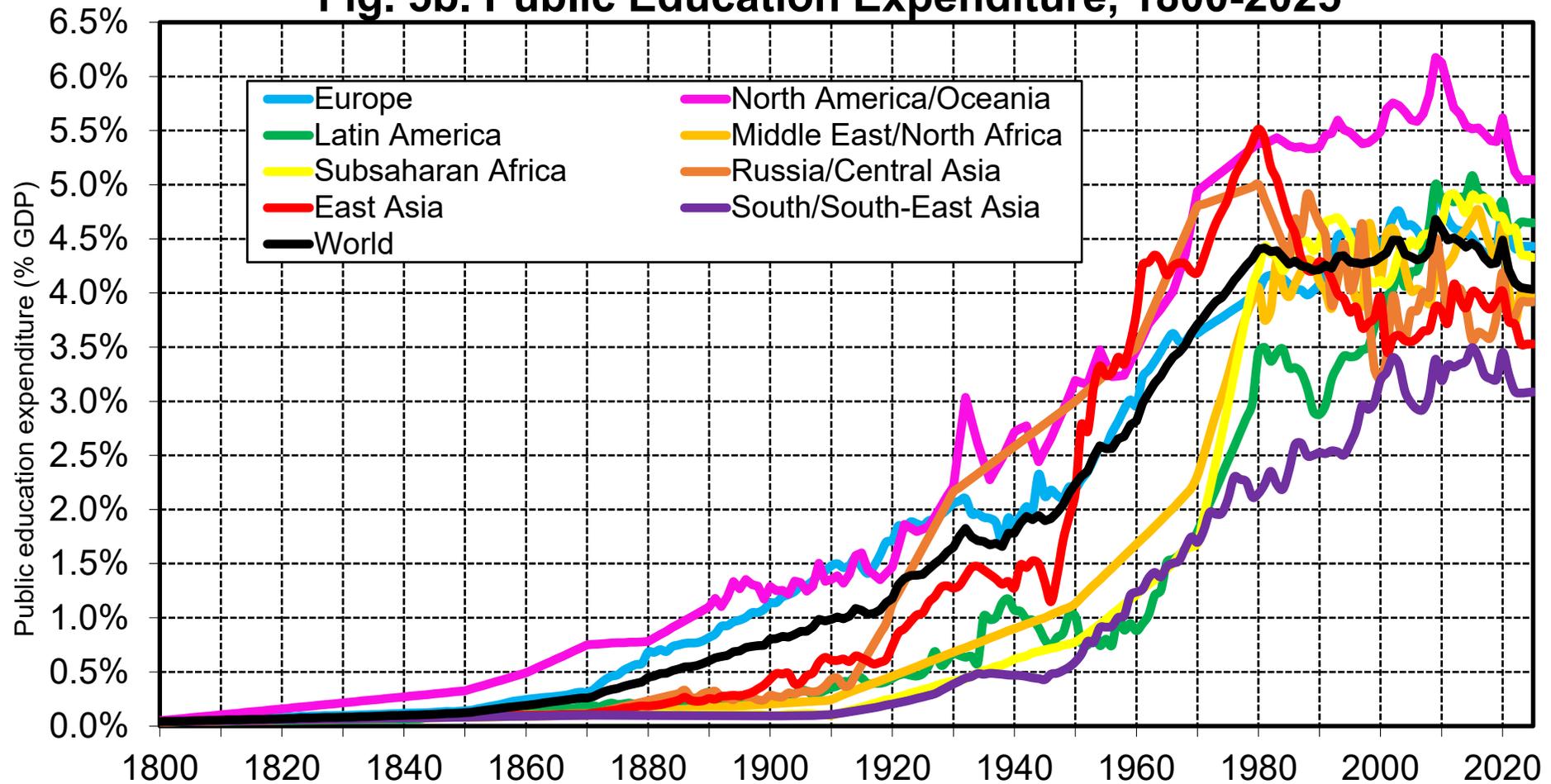

Legend:
- ■ Other expenditure (economic affairs etc.)
- ■ Old-age pensions, unemployment, family benefits, etc.
- ■ Research, culture, community, environment, etc.
- ■ Health (health insurance, hospitals, etc.)
- ■ Education (primary, secondary, tertiary)
- ■ Justice, police, administration, roads, etc.
- ■ Military personnel and equipment

Y-axis: Public expenditure (% GDP)

Data labels at right: 17%, 2%, 2%, 2%, 2%, 4%, 4%, 1%

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

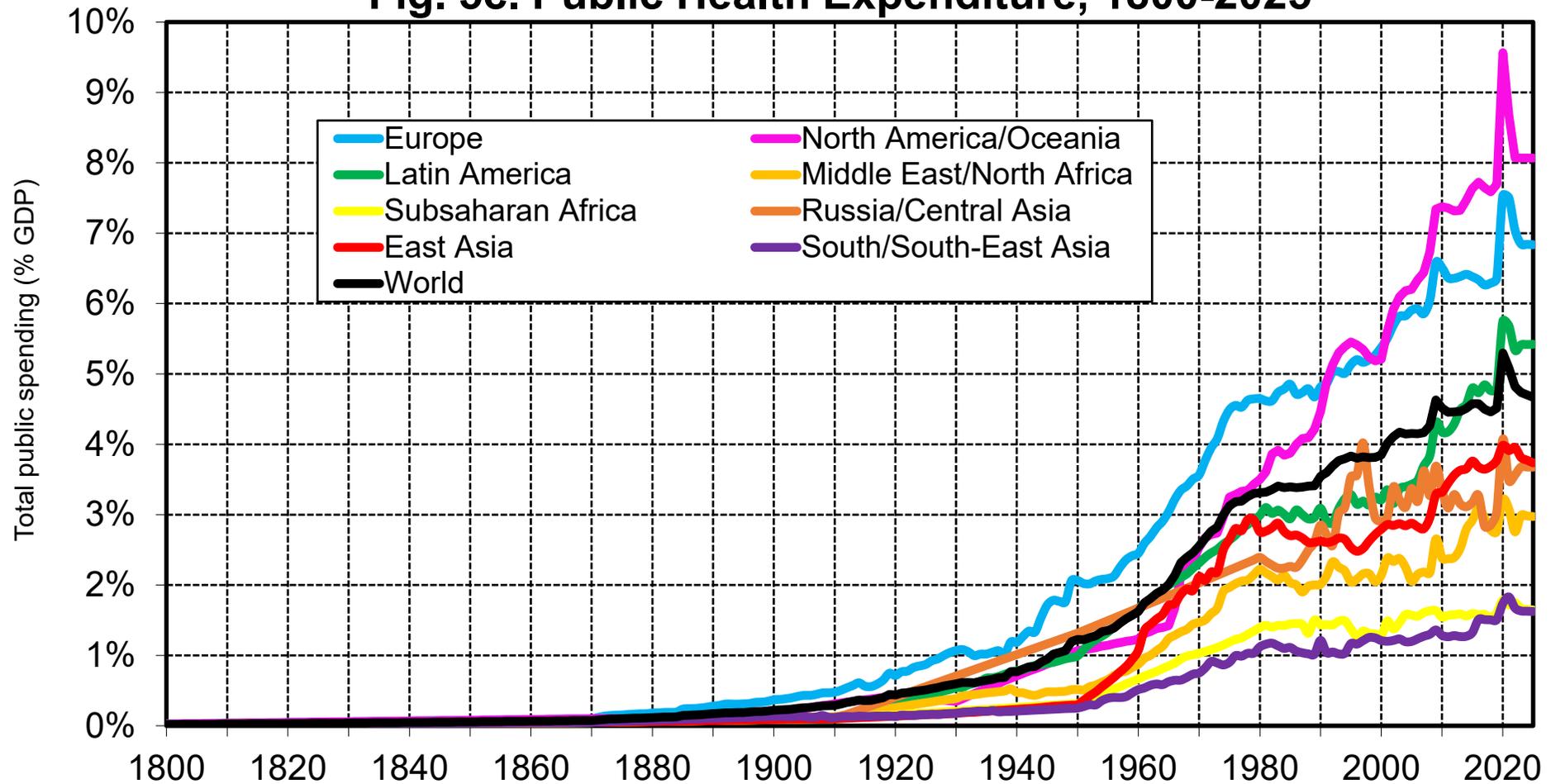# Fig. 5a. Public Education & Health Expenditure, 1800-2025

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
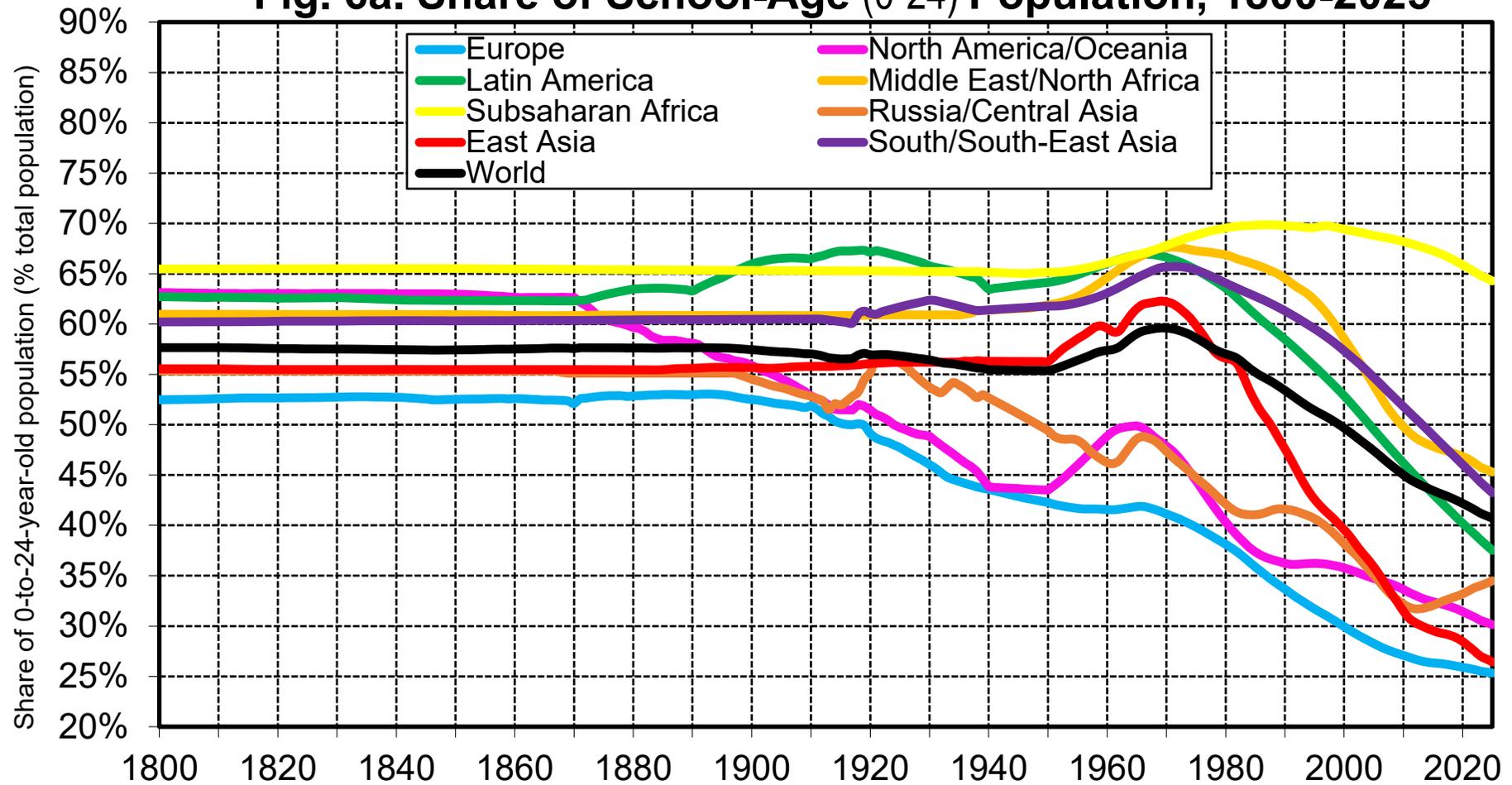
Fig. 5b. Public Education Expenditure, 1800-2025

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 meaningful comparisons. **Sources and series**: wid.world

Fig. 5c. Public Health Expenditure, 1800-2025

Legend:
- Europe
- North America/Oceania
- Latin America
- Middle East/North Africa
- Subsaharan Africa
- Russia/Central Asia
- East Asia
- South/South-East Asia
- World

Y-axis: Total public spending (% GDP), from 0% to 10%

X-axis: 1800 to 2020

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
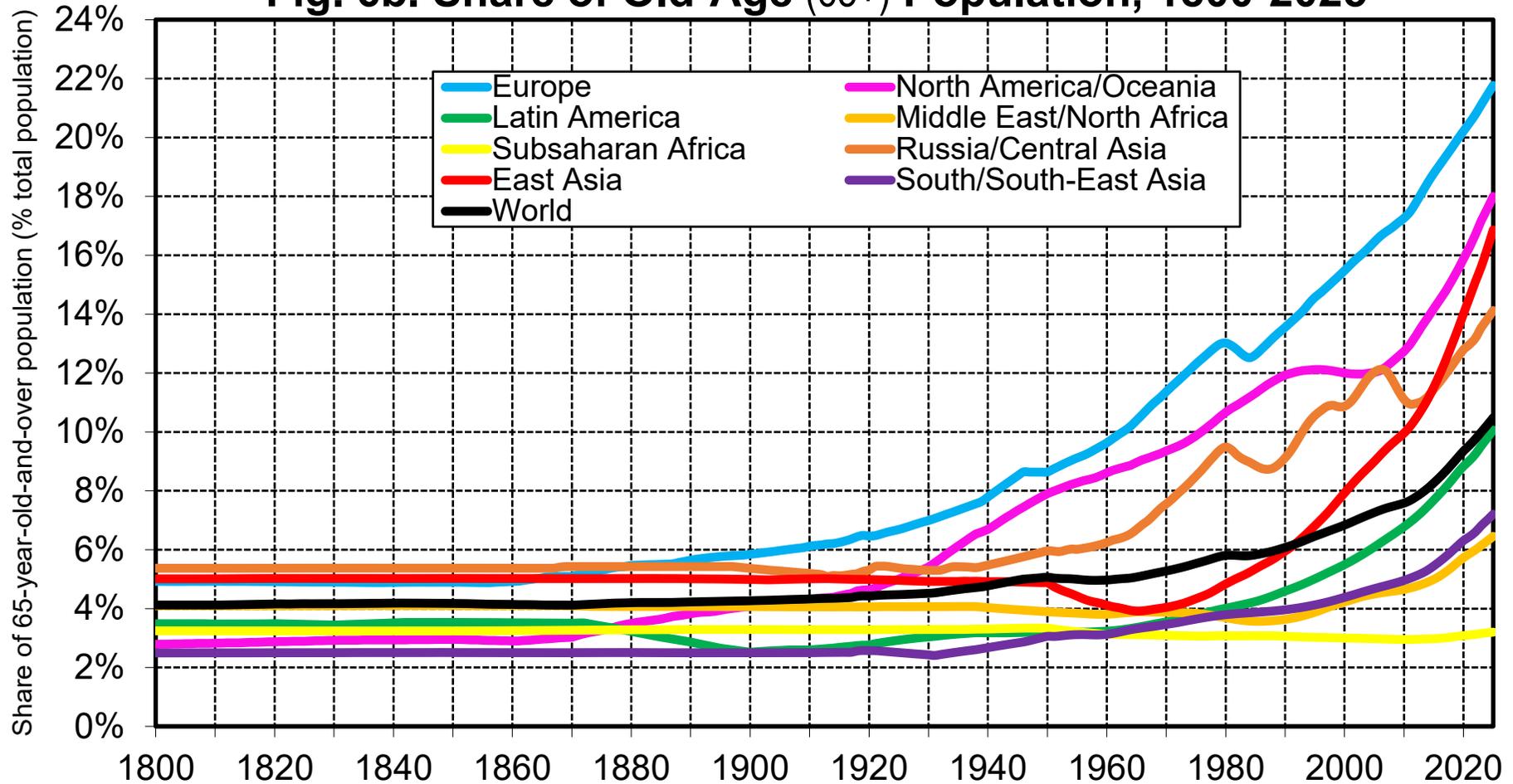
Fig. 6a. Share of School-Age (0-24) Population, 1800-2025

Legend:
- Europe
- Latin America
- Subsaharan Africa
- East Asia
- World
- North America/Oceania
- Middle East/North Africa
- Russia/Central Asia
- South/South-East Asia

Y-axis: Share of 0-to-24-year-old population (% total population)

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, it is critical to include some age adjustement in order to evaluate the impact of education expenditure.
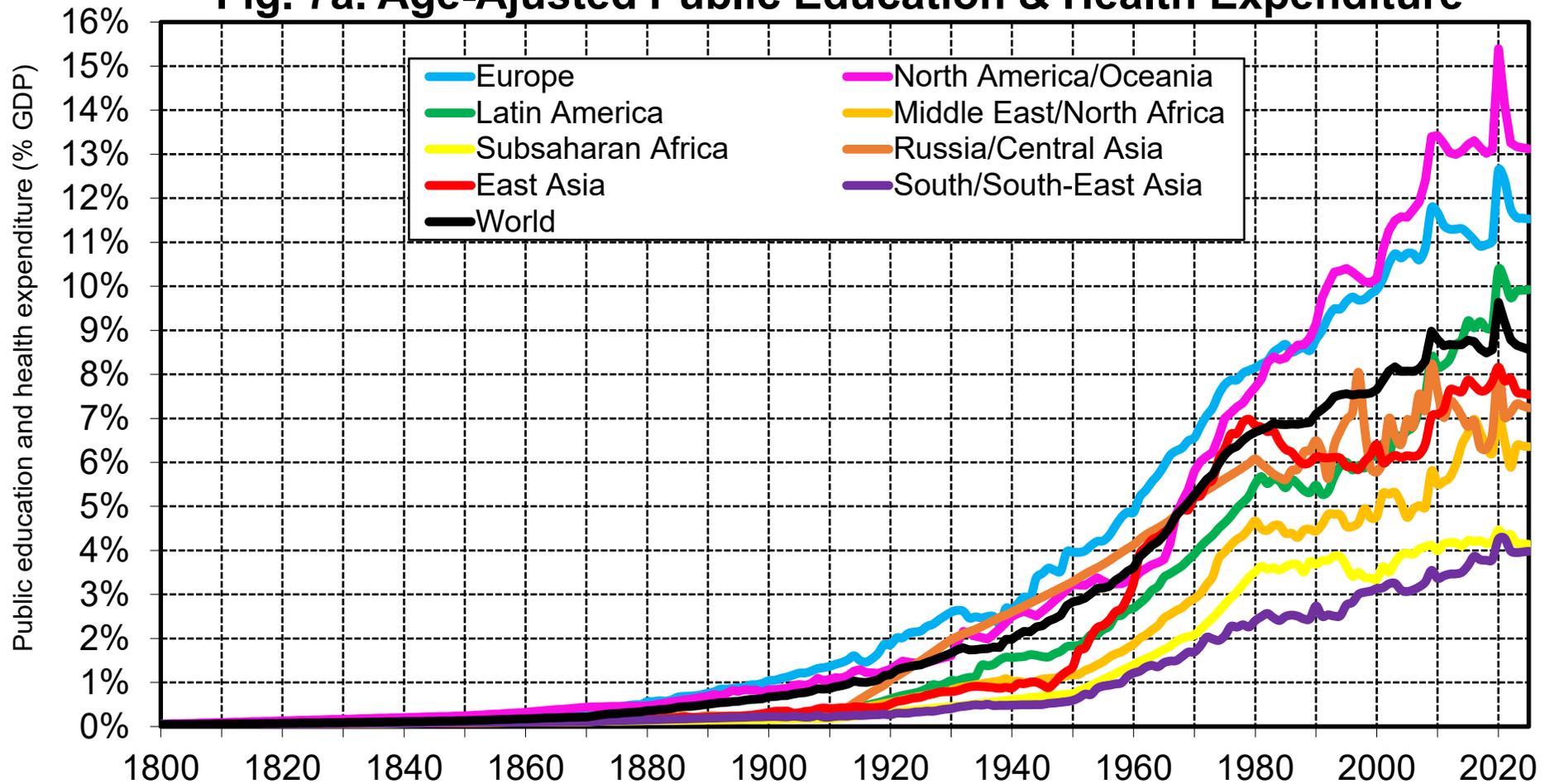**Sources and series**: see wid.world

Fig. 6b. Share of Old-Age (65+) Population, 1800-2025

Legend:
- Europe
- Latin America
- Subsaharan Africa
- East Asia
- World
- North America/Oceania
- Middle East/North Africa
- Russia/Central Asia
- South/South-East Asia

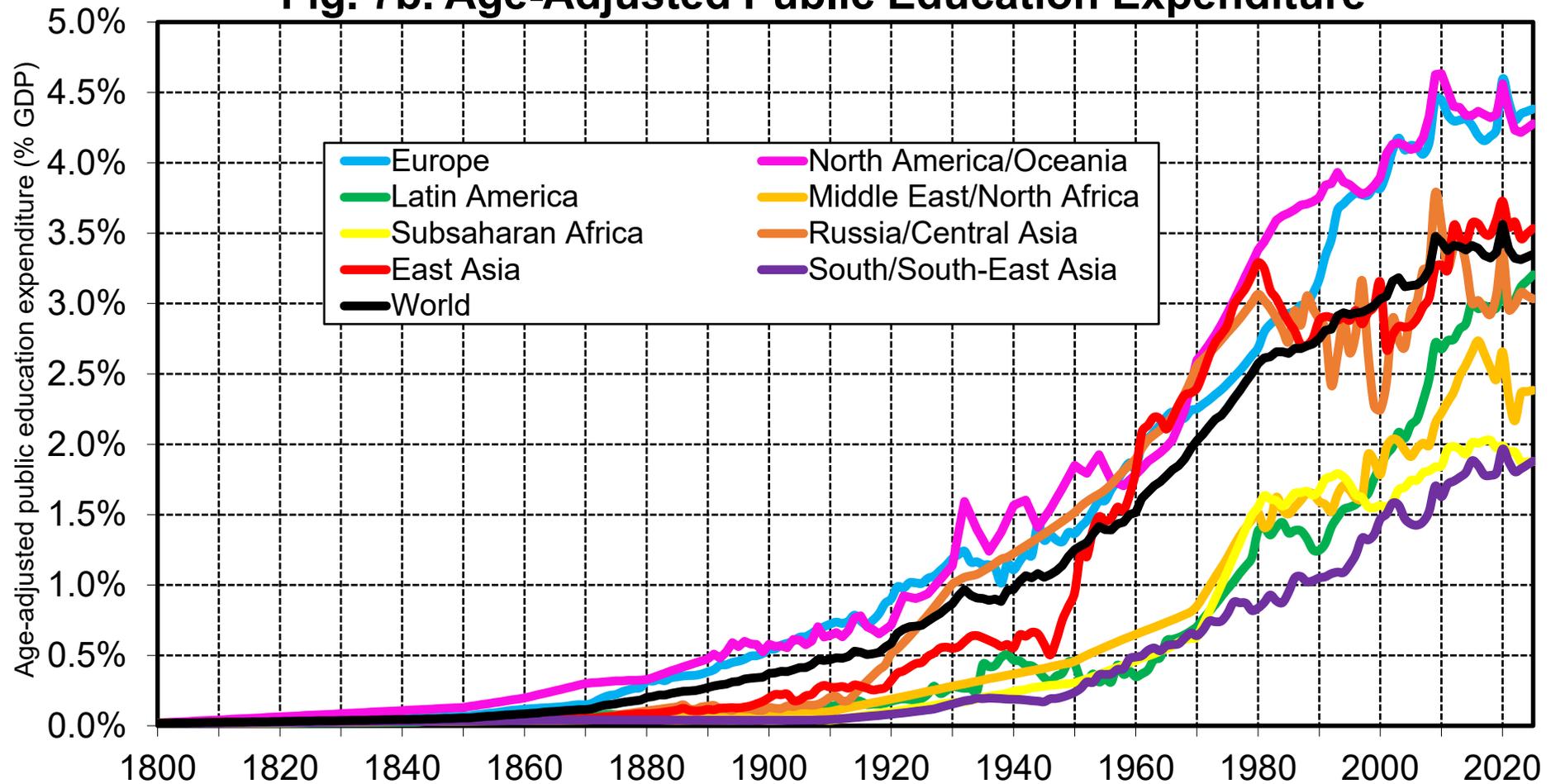Y-axis: Share of 65-year-old-and-over population (% total population)

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), it is critical to include some age adjustement in order to evaluate the impact of health expenditure. **Sources and series**: see wid.world

Fig. 7a. Age-Ajusted Public Education & Health Expenditure

Legend:
- Europe
- North America/Oceania
- Latin America
- Middle East/North Africa
- Subsaharan Africa
- Russia/Central Asia
- East Asia
- South/South-East Asia
- World

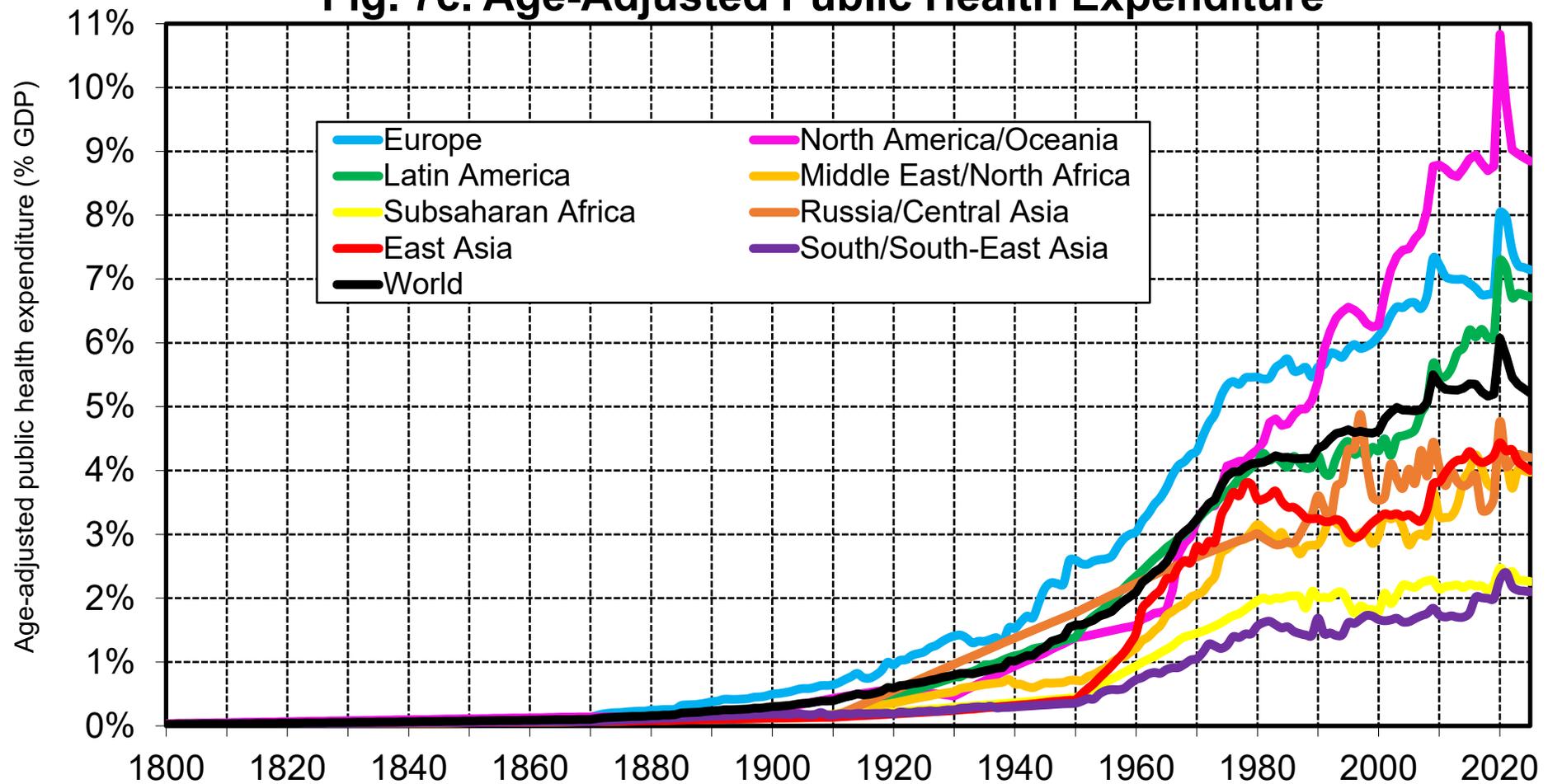Y-axis: Public education and health expenditure (% GDP), from 0% to 16%

X-axis: 1800 to 2020

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

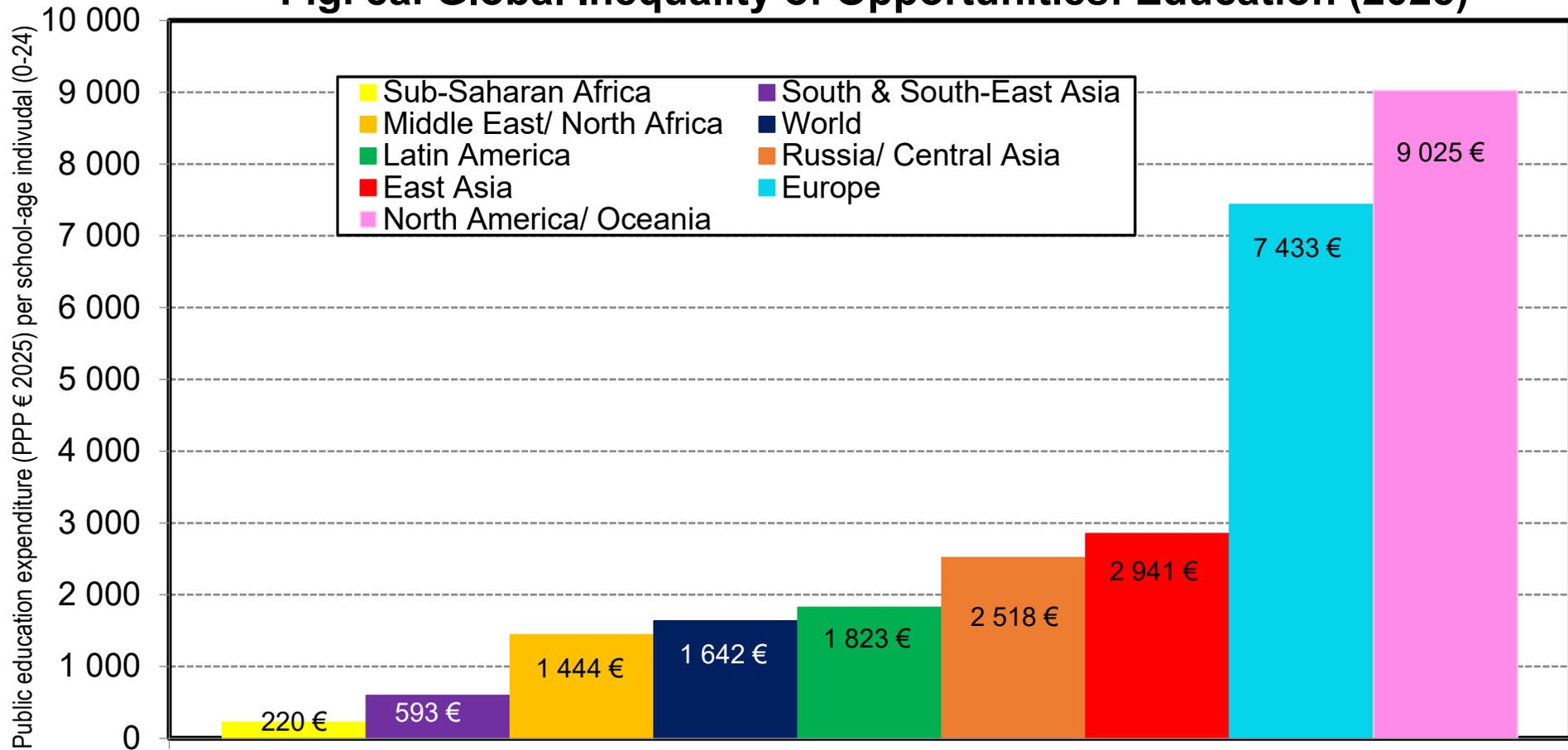# Fig. 7b. Age-Adjusted Public Education Expenditure

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

Fig. 7c. Age-Adjusted Public Health Expenditure

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
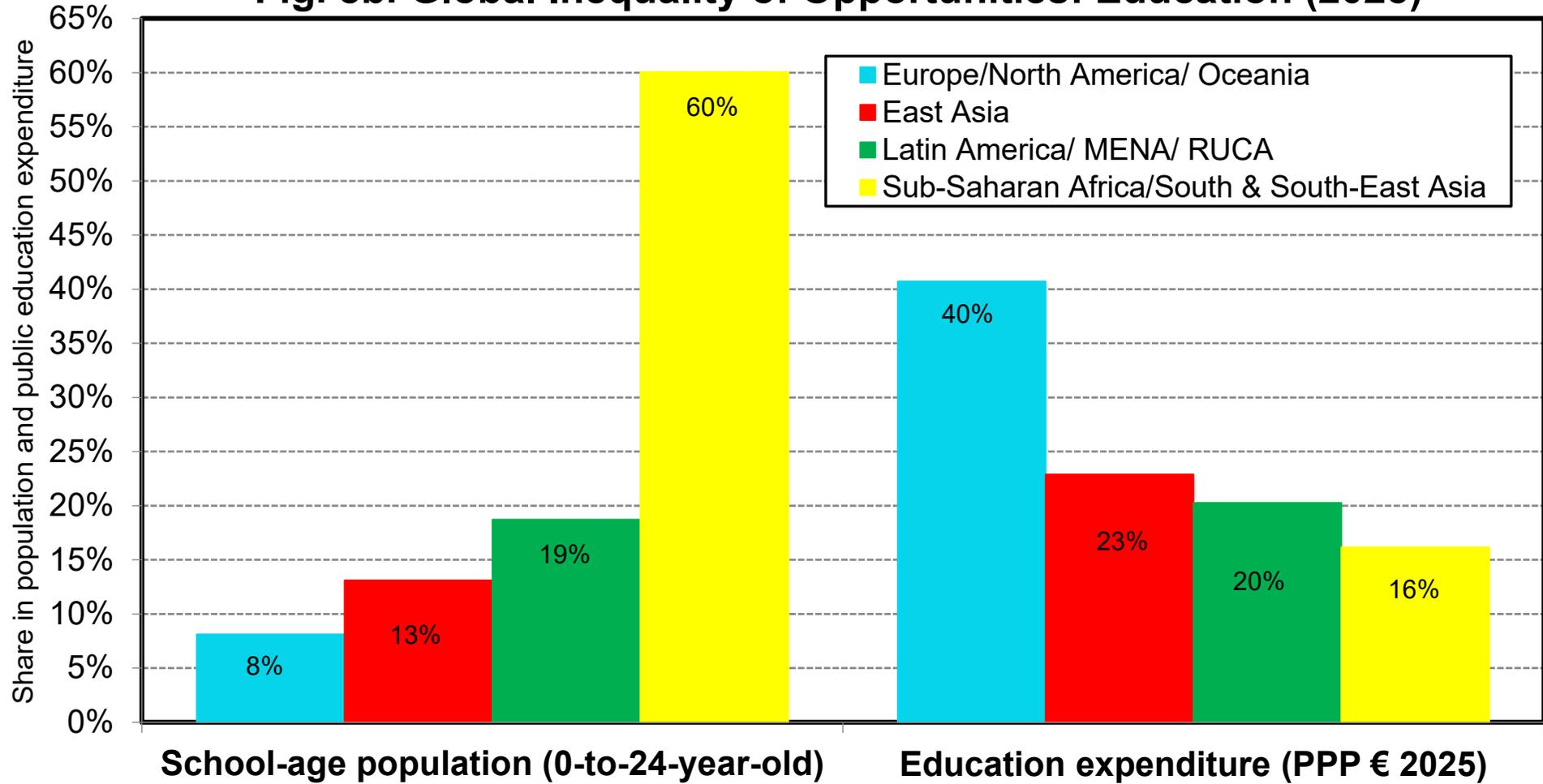
Fig. 8a. Global Inequality of Opportunities: Education (2025)

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

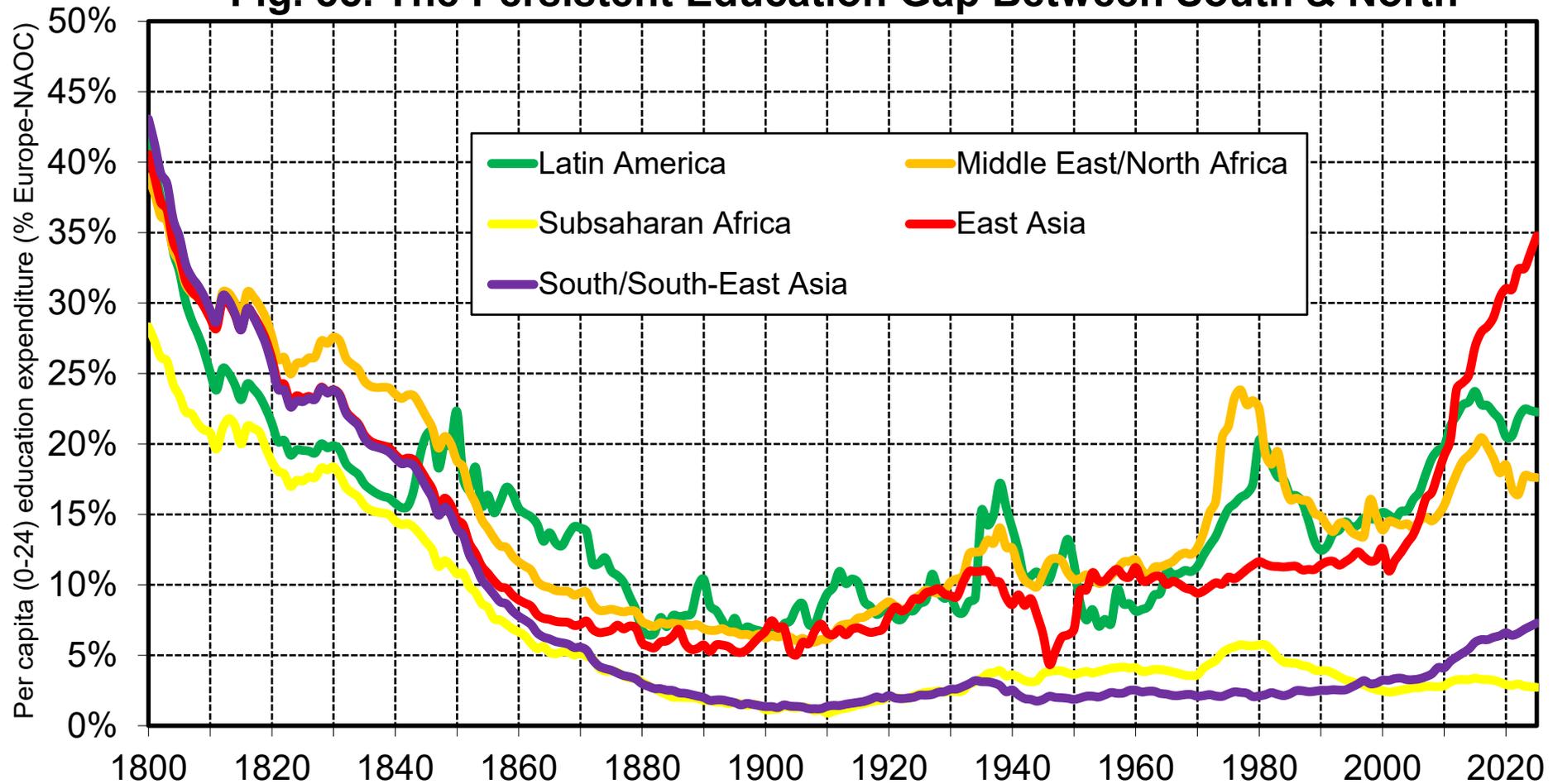Legend:
- Sub-Saharan Africa
- South & South-East Asia
- Middle East/ North Africa
- World
- Latin America
- Russia/ Central Asia
- East Asia
- Europe
- North America/ Oceania

Values:
- 220 €
- 593 €
- 1 444 €
- 1 642 €
- 1 823 €
- 2 518 €
- 2 941 €
- 7 433 €
- 9 025 €

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

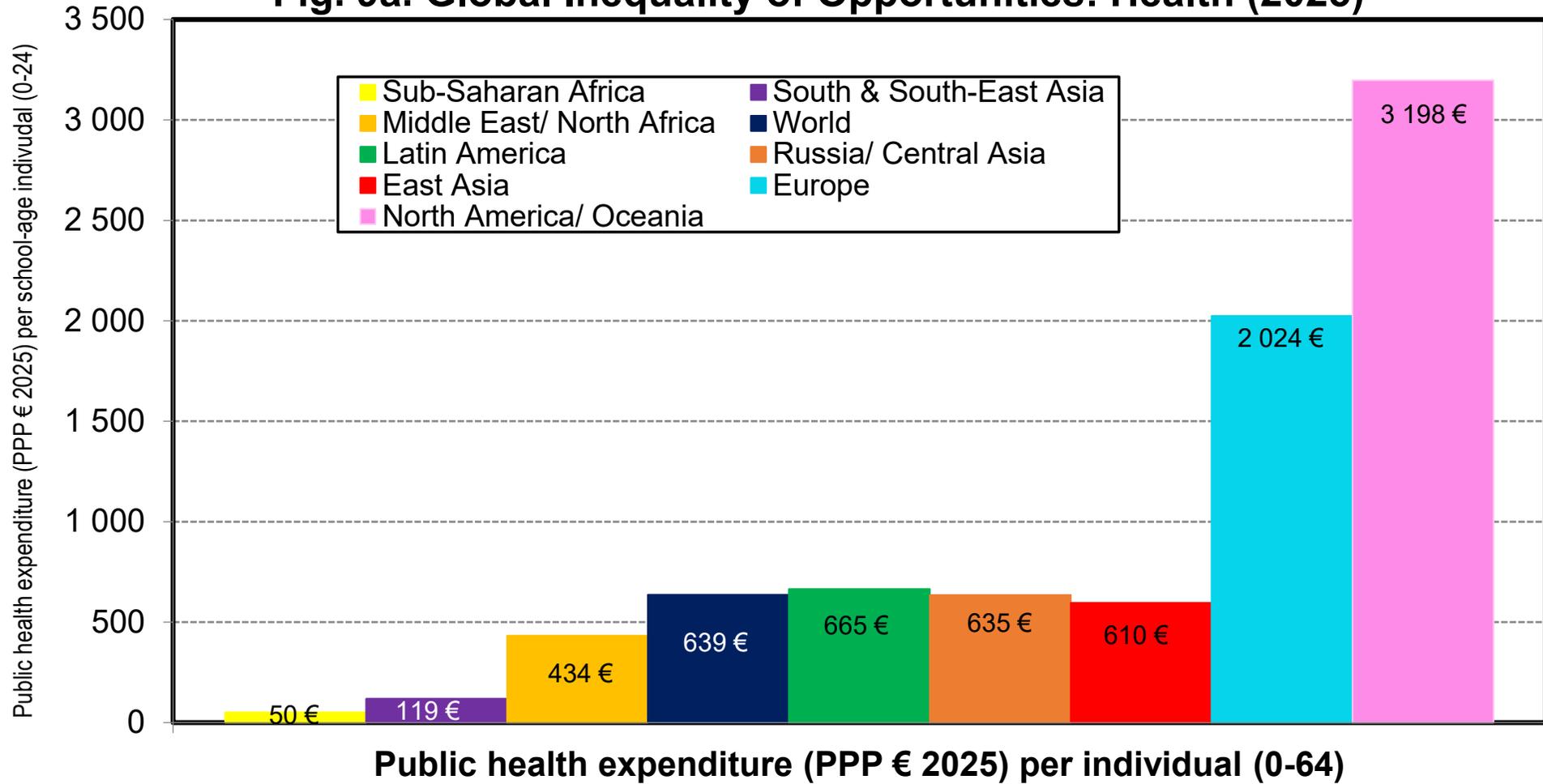# Fig. 8b. Global Inequality of Opportunities: Education (2025)

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

Fig. 8c. The Persistent Education Gap Between South & North

Legend:
- Latin America
- Middle East/North Africa
- Subsaharan Africa
- East Asia
- South/South-East Asia

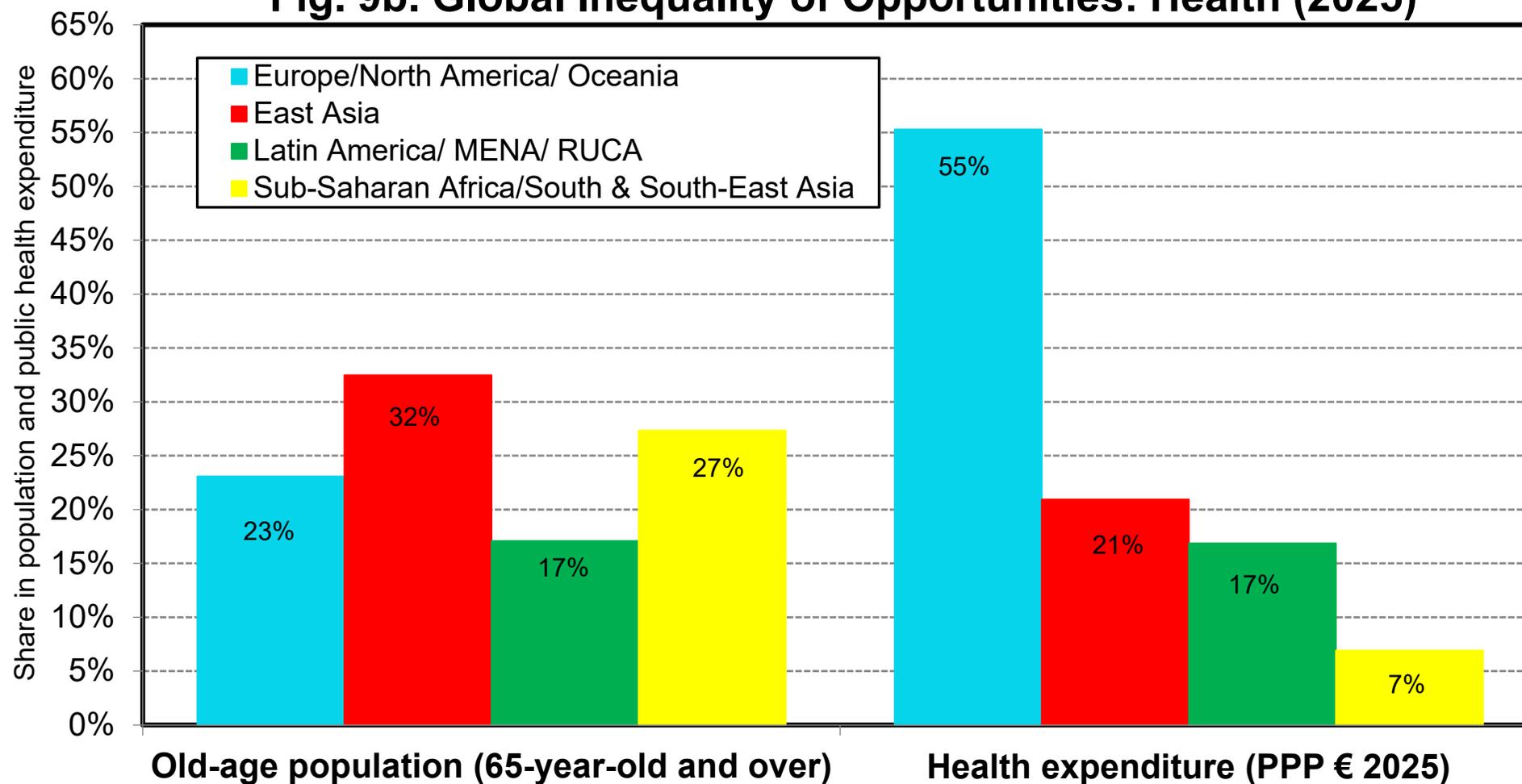Y-axis: Per capita (0-24) education expenditure (% Europe-NAOC)

X-axis: 1800 to 2020

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

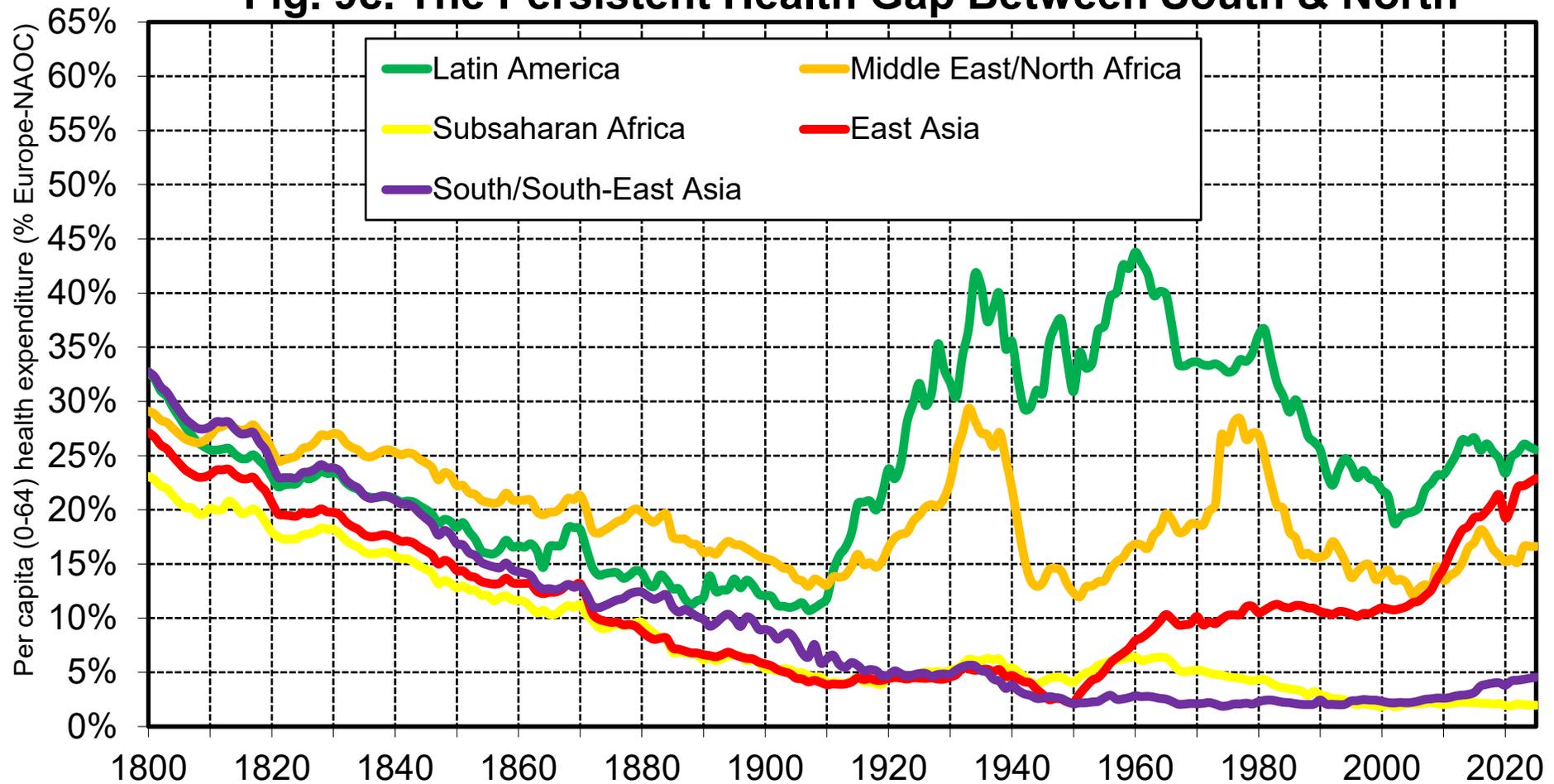# Fig. 9a. Global Inequality of Opportunities: Health (2025)

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

Legend:
- Sub-Saharan Africa
- Middle East/ North Africa
- Latin America
- East Asia
- North America/ Oceania
- South & South-East Asia
- World
- Russia/ Central Asia
- Europe

Y-axis: Public health expenditure (PPP € 2025) per school-age indivudal (0-24)

Bar values:
- 50 €
- 119 €
- 434 €
- 639 €
- 665 €
- 635 €
- 610 €
- 2 024 €
- 3 198 €

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

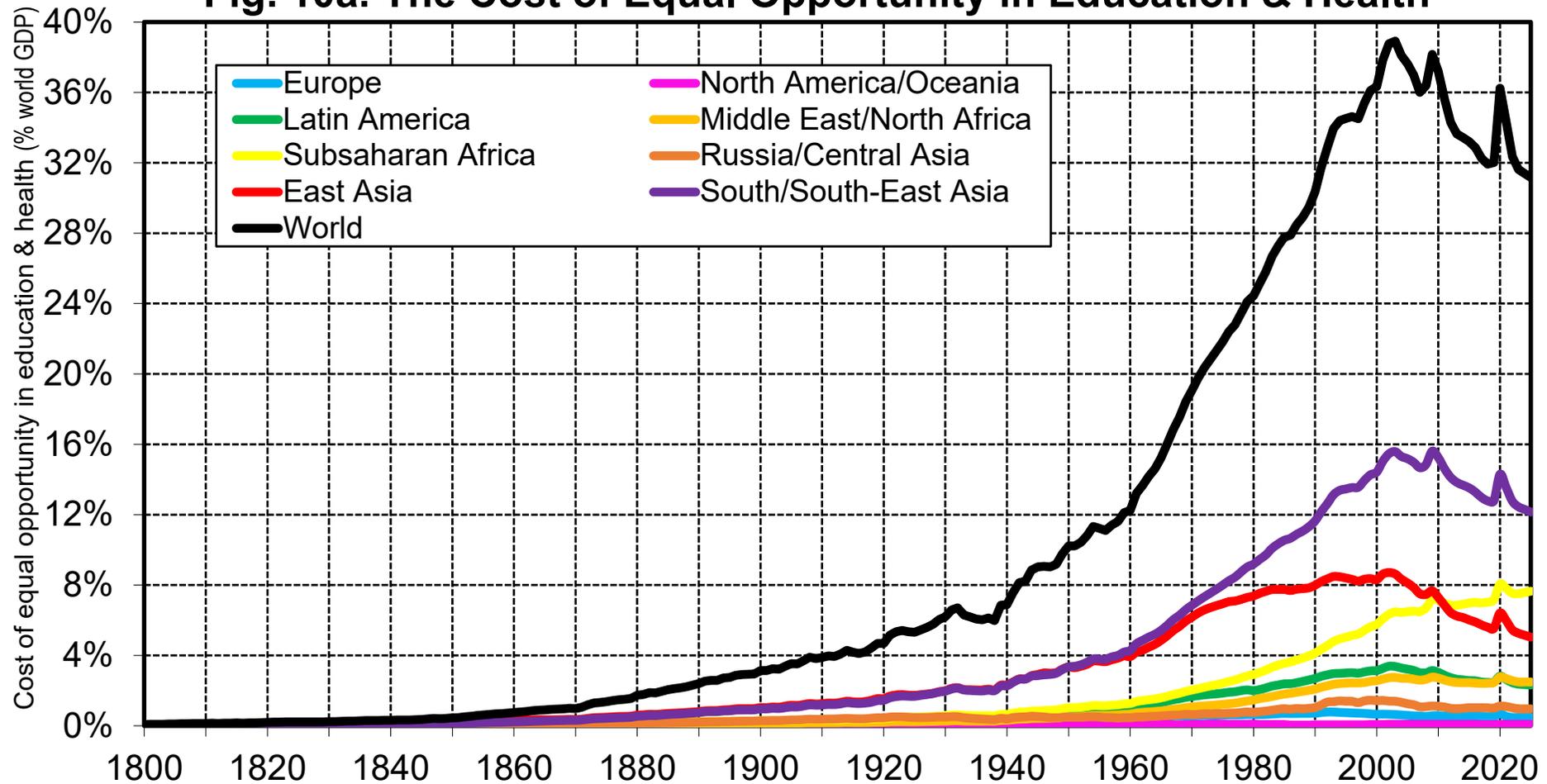# Fig. 9b. Global Inequality of Opportunities: Health (2025)

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
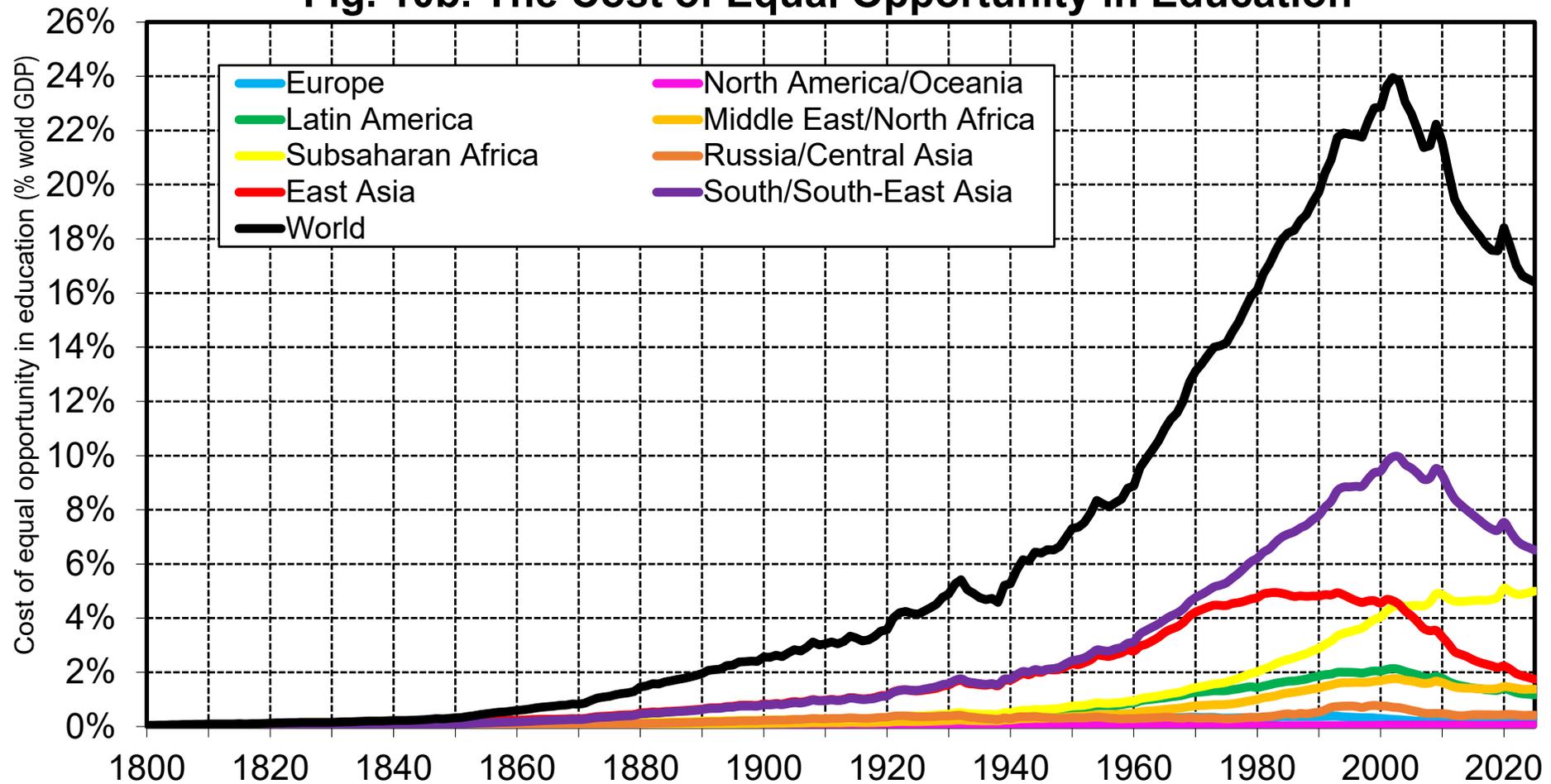
Fig. 9c. The Persistent Health Gap Between South & North

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

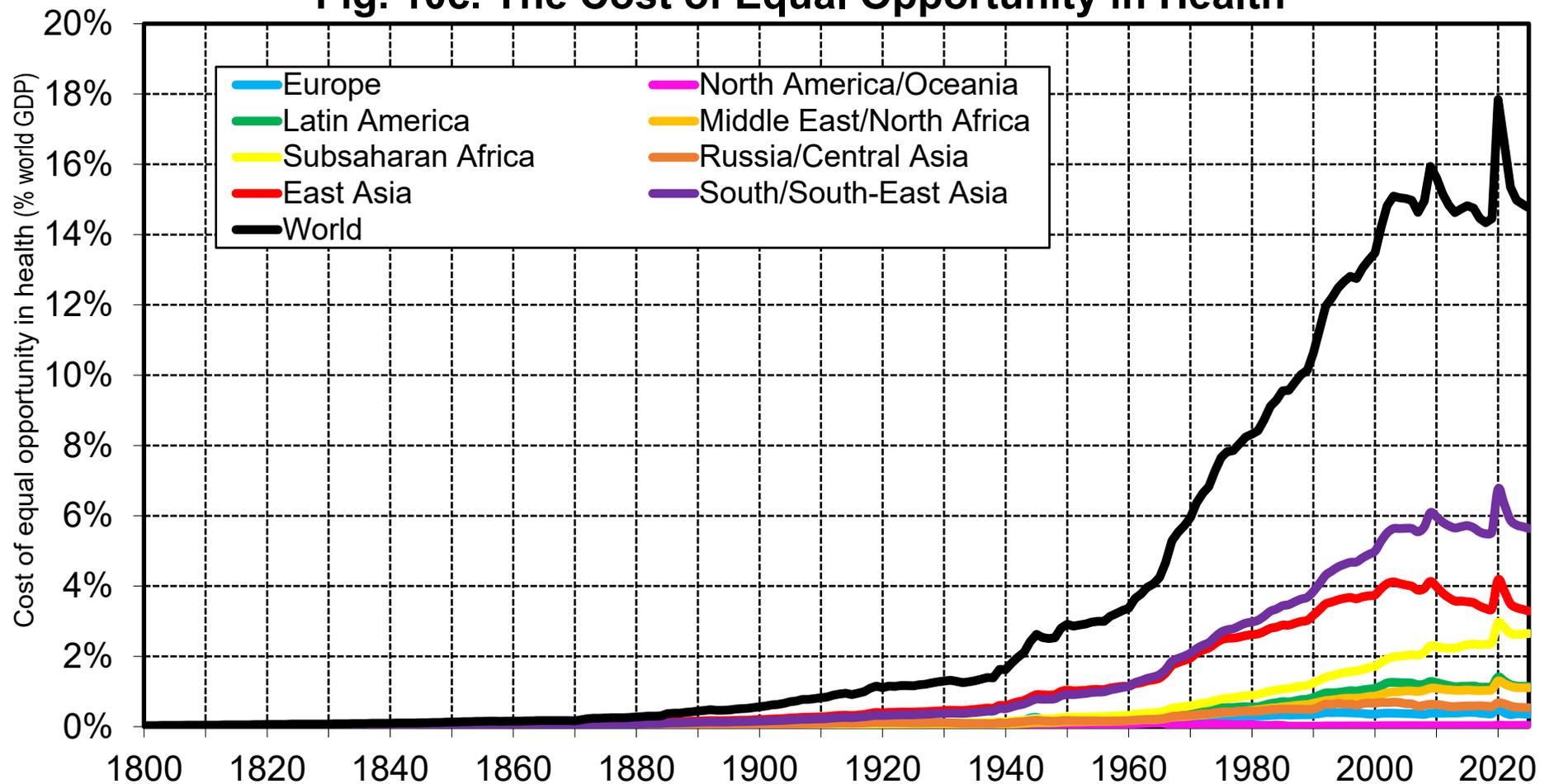# Fig. 10a. The Cost of Equal Opportunity in Education & Health

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

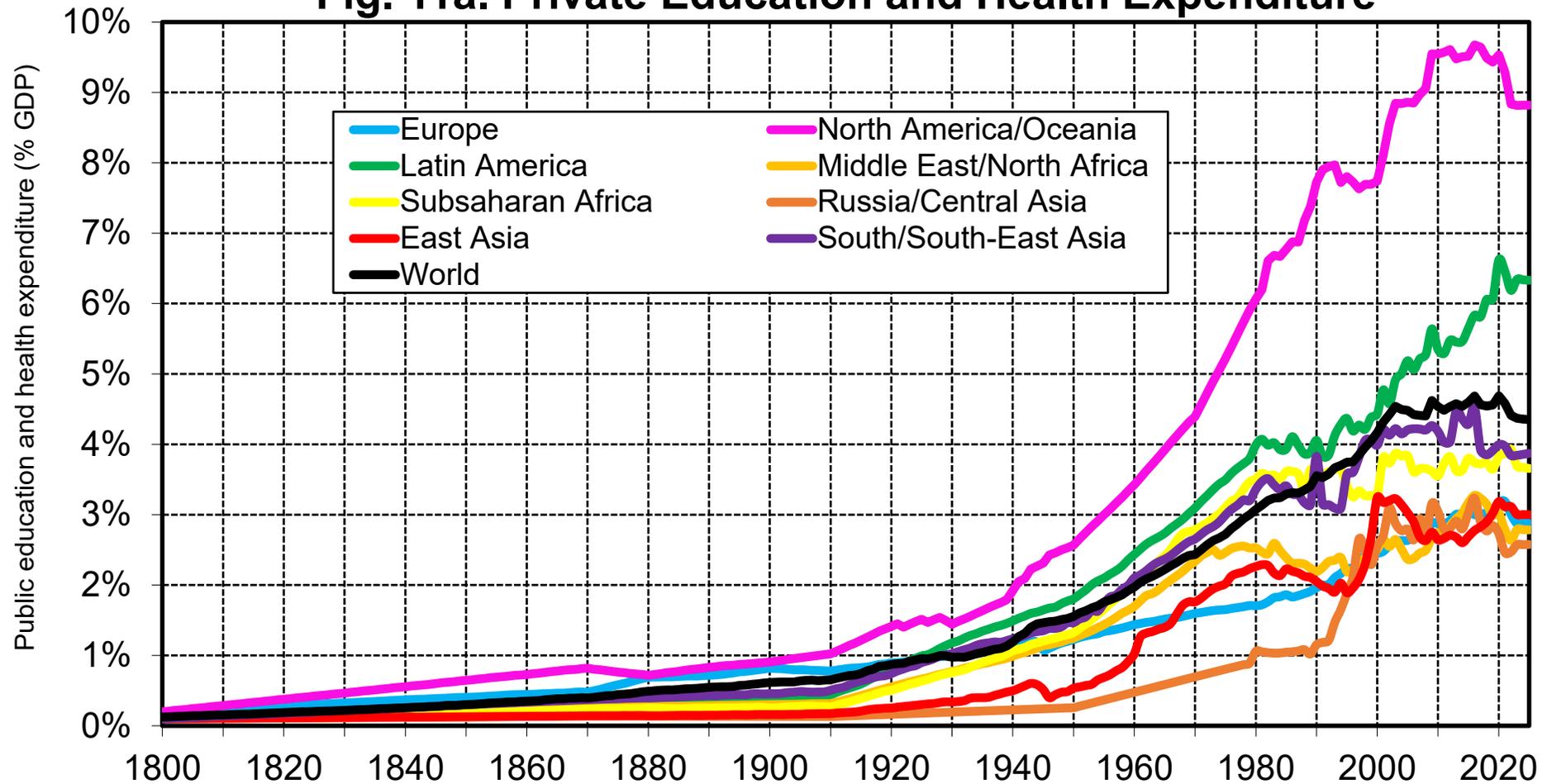# Fig. 10b. The Cost of Equal Opportunity in Education

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

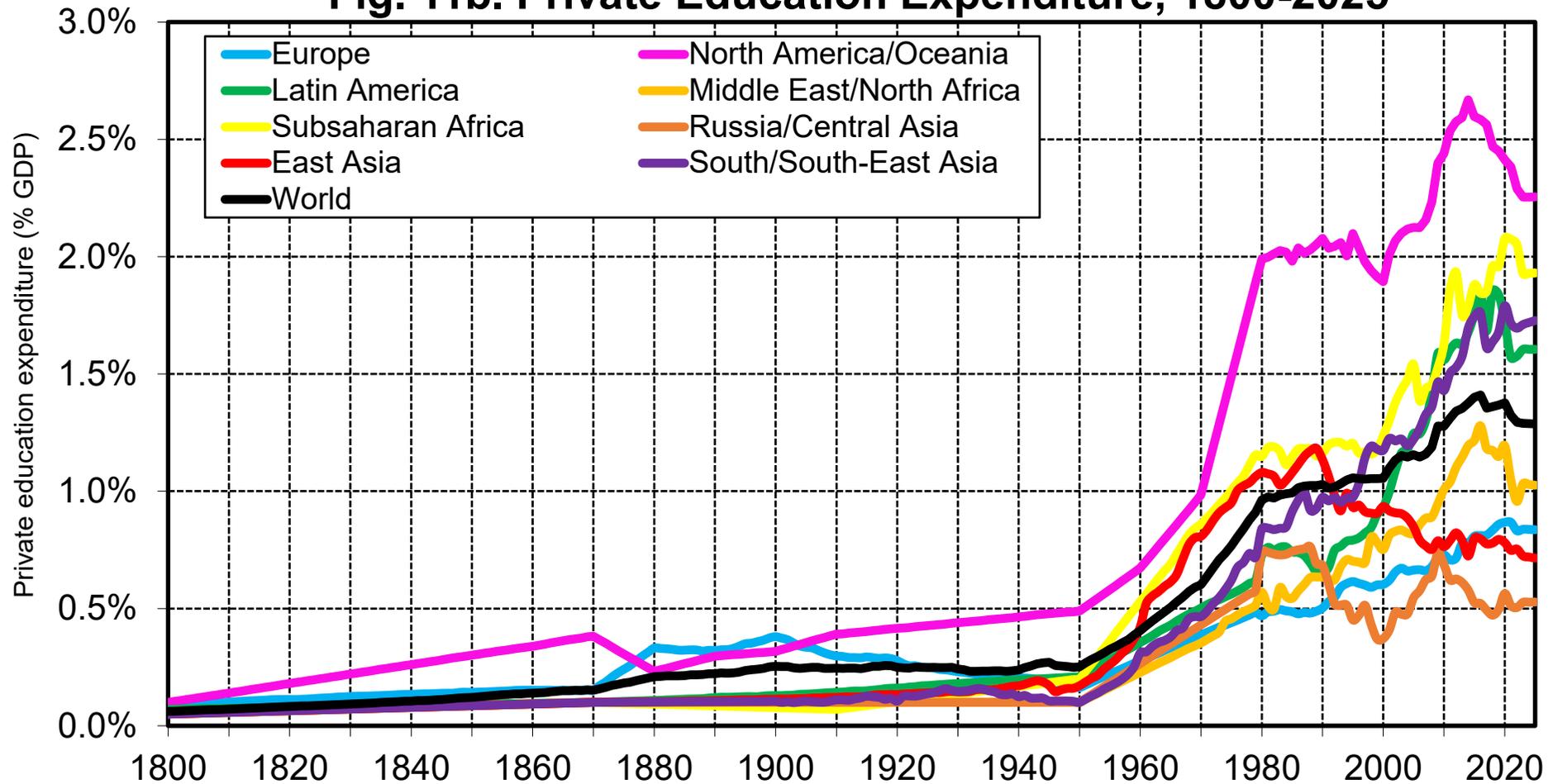# Fig. 10c. The Cost of Equal Opportunity in Health

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

Fig. 11a. Private Education and Health Expenditure

y-axis: Public education and health expenditure (% GDP)

Legend:
- Europe
- Latin America
- Subsaharan Africa
- East Asia
- World
- North America/Oceania
- Middle East/North Africa
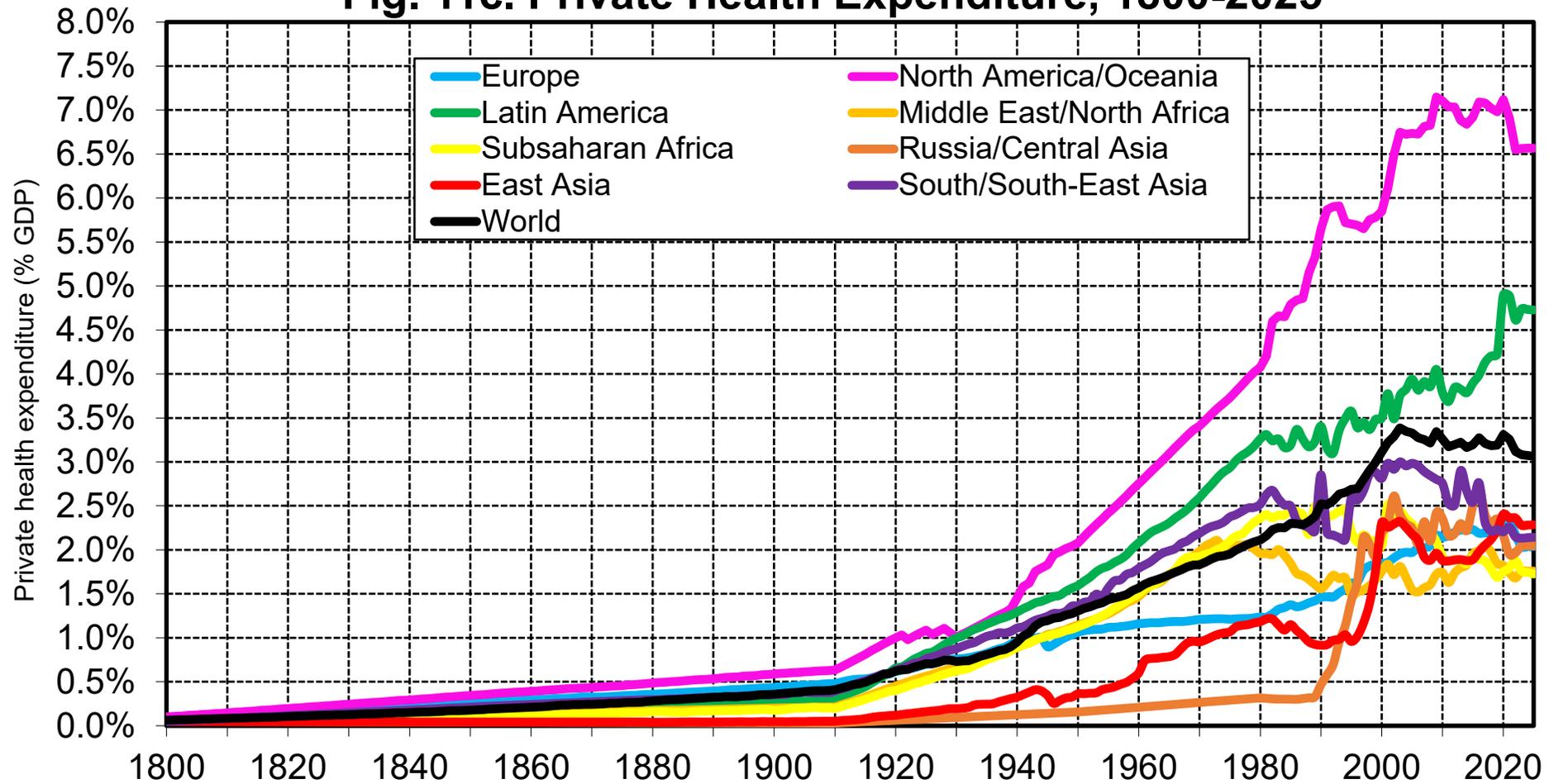- Russia/Central Asia
- South/South-East Asia

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

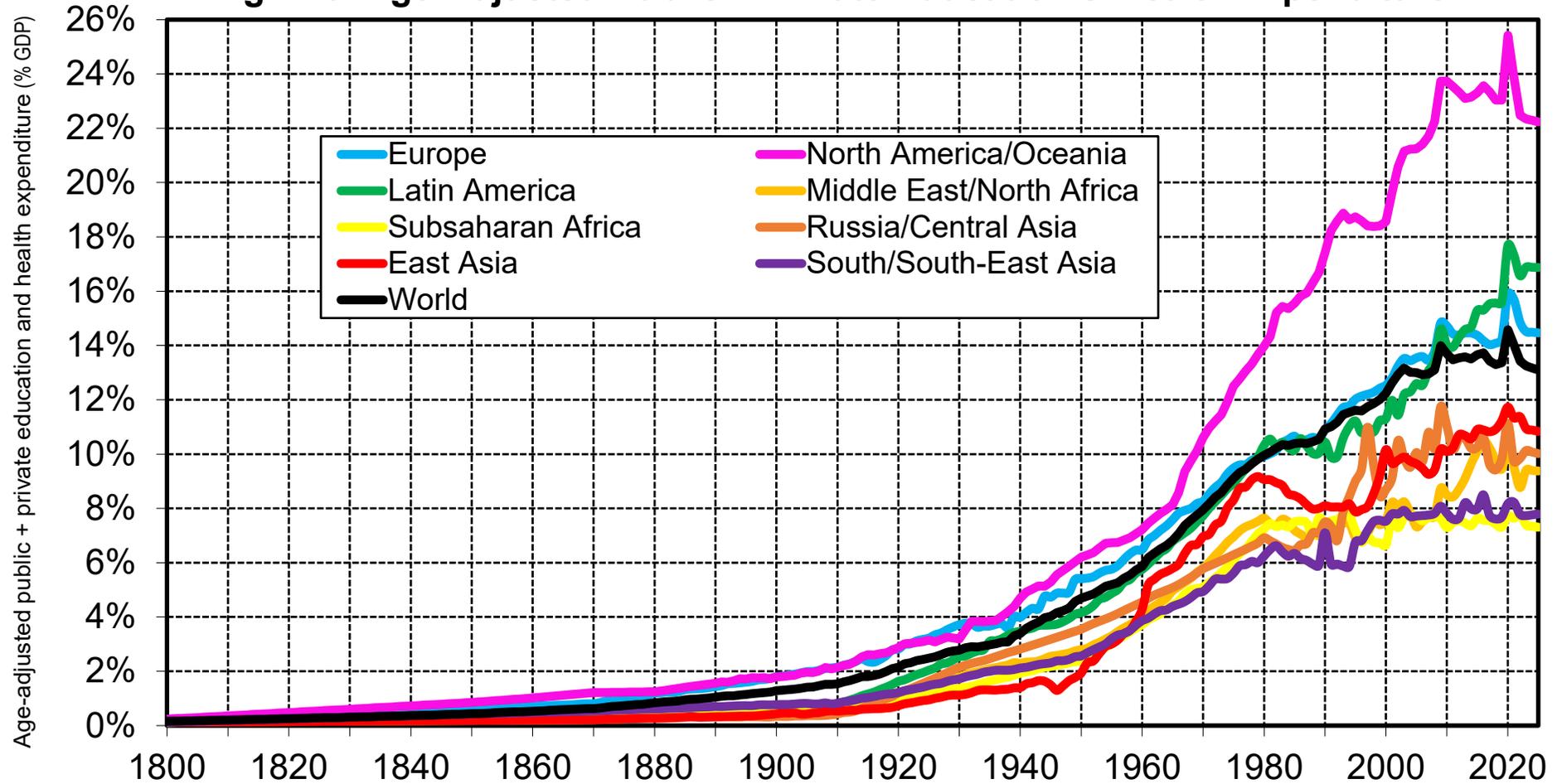# Fig. 11b. Private Education Expenditure, 1800-2025

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

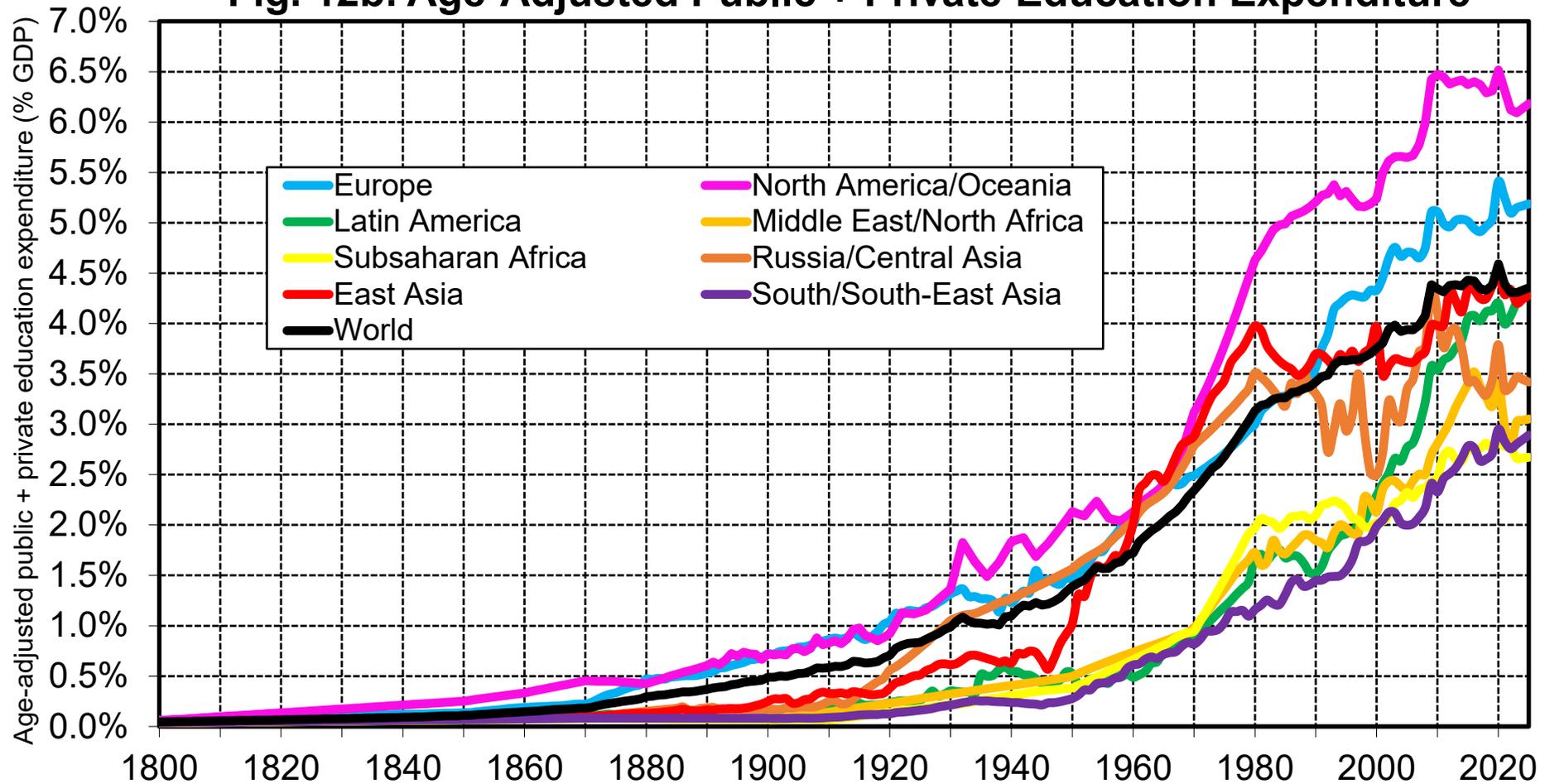# Fig. 11c. Private Health Expenditure, 1800-2025

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 3.1% of GDP in 2025, i.e. about 40% of total public + private education expenditure (7.8% of GDP). **Sources and series**: wid.world

Fig. 12a. Age-Adjusted Public + Private Education & Health Expenditure

Legend:
- Europe
- Latin America
- Subsaharan Africa
- East Asia
- World
- North America/Oceania
- Middle East/North Africa
- Russia/Central Asia
- South/South-East Asia

Y-axis: Age-adjusted public + private education and health expenditure (% GDP)
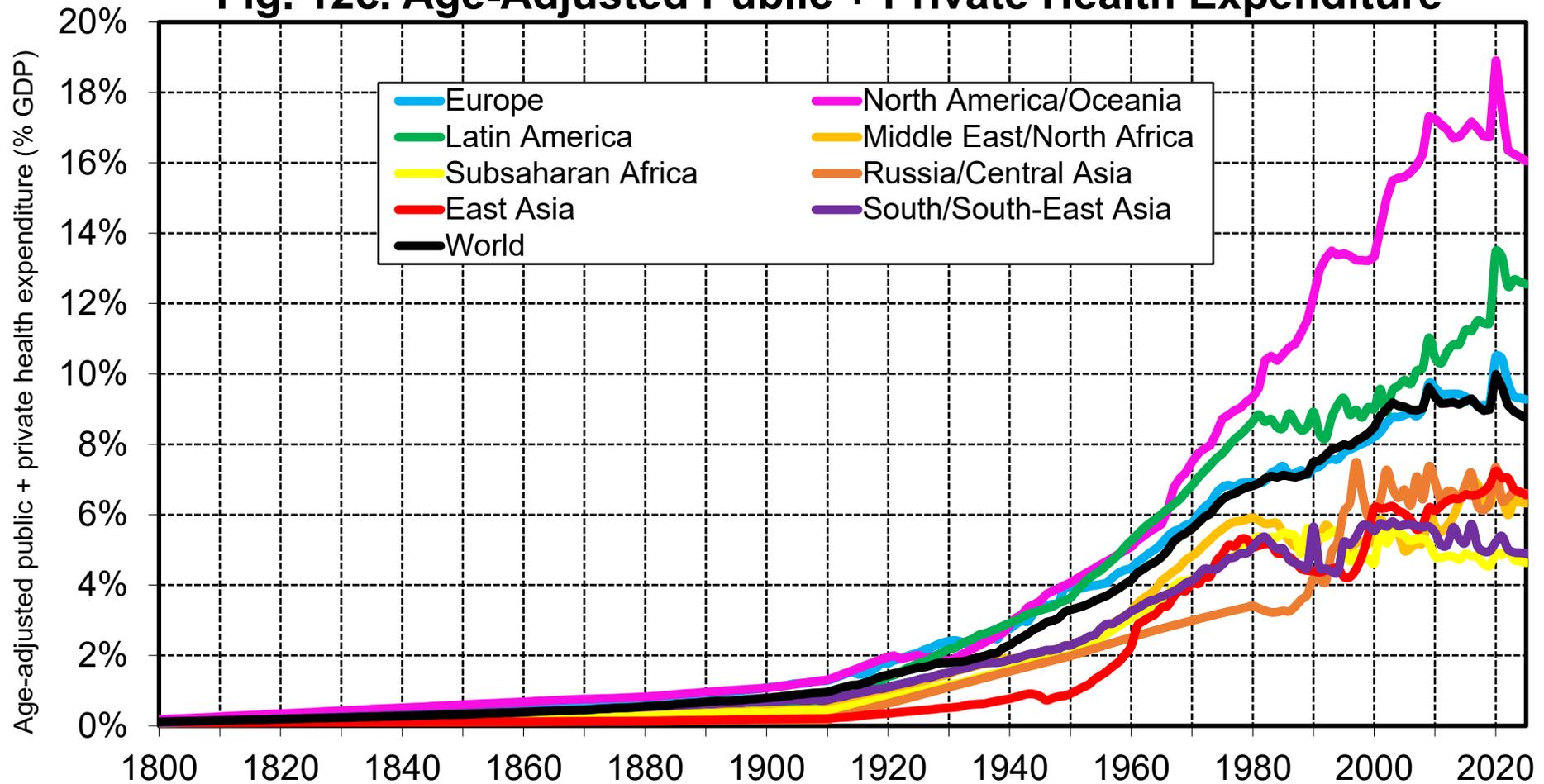
Interpretation. Total age-adjusted public and private education and health expenditure has increased from less than 1% of GDP before 1900 to about 14% of GDP in 2025 at the global level, with large gaps between regions, from about 8% of GDP in South & South-East Asia and Subsaharan Africa to about 23% in North America/Oceania. **Sources and series**: wid.world

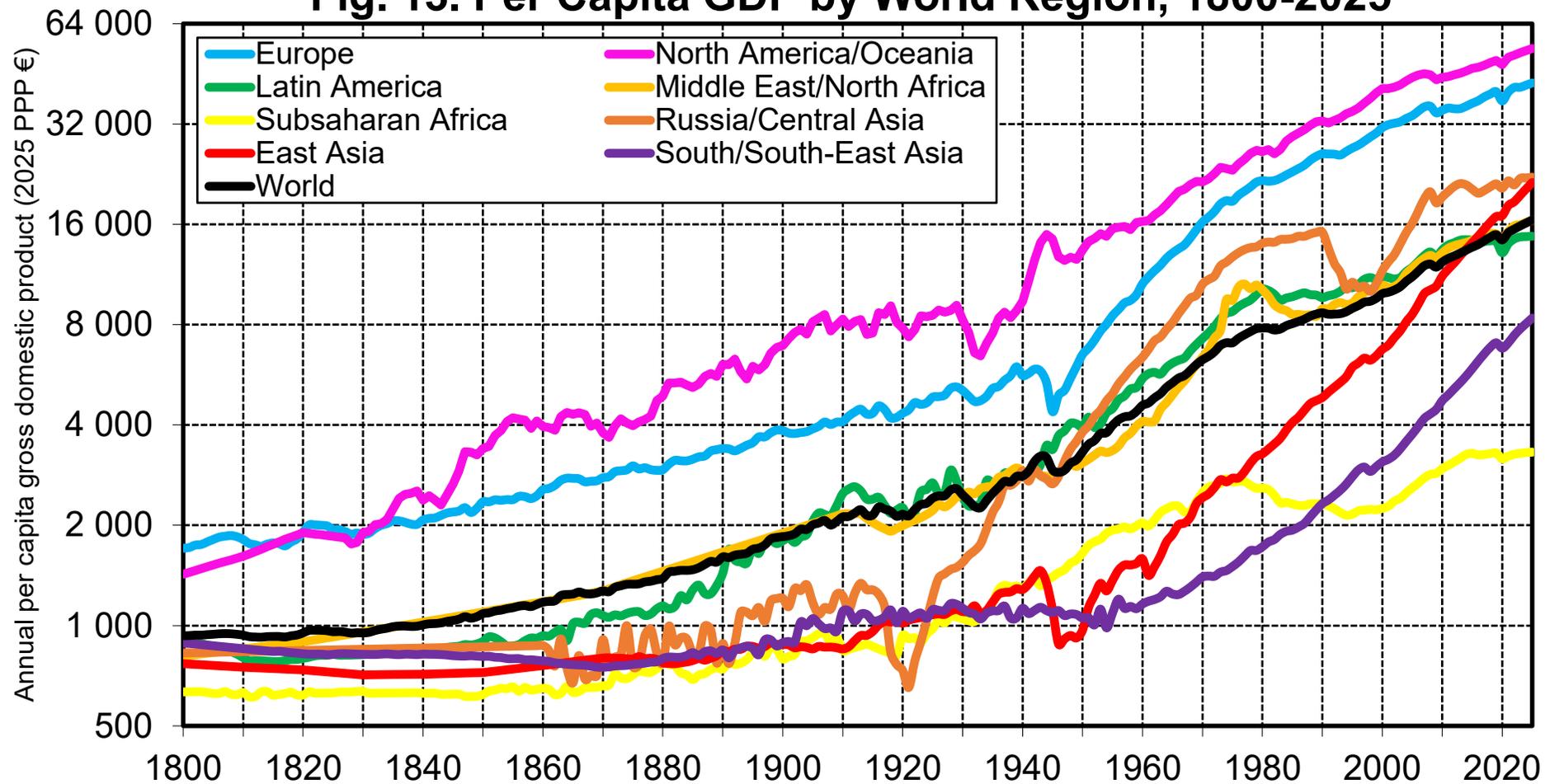# Fig. 12b. Age-Adjusted Public + Private Education Expenditure

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

Fig. 12c. Age-Adjusted Public + Private Health Expenditure

Legend:
- Europe
- Latin America
- Subsaharan Africa
- East Asia
- World
- North America/Oceania
- Middle East/North Africa
- Russia/Central Asia
- South/South-East Asia

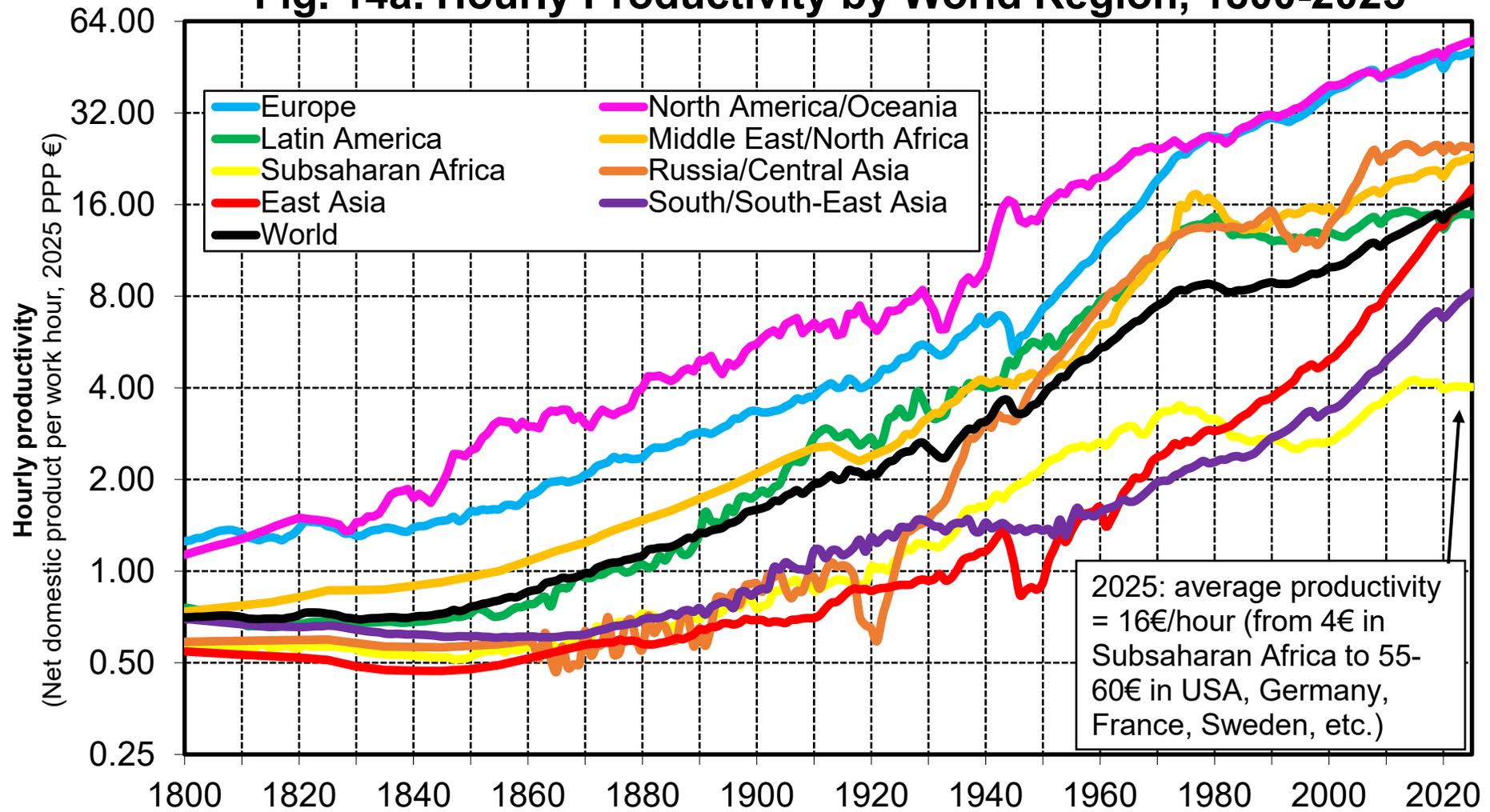Y-axis: Age-adjusted public + private health expenditure (% GDP)

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

Fig. 13. 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

Fig. 14a. Hourly Productivity by World Region, 1800-2025

Hourly productivity (Net domestic product per work hour, 2025 PPP €)

Legend:
- Europe
- Latin America
- Subsaharan Africa
- East Asia
- World
- North America/Oceania
- Middle East/North Africa
- Russia/Central Asia
- South/South-East Asia

2025: average productivity = 16€/hour (from 4€ in Subsaharan Africa to 55-60€ in USA, Germany, France, Sweden, etc.)

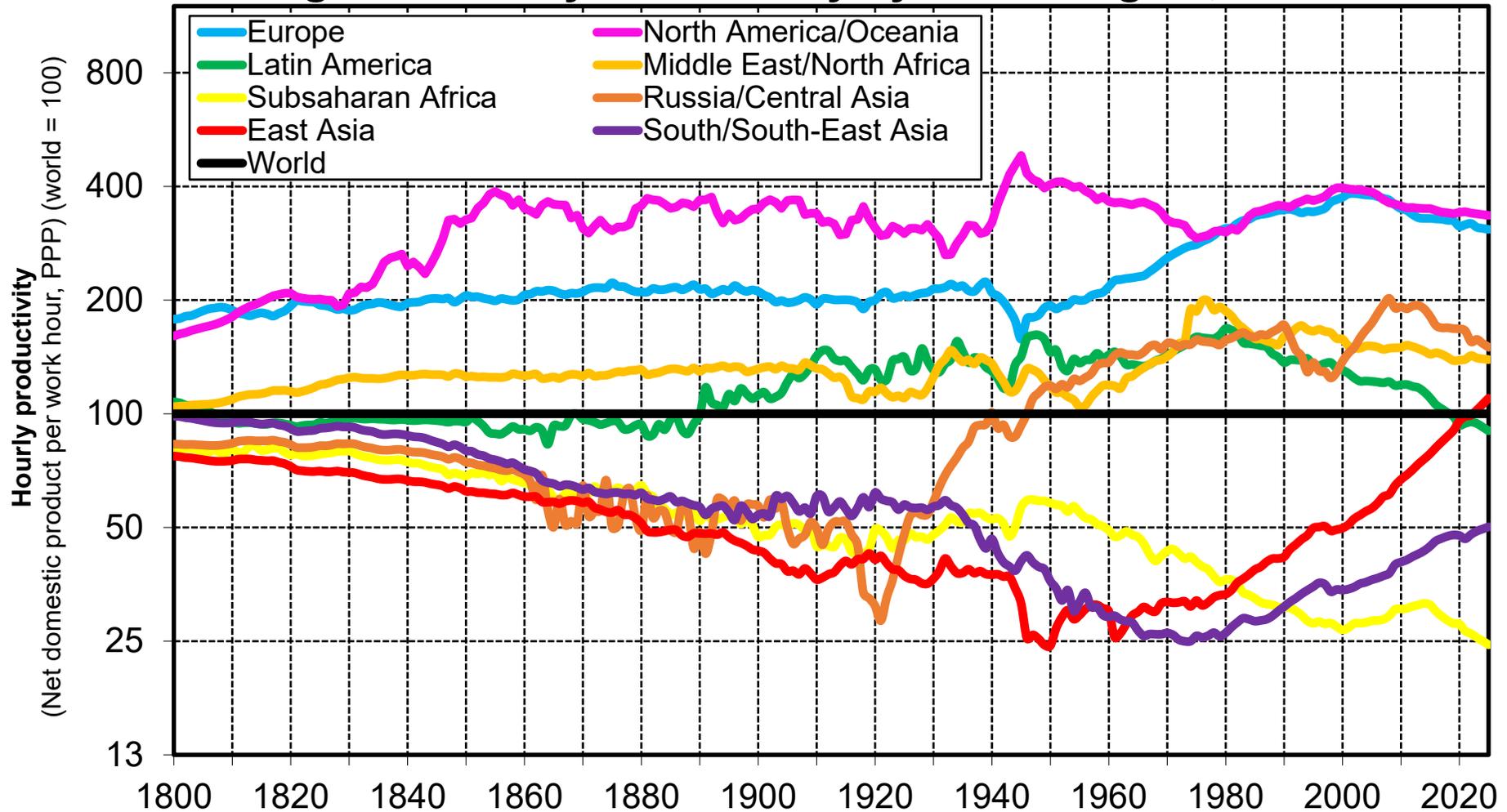**Interpretation**. Expressed in 2025 PPP €, hourly productivity (as defined by net domestic product by economic labour hour) rose from about 0.7€ in 1800 to 16€ in 2025 at the global level. I.e. it was multiplied by about 24, which corresponds to average annual real growth rate of 1,4% per year, with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

Fig. 14b. Hourly Productivity by Country, 1800-2025

Hourly productivity
(Net domestic product per work hour, 2025 PPP €)

Legend: Denmark, Sweden, USA, Germany, Britain, France, Brasil, China, India, World

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

Fig. 15a. Hourly Productivity by World Region, 1800-2025

Hourly productivity
(Net domestic product per work hour, PPP) (world = 100)

Legend:
- Europe
- North America/Oceania
- Latin America
- Middle East/North Africa
- Subsaharan Africa
- Russia/Central Asia
- East Asia
- South/South-East Asia
- World

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

Fig. 15b. Hourly Productivity by Country, 1800-2025
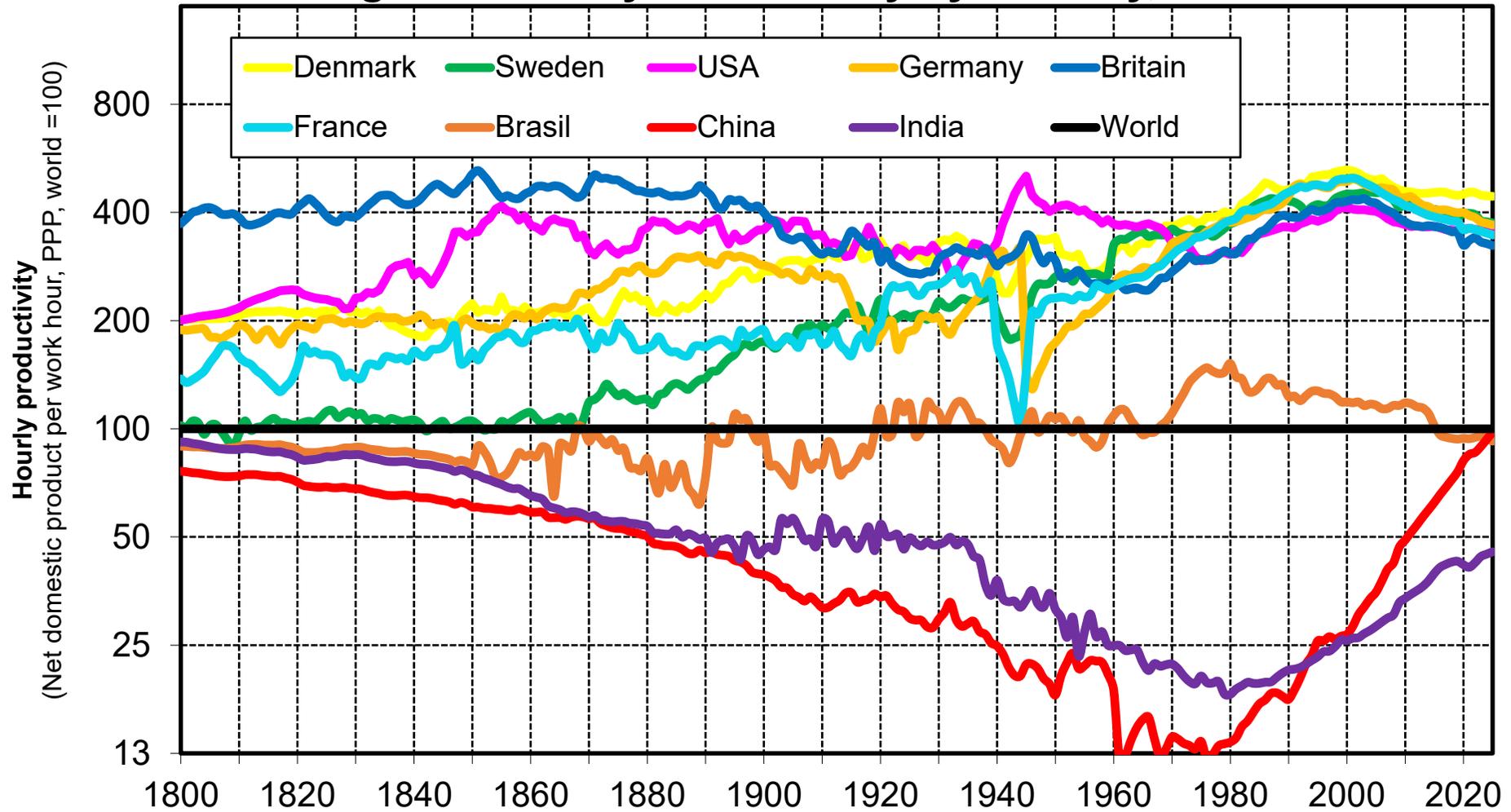

Interpretation. Between 1800 and 1900, Britain was the country in the world with the highest productivity (NDP per work hour), before being replaced by the USA between 1900 and 1970. Since 1970, Europe's highest productivity countries (incl. Denmark, Sweden, Germany, France, Britain) are on par with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

Legend: Denmark, Sweden, USA, Germany, Britain, France, Brasil, China, India, World

Y-axis: Hourly productivity (Net domestic product per work hour, PPP, world =100)

Table 2. 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

Table 3. 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) (s.e.)	13.328*** (0.751)		0.032*** (0.011)	
Incl. Basic Public Services (Justice, Police, Administration, Roads, etc.) (s.e.)		17.303*** (0.936)		0.039*** (0.014)
Incl. Military Expenditure (s.e.)		-4.020 (3.298)		-0.014 (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.

Table 4. The Impact of Human & Social Capital Expenditure on Productivity Growth, 1800-2025

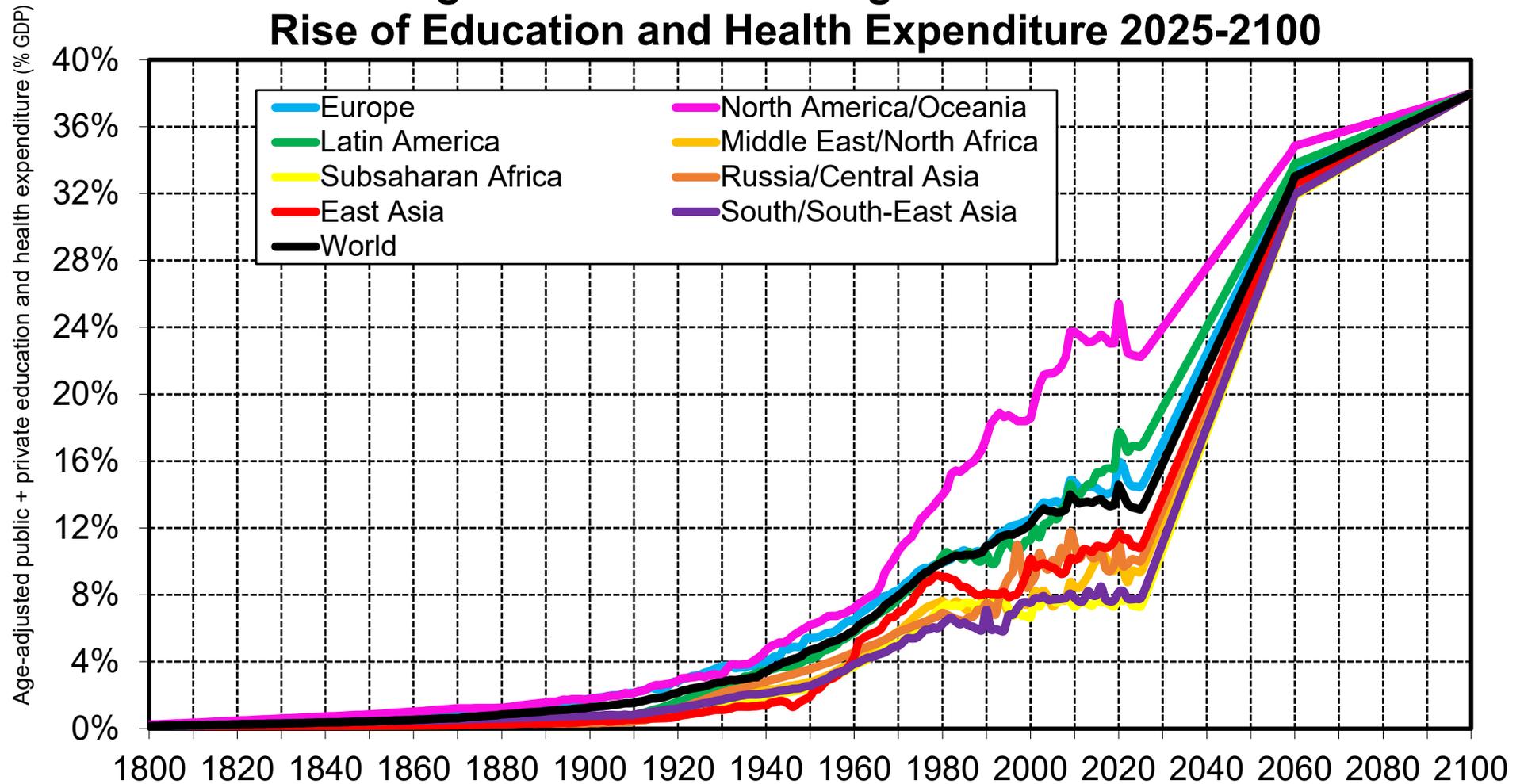|	Annual Growth Rate of Hourly Productivity (net domestic product per work hour) (computed over previous 20 years)				
Total Public Expenditure (% GDP) (averages over previous 20 years) (s.e.)	0.054*** (0.001)	0.048*** (0.001)			
Incl. Human & Social Expenditure (s.e.)			0.113*** (0.006)	0.053*** (0.006)	0.046*** (0.006)
Incl. Military Expenditure (s.e.)			0.029** (0.012)	-0.047*** (0.011)	0.006 (0.011)
Incl. Social Protection Expenditure (s.e.)			-0.037*** (0.006)	0.006 (0.006)	-0.021** (0.008)
Incl. Other Expenditure (s.e.)			-0.001 (0.015)	0.009 (0.016)	-0.014 (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.

Table 5. The Impact of Human Capital Expenditure on Productivity Growth, 1800-2025: Education vs Health Expenditure, Public vs Private Expenditure

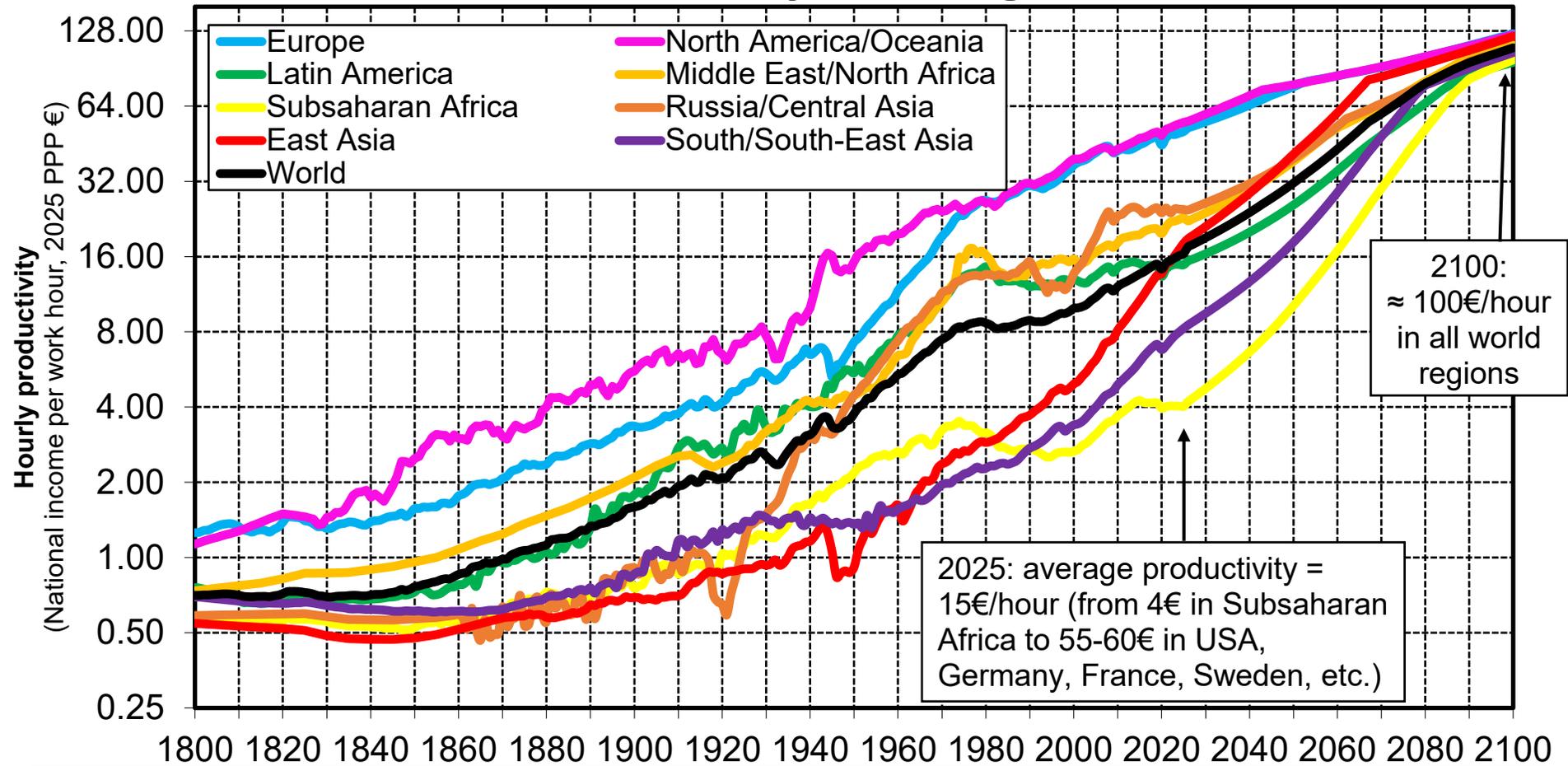|	Annual Growth Rate of Hourly Productivity (net domestic product per work hour) (computed over previous 20 years)								
Total Human Capital Expenditure (% GDP) (averages over previous 20 years) (s.e.)	0.099*** (0.004)	0.086*** (0.004)	0.166*** (0.005)						
Incl. Education (s.e.)				0.244*** (0.019)					
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).

Fig. 16a. 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

Fig. 16b. Global Convergence Scenario:
Rise of Productivity in All Regions 2025-2100

Legend:
- Europe
- North America/Oceania
- Latin America
- Middle East/North Africa
- Subsaharan Africa
- Russia/Central Asia
- East Asia
- South/South-East Asia
- World

Y-axis: **Hourly productivity** (National income per work hour, 2025 PPP €)
Y-axis values: 0.25, 0.50, 1.00, 2.00, 4.00, 8.00, 16.00, 32.00, 64.00, 128.00

X-axis values: 1800, 1820, 1840, 1860, 1880, 1900, 1920, 1940, 1960, 1980, 2000, 2020, 2040, 2060, 2080, 2100
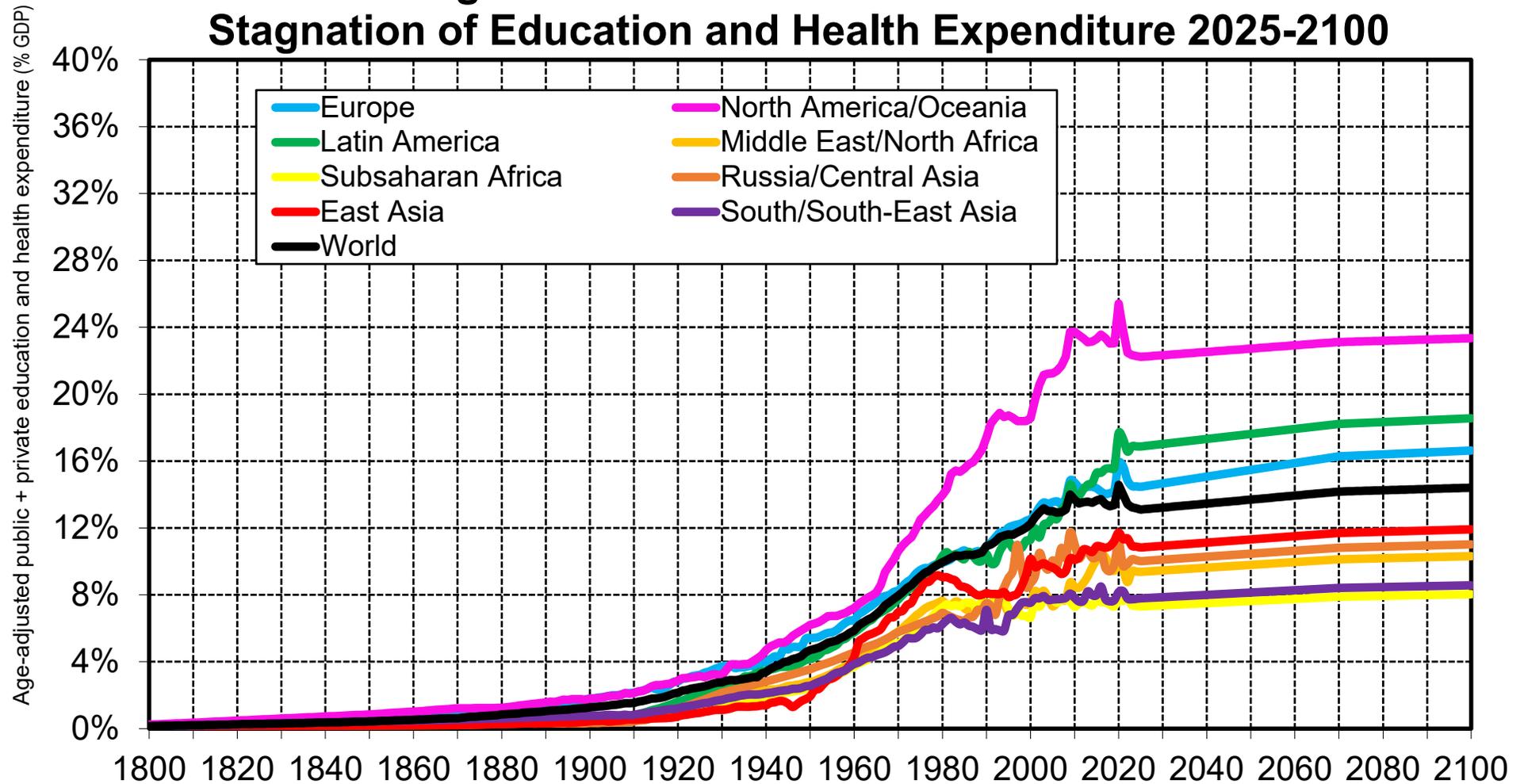
2100: ≈ 100€/hour in all world regions

2025: average productivity = 15€/hour (from 4€ in Subsaharan Africa to 55-60€ in USA, Germany, France, Sweden, etc.)
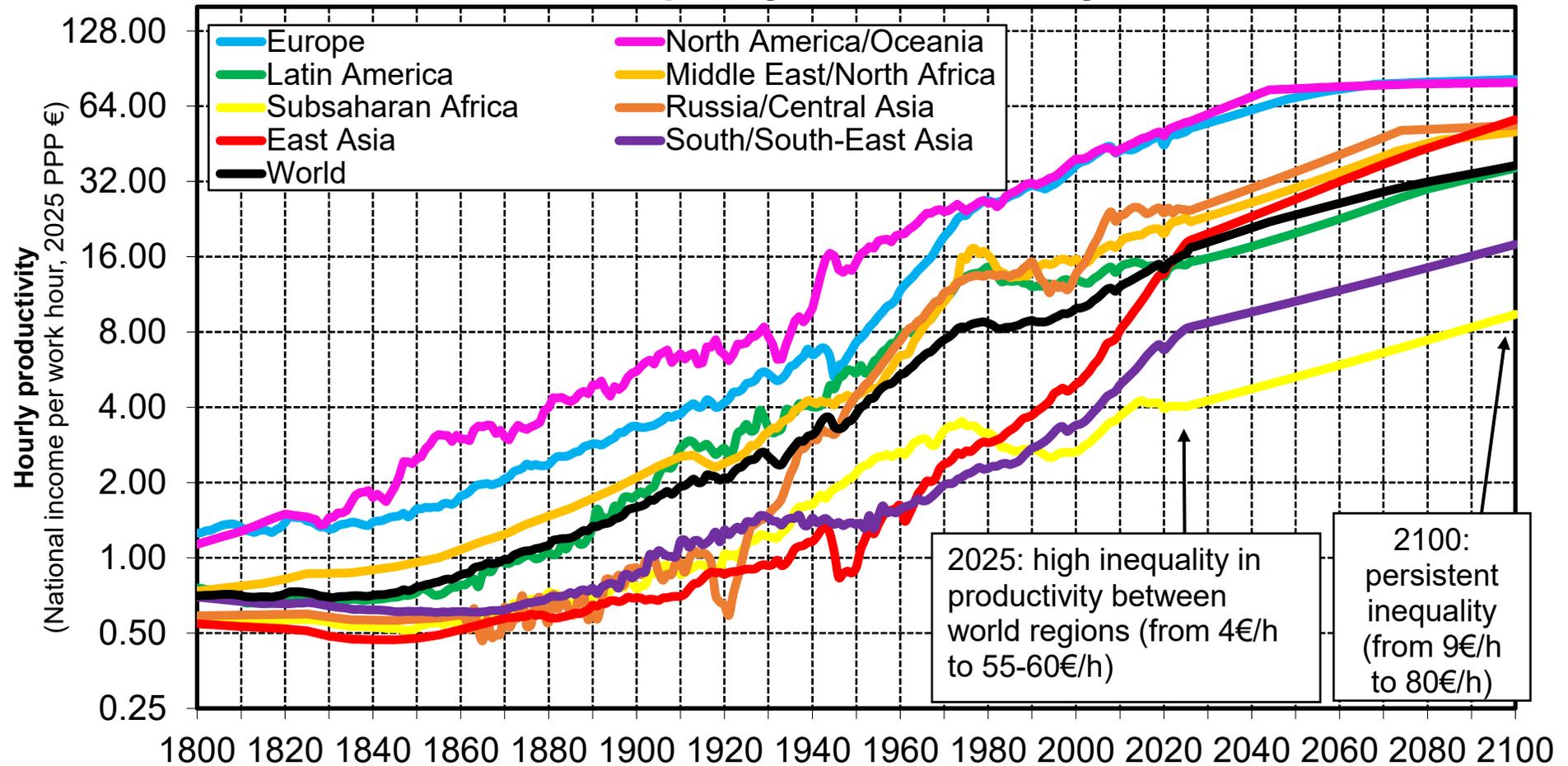
Interpretation. Under the "global convergence" scenario, productivity growth rates are projected to rise substantially in 2025-210, so that all regions converge to about 100-120€/hour by 2100. This involves in particular a large acceleration of productivity growth in Subsaharan Africa (4.4% per year over 2025-2100 period, i.e. the same as in East Asia 1990-2025). **Sources and series**: see wid.world

Fig. 17a. Business-as-Usual Scenario: Stagnation of Education and Health Expenditure 2025-2100

Legend:
- Europe
- Latin America
- Subsaharan Africa
- East Asia
- World
- North America/Oceania
- Middle East/North Africa
- Russia/Central Asia
- South/South-East Asia

Y-axis: Age-adjusted public + private education and health expenditure (% GDP)

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

Fig. 17b. Business-As-Usual Scenario: Persistent Inequality in Productivity 2025-2100

Legend:
- Europe
- Latin America
- Subsaharan Africa
- East Asia
- World
- North America/Oceania
- Middle East/North Africa
- Russia/Central Asia
- South/South-East Asia

Y-axis: Hourly productivity (National income per work hour, 2025 PPP €)

2025: high inequality in productivity between world regions (from 4€/h to 55-60€/h)

2100: persistent inequality (from 9€/h to 80€/h)

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

Table 6. 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

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