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Human capital, unequal opportunities and productivity convergence: A global historical perspective, 1800–2100☆

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A B S T R A C T

This paper constructs a new database on public expenditure and revenue and their components, particularly education and health expenditure, covering all world regions over the 1800–2025 period. Human capital expenditure has grown substantially, but with large and persistent inequalities. 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 at purchasing power parity, compared to 6% in 1980 and 4% in 1950. Human capital expenditure strongly correlates with productivity growth, especially for public education and in poor countries. Estimated returns from our macro-historical database are around 10%, in line with micro studies. Finally, we present simulations based on illustrative 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.

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 (Becker, 1964; Grossman, 1972; Sen, 1999; Barro and Lee, 2015). But to what extent did access to education and health become more inclusive at the global level in recent decades? Are we heading towards global convergence in human capital, well-being and productivity, or will substantial expansion in educational and health resources be required for this to happen over the course of the 21st century?

In order to bring new answers to these 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, as well as age-adjusted expenditure.

Our analysis delivers several key findings. First, we document a significant rise of human capital expenditure (as % of GDP) in all parts of the world in the long run, but with large 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 purchasing power parity terms, versus 6% in 1980 and 4% in 1950. Hence, according to this indicator, global inequality in educational investments did not decline in recent decades. The gap is also about 2 to 3 times larger in market exchange rates (MER) than in purchasing power parities (PPP) terms. We find similar results for health expenditure. In the long run, there was a large rise in global inequality in human capital expenditure between 1800 and 1950, followed by a stabilization at very high levels— and sometimes a further deepening of the gaps—over the 1950–2025 period.

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Next, we document a large correlation between (age-adjusted) total human capital expenditure and productivity growth over the 1800–2025 period. This relationship is larger for education than for healthcare and for public expenditure than for private expenditure. In effect, estimated returns on investment using our macro-historical database are around 10%, in line with micro studies (e.g., Akresh et al., 2022; Bhuller et al., 2017; Berlinski et al., 2025; Khanna, 2022; Zimmerman, 2014). While we do not claim our cross-country regressions to be causal, it is reassuring that our estimates are consistent with micro studies (including experimental and quasi-experimental research), which are much better identified but face other problems, such as external validity issues. Our estimates of the relationship between human capital and productivity growth also rely on a much broader dataset than earlier 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 draw on these results to present a set of simple, illustrative simulations based on alternative human capital expenditure trajectories over the 2025–2100 period. We explore the conditions under which convergence in human capital expenditure could lead to global productivity convergence by 2100 (around 100€/hour in all regions). Globally, average productivity is about 16€/hour in 2025, with large gaps between regions (from 4€/hour in Sub-Saharan Africa to 55-60€/hour in Europe and North America/Oceania). In a "global productivity convergence" scenario, age-adjusted total human capital expenditure could converge toward 35–40% of GDP. While this may seem large, the historical rise of human capital has been even larger. For instance, human capital expenditure was less than 2% of GDP in all parts of the world until 1910 but reached close to 25% of GDP in the United States in 2020–2025. Given the large projected rise in life expectancy and the growing needs in higher education and research in the future, it is plausible that the rise of human capital expenditure could continue at a high pace. We also consider a "business-as-usual" scenario, in which human capital expenditure stops rising and stagnates over 2025–2100. According to our simulations, this could lead not only to the perpetuation of large productivity gaps but also to growth slowdown in rich countries.

Over the past two centuries, the world has seen major progress in basic health and education indicators. 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 Fig. 1a). If past trends continue, life expectancy could reach about 85 years worldwide by 2100, while literacy rates and university enrolment rates could reach 95% or more (see Fig. 1b). At the same time, the stagnation of total human capital expenditure in recent decades—in spite of the continuous rise in higher education enrolment—has been suggested to be one of the main potential explanations behind growth slowdown (Piketty, 2020). Our exploratory simulations suggest this slowdown could worsen further if the rise of human capital expenditure observed in the 20th century does not continue 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, which makes it possible to compare the real resources that various societies have devoted to education and healthcare since 1800. 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 (Barro and Lee, 2013, 2015) rather than on expenditure. An important historical literature studies the evolution of social spending since the late 18th century, including human capital expenditure, but mostly concentrates on Western countries (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

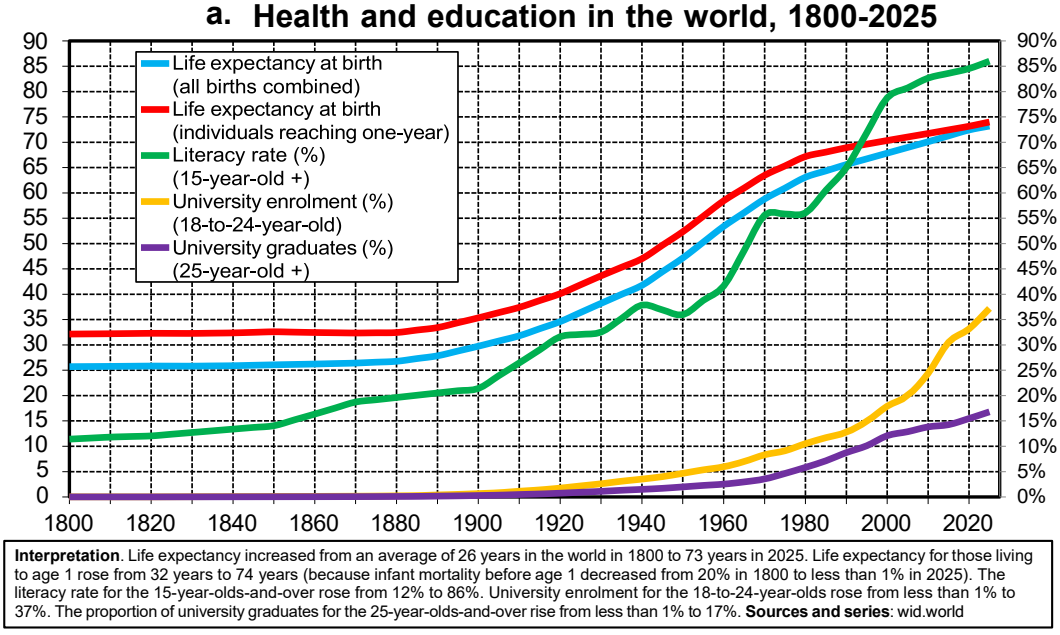

Fig. 1a. Health and education in the world, 1800–2025. Interpretation. Life expectancy increased from an average of 26 years in the world in 1800 to 73 years in 2025. Life expectancy for those living to age 1 rose from 32 years to 74 years (because infant mortality before age 1 decreased from 20% in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

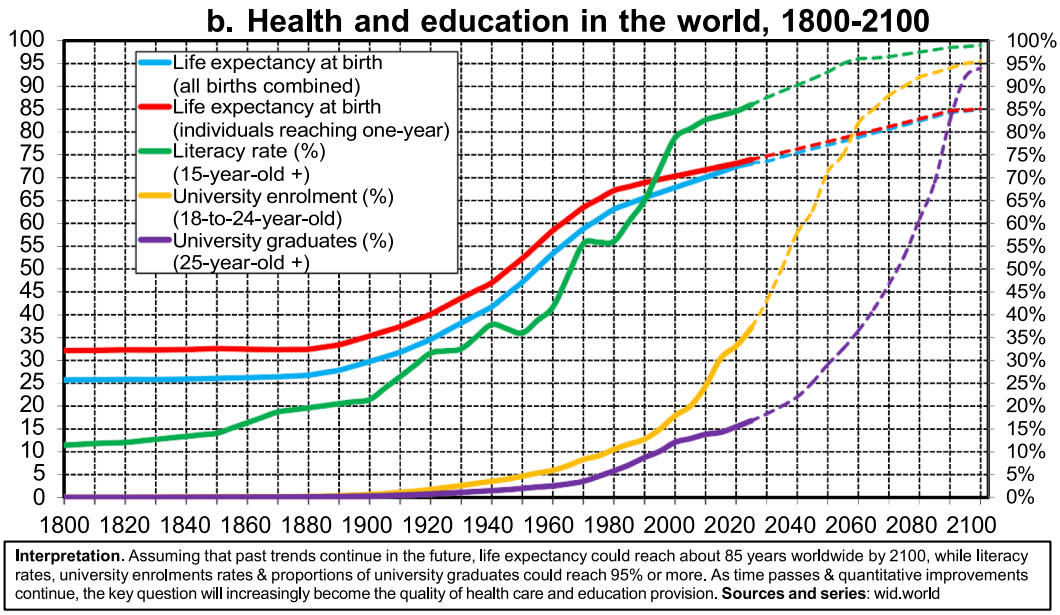

Fig. 1b. Health and education in the world, 1800–2100. Interpretation. Assuming that past trends continue in the future, life expectancy could reach about 85 years worldwide by 2100, while literacy rates, university enrolments rates & proportions of university graduates could reach 95% or more. As time passes & quantitative improvements continue, the key question will increasingly become the quality of health care and education provision. Sources and series: wid.world.

reviewed and compared all existing work and data series in this literature. For missing country-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), covering India and China since 1880–1900, and Gethin (2024, 2025a), who offers a detailed global perspective on public expenditure for the post-1980 period. Related contributions include Tanzi and Schucknecht (2000) on twentieth-century public expenditure worldwide; van Leeuwen (2007) on Indonesia, India, and Japan since the late nineteenth century; and Cogneau et al. (2021) on public revenue and expenditure in the French colonial empire in Africa and Indochina over 1830–1962. Despite our best efforts, we should make clear that the resulting series, now available online in the World Human Capital Expenditure (WHCE) 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 subperiods. 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 (e.g., Card, 1999, 2001; Deming, 2022; Duflo, 2001, 2004; Montenegro and Patrinos, 2021). 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 (e.g., Colin and Weil, 2018; Gethin, 2025b; Mendes and Pennings, 2025). Our methods and findings are complementary to these works. The main difference is that we adopt a much broader timespan, both from a retrospective viewpoint and from a prospective viewpoint.

The rest of the paper is organized as follows. Section 2 describes our data sources. Section 3 presents the main results on the uneven rise of education and health expenditure across world regions over 1800–2025. In Section 4 we use these series to explore 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 section discusses the construction of 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 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 also 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 the world population and GDP over the entire period. All countries, territories, and jurisdictions are defined throughout the 1800–2025 period on the basis of their 2025 territorial borders: all raw historical series were corrected accordingly so as to take territorial changes into account. Our 48 main countries represent about 85–90% of the world's population and GDP (measured either using MER or PPP terms), while the 9 residual regions cover the remaining 10–15% (see Nievas and Piketty, 2025a,b, Fig. 1). Regarding the recent decades (1980–2025), 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, 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, 2025a,b;

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/Southeast 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).

Gomez-Carrera et al., 2024).

The concepts used to define public expenditure and revenue throughout the 1800–2025 period follow the latest international guidelines set by international organizations (UN, IMF, Eurostat, OECD, World Bank, etc.), with a few exceptions. First, when referring to public expenditure and revenue, we always include 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.[1] In some cases, especially for earlier periods, 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 (Eurostat, 2019; IMF, 2014). More precisely, regarding the recent decades (1980–2025), we provide the following decomposition of public expenditure and revenue for all country-years, based on official COFOG categories (see Gethin, 2024):

$$\begin{aligned}&\text{Total public expenditure} = \text{military expenditure (defense)}\\&+\text{general public services}\\&+\text{public order and safety}\\&+\text{education (primary, secondary, tertiary)}\\&+\text{health (health insurance, hospitals , etc)}\\&+\text{recreation, culture, and religion}\\&+\text{housing and community amenities}\\&+\text{environmental protection}\\&+\text{social protection (social insurance \& assistance:}\\&\text{pensions, unemployment \& family benefits, etc.)}\\&+\text{economic affairs}\end{aligned} \tag{1}$$

$$\begin{aligned}&\text{Total public revenue} = \text{indirect taxes} + \text{property and wealth taxes}\\&+\text{personal income taxes}\\&+\text{corporate income taxes}\\&+\text{social contributions} + \text{other taxes}\\&+\text{nontax revenues (royalties, fines, etc).}\end{aligned} \tag{2}$$

Note that our concept of public expenditure always refers to primary public expenditure, that is, it excludes government interest payments.[2]

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:

$$\begin{aligned}&\text{Total public expenditure} = \text{military expenditure (defense)}\\&+\text{general public services} + \text{public order and safety}\\&+\text{education (primary, secondary, tertiary)}\\&+\text{health (health insurance, hospitals, etc.)}\\&+\text{other human \& social capital (research, culture, community, etc.)}\\&+\text{social protection(social insurance \& assistance:}\\&\text{pensions, unemployment \& family benefits, etc)}\\&+\text{other expenditures (economic affairs, etc)}\end{aligned} \tag{3}$$

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.[3]

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. For the 1980–2025 period, we follow the methods described by Gethin (2024, 2025). Namely, we primarily rely 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, such as series released by CEPAL, UNESCO, and WHO for specific country-years and

[1] 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).

[2] The 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 the Secondary government surplus/deficit as (Public revenue – Public expenditure – Interest payments).

[3] 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.

missing 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. 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 government non-tax revenue, and the corresponding sums are also included in public expenditure (e.g., IMF, 2014). We exclude these items from public revenue and expenditure and include them in private human capital expenditure. In practice, this does not make much difference at the aggregate level, but it can make a significant difference regarding the split between public versus private education and health expenditure.[4]

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 country-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).

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 to 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. In the absence of data for a given country-year, we rely on interpolation or on averages of similar countries in the same world region (see Online Appendix). 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 for instance Dincecco (2015); Genniaoli and Voth (2017); Hoffman (2011, 2012); Dincecco (2017) and Karaman and Pamuk (2010, 2013)). 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.

3. The uneven rise of education and health expenditure, 1800–2025

This section presents the main findings on the uneven global rise of human capital expenditure. The analysis begins with total expenditure and its main components, before examining education and health spending separately.

3.1. The uneven rise of public expenditure, 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 Fig. 2). Two facts are particularly striking. First, we observe a rise in public expenditure in all regions and during most sub-periods. The largest part of the rise happened between 1910 and 1980, but there was also a gradual increase in most world regions during the 1800–1910 period and again during the 1980–2025 period. In particular, the stabilization visible 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 and Central Asia following the fall of the USSR, public expenditure does keep rising in most world regions between 1980–1990 and 2025, albeit at a slower pace than during the 1910–1980 period.

The world's richest regions (Europe and North America/Oceania) have always had larger public expenditure than poorer regions, not only in absolute terms but also as a fraction of their GDP. During the 19th century, public expenditure was low everywhere, reaching less than 10% of GDP in all world regions, but it was significantly higher in Europe and North America/Oceania than in other parts of the world. On average over 1800–1900, public expenditure represented about 8% of GDP in Europe and 6% in North America/Oceania, compared with a world average of about 5% and 2–4% in other world regions.

By the late 20th century and early 21st century, Europe and North America/Oceania still have the highest levels of public expenditure, followed by East Asia, Russia/Central Asia, Latin America, and Middle East/North Africa. The poorest world regions, namely South & Southeast Asia and Sub-Saharan Africa, have the lowest levels of government spending (see Fig. 2).

Also note that public expenditure expressed as a fraction of GDP does display very large short-run variations, such as a large rise during the 2008 financial crisis or during the 2020 COVID crisis. These spikes are generally due to the combination of a rising numerator (expenditure) and a falling denominator (GDP).[5] However, these short-run variations are relatively secondary as compared to the long-run trends and the differences in levels across regions.

Turning to the composition of public spending, the rise of public expenditure is mostly due to the rise of social spending (broadly defined, including health, education, and social protection). We refer to this structural transformation towards growing government spending on education, healthcare, and social protection as the "rise of the global social state" (see Fig. 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.). 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 that together explain most of the rise. In effect, total public expenditure amounts to 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 expenditure (economic affairs excluding roads and basic infrastructure).

[4] 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, that is, 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 Fig. F3e-F3f and Gethin (2025) for further discussion of these conceptual and methodological issues.

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

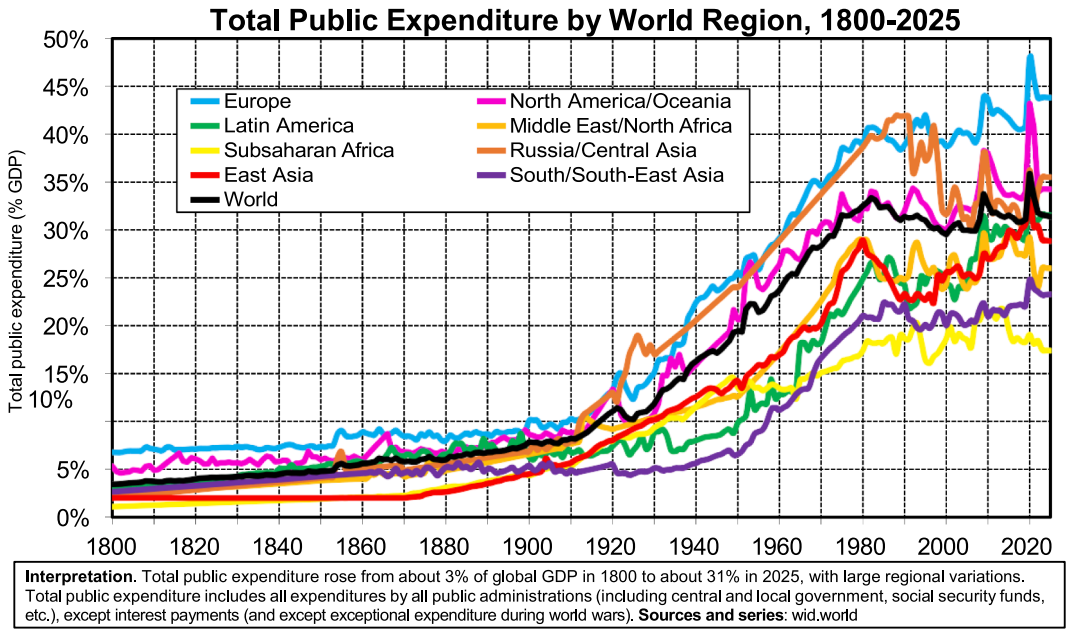

Fig. 2. Total Public Expenditure by World Region, 1800–2025. Interpretation. Total public expenditure rose from about 3% of global GDP in 1800 to about 31% in 2025, with large regional variations. Total public expenditure includes all expenditures by all public administrations (including central and local government, social security funds, etc.), except interest payments (and except exceptional expenditure during world wars). Sources and series: wid.world.

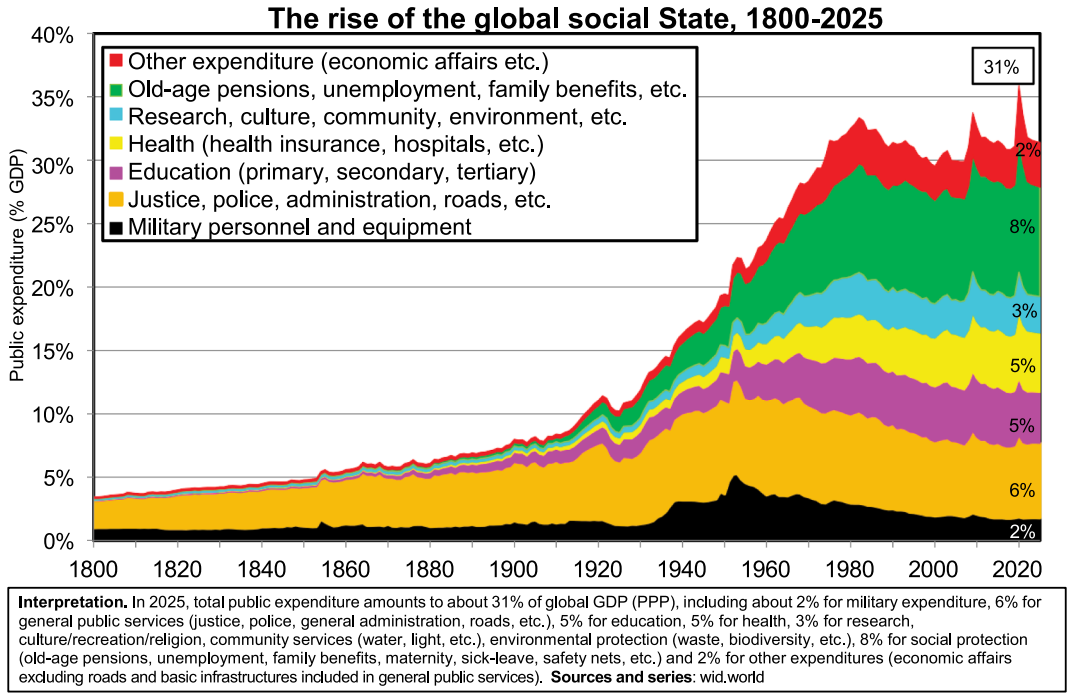

Fig. 3. The rise of the global social State, 1800–2025. **Interpretation.** In 2025, total public expenditure amounts to about 31% of global GDP (PPP), including about 2% for military expenditure, 6% for general public services (justice, police, general administration, roads, etc.), 5% for education, 5% for health, 3% for research, culture/recreation/religion, community services (water, light, etc.), environmental protection (waste, biodiversity, etc.), 8% for social protection (old-age pensions, unemployment, family benefits, maternity, sick-leave, safety nets, etc.) and 2% for other expenditures (economic affairs excluding roads and basic infrastructures included in general public services). **Sources and series**: wid.world.

The same general pattern is visible in all world regions, but with different scales. Europe's social state is the largest in the world, with total public expenditure reaching about 44% of GDP in 2025 (see Fig. 4a). In contrast, total public expenditure is only 17% of GDP in 2025 in Sub-Saharan Africa (see Fig. 4b). Other world regions fall in between: South & Southeast Asia stands at around 23% of GDP in 2025, Middle East/North Africa at about 26%, and Latin America, Russia/Central Asia, East Asia, and North America/Oceania at around 30–35%. Whatever the final level, however, the same general trend is visible in all regions: 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 expenditure; see Appendix Figs. A1c-A1k).

On the revenue side, the rise of the social state has come with the rise

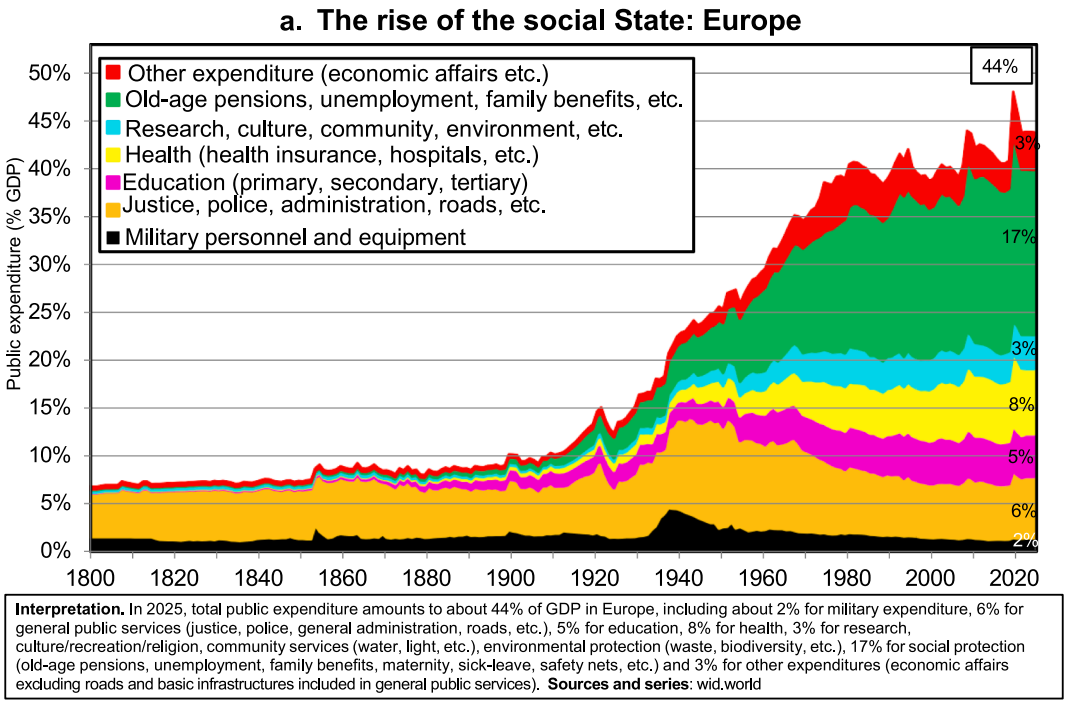

Fig. 4a. The rise of the social State: Europe. Interpretation. In 2025, total public expenditure amounts to about 44% of GDP in Europe, including about 2% for military expenditure, 6% for general public services (justice, police, general administration, roads, etc.), 5% for education, 8% for health, 3% for research, culture/recreation/religion, community services (water, light, etc.), environmental protection (waste, biodiversity, etc.), 17% for social protection (old-age pensions, unemployment, family benefits, maternity, sick-leave, safety nets, etc.) and 3% for other expenditures (economic affairs excluding roads and basic infrastructures included in general public services). Sources and series: wid.world.

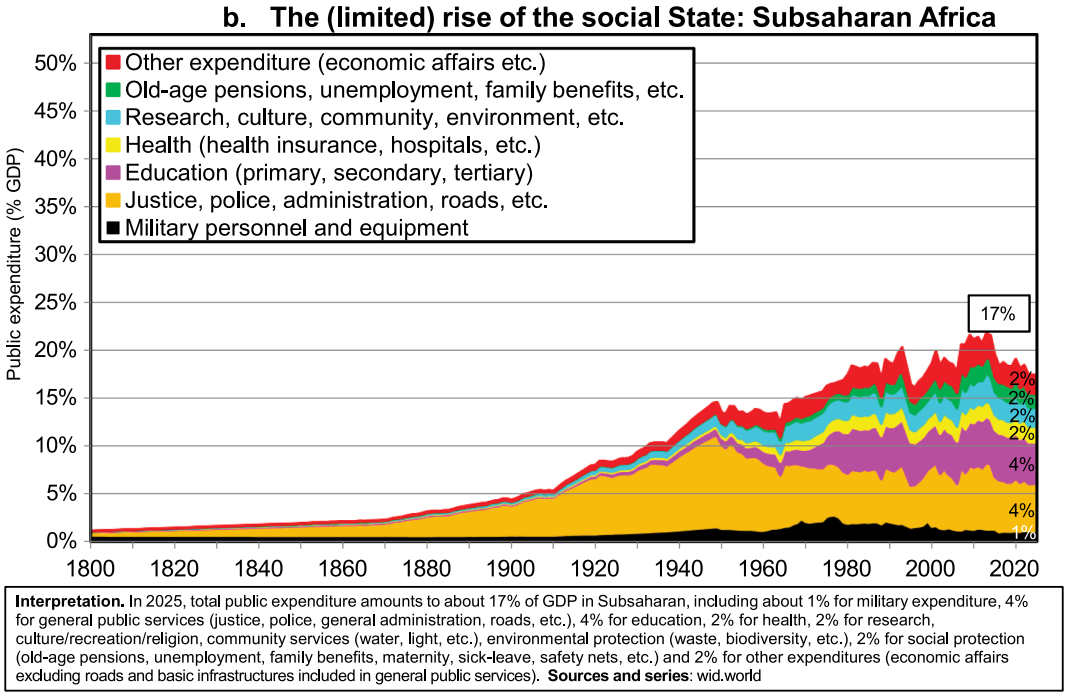

Fig. 4b. The (limited) rise of the social State: Sub-Saharan Africa. **Interpretation.** In 2025, total public expenditure amounts to about 17% of GDP in Sub-Saharan Africa, including about 1% for military expenditure, 4% for general public services (justice, police, general administration, roads, etc.), 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.

of the 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, especially in regions with the largest social states. The rise of income taxes has been particularly large in North America/Oceania, while the rise of social contributions has been more important in Europe (See Appendix Figs. B1c-B1k). However, there are exceptions and the frontier between these two forms of tax revenue should not be overestimated. For instance, Denmark has virtually no social contribution in the formal legal sense, and its generous social state is mostly financed by a large income tax (including various sub-components earmarked for pensions, unemployment benefits, health insurance, etc.). On the contrary, in regions like Sub-Saharan Africa and South & Southeast Asia, where the historical rise of the social state has been limited, indirect taxes still constitute a large share of total revenue. 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, compared to about 2–3% of GDP in Europe, North America/Oceania, and East Asia.

3.2. Human capital expenditure

This section turns to investigating more closely the evolution of human capital expenditure. At the global 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 ranged from about 5–6% of GDP in South & Southeast Asia and Sub-Saharan Africa to 11–14% of GDP in Europe and North America/Oceania (see Fig. 5a).

There are important differences in the historical trajectories of education and health spending across regions. 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 similar levels in many world regions, including Europe and Sub-Saharan Africa (see Fig. 5b). However, the share of the school-age population in the 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 expenditure 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 major variations across world regions, from 1 to 2% of GDP in South & Southeast Asia and Sub-Saharan Africa to 7–8% of GDP in Europe and North America/Oceania (see Fig. 5c). These very large gaps are partly due to different age structures (with a much larger old-age population share in richer countries). Even when two countries devote the same resources per head, an economy with a smaller school-age or elderly population naturally devotes a smaller share of GDP to these functions. Our objective here is not to measure per-student or per-patient spending, but to recover a comparable measure of overall fiscal mobilization that is not mechanically driven by demographic structures. Presenting both raw and age-adjusted series allows us to distinguish demographic effects from differences in policy choices, fiscal capacity, or political economy factors.

We first note that the share of the school-age population (0-to-24-year-old) varies significantly across world regions in 2025, from 23% in East Asia and 25% in Europe to 64% in Sub-Saharan Africa (see Fig. 6a). On the other side of the age distribution, the share of the old-age population (65-year-old-and-over) varies 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 the school-age population (0-to-24-year-old) is equal to 25% in all country-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 the average per capita health expenditure received by old-age individuals (65-year-old-and-over) tends to be on average about three times that received by individuals aged 0-to-64. This ratio appears to be relatively stable over time and across countries in recent decades (Morgan and Mueller, 2023). 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 the old-age population would be equal to 25% in all country-years (which corresponds approximately to the average level projected in

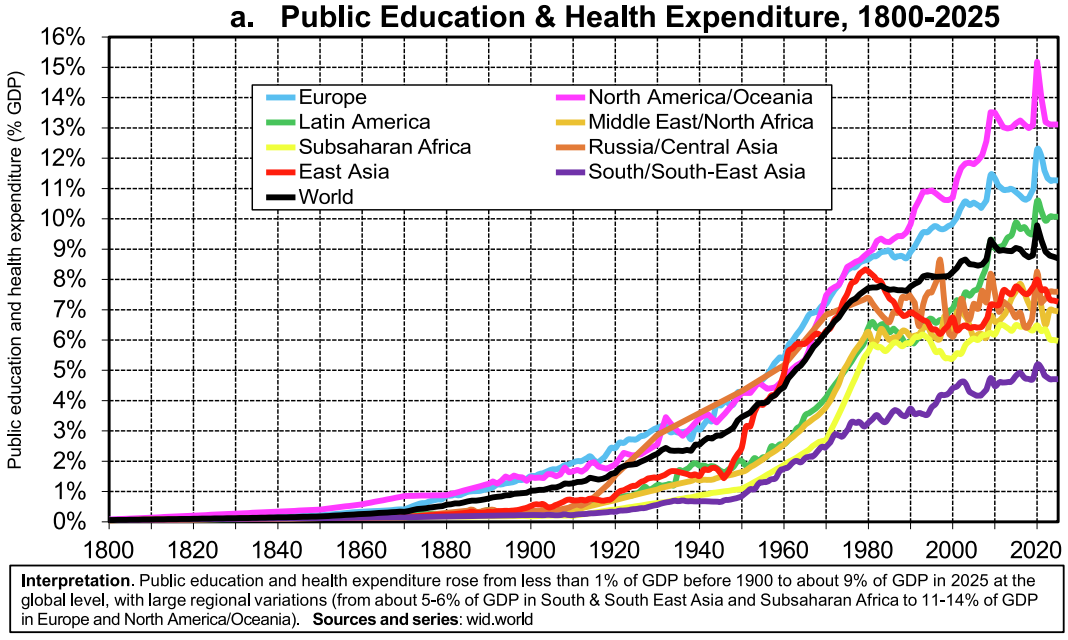

Fig. 5a. Public Education & Health Expenditure, 1800–2025. **Interpretation**. Public education and health expenditure rose from less than 1% of GDP before 1900 to about 9% of GDP in 2025 at the global level, with large regional variations (from about 5–6% of GDP in South & Southeast Asia and Sub-Saharan Africa to 11–14% of GDP in Europe and North America/Oceania). **Sources and series**: wid.world.

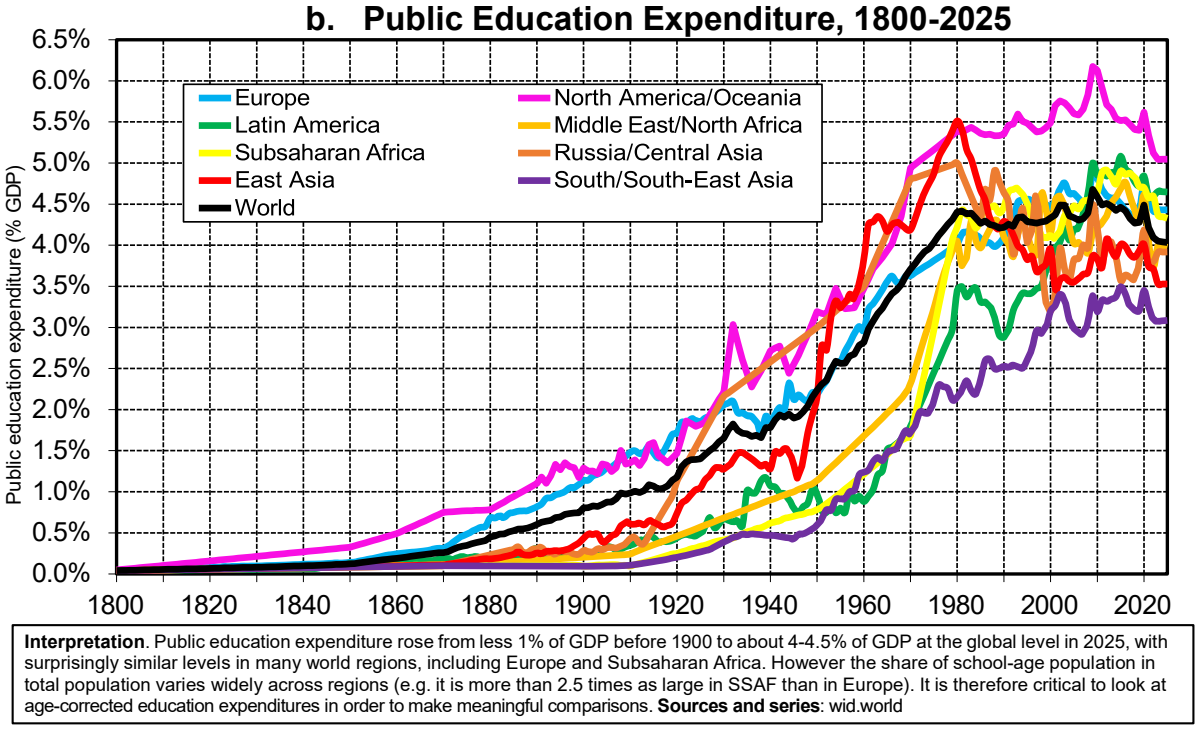

Fig. 5b. Public Education Expenditure, 1800–2025. Interpretation. Public education expenditure rose from less 1% of GDP before 1900 to about 4–4.5% of GDP at the global level in 2025, with surprisingly similar levels in many world regions, including Europe and Sub-Saharan Africa. However the share of 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.

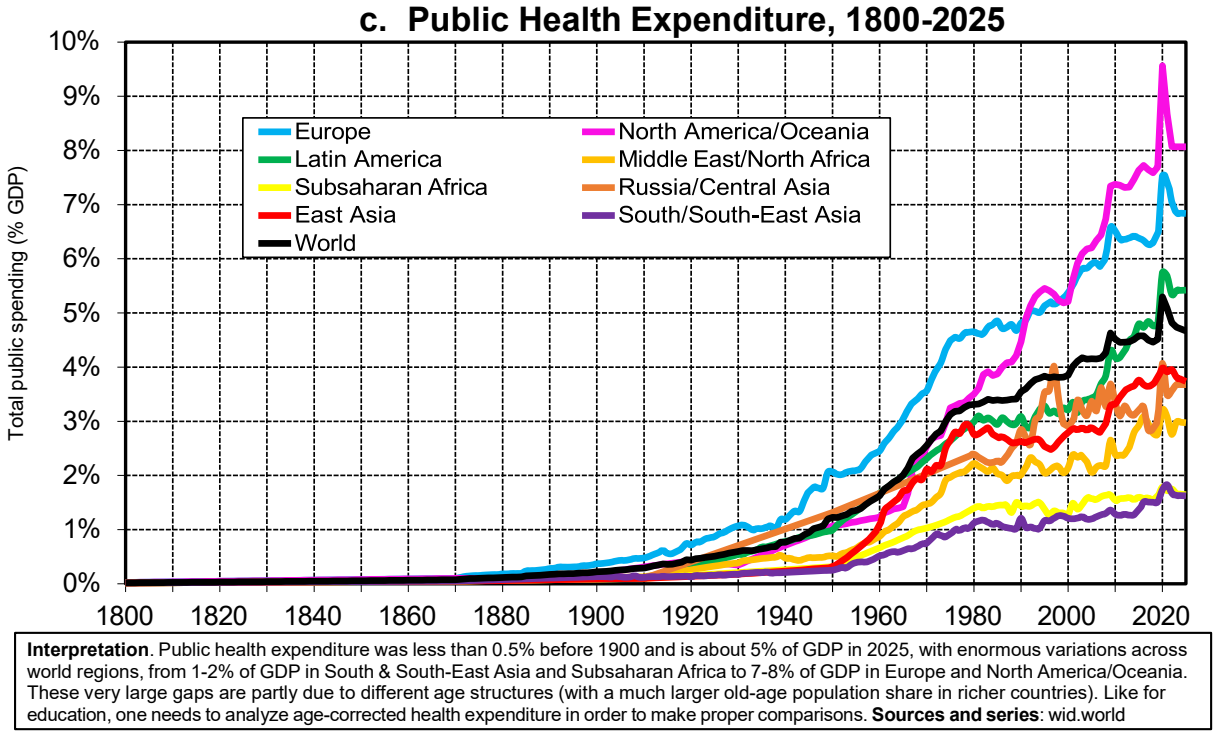

Fig. 5c. Public Health Expenditure, 1800–2025. **Interpretation**. Public health expenditure was less than 0.5% before 1900 and is about 5% of GDP in 2025, with enormous variations across world regions, from 1 to 2% of GDP in South & Southeast Asia and Sub-Saharan Africa to 7–8% of GDP in Europe and 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.

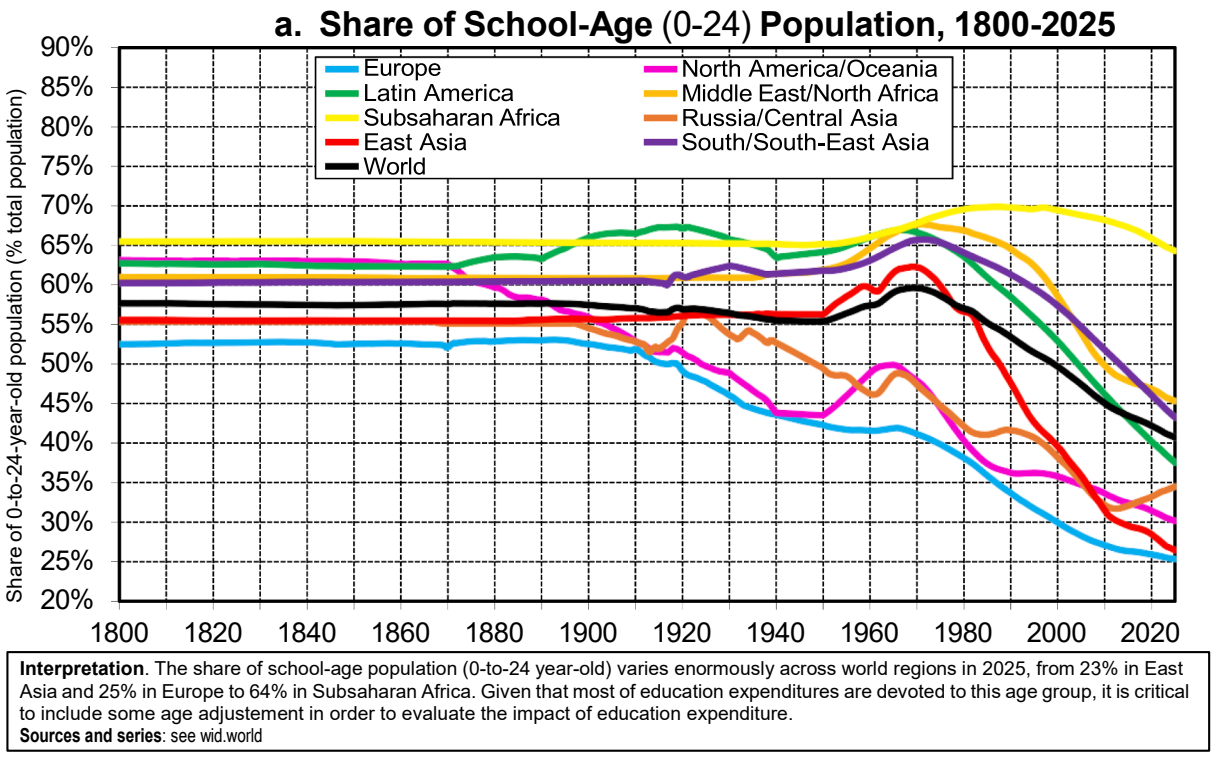

Fig. 6a. Share of School-Age (0–24) Population, 1800–2025. **Interpretation**. The share of school-age population (0-to-24 year-old) varies enormously across world regions in 2025, from 23% in East Asia and 25% in Europe to 64% in Sub-Saharan Africa. Given that most of education expenditures are devoted 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.

Europe in 2030) and keeping the same per-age-group expenditure as in the observed country-year (see Fig. 6b for differences in old-age population shares across different regions in the world).

After making these adjustments, 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 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 Fig. 7a). The gaps are somewhat larger after age adjustment than before age adjustment, as the unequalizing impact of the education adjustment more than counterbalances the equalizing impact of the health adjustment, especially for Sub-Saharan Africa (see Figs. 7b-7c).

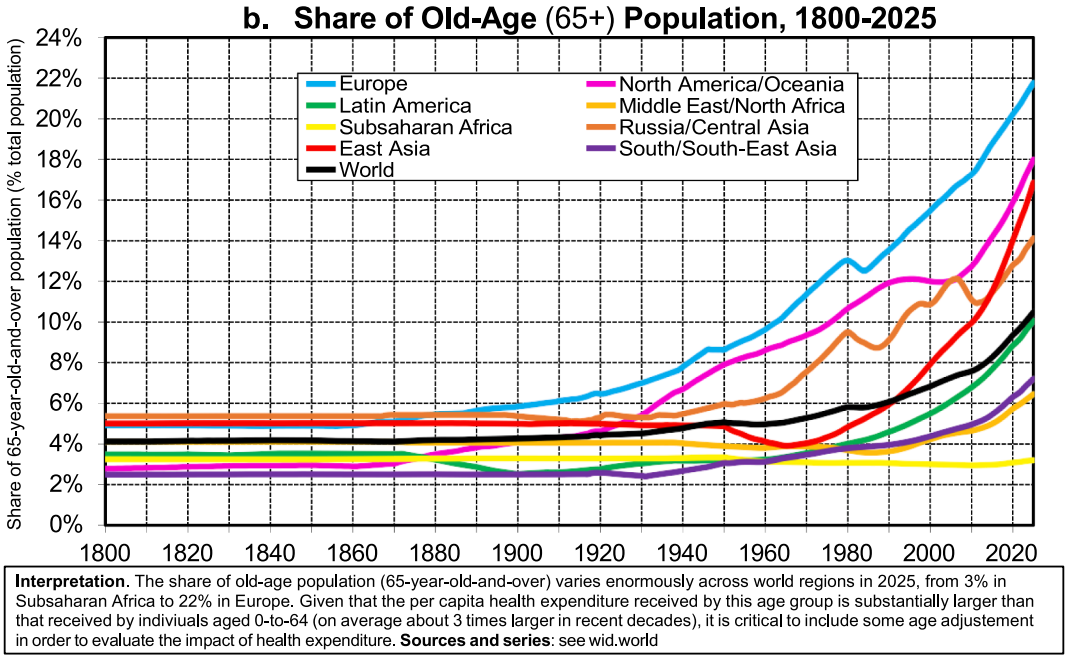

Fig. 6b. Share of Old-Age (65 +) Population, 1800–2025. **Interpretation**. The share of old-age population (65-year-old-and-over) varies enormously across world regions in 2025, from 3% in Sub-Saharan Africa to 22% in Europe. Given that the per capita health expenditure received by this age group is 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.

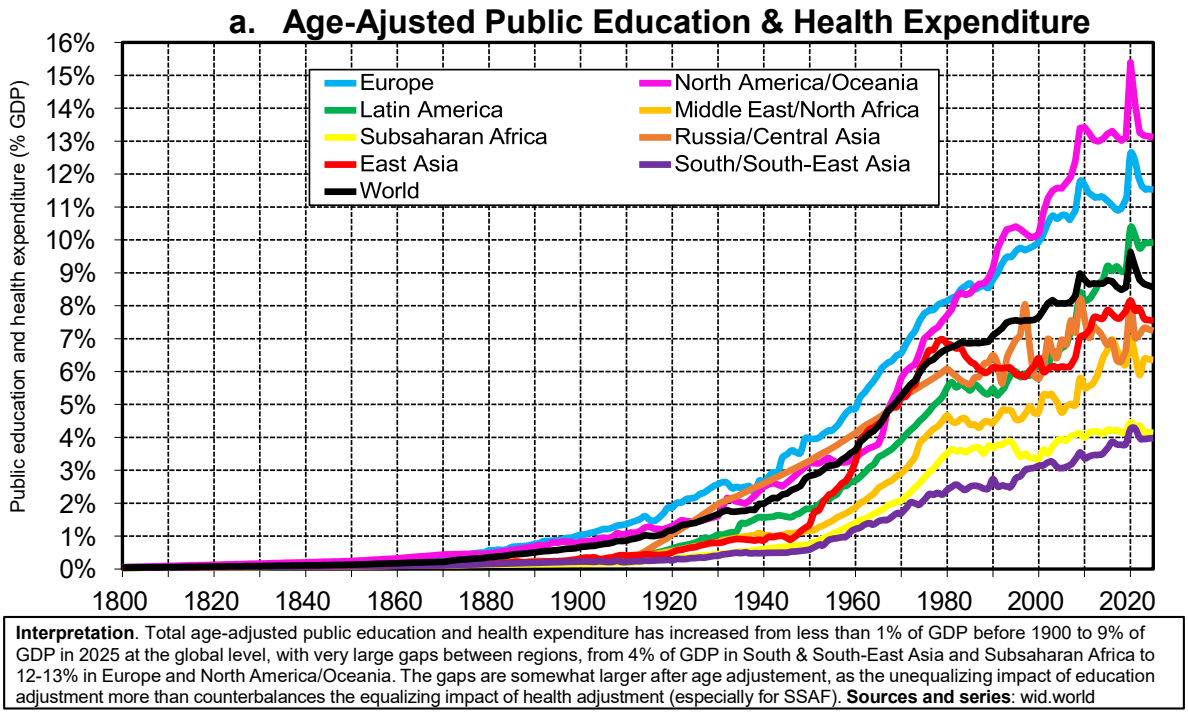

Fig. 7a. Age-Ajusted Public Education & Health Expenditure. Interpretation. Total age-adjusted public education and health expenditure has increased from less than 1% of GDP before 1900 to 9% of GDP in 2025 at the global level, with very large gaps between regions, from 4% of GDP in South & Southeast Asia and Sub-Saharan 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.

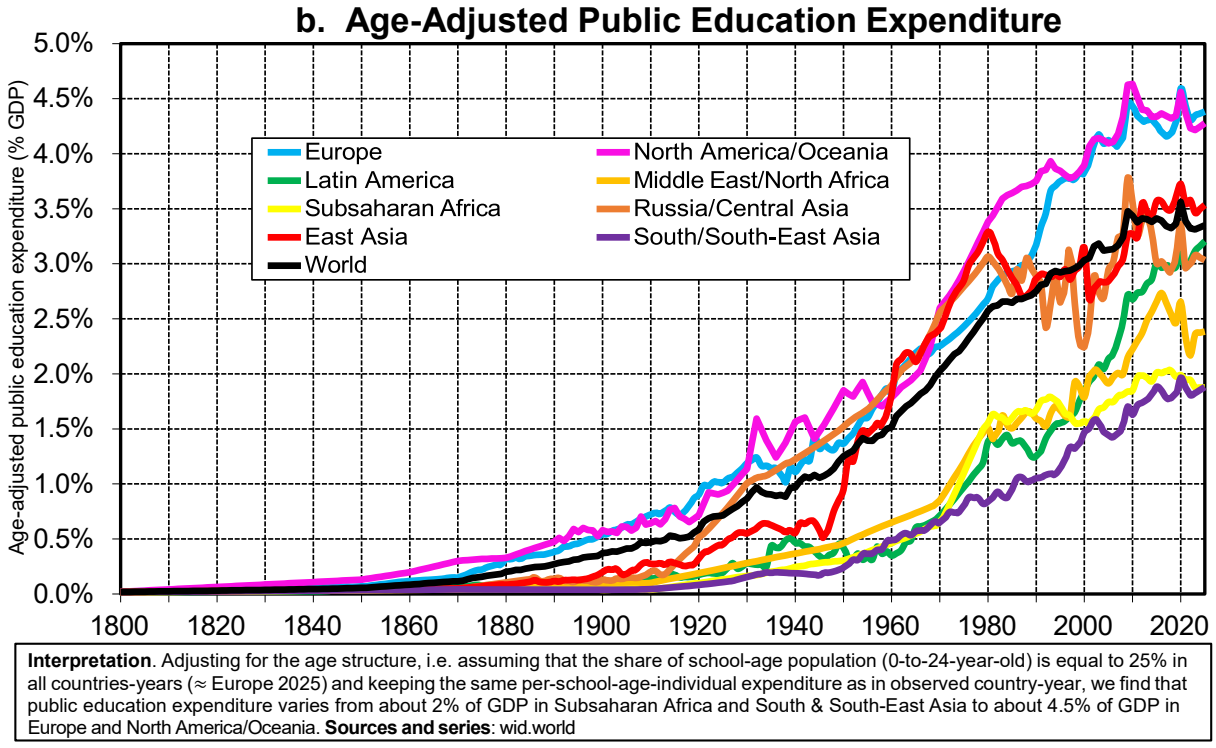

Fig. 7b. Age-Adjusted Public Education Expenditure. Interpretation. Adjusting for the age structure, i.e. assuming that the share of school-age population (0-to-24-year-old) is equal to 25% in all country-years (≈ Europe 2025) and keeping the same per-school-age-individual expenditure as in observed country-year, we find that public education expenditure varies from about 2% of GDP in Sub-Saharan Africa and South & Southeast Asia to about 4.5% of GDP in Europe and North America/Oceania. Sources and series: wid.world.

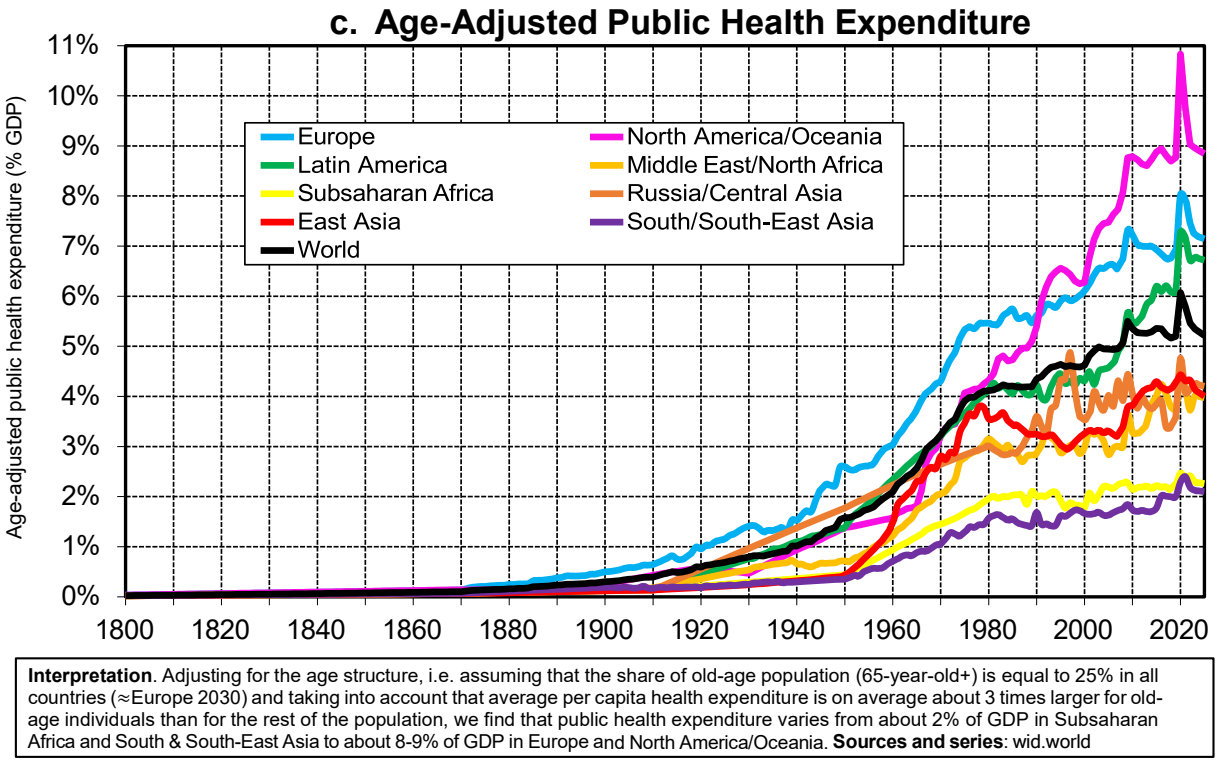

Fig. 7c. Age-Adjusted Public Health Expenditure. **Interpretation**. Adjusting for the age structure, i.e. assuming that the share of old-age population (65-year-old +) is equal to 25% in all countries (≈Europe 2030) and taking into account that average per capita health expenditure is on average about 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 Sub-Saharan Africa and South & Southeast Asia to about 8–9% of GDP in Europe and North America/Oceania. **Sources and series**: wid.world.

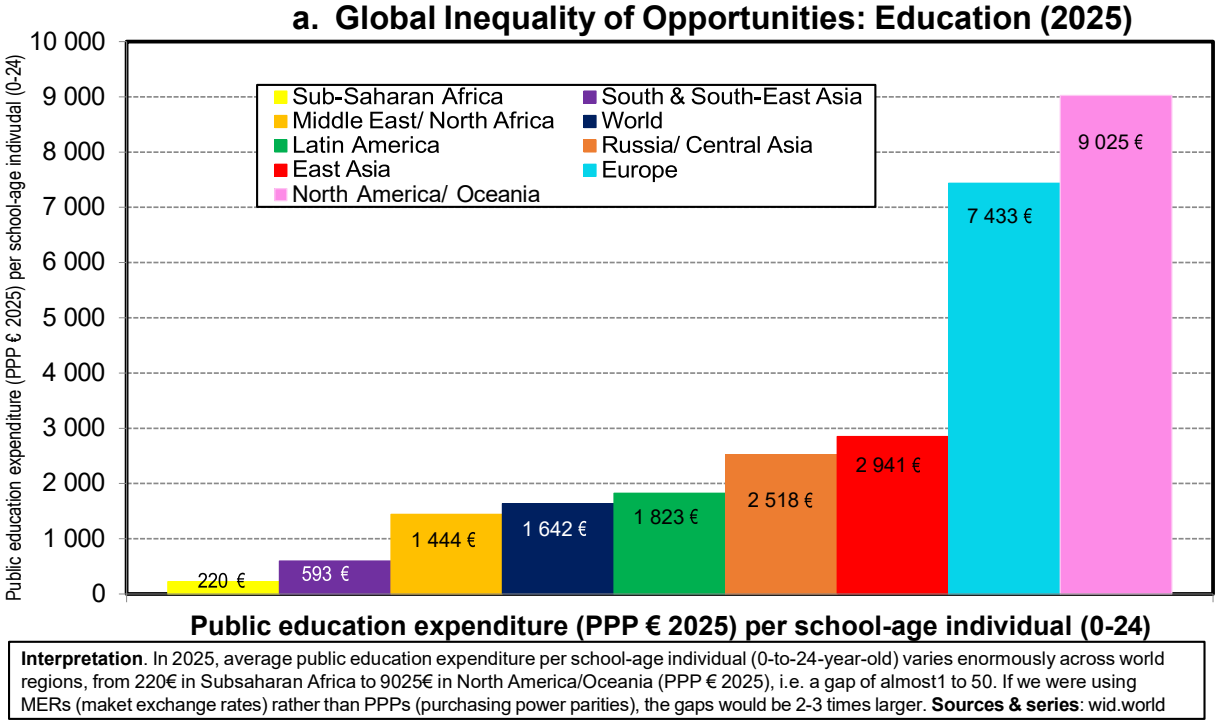

Fig. 8a. Global Inequality of Opportunities: Education (2025). Interpretation. In 2025, average public education expenditure per school-age individual (0-to-24-year-old) varies enormously across world regions, from 220€ in Sub-Saharan Africa to 9025€ in North America/Oceania (PPP € 2025), i.e. a gap 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.

3.3. The Persistence of global inequalities in access to education and health

One of the most striking results emerging from our database is the magnitude of the gap between world regions in terms of education expenditure, and the fact that this gap did not decrease in recent decades. Average public education expenditure per school-age individual (0-to-24-year-old) varies significantly across world regions, from 220€ in Sub-Saharan Africa to 9,025€ in North America/Oceania (PPP € 2025), corresponding to a gap of almost 1 to 50 (see Fig. 8a). These gaps are not due to the fact that prices are higher in rich countries as we are using PPP values. If we were to use MERs rather than PPPs, the gaps would be 2–3 times larger (see Nievas and Piketty (2025a), Fig. 4a). Put differently, Europe and North America/Oceania host 8% of the world school-age population in 2025 and benefit from 40% of world public education expenditure at PPP. In contrast, Sub-Saharan Africa and South & Southeast Asia host 60% of the global school-age population and benefit from 16% of expenditure (see Fig. 8b).

This gap did not decline in recent decades. The spending gap between the world's poorest and richest regions first increased strongly over the 1800–1950 period. At the start of the 19th century, it was relatively small because public education spending was uniformly low across all world regions: modern mass schooling systems had not yet been established, and most countries devoted only minimal resources to education. The large divergence observed during the 19th century reflects the fact that Europe and North America/Oceania were the first to expand public schooling systems and to increase education budgets significantly. For example, China's modern public schooling system emerged in the early 20th century, while in India though elements of a modern public schooling system appeared somewhat earlier, in the late 19th century, its scale remained extremely limited.

Following this initial rise, spending inequalities then stabilized at a very high level with little change over time. For instance, average public education expenditure per school-age individual in Sub-Saharan Africa was 4% of the Europe/NAOC average in 1950, 6% in 1980, and 3% in 2025 (see Fig. 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 from 50€ in Sub-Saharan Africa to 3,200€ in North America/Oceania, corresponding to a gap of about 1 to 60 (see Fig. 9a). Europe and North America/Oceania host 23% of the world old-age population (65 +) in 2025 and benefit from 55% of world public health expenditure at PPP. In contrast, Sub-Saharan Africa and South & Southeast Asia host 27% of the global old-age population and benefit from 7% of expenditure (see Fig. 9b). Average public health expenditure per 0-to-64-year-old individual in Sub-Saharan Africa was equal to 4% of the Europe-NAOC average in 1950 and 1980, and 2% in 2025 (see Fig. 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? Consider raising per-capita (age-adjusted) education and health expenditure to the same level as the Europe/NAOC average in all countries where it is lower. In 2025, this would cost 32% of world GDP, including 12% for South & Southeast Asia, 5% in East Asia and 8% for Sub-Saharan Africa (see Fig. 10a). Out of these 32% of world GDP, about half would come from equal access to education and half from equal access to healthcare (see Figs. 10b-10c). The cost of equal opportunity would have been much lower in the 19th century and early 20th century, as education and health expenditure were much lower at the time.

3.4. Public versus private human capital expenditure

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

Private education and health expenditure represents about 4.5% of

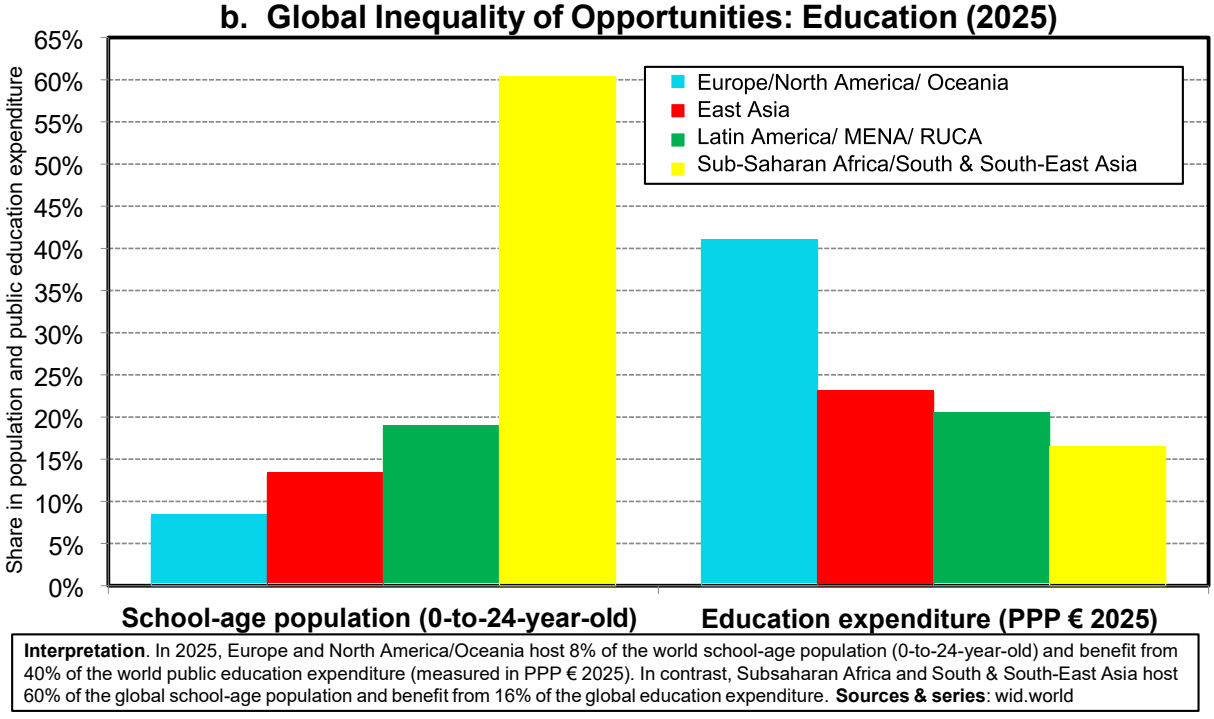

Fig. 8b. Global Inequality of Opportunities: Education (2025). **Interpretation.** In 2025, Europe and North America/Oceania host 8% of the world school-age population (0-to-24-year-old) and benefit from 40% of the world public education expenditure (measured in PPP € 2025). In contrast, Sub-Saharan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

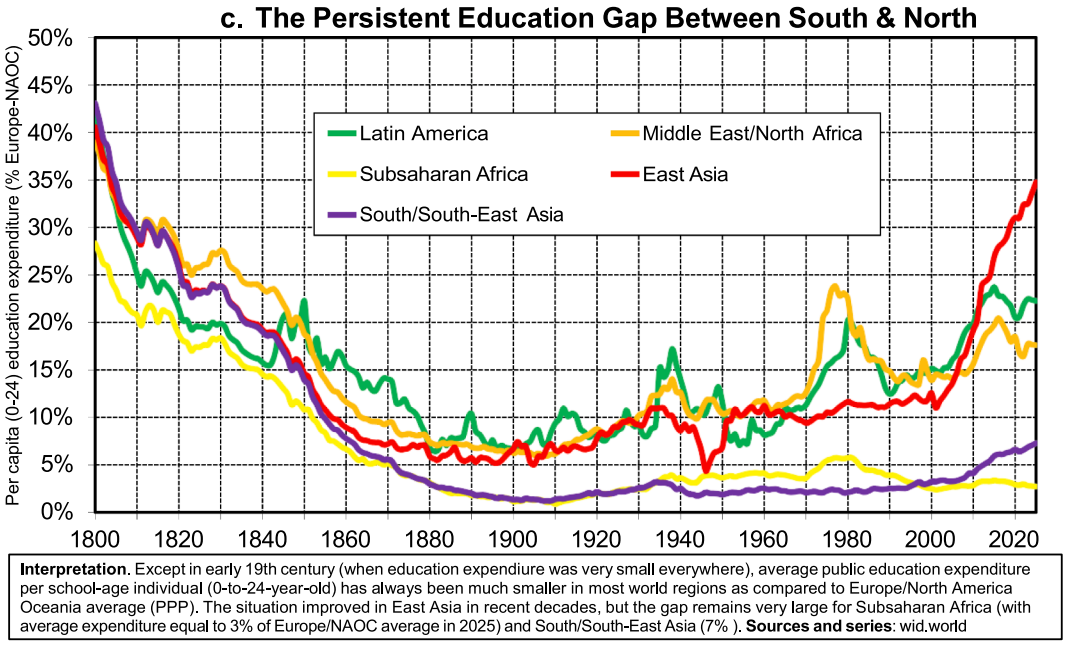

Fig. 8c. The Persistent Education Gap Between South & North. **Interpretation.** Except in early 19th century (when education expendiure was very small everywhere), average public education expenditure per school-age individual (0-to-24-year-old) has always been much smaller in most world regions as compared to Europe/North America Oceania average (PPP). The situation improved in East Asia in recent decades, but the gap remains very large for Sub-Saharan Africa (with average expenditure equal to 3% of Europe/NAOC average in 2025) and South/Southeast Asia (7%). **Sources and series**: wid.world.

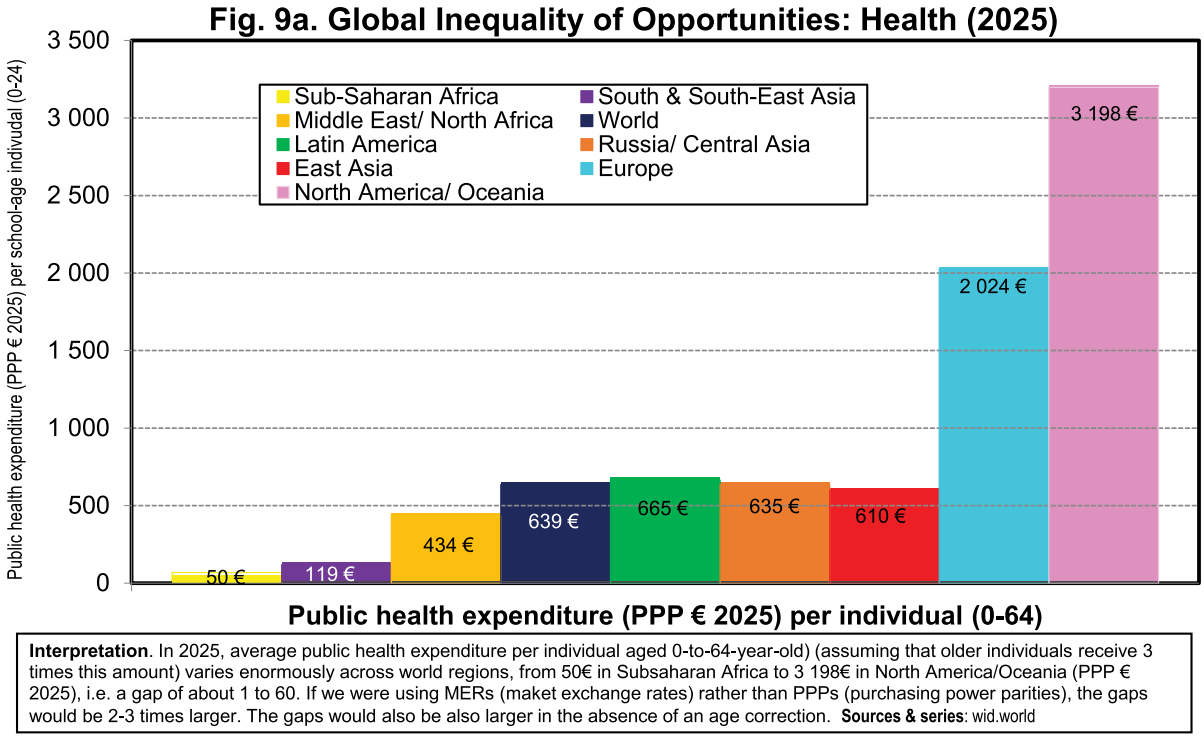

Fig. 9a. Global Inequality of Opportunities: Health (2025). Interpretation. In 2025, average public health expenditure per individual aged 0-to-64-year-old) (assuming that older individuals receive 3 times this amount) varies enormously across world regions, from 50€ in Sub-Saharan Africa to 3 198€ in 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.

GDP at the global level in 2025 ranging 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 Fig. 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 Fig. 11b). At the global level, private education expenditure represents 1.3% of GDP in 2025, or about 24% of total education expenditure (5.3% of GDP). Private health expenditure also increased substantially in recent decades in North America/Oceania,

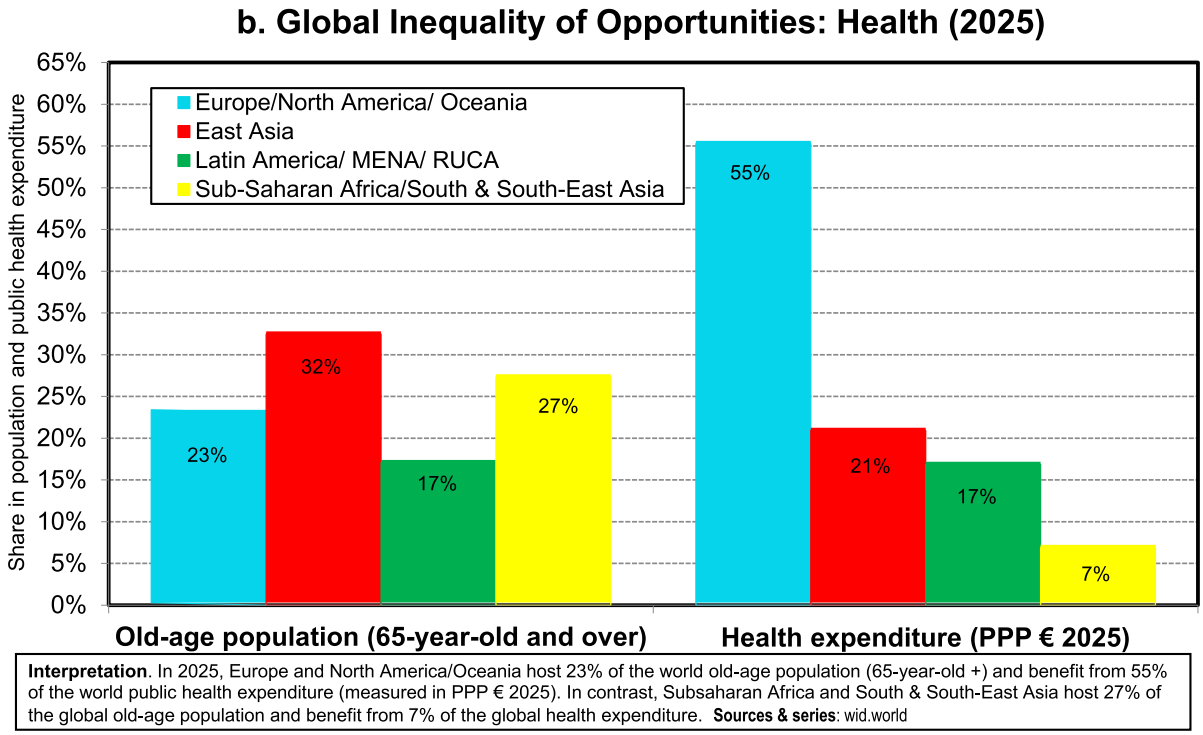

Fig. 9b. Global Inequality of Opportunities: Health (2025). **Interpretation**. In 2025, Europe and North America/Oceania host 23% of the world old-age population (65-year-old +) and benefit from 55% of the world public health expenditure (measured in PPP € 2025). In contrast, Sub-Saharan Africa and South & Southeast Asia host 27% of the global old-age population and benefit from 7% of the global health expenditure. **Sources & series**: wid.world.

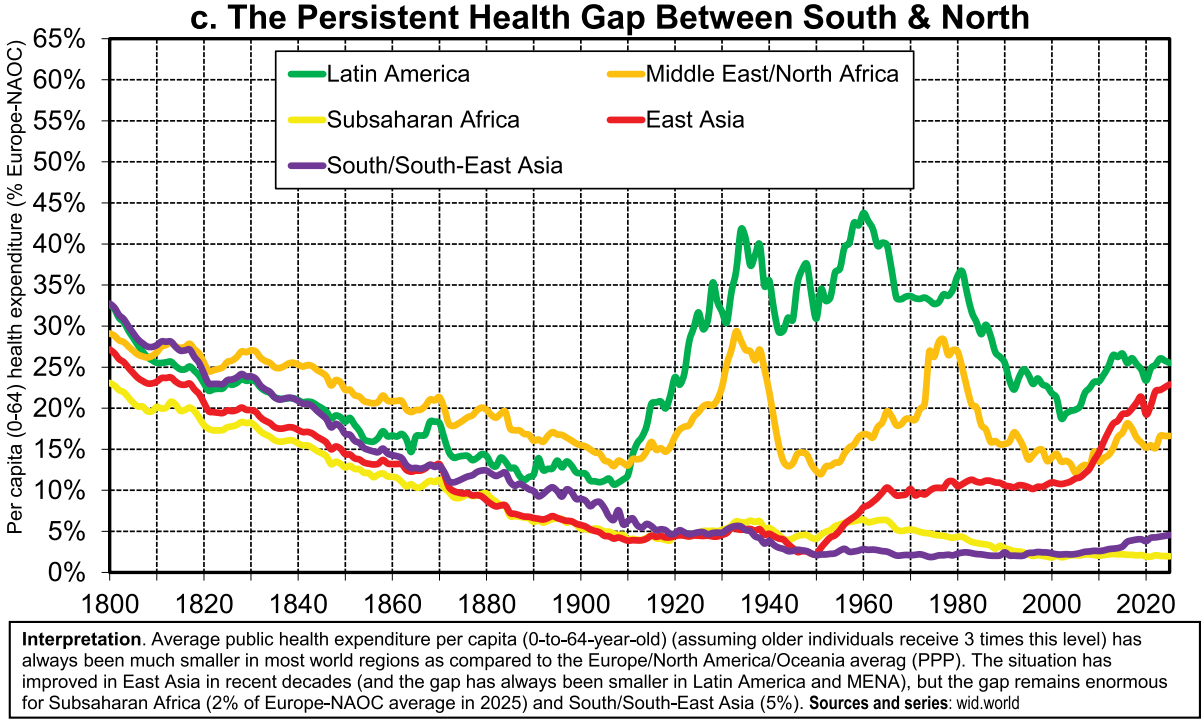

Fig. 9c. The Persistent Health Gap Between South & North. Interpretation. Average public health expenditure per capita (0-to-64-year-old) (assuming older individuals receive 3 times this level) has always been much smaller in most world regions as compared to the Europe/North America/Oceania averag (PPP). 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 Sub-Saharan Africa (2% of Europe-NAOC average in 2025) and South/Southeast Asia (5%). Sources and series: wid.world.

and to a lesser extent in Latin America (see Fig. 11c). At the global level, private health expenditure represents 3.1% of GDP in 2025, or about 40% of total health expenditure (7.8% of GDP).

Applying the same age adjustment method to both public and private human capital expenditure delivers the following results. Total age-adjusted public and private education and health expenditure has

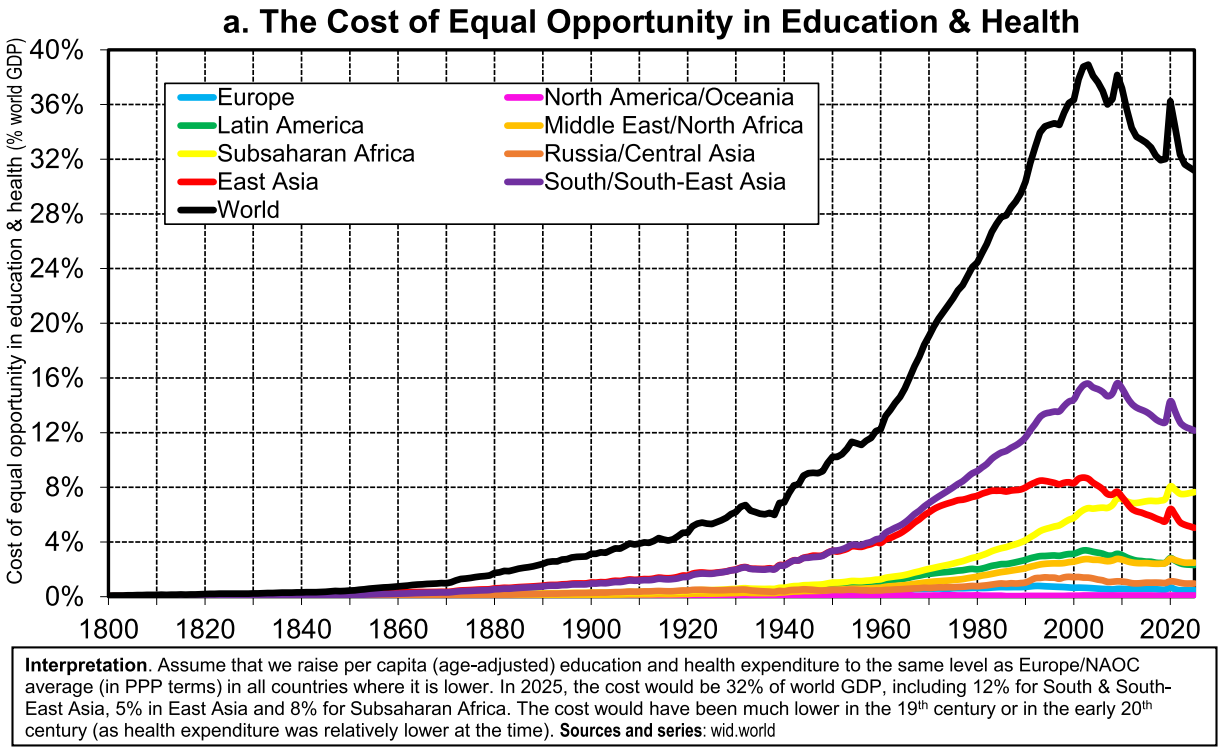

Fig. 10a. The Cost of Equal Opportunity in Education & Health. **Interpretation**. Assume that we raise per capita (age-adjusted) education and health expenditure to the same level as Europe/NAOC average (in PPP terms) in all countries where it is lower. In 2025, the cost would be 32% of world GDP, including 12% for South & Southeast Asia, 5% in East Asia and 8% for Sub-Saharan 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.

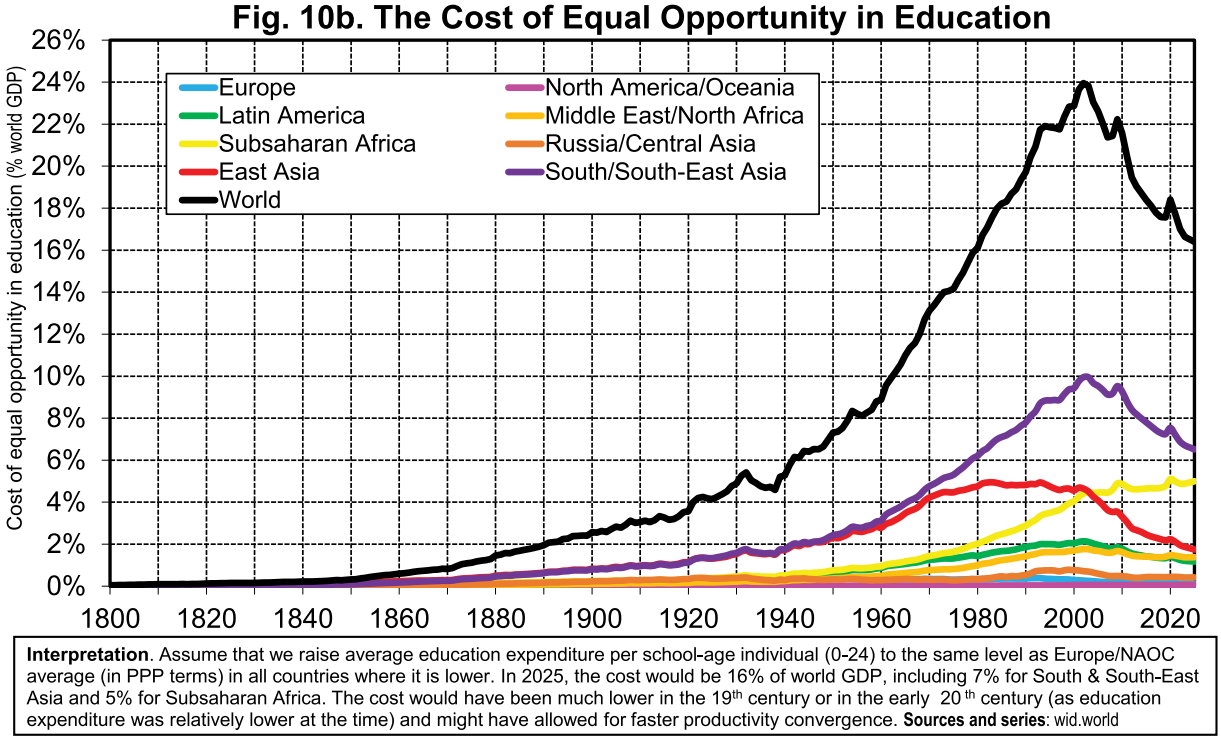

Fig. 10b. The Cost of Equal Opportunity in Education. **Interpretation**. Assume that we raise average education expenditure per school-age individual (0–24) to the same level as Europe/NAOC average (in PPP terms) in all countries where it is lower. In 2025, the cost would be 16% of world GDP, including 7% for South & Southeast Asia and 5% for Sub-Saharan Africa. The cost would have been much lower in the 19th century or in the early 20 th century (as education expenditure was relatively lower at the time) and might have allowed for faster productivity convergence. **Sources and series**: wid.world.

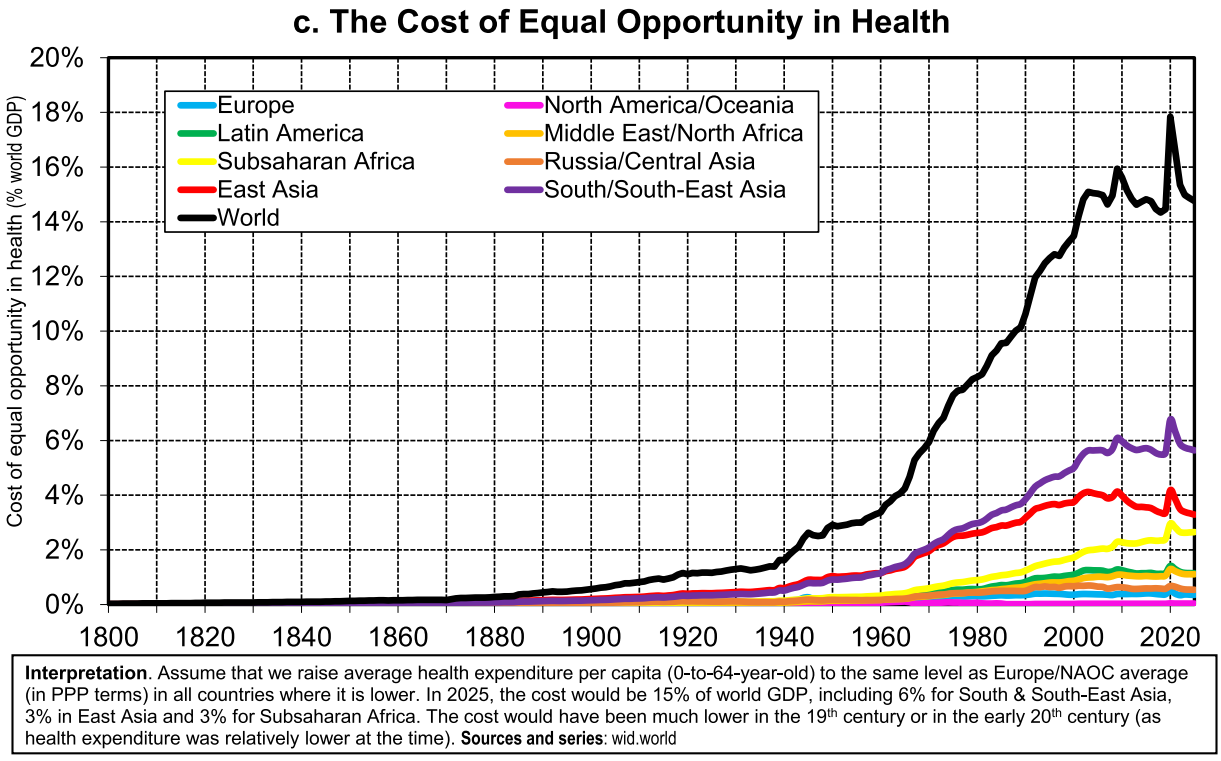

Fig. 10c. The Cost of Equal Opportunity in Health. Interpretation. Assume that we raise average health expenditure per capita (0-to-64-year-old) to the same level as Europe/NAOC average (in PPP terms) in all countries where it is lower. In 2025, the cost would be 15% of world GDP, including 6% for South & Southeast Asia, 3% in East Asia and 3% for Sub-Saharan 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.

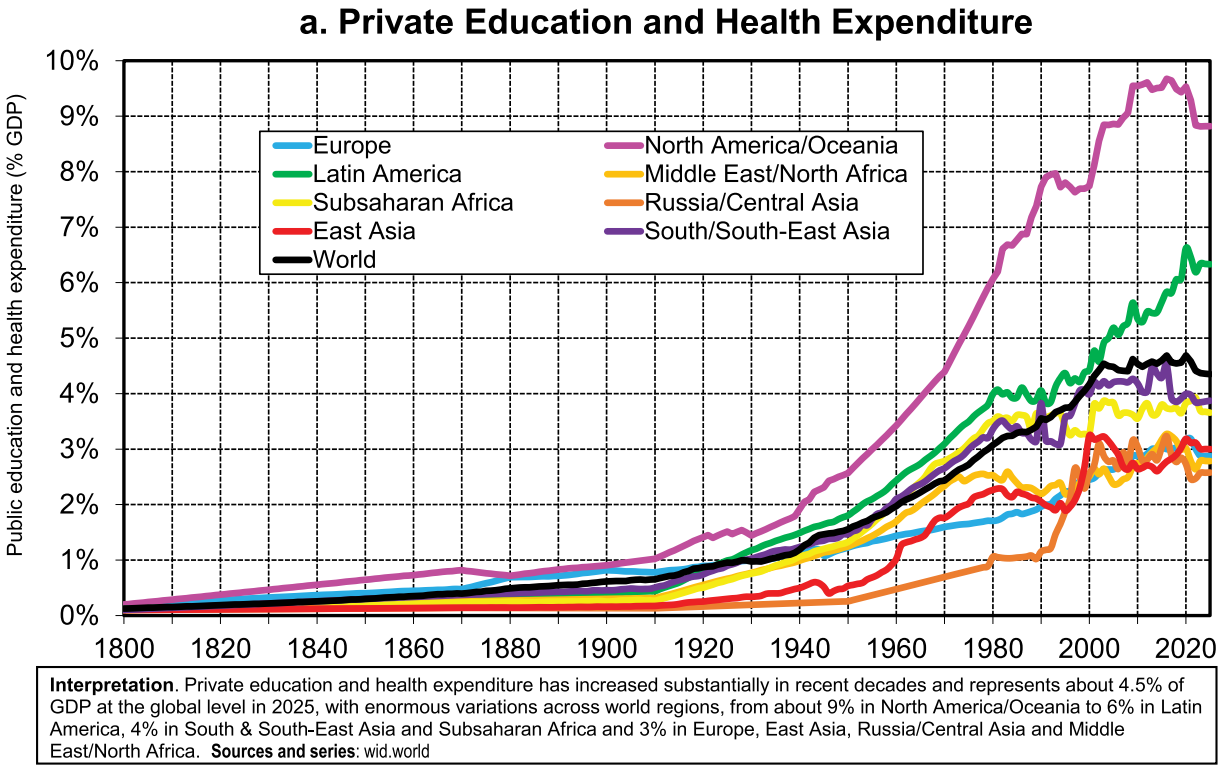

Fig. 11a. Private Education and Health Expenditure. **Interpretation**. Private education and health expenditure has increased substantially in recent decades and represents about 4.5% of GDP at the global level in 2025, with enormous variations across world regions, from about 9% in North America/Oceania to 6% in Latin America, 4% in South & Southeast Asia and Sub-Saharan Africa and 3% in Europe, East Asia, Russia/Central Asia and Middle East/North Africa. **Sources and series**: wid.world.

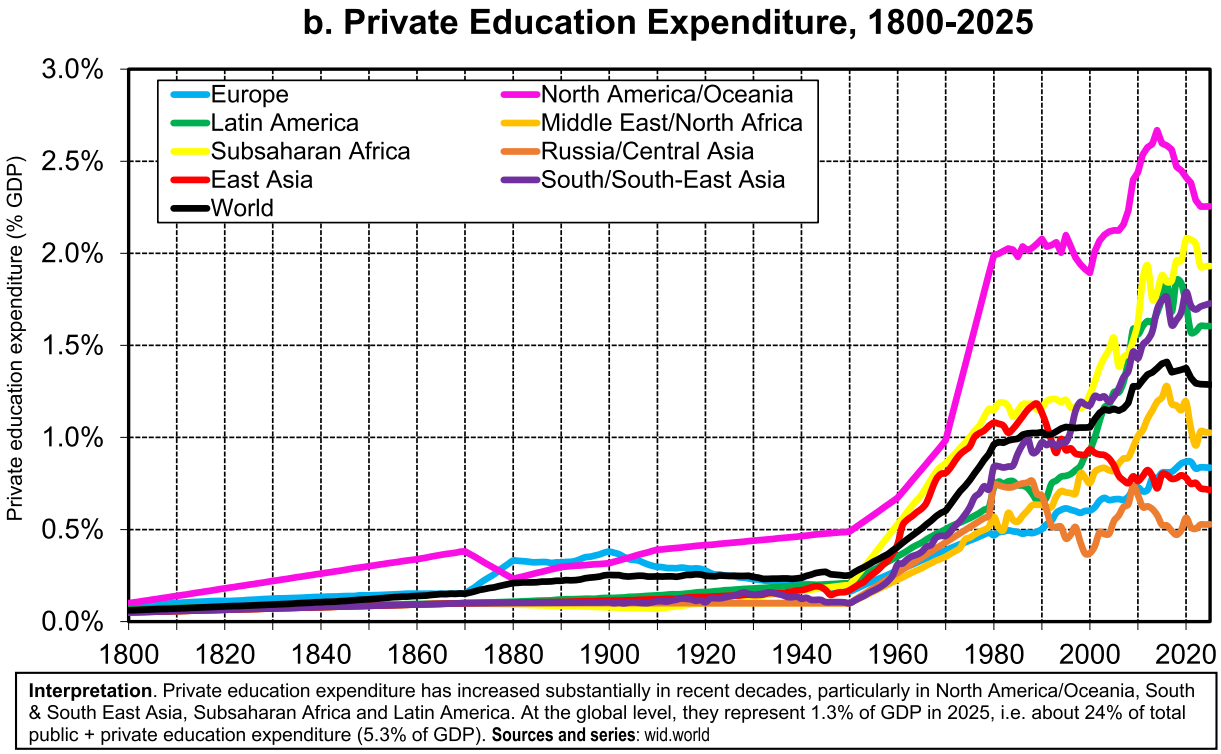

Fig. 11b. Private Education Expenditure, 1800–2025. **Interpretation**. Private education expenditure has increased substantially in recent decades, particularly in North America/Oceania, South & South East Asia, Sub-Saharan Africa and Latin America. At the global level, they represent 1.3% of GDP in 2025, i.e. about 24% of total public + private education expenditure (5.3% of GDP). **Sources and series**: wid.world.

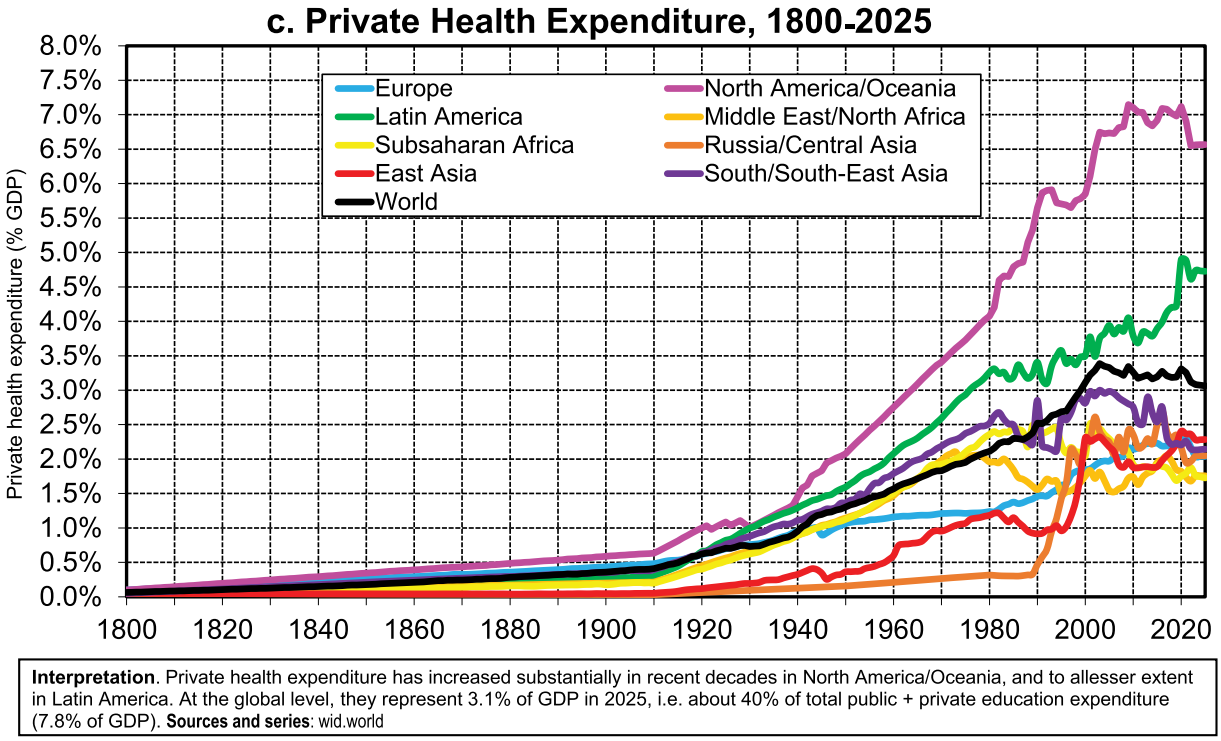

Fig. 11c. Private Health Expenditure, 1800–2025. **Interpretation**. Private health expenditure has increased substantially in recent decades in North America/Oceania, and to allesser extent in Latin America. At the global level, they represent 3.1% of GDP in 2025, i.e. about 40% of total public + private education expenditure (7.8% of GDP). **Sources and series**: wid.world.

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 Fig. 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

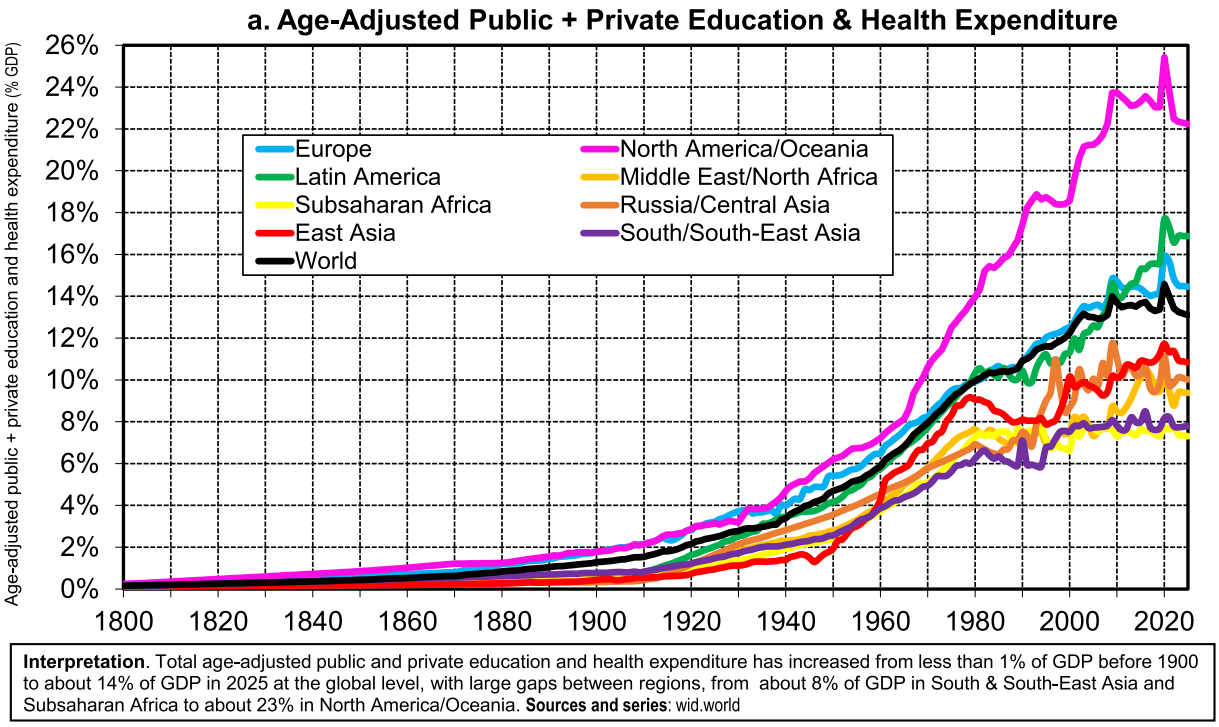

Fig. 12a. Age-Adjusted Public + Private Education & Health Expenditure. Interpretation. Total age-adjusted public and private education and health expenditure has increased from less than 1% of GDP before 1900 to about 14% of GDP in 2025 at the global level, with large gaps between regions, from about 8% of GDP in South & Southeast Asia and Sub-Saharan Africa to about 23% in North America/Oceania. **Sources and series**: wid.world.

figures ranging from about 2.5% of GDP in South & Southeast Asia and Sub-Saharan Africa to about 6–6.5% in North America/Oceania (see Fig. 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 variations from about 4–5% of GDP in South & Southeast Asia and Sub-Saharan Africa to about 16% in North America/Oceania (see Fig. 12c).

The inclusion of private expenditure also considerably modifies the

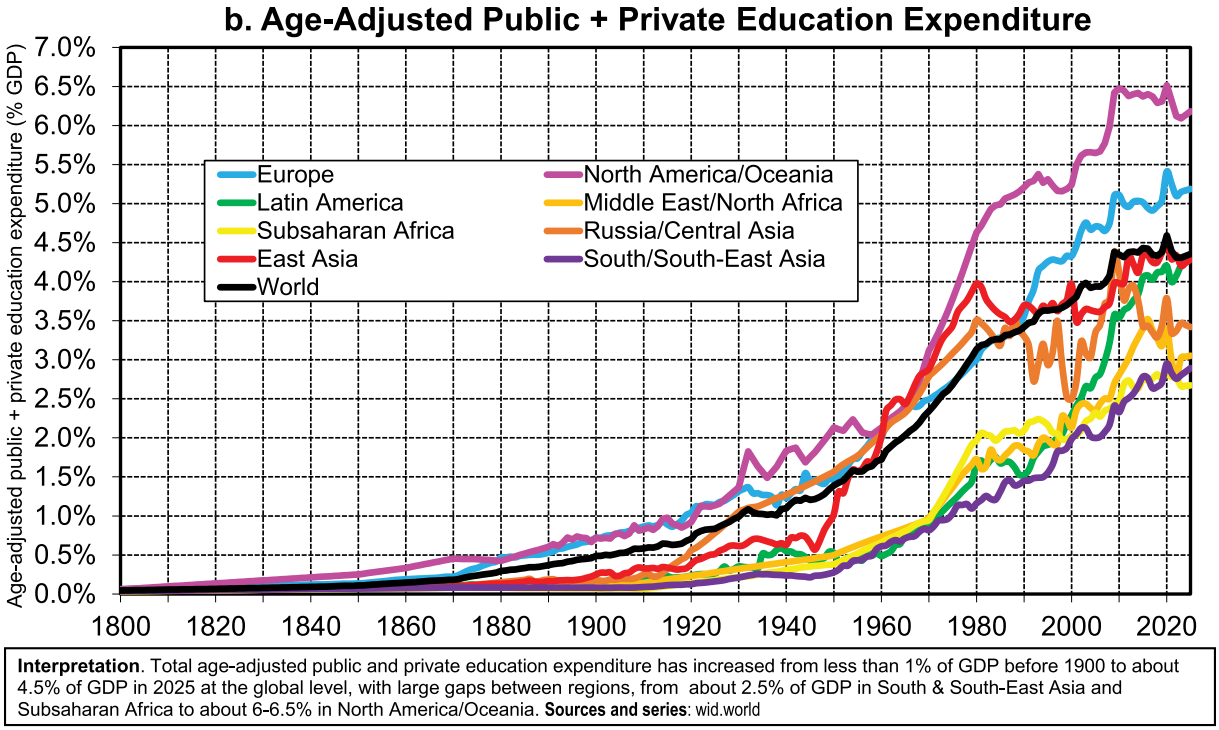

Fig. 12b. Age-Adjusted Public + Private Education Expenditure. **Interpretation**. Total age-adjusted public and private education expenditure has increased from less than 1% of GDP before 1900 to about 4.5% of GDP in 2025 at the global level, with large gaps between regions, from about 2.5% of GDP in South & Southeast Asia and Sub-Saharan Africa to about 6–6.5% in North America/Oceania. **Sources and series**: wid.world.

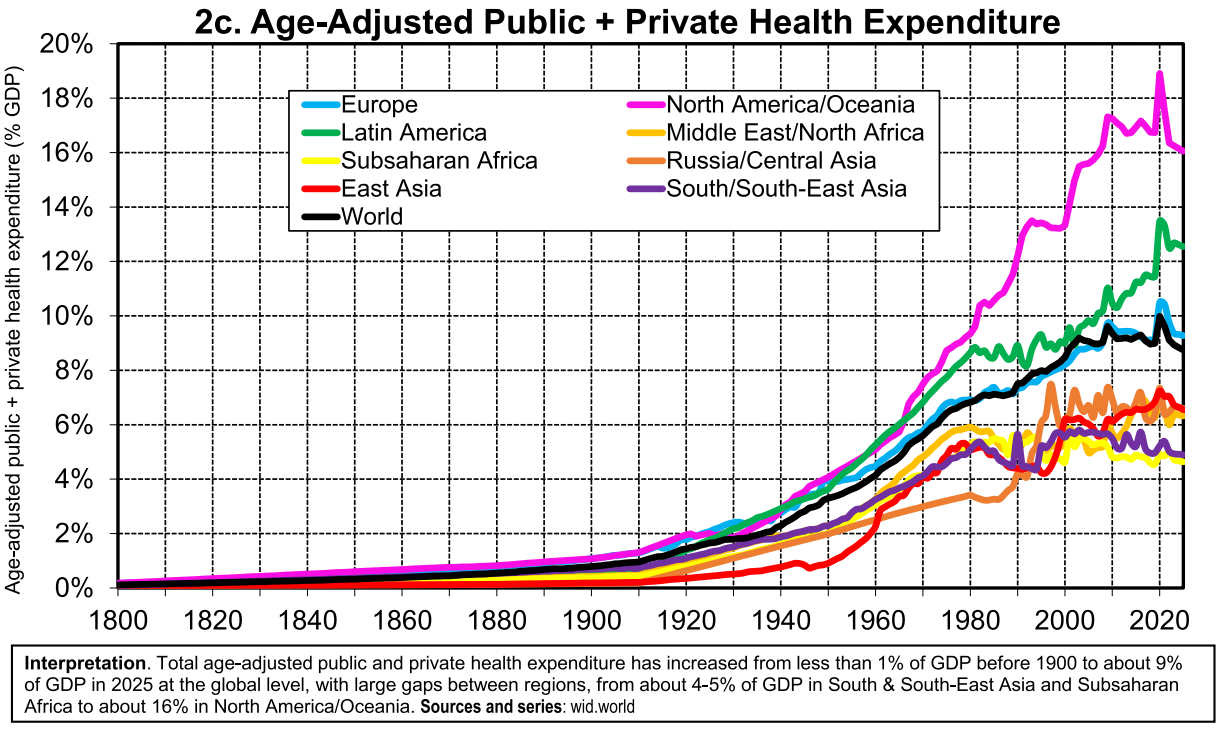

Fig. 12c. Age-Adjusted Public + Private Health Expenditure. **Interpretation**. Total age-adjusted public and private health expenditure has increased from less than 1% of GDP before 1900 to about 9% of GDP in 2025 at the global level, with large gaps between regions, from about 4–5% of GDP in South & Southeast Asia and Sub-Saharan Africa to about 16% in North America/Oceania. **Sources and series**: wid.world.

ranking between countries and regions. Due to the high private expenditure observed in the U.S. (for education and especially for health), total public and private human capital expenditure has become much larger in North America/Oceania than in Europe in recent decades. Interpreting these differences, however, requires caution. Higher spending does not necessarily translate into better outcomes: for example, health indicators are generally better in Europe than in the United States. Although the determinants of this gap are multifaceted, the comparison underscores that high private health expenditure does not automatically ensure better health outcomes (e.g., Michaud et al., 2011; Roser, 2017; Case and Deaton, 2020). Latin America also 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.

4. Human Capital, productivity and comparative development

This section turns to the relationship between human capital expenditure, productivity growth, and comparative development. The analysis starts with a brief overview of long-run productivity trends, followed by an examination of how state capacity contributed to the early productivity gap around 1800–1840. The final part of the section explores productivity dynamics over 1800–2025 and the role played by human capital expenditure.

4.1. The uneven rise of productivity

We first recall basic facts about productivity growth over the 1800–2025 period. At the global level, per capita GDP rose from about 900€ in 1800 to 16,000€ in 2025 at PPP. Hence, it was multiplied by about 18, which corresponds to a real average annual growth rate of 1.3%, with large variations over time and across regions. In 2025, per capita GDP varies from about 3,000€ on average in Sub-Saharan Africa to about 40,000–50,000€ in Europe and North America/Oceania, corresponding to a gap of 1 to 15 (see Fig. 13).

Labor hours have declined in the long run and vary significantly 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 labor hours estimated in Andreescu et al. (2025). At the global level, hourly productivity rose from about 0.7€ in 1800 to 16€ in 2025. It was thus multiplied by 24, which corresponds to a real average annual growth rate of 1.4%, with large variations over time and across regions. In 2025, productivity varies from about 4€ per hour in Sub-Saharan Africa to 55-60€ in Europe and North America/Oceania (see Fig. 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 (including Denmark, Sweden, the Netherlands, Norway, Germany, France, and Britain) have approximately the same productivity level as the USA, around 55-60€/hour, and even a bit more in some Nordic countries (see Fig. 14b).

If we divide regional productivity by the world average, inequality in hourly productivity between world regions appears to have risen between 1800 and 1950 before starting to decline since 1950–1960, with large geographical variations. In 2025, productivity is close to the world average in East Asia but only 50% of the world average in South & Southeast Asia and 25% in Sub-Saharan Africa (see Figs. 15a–b). 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 an 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 these processes tend to be limited in time (see Table 2).

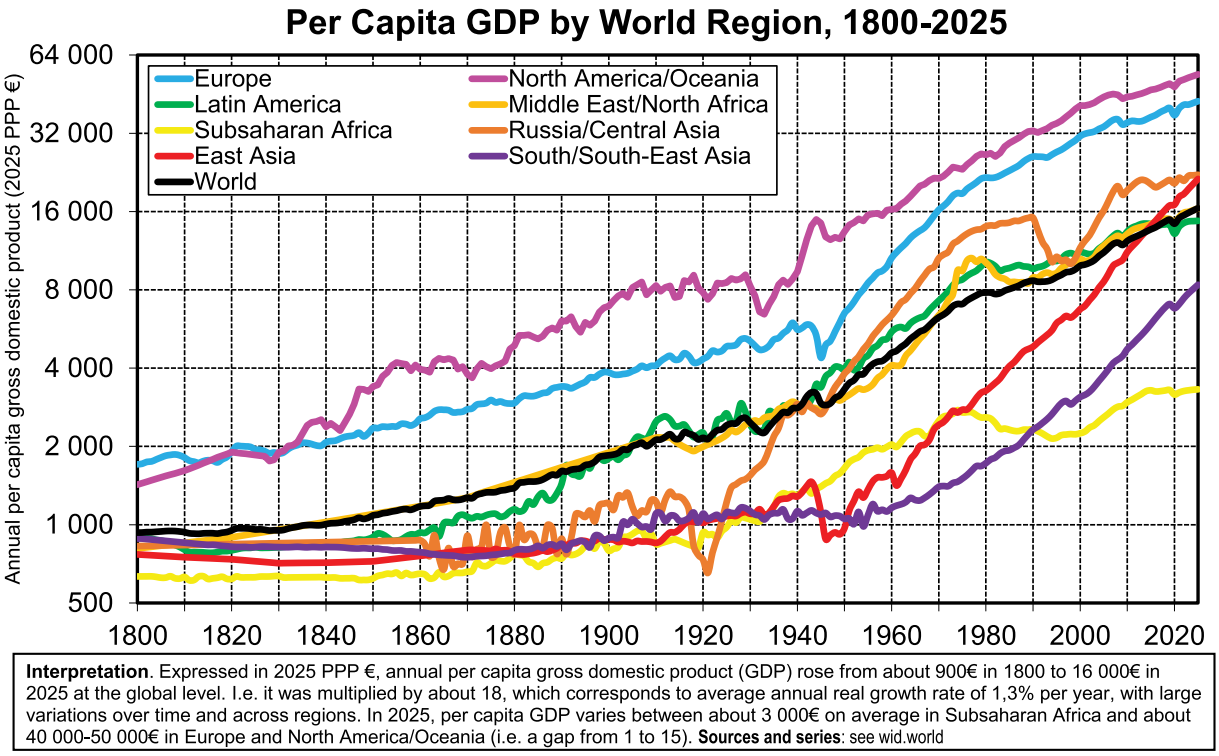

Fig. 13. Per Capita GDP by World Region, 1800-2025**Interpretation**. Expressed in 2025 PPP €, annual per capita gross domestic product (GDP) rose from about 900€ in 1800 to 16 000€ in 2025 at the global level. I.e. it was multiplied by about 18, which corresponds to average annual real growth rate of 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 Sub-Saharan 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.

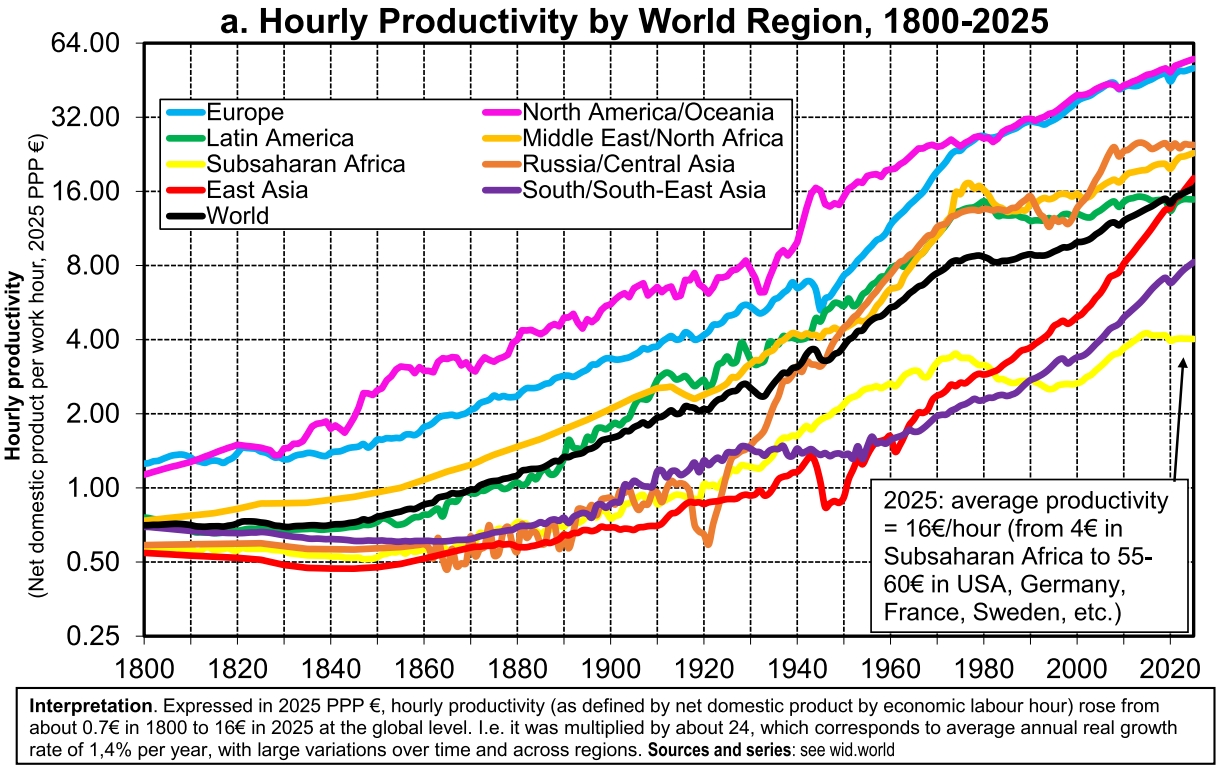

Fig. 14a. Hourly Productivity by World Region, 1800–2025. **Interpretation**. Expressed in 2025 PPP €, hourly productivity (as defined by net domestic product by economic labour hour) rose from about 0.7€ in 1800 to 16€ in 2025 at the global level. I.e. it was multiplied by about 24, which corresponds 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.

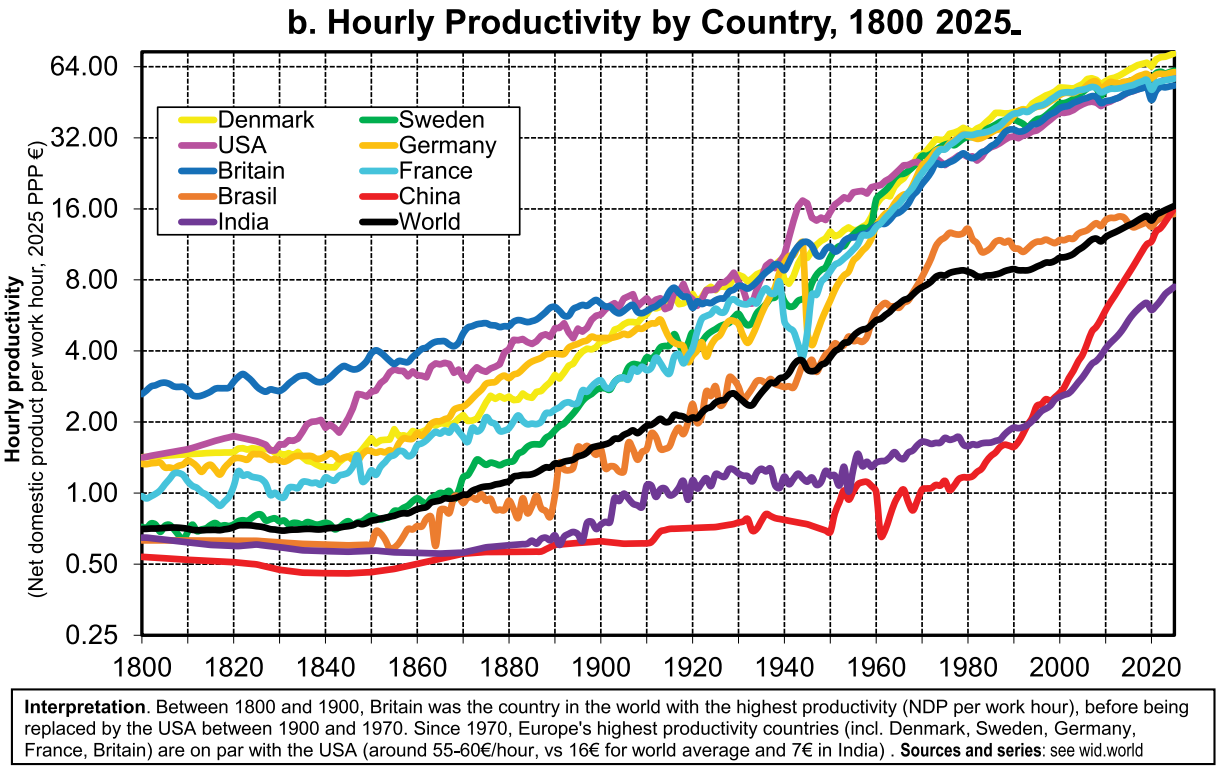

Fig. 14b. Hourly Productivity by Country, 1800–2025. Interpretation. Between 1800 and 1900, Britain was the country in the world with the highest productivity (NDP per work hour), before being replaced by the USA between 1900 and 1970. Since 1970, Europe's highest productivity countries (incl. Denmark, 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.

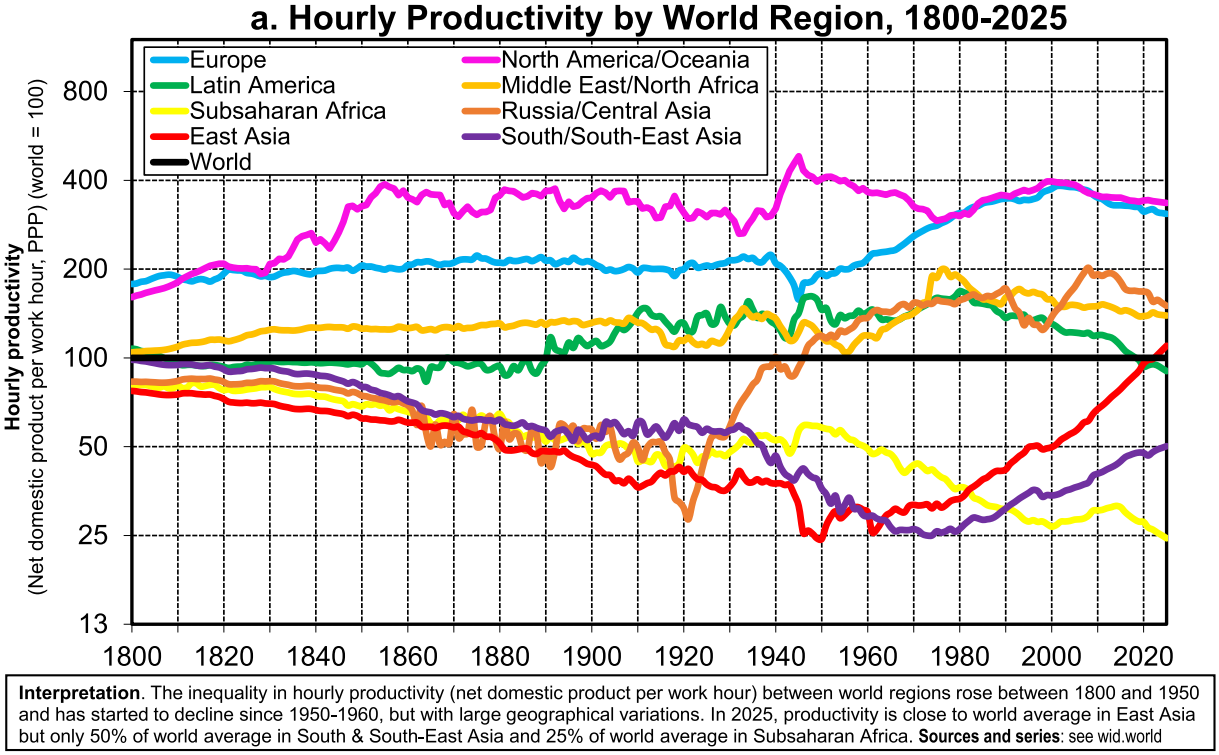

Fig. 15a. Hourly Productivity by World Region, 1800–2025. **Interpretation**. The inequality in hourly productivity (net domestic product per work hour) between world regions rose between 1800 and 1950 and has started to decline since 1950–1960, but with large geographical variations. In 2025, productivity is close to world average in East Asia but only 50% of world average in South & Southeast Asia and 25% of world average in Sub-Saharan Africa. **Sources and series**: see wid.world.

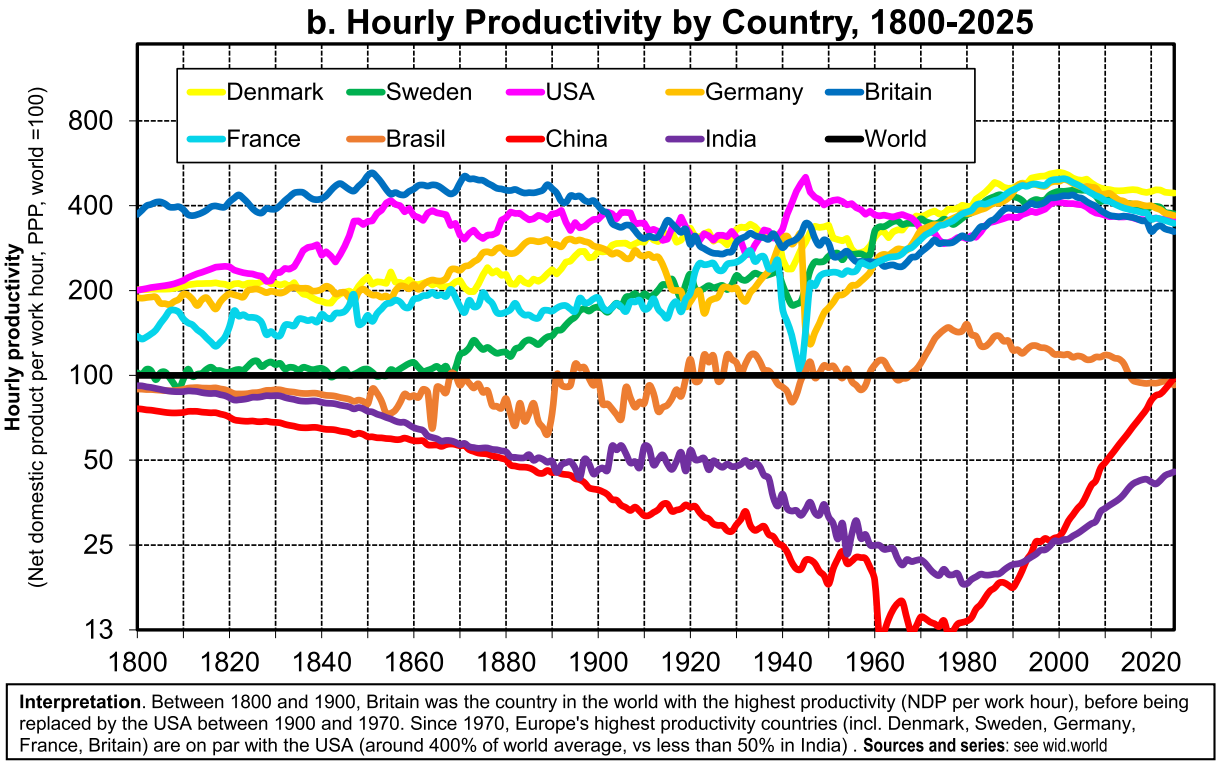

Fig. 15b. Hourly Productivity by Country, 1800–2025. Interpretation. Between 1800 and 1900, Britain was the country in the world with the highest productivity (NDP per work hour), before being replaced by the USA between 1900 and 1970. Since 1970, Europe's highest productivity countries (incl. Denmark, 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.

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/Southeast 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.

4.2. State capacity and the early productivity gap in the 19th century

In 1800, disparities in per capita GDP and hourly productivity between Europe and North America/Oceania and the rest of the world were already sizeable, with a gap of about 1 to 2. These differences widened further over 1800–1950 but were already clearly visible at the start of the 19th century.[6] However, given comparable cross-country data for the pre-1800 period is limited, our dataset cannot help in understanding the origins of the earlier divergence. Our empirical analysis therefore focuses on documenting patterns from 1800 onward.

To this end, we report simple regressions between average productivity in 1800–1820 and the level of public expenditure (see Table 3). Naturally, these correlations should not be interpreted causally, as public expenditure and productivity likely influenced one another, and a number of omitted factors—such as institutional quality, geopolitical context, or technological adoption—were also relevant, but they can at least provide illustrative evidence. We find that countries with higher state capacity (as proxied by total public expenditure) also had higher productivity in 1800–1820: an increase in public expenditure by 1 percentage point of GDP is associated with a 13.3% rise in GDP. Given that public expenditure varies at the time from 1 to 2% of GDP in the poorest world regions to about 7% in Europe, this implies that the state

[6] The historical literature generally agrees that such gaps did not exist around 1500 and emerged gradually between 1500 and 1800, although the precise timing varies across studies (e.g., Maddison 2001; Pomeranz 2000; Broadberry et al. 2018).

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)	13.328***		0.032***	
(s.e.)	(0.751)		(0.011)	
Incl. Basic Public Services (Justice, Police, Administration, Roads, etc.)		17.303***		0.039***
(s.e.)		(0.936)		(0.014)
Incl. Military Expenditure		−4.020		−0.014
(s.e.)		(3.298)		(0.038)
R2	0.34	0.37	0.01	0.01
N.obs	627	627	627	627

Interpretation. In 1800–1820, countries with higher state capacity (as proxied by total public expenditure) also have higher productivity. A rise in public expenditure by 1% of GDP is associated with a 13.3% rise in GDP. Given that public expenditure varies at the time from 1 to 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.

capacity gap at the time correlates with around 60–80% of the productivity gap (about 1 to 2 at the time). Higher state capacity is also associated with higher growth rates over the 1800–1840 period. Interestingly, the correlation seems to be driven by basic public services (justice, police, administration, roads, etc.) rather than by military expenditure.

4.3. Productivity growth and human capital expenditure, 1800–2025

This section now explores the relationship between productivity growth and human capital expenditure over the entire 1800–2025 period. We run regressions of the following form, gradually introducing various control variables and fixed effects:

$$ProductivityGrowthRate_{it} = a + b^{*}HumanCapitalExpenditure_{it} + Controls_{it} + e_{it} \quad (4)$$

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.

The first specification includes total public expenditure as the sole explanatory variable, followed by progressively richer models (see Table 4). We find a positive and statistically significant coefficient: 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 (Bauluz et al., 2025). Interestingly, the effect is driven by human and social capital expenditure, a broad category including basic public services (justice, police, administration, roads, etc.), public human capital expenditure (education, health), and other human and social capital expenditure (research, culture, community, environment, etc.). It also holds after the inclusion of country fixed effects, capital-output ratios and interacted region-period fixed effects (8 world regions interacted with 6 periods: 1800–1840, 1840–1880, 1880–1910, 1910–1950, 1950–1990, and 1990–2025). Other categories of public expenditure (in particularly military expenditure and social protection) have no robust significant correlation with productivity growth.

We then concentrate on human capital expenditure strictly speaking—education and health—, including both public and private expenditure (see Table 5). When age-adjusted human capital expenditure 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). If we were to interpret this coefficient causally, this would imply an annual

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)	0.054***	0.048***			
(s.e.)	(0.001)	(0.001)			
Incl. Human & Social Expenditure			0.113***	0.053***	0.046***
(s.e.)			(0.006)	(0.006)	(0.006)
Incl. Military Expenditure			0.029**	−0.047***	0.006
(s.e.)			(0.012)	(0.011)	(0.011)
Incl. Social Protection Expenditure			−0.037***	0.006	−0.021**
(s.e.)			(0.006)	(0.006)	(0.008)
Incl. Other Expenditure			−0.001	0.009	−0.014
(s.e.)			(0.015)	(0.016)	(0.014)
Country Fixed Effects	NO	YES	YES	YES	YES
Capital-Output Ratio	NO	YES	YES	YES	YES
Period Fixed Effects	NO	NO	NO	YES	YES
Region x Period Fixed Effects	NO	NO	NO	NO	YES
Countries Covered	ALL	ALL	ALL	ALL	ALL
R2	0.14	0.21	0.23	0.33	0.53
N.obs	10,602	10,602	10,602	10,602	10,602

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)	0.099***	0.086***	0.166***						
(s.e.)	(0.004)	(0.004)	(0.005)						
Incl. Education				0.244***					
(s.e.)				(0.019)					
Incl. Health				0.040***					
(s.e.)				(0.008)					
Incl. Public Expenditure					0.159***				
(s.e.)					(0.006)				
Incl. Private Expenditure					0.017*				
(s.e.)					(0.010)				
Incl. Public Education						0.420***	0.336***	0.850***	0.155***
(s.e.)						(0.013)	(0.014)	(0.025)	(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	10,602	10,602	8743	10,602	10,602	10,602	10,602	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).

rate of return to human capital investment of about 10%, which is consistent with the returns estimated in micro studies (e.g., Akresh et al., 2022; Berlinski et al., 2025; Bhuller et al., 2017; Khanna, 2022; Zimmerman, 2014). 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€/hour at PPP) 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 ratios, and interacted region-period fixed effects.

In the absence of high-quality historical data on education and health inputs covering this period, our reduced-form analysis does not allow investigating the precise channels through which education and health spending might affect productivity. Among natural candidates, human capital expenditure can directly contribute to improving educational attainment, cognitive skills, and overall health, all of which have been shown to play an important role in shaping long-run development (e.g., Hanushek and Woessmann, 2008; Hendricks and Schoellman, 2018; Lorentzen et al., 2008; Rossi, 2020). We hope that future research can contribute to better disentangling the theoretical and empirical channels linking expenditure on human capital accumulation and long-run productivity growth.

We stress again that we are well aware of the limitations associated with 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 interacted region-period fixed effects. However, it is still reassuring and interesting that our estimates are consistent with micro studies, which are better identified but face other problems such as limited external validity. 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 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 making identification challenging. We leave this to future work and hope that our findings and the database developed in this paper will contribute to stimulating more research in this area.

5. Counterfactual simulations & illustrative development trajectories

We conclude by presenting a set of simple, illustrative simulations designed to explore the potential implications of alternative trajectories for education and health expenditure over the 2025–2100 period. These simulations are not meant as forecasts or policy prescriptions, but rather as exploratory exercises using the historical relationships documented in the preceding sections.

We begin with a "business-as-usual" trajectory. In this scenario, total age-adjusted public and private expenditure on education and health stabilizes as a share of GDP in all world regions over 2025–2100 (Fig. 16a). This corresponds to a situation in which countries do not significantly expand fiscal resources devoted to human capital, and overall expenditure is sustained close to the levels observed today. In practice, such a trajectory might entail a continued rise in private expenditure—similar to recent patterns observed in the United States and parts of Latin America. For simplicity, we do not model the underlying evolution of public and private components. Using the return to human capital estimated in our historical regressions, this business-as-usual scenario implies that large cross-regional productivity gaps would persist. For example, in 2100 average hourly productivity would reach only about €9 in Sub-Saharan Africa, compared with roughly €80 in Europe and North America/Oceania (Fig. 16b).

In contrast, we study an alternative global convergence scenario in which education and health expenditure gradually converge to 38 percent of GDP in all countries and regions by 2100 (Fig. 17a). This corresponds to a stylized continuation of the long-run upward trend observed over 1800–2025. Feeding this trajectory into the same empirical framework—with annual returns declining from roughly 20 percent in low-income settings to 10 percent in middle-income settings and 5 percent in high-income settings—delivers substantially higher projected productivity growth rates. Under this illustrative scenario, all major world regions converge to productivity levels of approximately €100-€120 per hour by 2100 (Fig. 17b). The implied acceleration is particularly pronounced for Sub-Saharan Africa, where projected annual growth reaches about 4.4 percent in 2025–2100, comparable to East Asia's realized performance over 1990–2025 (Table 6).

On the whole, these simulations should be viewed as stylized

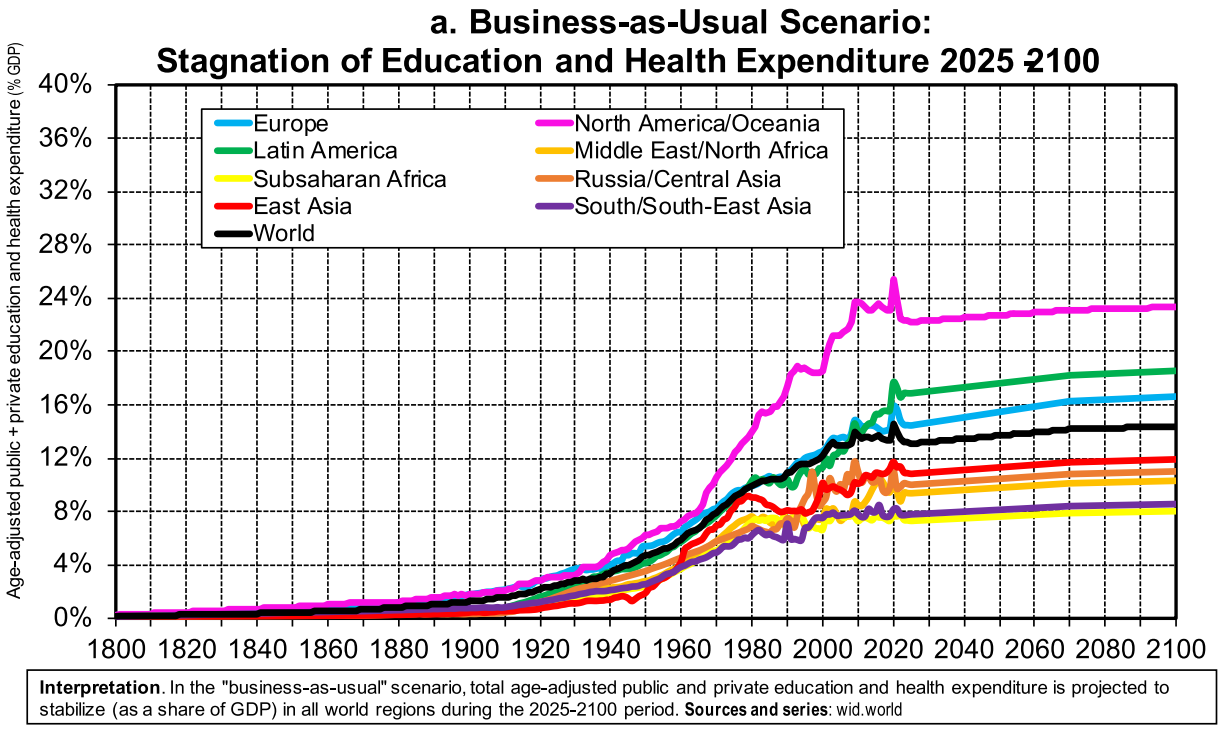

Fig. 16a. Business-as-Usual Scenario: Stagnation of Education and Health Expenditure 2025–2100. **Interpretation**. In the "business-as-usual" scenario, total age-adjusted public and private education and health expenditure is projected to stabilize (as a share of GDP) in all world regions during the 2025–2100 period. **Sources and series**: wid.world.

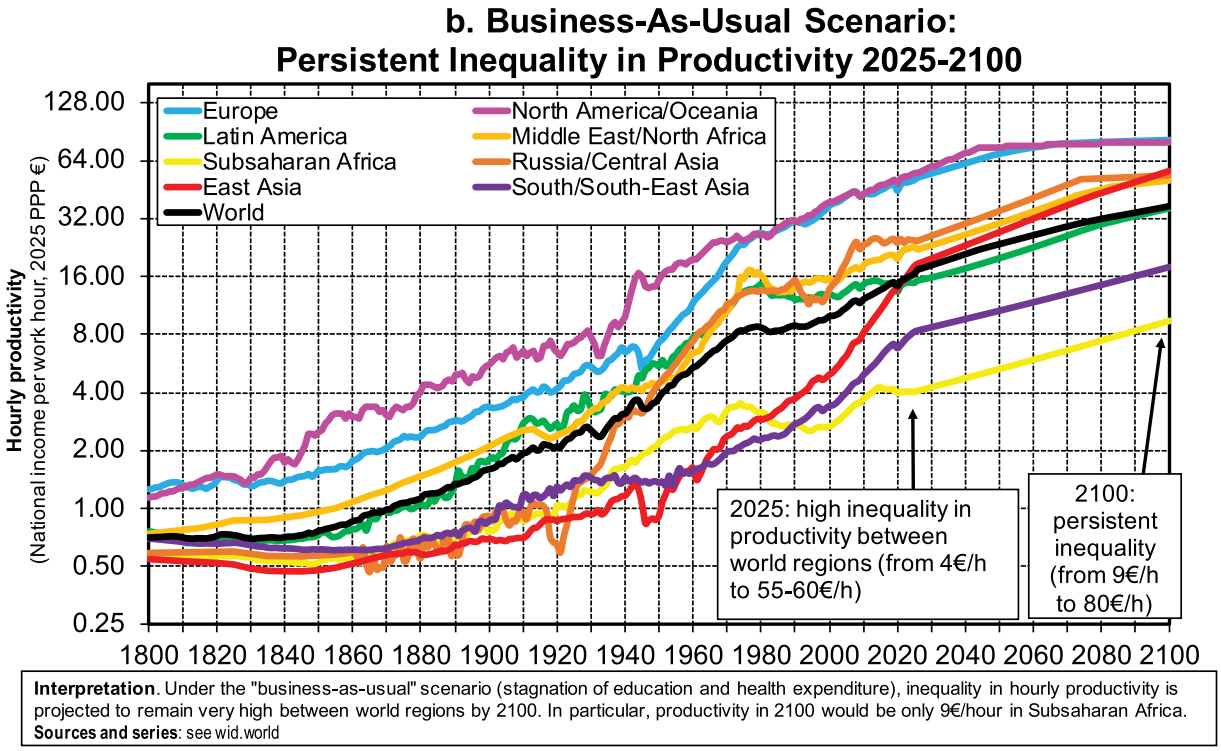

Fig. 16b. Business-As-Usual Scenario: Persistent Inequality in Productivity 2025–2100. Interpretation. Under the "business-as-usual" scenario (stagnation of education and health expenditure), inequality in hourly productivity is projected to remain very high between world regions by 2100. In particular, productivity in 2100 would be only 9€/hour in Sub-Saharan Africa. **Sources and series**: see wid.world.

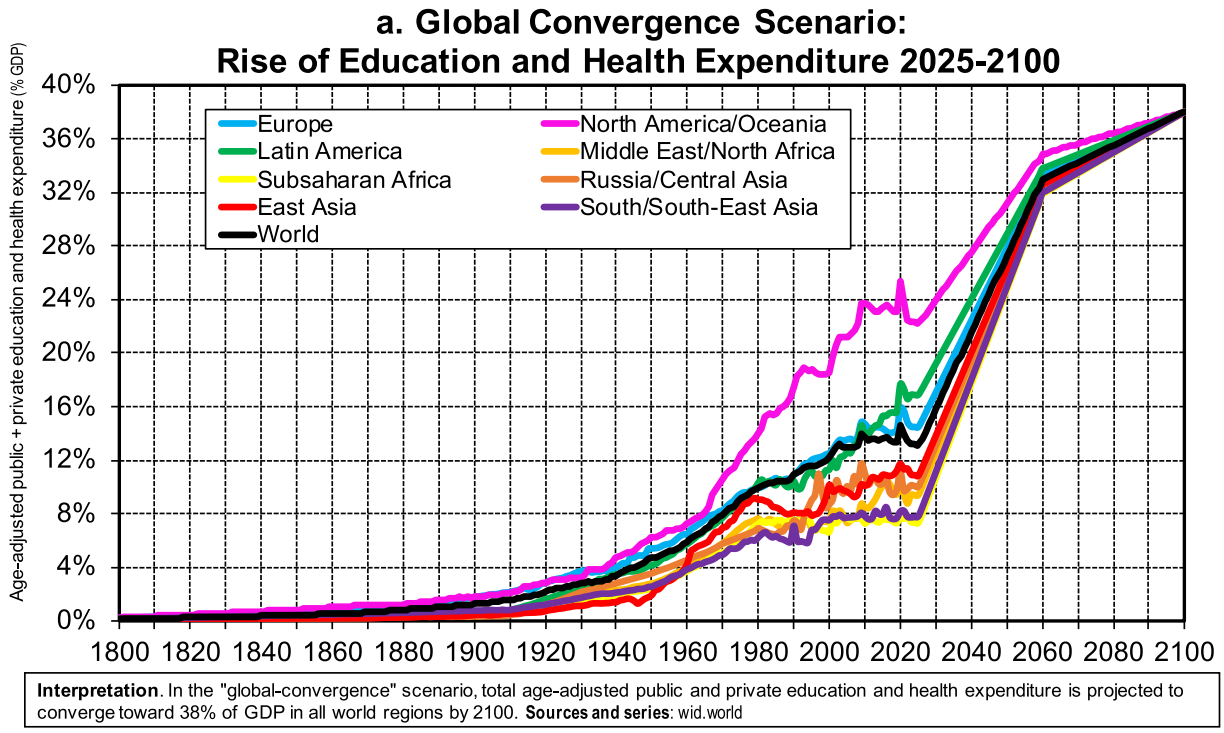

Fig. 17a. Global Convergence Scenario: Rise of Education and Health Expenditure 2025–2100. Interpretation. In the "global-convergence" scenario, total age-adjusted public and private education and health expenditure is projected to converge toward 38% of GDP in all world regions by 2100. Sources and series: wid.world.

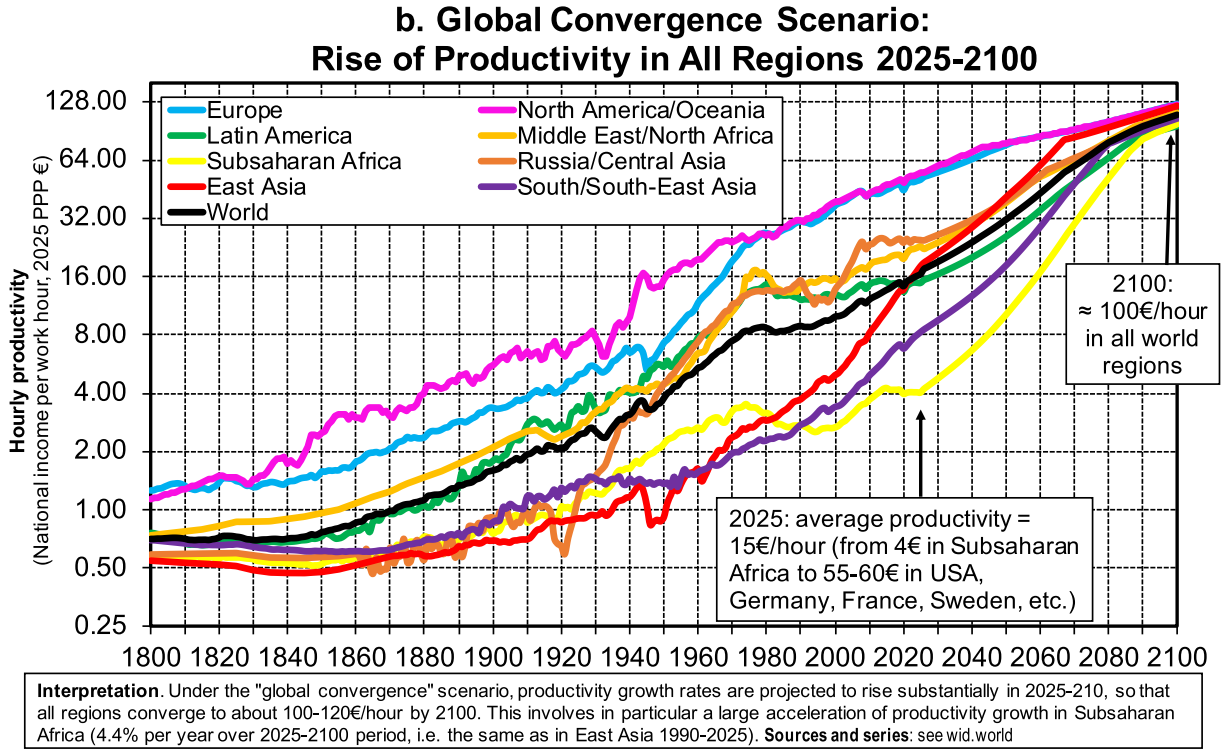

Fig. 17b. Global Convergence Scenario: Rise of Productivity in All Regions 2025–2100. Interpretation. Under the "global convergence" scenario, productivity growth rates are projected to rise substantially in 2025–210, so that all regions converge to about 100-120€/hour by 2100. This involves in particular a large acceleration of productivity growth in Sub-Saharan 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.

exercises that explore the quantitative implications of different long-run expenditure trajectories, based on the historical associations documented earlier. They abstract from many factors that would shape actual outcomes and could interact with future investment trajectories—including demographic change, political economy constraints, institutional capacity, technological shifts, and private–public

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/Southeast 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.

substitution—and are therefore not intended as forecasts. Overall, they illustrate the magnitude of potential differences between alternative paths of human capital investment and the major role that these different paths could play in shaping global productivity convergence over the course of the 21st century.

6. Conclusion

In this paper we have constructed a new global historical database on public expenditure and revenue and their components covering all world regions over the 1800–2025 period. We exploited this database to reassess a number of key issues regarding the relation between human capital, unequal opportunities, and global productivity convergence.

We documented a broad and sustained rise in human capital spending in all world regions in the past two centuries. However, in spite of substantial progress in absolute terms, large inequalities in education and health investments persist: 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, compared to 6% in 1980 and 4% in 1950. We have found a large correlation between human capital expenditure and productivity growth over the 1800–2025 period, especially for public education and for poor countries. The implied returns using our macro-historical database are around 10% or more, in line with micro studies. Finally, we showed with stylized counterfactual simulations that convergence in human capital expenditure could lead to global productivity convergence by 2100 at around 100€/hour in all regions.

These findings raise important issues and avenues for future research. First, what is the best possible way to finance expansions in human capital expenditure? One possibility could be to do so through a combination of national taxes and international lending institutions, which has been the path taken by most developing countries in recent decades. Another possibility could be to have a "global justice fund", similar to the green climate fund established 15 years ago under the United Nations Framework Convention on Climate Change, with contributions from rich countries. It would be interesting to study the winners and losers from these different types of financing systems during the transition period. Next, we have entirely ignored in this research the ecological constraints and planetary boundaries associated with global economic convergence. The financing of decarbonation and alternative energy infrastructures would put substantial extra pressure on national governments or a global justice fund. In addition, one would need to describe more precisely the structural transformation and the combination of sectoral choices and labor hour reductions which could make global convergence viable. We hope that the results presented in this paper will contribute to stimulating further research in this area.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpubeco.2026.105578.

Data availability

All the underlying data are publicly available in the online World Human Capital Expenditure Database: whce.world.

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