Global probability of dying before age 70: how many years ahead or behind are regions and nations? Cross-national comparisons 2000 and 2019

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ABSTRACT

Background: Despite significant mortality declines, disparities in the probability of premature death (PPD) persist globally. This study examines the uneven decline in PPD across geographic regions, comparing progress against both the global PPD and PPD expected at observed levels of economic development.

Methods: PPD (defined here as death before age 70) was constructed using age-specific mortality probabilities from United Nations World Population Prospect life tables 1950–2019. We conducted a comparative analysis of PPD across global regions for the years 2000 and 2019 and determined how many years each region was behind or ahead of the global PPD. We further obtained data on gross domestic product (GDP) per capita from the Maddison Project and compared regions to annual Preston curves to determine where they stood regarding the PPD expected given their GDP. We highlight results for 7 global regions and three large countries.

Findings: Global PPD decreased from 0.57 in 1970 to 0.31 in 2019, yet progress was uneven, with sub-Saharan Africa, Central Asia, and India lagging behind. For example, sub-Saharan Africa's PPD in 2019 corresponded to the 1976 global PPD. Conversely, China had achieved the 2019 Global PPD in 2000. Of the highlighted regions and countries, when considering PPD expected given GDP, the United States was the furthest behind and China furthest ahead.

Interpretation: Disparities in the probability of premature death across regions reflect broader issues of global health equity. International cooperation should ensure that technological and medical advancements lead to universal health benefits which are widely and fairly shared.

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Keywords: Probability of premature death; mortality decline; Preston curve; global health disparities; equity; years behind.

Introduction

Human life expectancy has been on an upward trajectory for over two centuries as advances in medical science, public health, and living standards drastically reduce premature deaths.[1,2] However, progress has been uneven across regions leading to stark disparities in mortality. For example, the probability of dying before age 70 in 2019 was 15% in Western Europe and Canada, 22% in the United States, 36% in India, and 52% in sub-Saharan Africa.[3] Where regions stand relative to the development of health outcomes over time reflects inequality in improvements of living standards and implementation of life extending technologies.

Economic growth and life expectancy improvements are both a part of a broader development process with many shared explanatory factors. Causal links between economics growth and health have also been suggested, running in both directions: Improved health can increase growth, since healthier populations are more productive and have greater incentives to both save and invest in their human capital, as they expect to live longer.[2,4] Growth can improve health, for example, allowing the building and maintenance of important public health infrastructure and increased spending on medical treatments.[2]

Development is by its nature a long run process and gaps in important outcomes highlight disparities.[5–7] This paper examines the uneven decline in probability of premature death (PPD: defined here as dying before age 70) across global regions. Our comparative analysis demonstrates how many years behind or ahead of global PPD a geographic region was in 2000 and 2019. For instance, a region with a PPD in 2019 that was last observed in 1999 for the global PPD was considered 20 years behind the global PPD progress. Conversely, a region whose PPD in 1999 was equivalent to the global PPD of 2019 was considered 20 years

ahead. We also assessed the PPD position relative to the expected level of progress given economic development by integrating the Preston curve into our examination.

In the context of long run and largely uninterrupted declines in premature mortality, this comparative approach illuminates uneven progress across regions. By comparing mortality disparities as years behind or ahead of the global curve, rather than studying, for example, rate ratios, this study highlights the temporal nature of mortality decline across the world.

Methods

Data sources

Mortality probabilities for single year age groups were obtained for 236 countries and territories between 1950–2019 from the United Nations World Population Prospects (UN WPP) 2022 life tables.[8] These mortality probabilities were used to calculate the probability of dying before age 70 years, referred to as the probability of premature death (PPD). We aggregated these mortality probabilities for ten regions, as well as globally, weighted by population below age 70 in each country, also obtained from the World Population Prospects 2022.[9] We restricted our analyses to years before 2020 to avoid temporary distortions due to the Covid-19 pandemic.

We also obtained real GDP per capita (in 2011 $) and total population for 169 countries up to 2018 from the 2020 version of the Maddison Project Database.[10] We excluded GDP estimates for years before 1950 since mortality estimates were only available for the whole world after 1950. Since the most recent year in the Maddison database was 2018, while our analysis included 2019, we estimated GDP for 2019 by linearly extrapolation using the GDP estimates

for 2017 and 2018. GDP was aggregated for regions using the population estimates provided in the Madison database.

Regional aggregations

We follow the regional classification used in the third Lancet Commission on Investing in Health. The world regions studied were Central Asia, Central & Eastern Europe, Middle East & North Africa, sub-Saharan Africa, Latin America & the Caribbean, Western Pacific & Asia (excluding China) and the North Atlantic. We also considered three large countries individually: China, India, and the United States. For example, the North Atlantic region consisted of the Western European countries and Canada. Central Asia consisted of Afghanistan, Azerbaijan, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan. See Supplementary Table S1 for a list of countries by region. We also show results for the 30 most populous countries in the year 2019 based on population data from the UN WPP.[9]

Estimating years behind or ahead of the global probability of premature mortality

Our benchmark was the global PPD from 1950 to 2019. For each year, 2000 and 2019, we determined how many years behind or ahead a region was from the global PPD (Supplementary Table S2). As an example, consider India in 2019. Since India had a PPD above the global PPD it was behind the benchmark. Then, we identified the last (ie, most recent) year the benchmark still had a greater PPD than India's 2019 PPD. That year was 2005. Therefore, India was 14 years behind the global average PPD in 2019. (Then in 2006 the global PPD reached a lower PPD than India had in 2019.) On the other hand, China was ahead of the benchmark since it had a PPD below the global PPD in 2019. Then, we identified the last year China's PPD was

above the global 2019 PPD, before reaching a lower PPD. That year was 2000, so China was 19 years ahead of the 2019 global PPD.

Estimating years behind or ahead of Preston curves

The Preston curve is a seminal concept relating life expectancy to per capita income demonstrating that wealthier countries tend to enjoy higher life expectancies.[11] Due to technological advancements, the Preston curve is suggested to shifts upwards across time, such that same levels of income would result in better life expectancy in more recent years than in the past.[12,13] Countries will deviate from the curve due to many factors, such as, inequality and priorities and effectiveness of health spending. We estimated how far behind or ahead regions were from the Preston curve given their GDP and PPD.

For this, we first estimated Preston curves for each year 1950–2019: Pooling all the years 1950–2019 and the 169 countries with available GDP data (see Supplementary Table S1), we estimated a linear regression of PPD on (log) real GDP per capita and separate intercepts for each year (Supplementary Table S3). Theory predicts that technological advancements result in the intercepts shifting downward (upward when studying life expectancy), such that in more recent years, lower PPD should be achieved for the same level of GDP. We observed a few cases where the intercepts moved slightly upward across years, and adjusted these such that the intercept each year was the lowest ever observed since 1950 (Supplementary Table S3 and Figure S1). This adjustment did not have an impact on years behind or ahead estimates.

First, we determined whether the PPD observed in a region in 2019 was higher or lower than the PPD predicted by that regions 2019 GDP. In other words, we determined whether a region was above or below the 2019 Preston curve given that regions 2019 PPD and GDP. The region was behind the Preston curve in 2019 if its observed PPD was greater than the PPD predicted

from the Preston curve: Then we identified the most recent year with a PPD predicted by a Preston curve (given the target region's 2019 GDP) that was greater than observed in the target region in 2019. The region was ahead of the Preston curve in 2019 if its observed PPD was lower than the PPD predicted from the 2019 Preston curve: Then we find the most recent year the PPD observed in the target region was greater than the PPD predicted from the Preston curve in 2019 (given the target region's 2019 GDP).

All analyses were done using Stata 16 (Stata Corp).

Sensitivity analyses

As a sensitivity analysis we moved away from the idea of Preston curves when estimating years behind relative to GDP, and allow a more flexible relationship between GDP and PPD. We regress PPD on an intercept and log of GDP per capita for each year separately, obtaining a year specific intercepts and GDP slopes (Supplementary Table S3 and Figure S1). Using this specification, the predicted PPD across the distribution of GDP could intersect between different years and have greater PPD at the intercepts in later years than earlier, which goes against what would be suggested by the Preston curve (ie, the same level of GDP should generally not predict a lower PPD in an earlier year than a later year: or the amount of health returns for a give GDP should increase across years). Using this more flexible equation, we determined years behind or ahead for a given level of GDP in the same way as before (ie, referring to the most recent year a lower PPD was observed for a give GDP).

Supplementary analyses

As a supplementary analysis, we used the frontier PPD as a benchmark, instead of global PPD. The frontier PPD was defined as the country with the lowest PPD within each year. We

excluded countries with a population below 3 million in 2019. Since the earliest PPD observed was 1950, we supplement the UN WPP data with data from the Human Mortality Database (HMD), which provides age-specific mortality probabilities extending back to l751. The early HMD estimates were only available for a few countries: however, these countries were likely to be (or at least close to being) the global frontier before 1950.

We removed a few temporary setbacks to frontier PPD decline: therefore, the interpretation of the benchmark is the lowest PPD ever observed. For example, the frontier PPD increased in 1940 (to 0.41) and did not reach the 1939 level (0.39) until 1942 (0.37). Therefore, 1940–1942 had the same level of frontier PPD observed as 1939: that is, the lowest ever observed. This might cause a few regions to be observed to be further behind than when compared to true frontier PPD within each year. For example, if the 2019 PPD for a region was 0.415, the region would have been suggested to be 79 years behind when compared to the unadjusted frontier PPD, since the most recent year with a frontier PPD below 0.415 was 1940. After removing the temporary increase in the frontier PPD 1940–1942, frontier PPD below 0.415 was last observed in 1936, meaning the regions would have been 83 years behind in 2019.

We also show all our results separated for men and women.

Compliance with ethical standards

This project used publicly accessible aggregate data from the United Nations World Population Prospects and the Maddison Project. These activities do not meet the regulatory definition of human subject research. As such, an Institutional Review Board review was not required.

Role of the funding source

No funding source played a role in the data collection and analysis, reporting and interpretation of results, or the decision to submit the manuscript for publication. Karlsson had full access to all data used in the study. # made the decision to submit it for publication.

Results

Behind or ahead of the global PPD

The global PPD declined from 0.57 in 1970 to 0.31 in 2019 (Figure 1). Three regions had a PPD behind the global PPD in 2019: Sub-Saharan Africa, Central Asia, and India. The last year the global PPD was as low as in sub-Saharan Africa was 1976, when it was 0.52. Central Asia had a PPD in 2019 last observed for the global PPD in 1998, or 0.4, while India's had a PPD last observed for the global PPD in 2005, 0.37.

This means that sub-Saharan Africa was 43 years behind the global PPD in 2019, while Central Asia was 21 years behind and India 24 years behind (Figure 2). Since 2000, sub-Saharan Africa has moved slightly closer to the global PPD, having been 52 years behind the global PPD in 2000. India's relative gains were larger, having been 21 years behind in 2000. Central Asia, however, fell further behind, having been 19 years behind in 2000.

The North Atlantic was the furthest ahead of the global PPD both in 2000 and 2019, or 52 and 43 years, respectively. The United States was 32 years ahead of the global PPD, both in 2000 and 2019. China made gains in PPD relative to the global PPD, being 12 years ahead in 2000 and 19 years ahead in 2019. Central & Eastern Europe went from being 9 years behind in 2000 to one year ahead of the global PDD in 2019.

Of the 30 most populous countries, Japan and Spain were furthest ahead of the global PPD in 2019, 49 years, followed by France and Italy at 42 years ahead, while Nigeria was the furthest behind, 59 years, followed by Kenya, 49 years, and the Democratic Republic of the Congo (Congo DR), at 41 years behind (Figure 3).

Behind or ahead of the Preston curve

The United States was the furthest behind considering its GDP per capita, being on the 1974 Preston curve in 2019 (Figure 3 and Supplementary Figures S2–3). In 2019, Central & Eastern Europe were on the 1979 Preston curve, sub-Saharan Africa on the 1981 one, Central Asia on the 1990's. India had a PPD of 0.36 and a GDP of around $7000 per capita putting it on the 2011 Preston curve (Figure 3 and Supplementary Table S1). Other regions were ahead of the Preston curve.

The United States had the largest shift backward from the Preston curve, being 27 years behind in 2000 and 45 years behind in 2019 (Figure 4). Central & Eastern Europe also moved backward, from being 29 years behind in 2000 to being 40 years behind the Preston curve in 2019. Central Asia also had a large backward slide, from being 12 years behind in 2000 to 29 years behind in 2019. Sub-Saharan Africa witnessed little change, being 39 years behind in 2000 and 38 in 2019. China was the furthest ahead of the Preston curve, or 15 years ahead in 2000 and 16 years ahead in 2019, with a PPD of 0.21 and GDP of around $13 000 per capita (Figure 4 and Supplementary Table S1). The North Atlantic was 1 year ahead of the Preston curve in 2000 and 10 years ahead in 2019.

Of the largest 30 countries, Nigeria and South Africa were further behind the Preston curve than 1950, meaning the distance could not be calculated. Otherwise, Kenya, Russia, and the

United States were the furthest behind the Preston curve in 2019, while Vietnam, Spain, and Italy were the furthest ahead (Supplementary Figure S4).

Sensitivity analyses

Using a more flexible specification when predicting PPD for a given GDP shows largely similar results as using Preston curves with fixed slopes across years (Supplementary Figure S5–6). The largest absolute difference between the two model specifications, among the 10 main regions studied, was for the United States, which was seven fewer years behind when using the more flexible specification.

Supplementary results

The North Atlantic was closest to the frontier, having a PPD of 0.15, last observed in the frontier in 2006 (Supplementary Figure S7). Sub-Saharan Africa was the furthest behind, having PPD in 2019 last observed in the frontier in 1919, or a PPD of 0.52. However, sub-Saharan was 147 years behind the frontier in 2000, while being 100 years behind in 2019 (Supplementary Figure S8). Nigeria was the furthest behind the frontier, or 161 years in 2019 (Supplementary Figure S9).

Among the 10 regions studied here, sex differences were particularly large in Central & Eastern Europe, where men were 24 years behind in 2000 while women were 41 years ahead (Supplementary Figures S10–22 Table S4). That gap had narrowed but remained large in 2019. In 2019, women were 13 years further ahead than men in the North Atlantic, 15 in the United States, seven in Latin America & the Caribbean, five in Western Asia & Pacific, and three more years ahead in the Middle East & North Africa. Meanwhile, men were five years

further behind than women in Central Asia, and women were eight years further behind than men in India and three years in sub-Saharan Africa.

Discussion

The global PPD has declined dramatically, from 0.57 in 1970 to 0.31 in 2019. However, the progress has been uneven, with sub-Saharan Africa, Central Asia, and India lagging. For example, India's PPD was 0.364 in 2019: The most recent year the global PPD was greater than 0.364 was 2005 (when it was 0.366, declining to 0.360 in 2006), putting India 14 years behind the global PPD. Central Asia was 21 years behind and sub-Saharan Africa 43. Other regions were ahead of the global curve. For example, China had a PPD of 0.21 in 2019. The last year China had a PPD above the 2019 global PPD of 0.31 was in 2000, when it was .312 (declining to .299 in 2001), putting China 19 years ahead of the global PPD.

These patterns were somewhat different when considering the PPD expected for a given GDP using Preston curves. India had a GDP of around $7000 per capita and a PPD of 0.36 in 2019. Meanwhile, the Preston curve predicted a PPD of 0.35 for a $7000 GDP. The most recent Preston curve to predict a PPD below 0.36 for a GDP of $7000 was in 2011, putting India seven years behind the 2019 Preston curve. Although being ahead of the global average in 2019, Central & Eastern Europe and the United States were behind the Preston curve. In fact, the United States was the furthest behind the Preston curve of all regions, being 45 years behind in 2019 (while being 38 years ahead of the global PPD).

Other regions were ahead of the Preston curve. For example, China had a GDP per capita of $13 000 and a PPD of 0.20 in 2019 while the 2019 Preston curve predicted a PPD of 0.28 for that level of GDP. The most recent year where a GDP of $13 000 predicted a PPD above 0.20 was 2003, putting China 16 years ahead of the Preston curve in 2019.

Together these results highlight an uneven process of mortality improvements across regions, both overall and when considering the mortality expected for a give level of economic development. The relative lag in the PPD decline observed in sub-Saharan Africa, Central Asia, and India may reflect a wide range of factors, for example, difficulties in implementing health enhancing innovation, and low living standards, as well as unique challenges related to these contexts. Despite enormous improvements, sub-Saharan Africa continues to have high mortality from infectious diseases and neonatal and maternal conditions, due to a lack of the most basic healthcare and public services for much of the population.[14] Although infectious diseases and neonatal conditions continue to play a sizable role in premature mortality in Central Asia and India, noncommunicable diseases are increasingly driving premature mortality differentials, suggesting a need for behavioral and medical intervention, particularly to tackle early deaths from cardiovascular disease and diabetes.

Early advances in agricultural technology improved nutrition[15] and discovery of the germ theory of diseases eventually led to improvements in sanitation, hygiene, and food standards, causing early declines in mortality and increased life expectancy in today's rich countries in the 19th and early 20th century.[16,17] Implementing these early technological innovations required public action and major investments into large scale projects: Health improvements were, therefore, somewhat more contingent on economic growth. The following health enhancing inventions and innovations were to a larger extent individually targeted medical interventions: For example, vaccines, oral rehydration therapy, and statins can have a large health benefits at a low cost, enabling countries to achieve better levels of health at a lower level economic development than before.[18] Therefore, the Preston curve has shifted, such that the same level of GDP should afford better health today than in the past.

The structural, historical, and socio-political context of each region plays a crucial role in shaping health outcomes at any level of economic development. Incomes may be highly unequally distributed, not spent on health, or even achieved through means that are detrimental to health. Conversely, countries can also make use of resources efficiently, prioritize health, implement cost-effective interventions, or practices healthy behaviors (ie, dietary and alcohol restrictions) and thereby achieve low mortality at low level of GDP. However, ultimately, living standards and the ability to implement health enhancing interventions—such as provision of healthcare, public safety, and establishment and maintenance of water, sanitation, and other important infrastructure—is bounded by aggregate income. Taking these economic constraints into account suggests that China manages to ensure high level of health for its level of economic development. Conversely, the results suggest that the United States, Central & Eastern Europe, sub-Saharan Africa, and Central Asia were far behind the PPD expected given their level of aggregate income. The reasons why economic development does not translate into low mortality are likely to vary across these regions.

Despite a high GDP (and the highest global health care spending[19]), the Unites States has exceptionally high levels of economic inequality.[20] The individual income-health relationship tends to show diminishing returns of health to increased income: therefore, greater level of inequality at the same level of income will inevitably lead to higher observed mortality in aggregate data.[21–23] Further, the healthcare systems in the United States suffers from spending waste[24] and violent crime and road traffic deaths cause an unusually high loss of life for a rich country.[14] Finally, the United States is going through a substance use epidemic, which has been claiming an increasing number of lives, especially since 2014.[25] In fact, despite continued economic growth, life expectancy in the United States has been declining.[26]

Central & Eastern Europe has witnessed rapid economic growth, especially since 1990, but continues to have a large number of deaths due to alcohol misuse and suicide, especially among men.[14,27] The prominence of the mining sector and "the resource curse"—which is suggested by some to reduce human development by increasing inequality[28] and decreasing quality of institutions[29] and public spending[30]—in economies across sub-Saharan Africa, may to an extent explain why it remains far behind of the Preston curve.[31]

Limitations

Our conclusions rely on the quality and availability of mortality and economic data across regions. However, we used data from the UN WPP for the main analysis, which are widely used and generally considered reliable. Comparing regions based on years behind or ahead of global PPD progress simplifies complex temporal dynamics and regional disparities. Further, PPD is a period measure: mortality rates in a given year, particularly in the older age groups, reflected accumulation of adverse exposures over the life course and PPD in a given year has determinants that stretch far back in time. Finally, the links between GDP and PPD estimated in our paper were not causal in either direction. However, our goal was to comment on expected PPD for a given level of economic development, which does not imply causality. Although the overall patterns were robust to an alternative specification of the relationship between GDP and PPD, there were some differences in the magnitudes.

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18 Kremer M, Glennerster R. Chapter Four - Improving Health in Developing Countries: Evidence from Randomized Evaluations11We are grateful to Jacobus de Hoop, Ludovica Gazze, Martin Rotemberg, Mahvish Shaukat, and Anna Yalouris for excellent research assistance. This chapter draws on Ahuja et al. (2010); Holla and Kremer (2009); Glennerster et al. (2009); and Bates et al. (2011). In: Pauly MV, Mcguire TG, Barros PP, eds. Handbook of Health Economics. Elsevier, 2011: 201–315.

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Contributions

Omar Karlsson did data management, analysis, reporting, and wrote the manuscript. # devised the conceptual idea of the paper. # provided critical feedback on the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Declarations of interest

None.

Data availability

United Nations Population Prospects single age life tables are available at population.un.org. The Maddison Project GDP per capita is available at https://www.rug.nl/. Human Mortality Database is available at https://www.mortality.org/.

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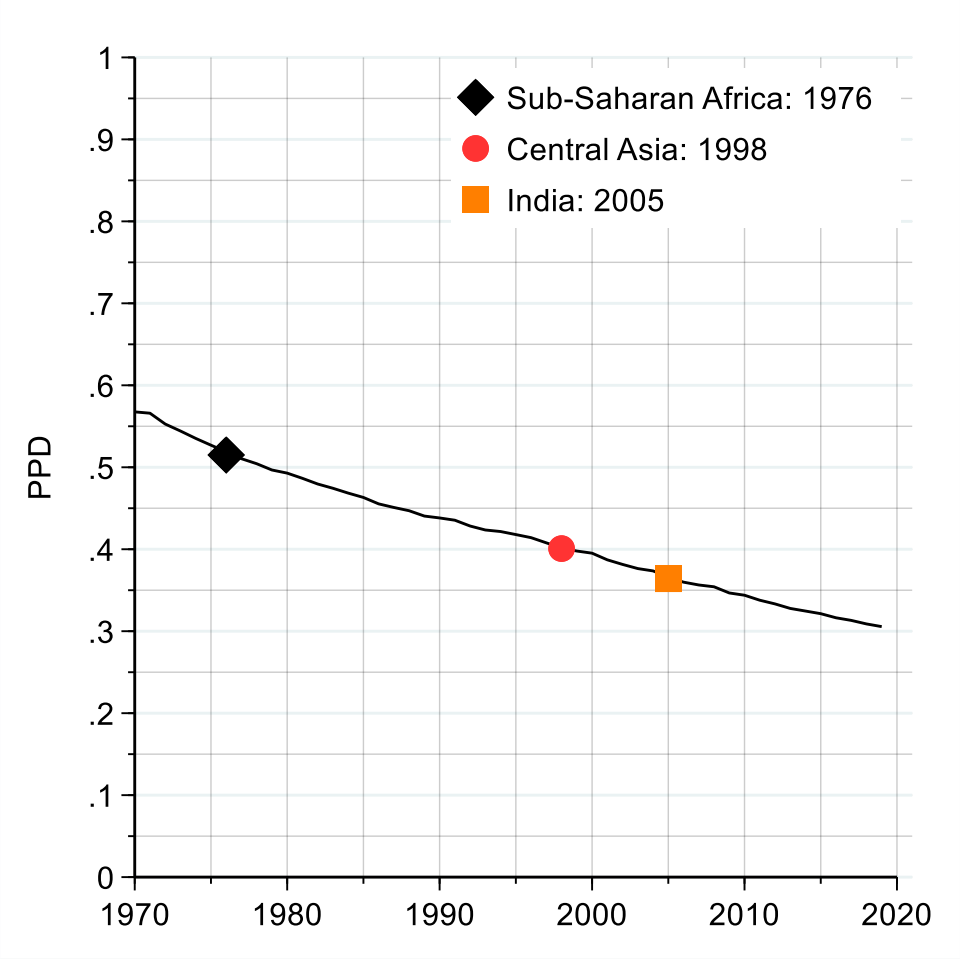
Supplementary information

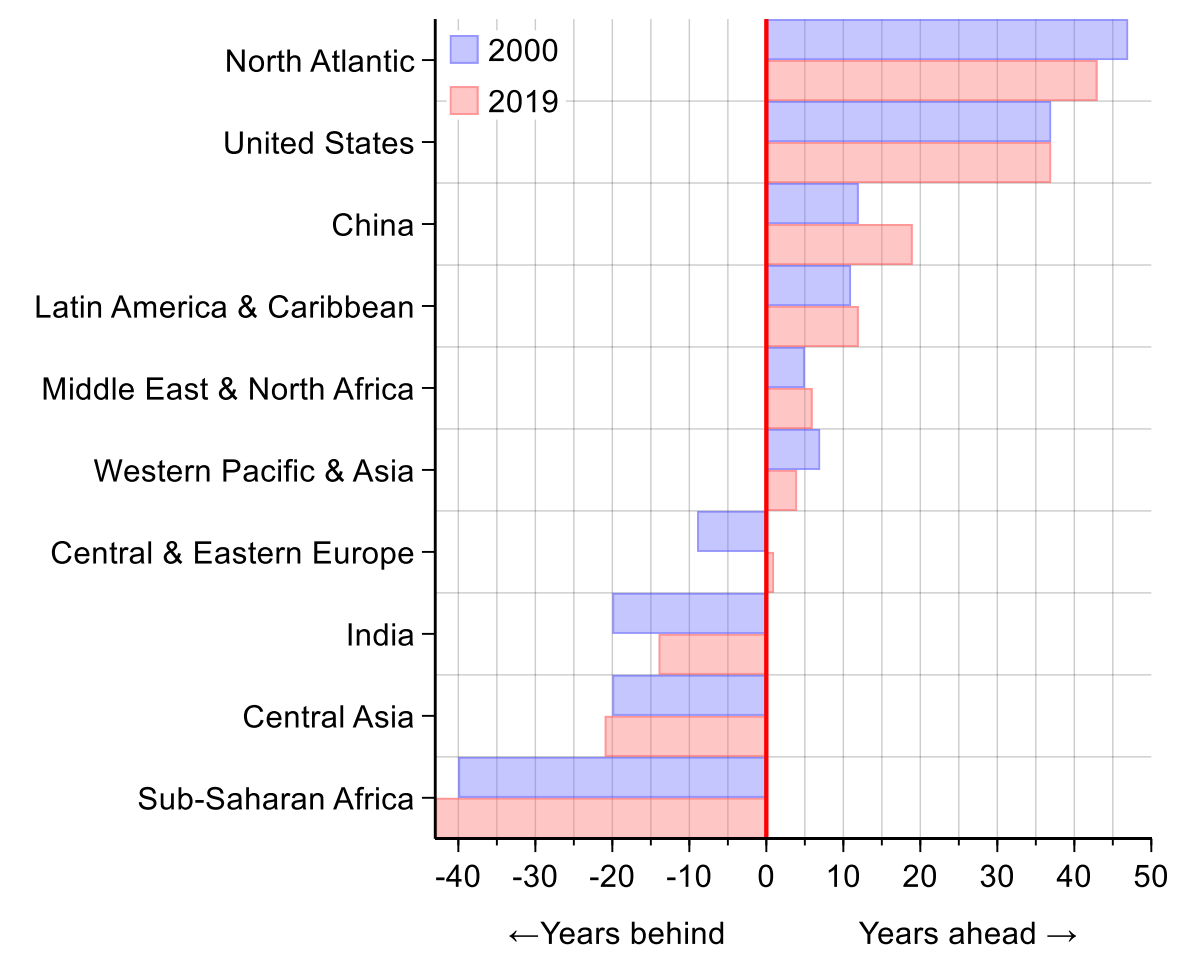
Supplement.

Figure 1. Global PPD across time (line) and for regions in 2019 (markers)



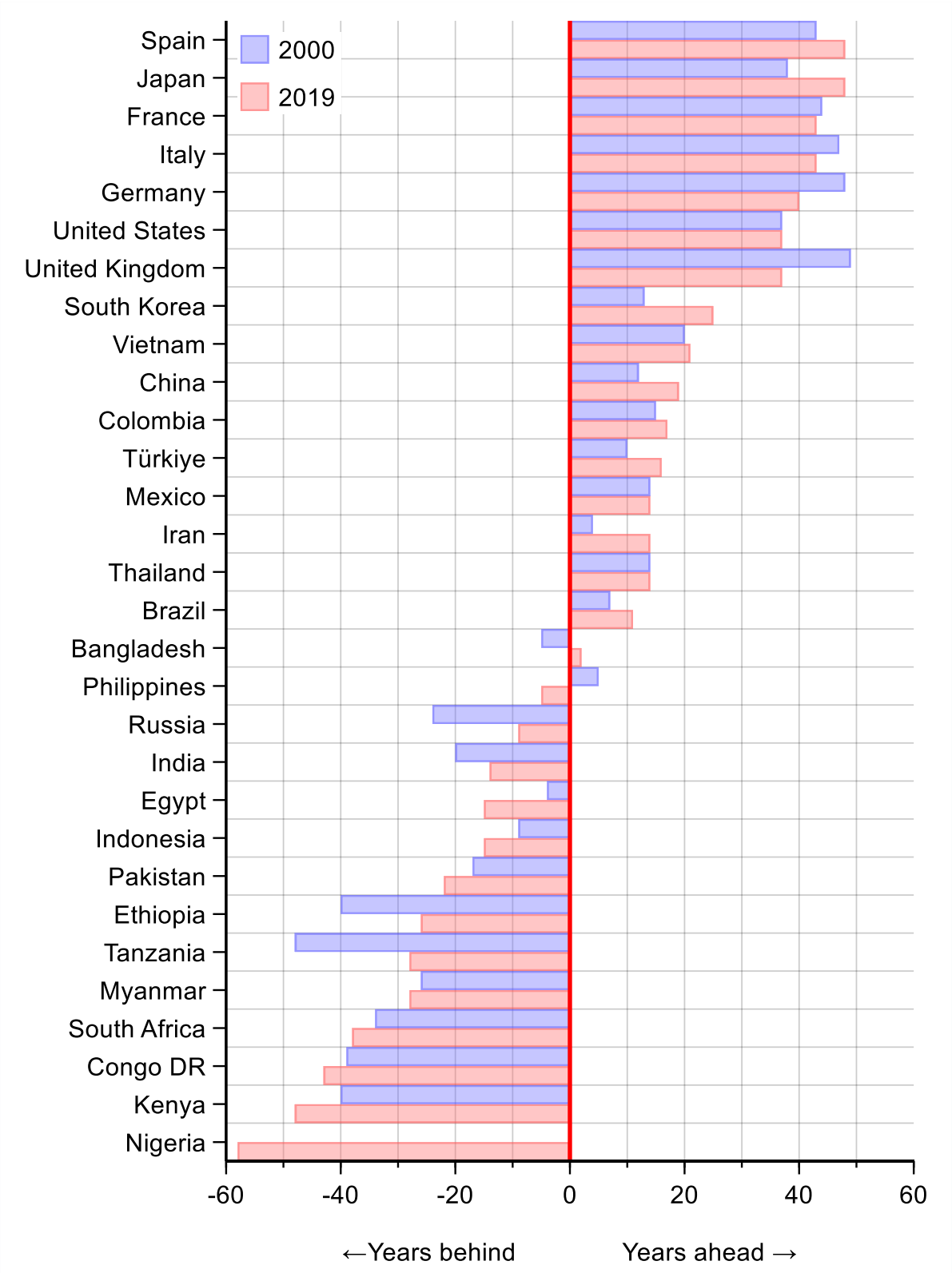
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Regions with lower PPD than the global average are not shown. Data source: UN WPP.

Figure 2. Years behind or ahead of the global PPD



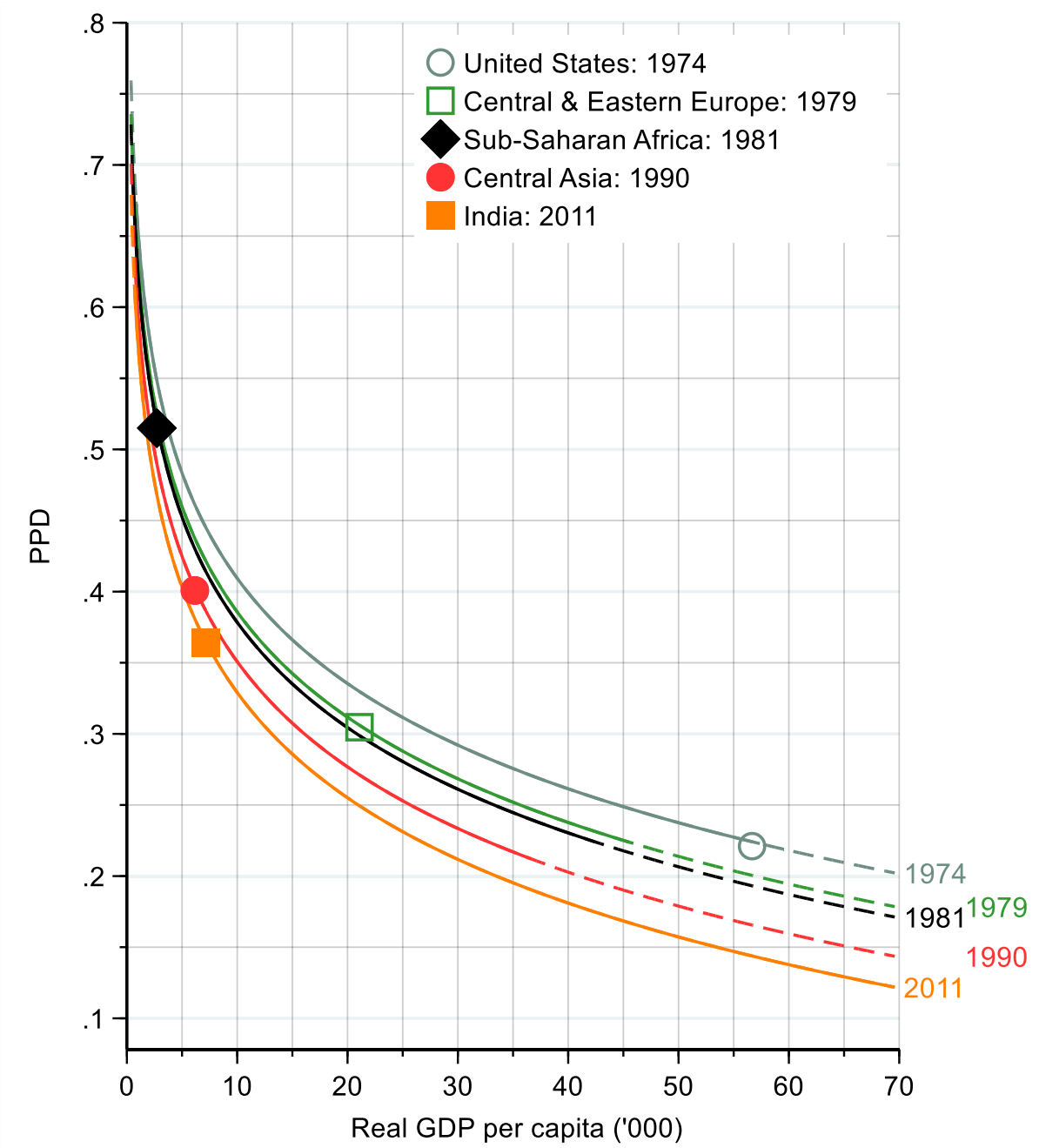
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Data source: UN WPP.

Figure 3. Years behind or ahead of the global PPD: 30 most populous countries in 2019



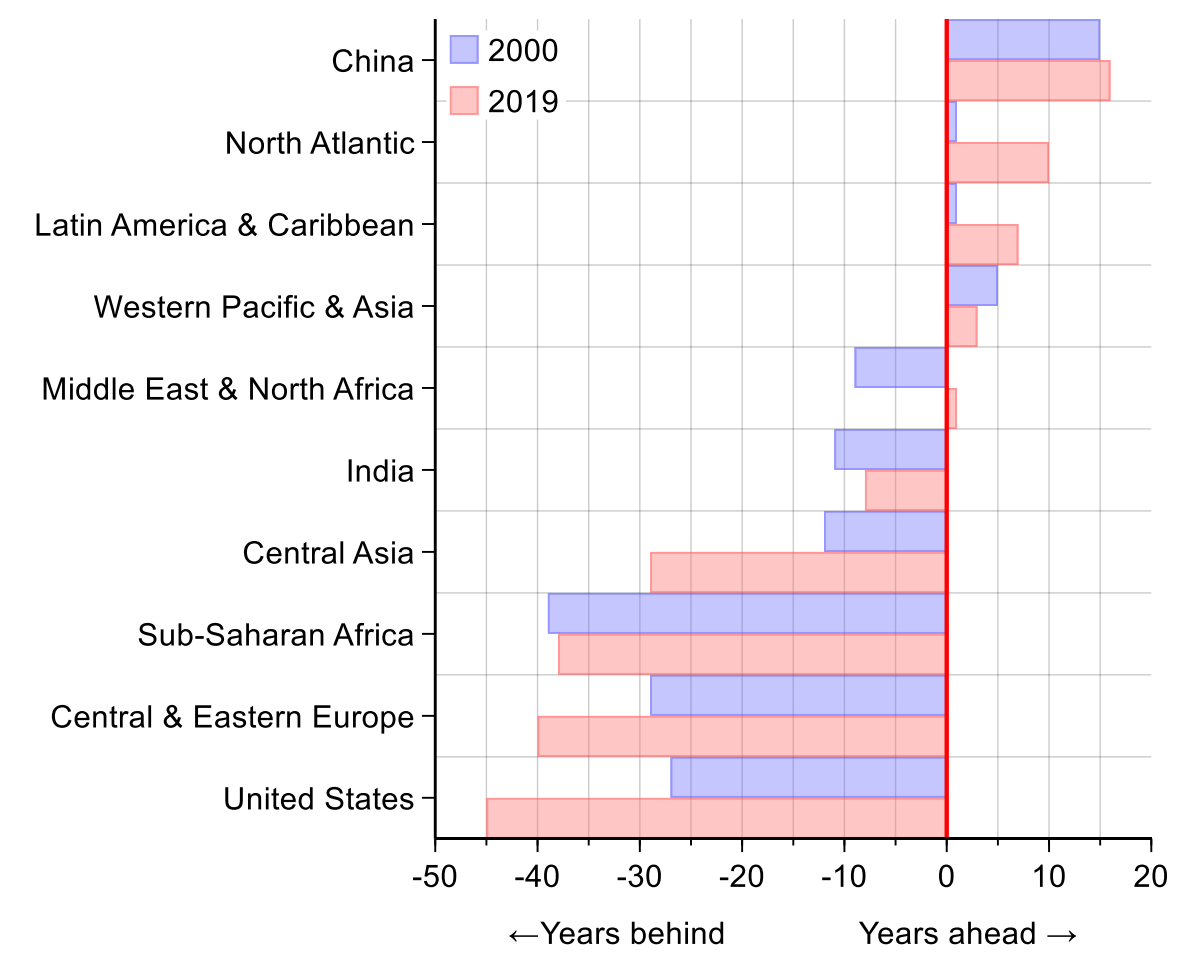
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Missing bars indicate being further behind than 1950 (the earliest available data). Data source: UN WPP.

Figure 4. Preston curves for different years (lines) and observed PPD and GDP for regions in 2019 (markers)



Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Preston curves were estimated for each year by regressing PPD on log of GDP with a separate intercept for each year. The slope for GDP is constant across years while the intercept varies across years. The intercepts were adjusted such that they never increased across years. The dashed line indicates GDP beyond what was observed in that year. Regions with probability below the 2019 Preston curve are not shown. Data source: UN WPP and the Maddison Project.

Figure 5. Years behind or ahead of the Preston curve



Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Data source: UN WPP and the Maddison Project.

Supplement: Years behind or ahead of the global probability of dying before age 70 years

Table S1: Regions and availability of GDP data in parentheses*

Central & East-ern Europe	Central Asia	Latin America & the Caribbean	Middle East & North Africa	North Atlantic	Sub-Saharan Africa	Western Pac-ific & Asia
Albania (1950–2018)	Afghanistan (1950–2018)	Anguilla (No GDP)	Algeria (1950–2018)	Andorra (No GDP)	(1950–2018)	American Samoa (No GDP)
Armenia (1973–2018)	Azerbaijan (1973–2018)	Antigua & Barbuda (No GDP)	Bahrain (1950–2018)	Austria (1950–2018)	Angola (1950–2018)	Australia (1950–2018)
Belarus (1973–2018)	Kazakhstan (1973–2018)	Argentina (1950–2018)	Egypt, Arab Rep. (1950–2018)	Belgium (1950–2018)	Benin (1950–2018)	Bangladesh (1950–2018)
Bosnia & Herzegovina (1952–2018)	Kyrgyz Republic (1973–2018)	Aruba (No GDP)	Iran, Islamic Rep. (1950–2018)	Bermuda (No GDP)	Botswana (1950–2018)	Bhutan (No GDP)
Bulgaria (1950–2018)	Mongolia (1950–2018)	Bahamas, The (No GDP)	Iraq (1950–2018)	Canada (1950–2018)	Burkina Faso (1950–2018)	Brunei Darussalam (No GDP)
Croatia (1952–2018)	Pakistan (1950–2018)	Barbados (1950–2018)	Israel (1950–2018)	Cyprus (1950–2018)	Burundi (1950–2018)	Cambodia (1950–2018)
Czechia (1970–2018)	Tajikistan (1973–2018)	Belize (No GDP)	Jordan (1950–2018)	Denmark (1950–2018)	Cabo Verde (1950–2018)	Cook Islands (No GDP)
Estonia (1973–2018)	Turkmenistan (1973–2018)	Bolivia (1950–2018)	Kuwait (1950–2018)	Faroe Islands (No GDP)	Cameroon (1950–2018)	Fiji (No GDP)
Georgia (1973–2018)	Uzbekistan (1973–2018)	Bonaire, Sint Eustatius & Saba (No GDP)	Lebanon (1950–2018)	Finland (1950–2018)	Central African Republic (1950–2018)	French Polynesia (No GDP)
Hungary (1950–2018)		Brazil (1950–2018)	Libya (1950–2018)	France (1950–2018)	Chad (1950–2018)	Guam (No GDP)
Kosovo (No GDP)		British Virgin Islands (No GDP)	Morocco (1950–2018)	Germany (1950–2018)	Comoros (1950–2018)	Hong Kong SAR, China (1950–2018)
Latvia (1973–2018)		Cayman Islands (No GDP)	Oman (1950–2018)	Gibraltar (No GDP)	Congo, Dem. Rep. (1950–2018)	Indonesia (1950–2018)
Lithuania (1973–2018)		Chile (1950–2018)	Qatar (1950–2018)	Greece (1950–2018)	Congo, Rep. (1950–2018)	Japan (1950–2018)
Moldova (1973–2018)		Colombia (1950–2018)	Saudi Arabia (1950–2018)	Greenland (No GDP)	Côte d’Ivoire (1950–2018)	Kiribati (No GDP)
Montenegro (1952–2018)		Costa Rica (1950–2018)	Syria (1950–2018)	Guernsey (No GDP)	Djibouti (1950–2018)	Korea, Dem. People's Rep. (1990–2018)
North Macedonia (1952–2018)		Cuba (1950–2018)	Tunisia (1950–2018)	Iceland (1950–2018)	Equatorial Guinea (1950–2018)	Korea, Rep. (1950–2018)
Poland (1950–2018)		Curaçao (No GDP)	Türkiye (1950–2018)	Ireland (1950–2018)	Eritrea (No GDP)	Lao PDR (1950–2018)
Romania (1950–2018)		Dominica (1950–2018)	United Arab Emirates (1950–2018)	Isle of Man (No GDP)	Eswatini (1950–2018)	Macao SAR, China (No GDP)
Russia (1960–2018)		Dominican Republic (1950–2018)	West Bank & Gaza (1950–2018)	Italy (1950–2018)	Ethiopia (1950–2018)	Malaysia (1950–2018)
Serbia (1952–2018)		Ecuador (1950–2018)	Yemen, Rep. (1950–2018)	Jersey (No GDP)	Gabon (1950–2018)	Maldives (No GDP)
Slovak Republic (1985–2018)		El Salvador (1950–2018)		Liechtenstein (No GDP)	Gambia, The (1950–2018)	Marshall Islands (No GDP)
Slovenia (1952–2018)		Falkland Islands (No GDP)		Luxembourg (1950–2018)	Ghana (1950–2018)	Micronesia, Fed. Sts. (No GDP)
Ukraine (1973–2018)		French Guiana (No GDP)		Malta (1950–2018)	Guinea (1950–2018)	Myanmar (1950–2018)
		Grenada (No GDP)		Monaco (No GDP)	Guinea-Bissau (1950–2018)	Nauru (No GDP)
		Guadeloupe (No GDP)		Netherlands (1950–2018)	Kenya (1950–2018)	Nepal (1950–2018)
		Guatemala (1950–2018)		Norway (1950–2018)	Lesotho (1950–2018)	New Caledonia (No GDP)
		Guyana (No GDP)		Portugal (1950–2018)	Liberia (1950–2018)	New Zealand (1950–2018)
		Haiti (1950–2018)		Saint Pierre & Miquelon (No GDP)	Madagascar (1950–2018)	Niue (No GDP)
		Honduras (1950–2018)		San Marino (No GDP)	Malawi (1950–2018)	Northern Mariana Islands (No GDP)
		Jamaica (1950–2018)		Spain (1950–2018)	Mali (1950–2018)	Palau (No GDP)
		Martinique (No GDP)		Sweden (1950–2018)	Mauritania (1950–2018)	Papua New Guinea (No GDP)
		Mexico (1950–2018)		Switzerland (1950–2018)	Mauritius (1950–2018)	Philippines (1950–2018)
		Montserrat (No GDP)		United Kingdom (1950–2018)	Mayotte (No GDP)	Samoa (No GDP)
		Nicaragua (1950–2018)			Mozambique (1950–2018)	Singapore (1950–2018)
		Panama (1950–2018)			Namibia (1950–2018)	Solomon Islands (No GDP)
		Paraguay (1950–2018)			Niger (1950–2018)	Sri Lanka (1950–2018)
		Peru (1950–2018)			Nigeria (1950–2018)	Taiwan, China (1950–2018)
		Puerto Rico (1950–2018)			Reunion (No GDP)	Thailand (1950–2018)
		Saint Barthelemy (No GDP)			Rwanda (1950–2018)	Timor-Leste (No GDP)
		Sint Maarten (Dutch part) (No GDP)			Saint Helena (No GDP)	Tokelau (No GDP)
		St. Kitts & Nevis (No GDP)			Senegal (1950–2018)	Tonga (No GDP)
		St. Lucia (1950–2018)			Seychelles (1950–2018)	Tuvalu (No GDP)

Central & Eastern Europe	Central Asia	Latin America & the Caribbean	Middle East & North Africa	North Atlantic	Sub-Saharan Africa	Western Pacific & Asia
		St. Martin (French part) (No GDP)			Sierra Leone (1950–2018)	Vanuatu (No GDP)
		St. Vincent & the Grenadines (No GDP)			Somalia (No GDP)	Vietnam (1950–2018)
		Suriname (No GDP)			South Africa (1950–2018)	Wallis & Futuna (No GDP)
		Trinidad & Tobago (1950–2018)			South Sudan (No GDP)	
		Turks & Caicos Islands (No GDP)			Sudan (1950–2018)	
		Uruguay (1950–2018)			São Tomé & Príncipe (1950–2018)	
		Venezuela, RB (1950–2018)			Tanzania (1950–2018)	
		Virgin Islands (U.S.) (No GDP)			Togo (1950–2018)	
					Uganda (1950–2018)	
					Western Sahara (No GDP)	
					Zambia (1950–2018)	
					Zimbabwe (1950–2018)	

Notes: *Countries without a year range in parentheses have complete GDP data 1950–2018. GDP for 2019 was linearly extrapolated for all countries with available GDP for 2017 and 2018.

Table S2. PPD and GDP in 2000 and 2019

	PPD 2000	GDP 2000	PPD 2019	GDP 2019
Central & Eastern Europe	0.43	9,164	0.30	21,087
Central Asia	0.48	2,958	0.40	6,163
China	0.31	4,730	0.21	13,469
India	0.49	2,753	0.36	7,164
Latin America & Caribbean	0.34	9,342	0.27	13,131
Middle East & North Africa	0.37	8,256	0.28	14,131
North Atlantic	0.21	32,580	0.15	40,168
Sub-Saharan Africa	0.66	1,515	0.52	2,713
United States	0.25	45,887	0.22	56,662
Western Pacific & Asia	0.36	5,875	0.29	11,410
World	0.40	5,348	0.31	10,949

Notes: Probability of premature death (PPD) was defined as dying before age 70 years. GDP was per capita in 2011$.

Details and other results from Preston curves

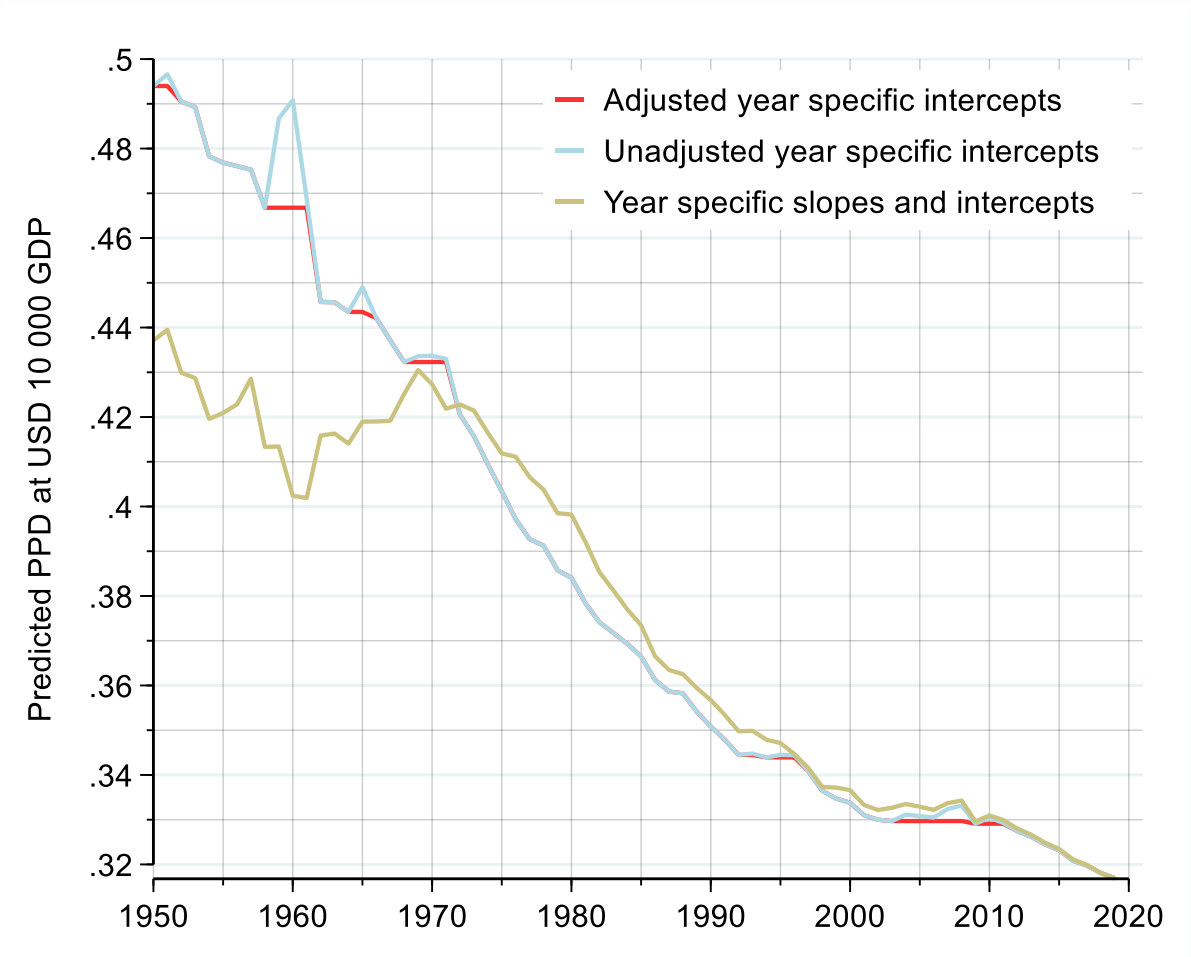
Table S3. Results from linear regressions of PPD on log of real GDP per capita

Year	Main model		Sensitivity check	
	Intercept	Coefficient	Intercept	Coefficient
1950	1.478	-0.107	1.730	-0.140
1951	1.480 (1.478)	-0.107	1.746	-0.142
1952	1.474	-0.107	1.765	-0.145
1953	1.473	-0.107	1.774	-0.146
1954	1.462	-0.107	1.752	-0.145
1955	1.461	-0.107	1.744	-0.144
1956	1.460	-0.107	1.736	-0.143
1957	1.459	-0.107	1.703	-0.138
1958	1.450	-0.107	1.731	-0.143
1959	1.470 (1.450)	-0.107	1.858	-0.157
1960	1.474 (1.450)	-0.107	1.961	-0.169
1961	1.452 (1.450)	-0.107	1.814	-0.153
1962	1.429	-0.107	1.595	-0.128
1963	1.429	-0.107	1.598	-0.128
1964	1.427	-0.107	1.604	-0.129
1965	1.433 (1.427)	-0.107	1.617	-0.130
1966	1.426	-0.107	1.569	-0.125
1967	1.421	-0.107	1.532	-0.121
1968	1.416	-0.107	1.460	-0.112
1969	1.417 (1.416)	-0.107	1.438	-0.109
1970	1.417 (1.416)	-0.107	1.461	-0.112
1971	1.417 (1.416)	-0.107	1.494	-0.116
1972	1.404	-0.107	1.388	-0.105
1973	1.399	-0.107	1.356	-0.101
1974	1.393	-0.107	1.341	-0.100
1975	1.387	-0.107	1.324	-0.099
1976	1.381	-0.107	1.275	-0.094
1977	1.376	-0.107	1.268	-0.094
1978	1.375	-0.107	1.273	-0.094
1979	1.369	-0.107	1.265	-0.094
1980	1.368	-0.107	1.246	-0.092
1981	1.362	-0.107	1.243	-0.092
1982	1.358	-0.107	1.259	-0.095
1983	1.355	-0.107	1.270	-0.096
1984	1.353	-0.107	1.281	-0.098
1985	1.350	-0.107	1.284	-0.099
1986	1.345	-0.107	1.293	-0.101
1987	1.342	-0.107	1.294	-0.101
1988	1.342	-0.107	1.297	-0.102
1989	1.338	-0.107	1.282	-0.100
1990	1.334	-0.107	1.272	-0.099
1991	1.332	-0.107	1.273	-0.100
1992	1.328	-0.107	1.272	-0.100
1993	1.328	-0.107	1.273	-0.100
1994	1.328	-0.107	1.283	-0.102
1995	1.328	-0.107	1.297	-0.103
1996	1.328	-0.107	1.325	-0.106
1997	1.325	-0.107	1.315	-0.106
1998	1.320	-0.107	1.309	-0.105
1999	1.318	-0.107	1.285	-0.103
2000	1.317	-0.107	1.277	-0.102
2001	1.315	-0.107	1.281	-0.103
2002	1.314	-0.107	1.279	-0.103

Year	Main model		Sensitivity check	
	Intercept	Coefficient	Intercept	Coefficient
2003	1.313	-0.107	1.263	-0.101
2004	1.315 (1.313)	-0.107	1.269	-0.102
2005	1.314 (1.313)	-0.107	1.269	-0.102
2006	1.314 (1.313)	-0.107	1.270	-0.102
2007	1.316 (1.313)	-0.107	1.276	-0.102
2008	1.317 (1.313)	-0.107	1.279	-0.103
2009	1.313	-0.107	1.294	-0.105
2010	1.314 (1.313)	-0.107	1.292	-0.104
2011	1.313	-0.107	1.277	-0.103
2012	1.311	-0.107	1.272	-0.103
2013	1.310	-0.107	1.269	-0.102
2014	1.308	-0.107	1.265	-0.102
2015	1.307	-0.107	1.253	-0.101
2016	1.304	-0.107	1.241	-0.100
2017	1.303	-0.107	1.234	-0.099
2018	1.302	-0.107	1.229	-0.099
2019	1.301	-0.107	1.223	-0.098

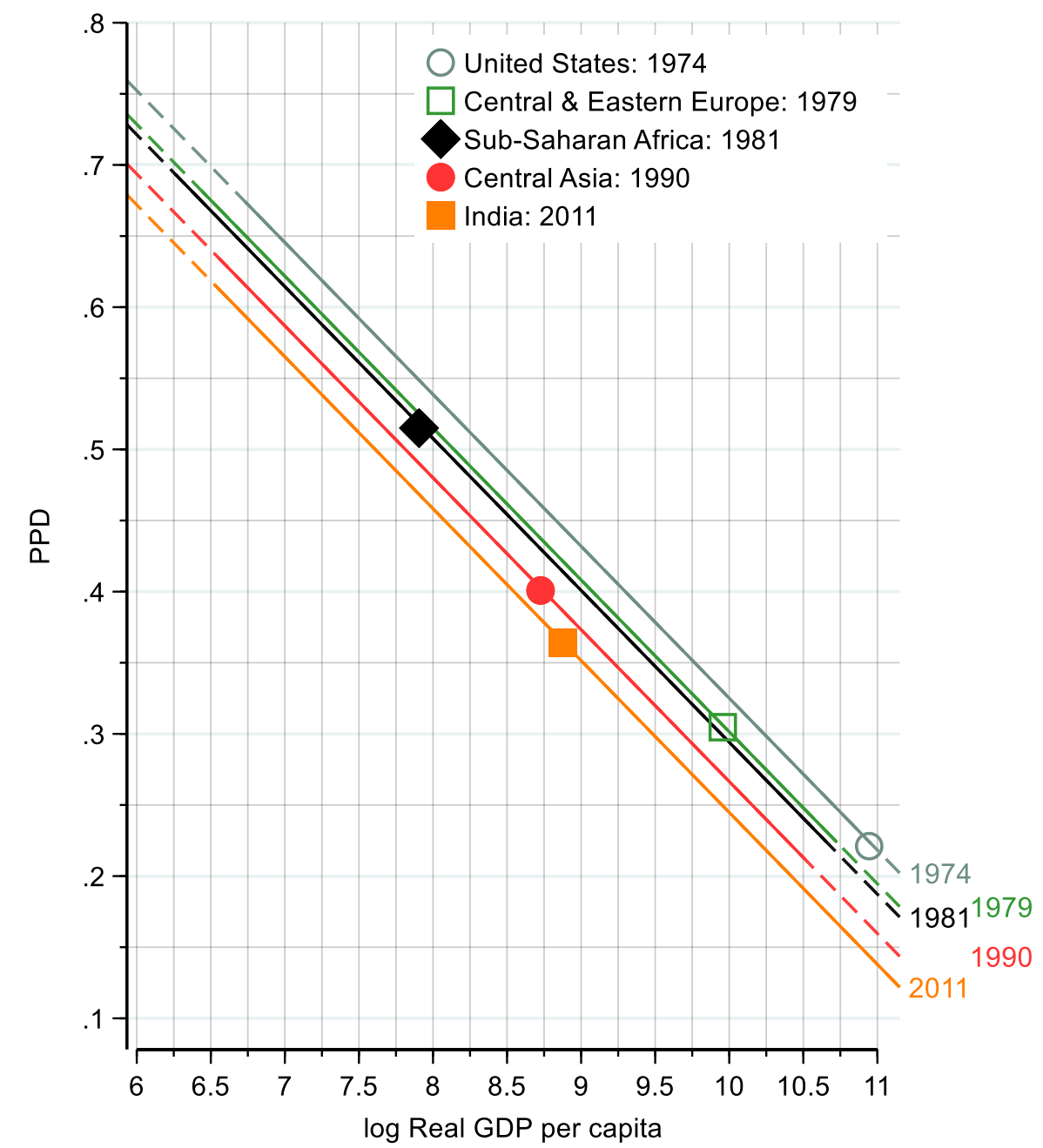
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Main model: Preston curves were estimated for each year by regressing PPD on log of real GDP per capita with a separate intercept for each year but a coefficient for GDP that was constant across years. In the main model, the intercepts shown in parenthesis were adjusted such that they never increased across years. The sensitivity check estimated the same models allowing the coefficient for GDP to vary across year. No adjustments were made to the intercepts in the sensitivity check. Data source: UN WPP and the Maddison Project.

Figure S1. Predicted PPD at USD 10 000 GDP per capita from main model (before and after adjusting the year specific intercepts) and the sensitivity specification



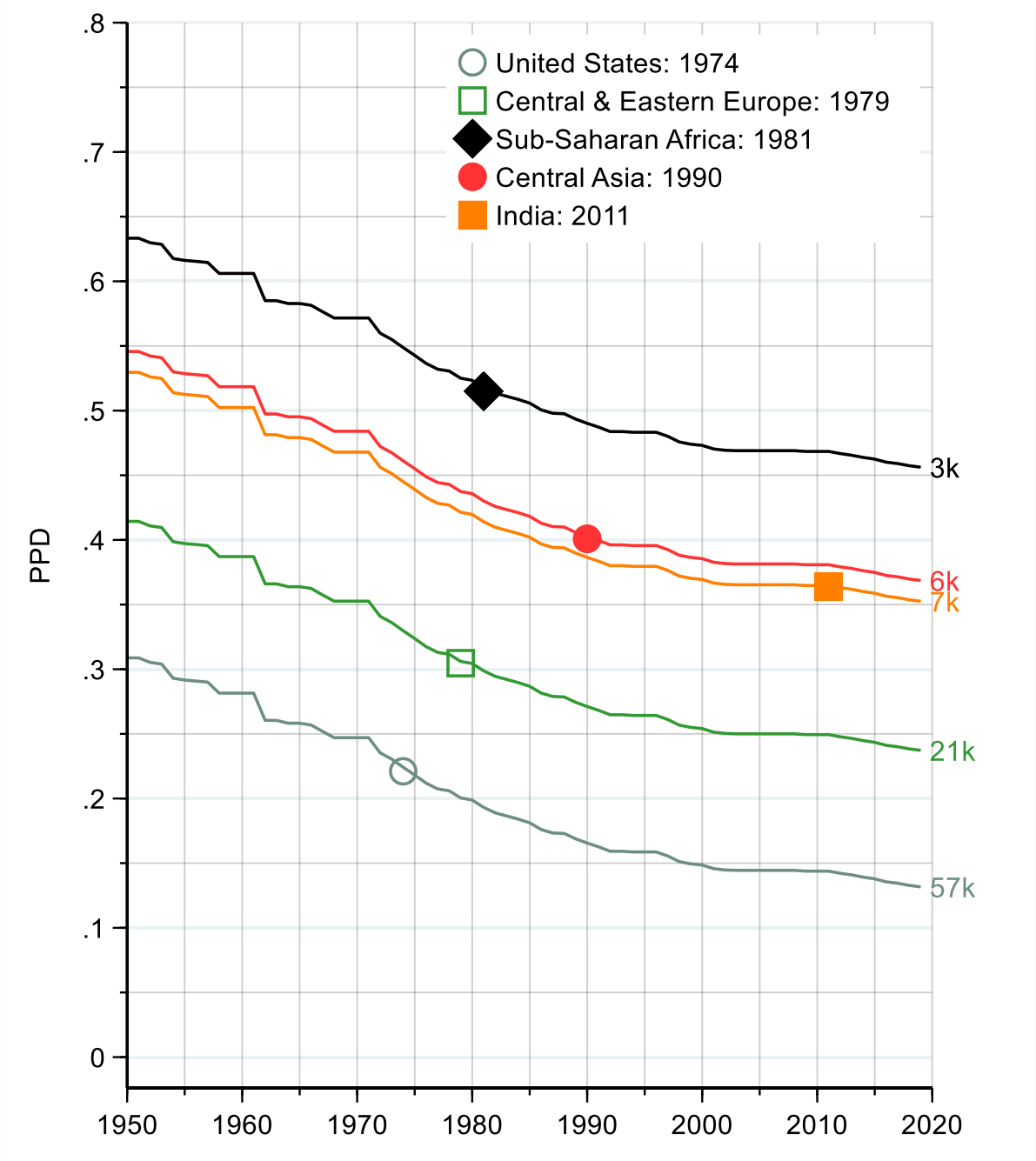
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Predicted PPD was estimated as PPD on log real GDP per capita and a separate intercept for each year. The year specific intercepts were adjusted such that they never decreased across years.

Figure S2. Preston curves for different years (lines) and observed PPD and log GDP for regions in 2019 (markers)



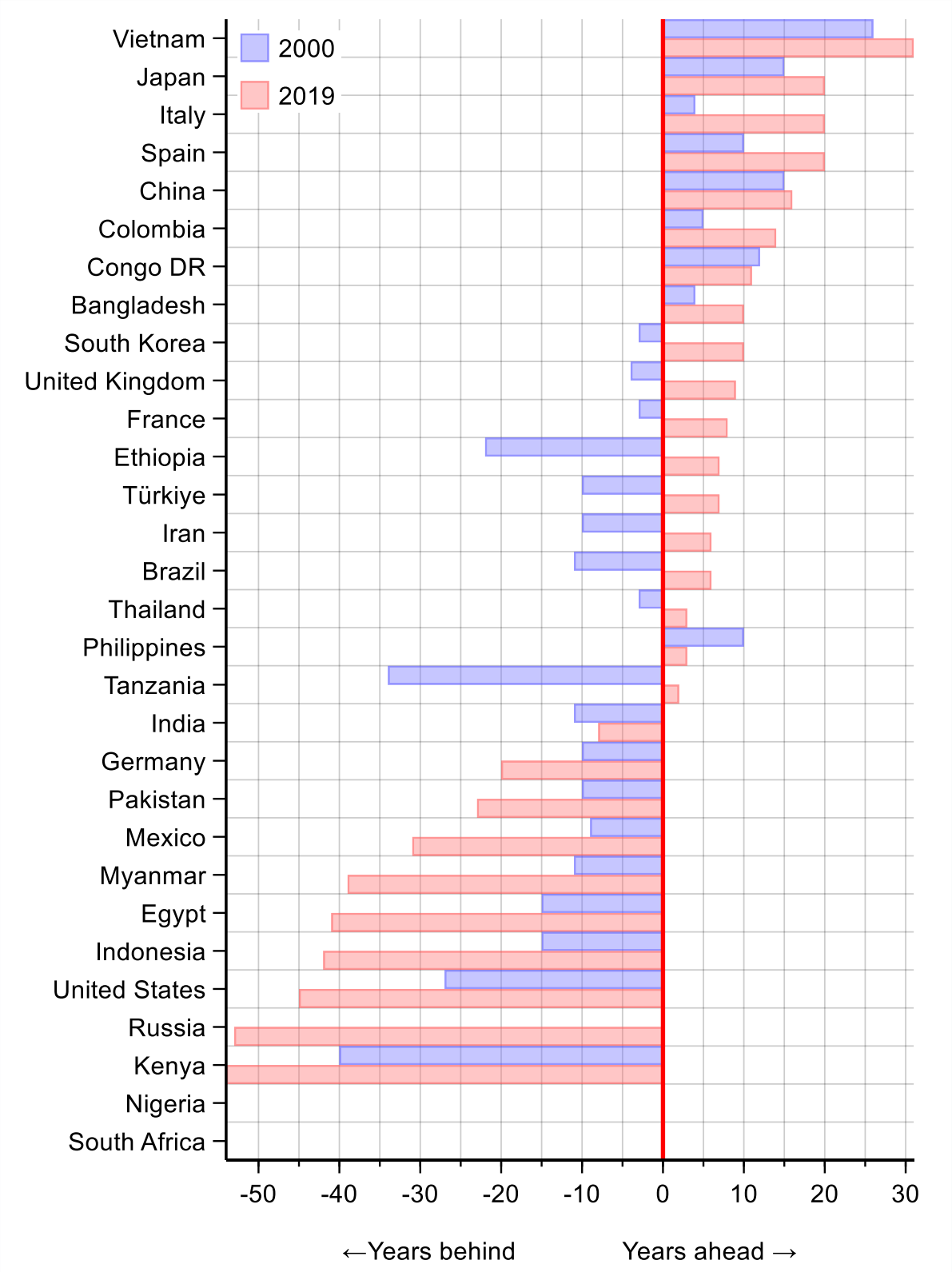
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Preston curves were estimated for each year by regressing PPD on log of GDP with a separate intercept for each year. The slope for GDP is constant across years while the intercept varies across years. The intercepts were adjusted such that they never increased across years. The dashed line indicates GDP beyond what was observed in that year. Regions with probability below the 2019 Preston curve are not shown. Data source: UN WPP and the Maddison Project.

Figure S3. PPD predicted by Preston curves across years for different levels of GDP (lines) and observed PPD for regions in 2019 (markers)



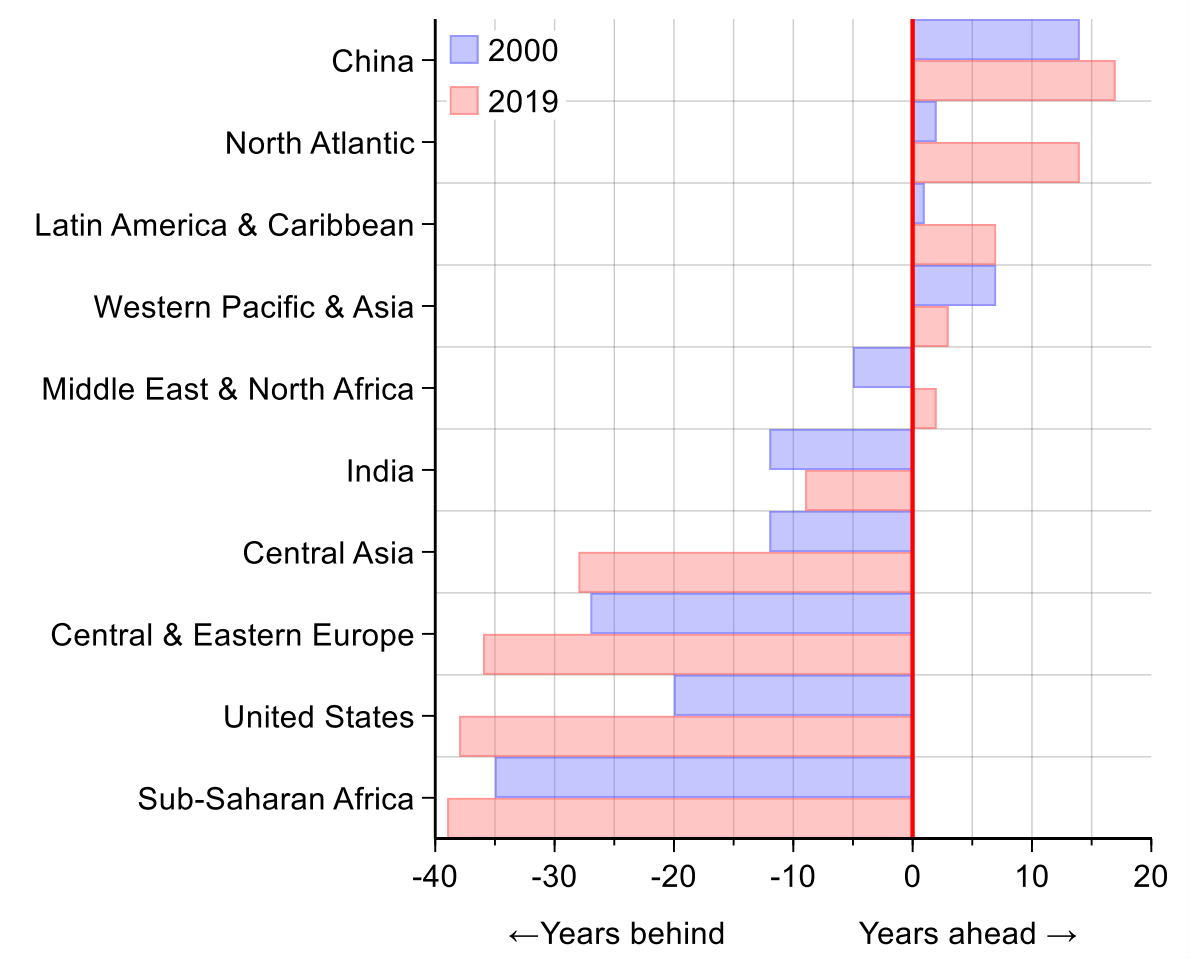
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Preston curves were estimated for each year by regressing PPD on log of GDP with a separate intercept for each year. The slope for GDP is constant across years while the intercept varies across years. The intercepts were adjusted such that they never increased across years. Regions with probability below the 2019 Preston curve are not shown. Data source: UN WPP and the Maddison Project.

Figure S4. Years behind or ahead of the Preston curve: 30 most populous countries in 2019



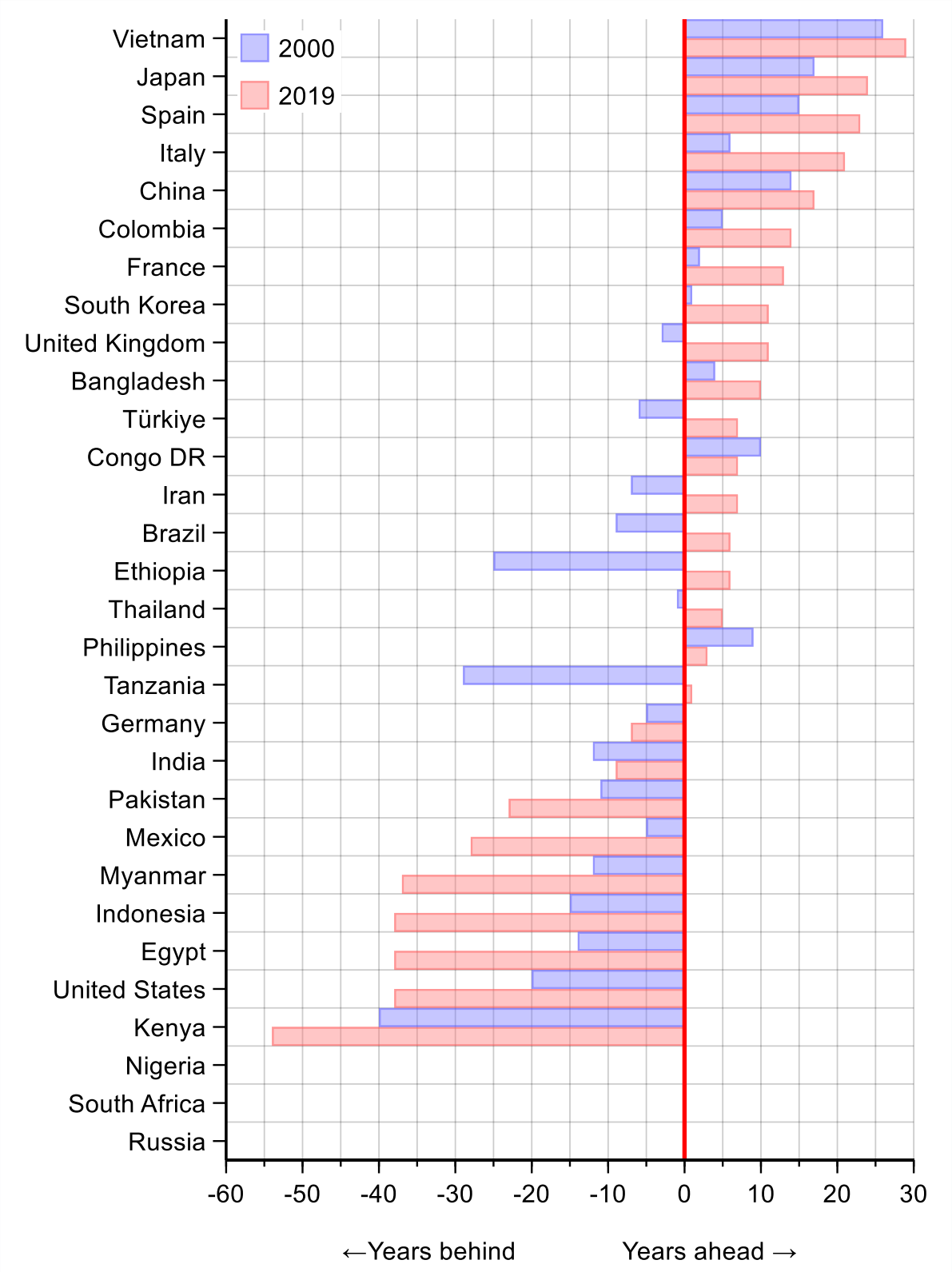
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Missing bars indicate being further behind than 1950 (the earliest available data). Data source: UN WPP and the Maddison Project.

Figure S5. Years behind or ahead relative to PPD predicted by current GDP



Notes: Probability of premature death (PPD) was defined as dying before age 70 years. See Sensitivity analyses section for details. Data source: UN WPP and the Maddison Project.

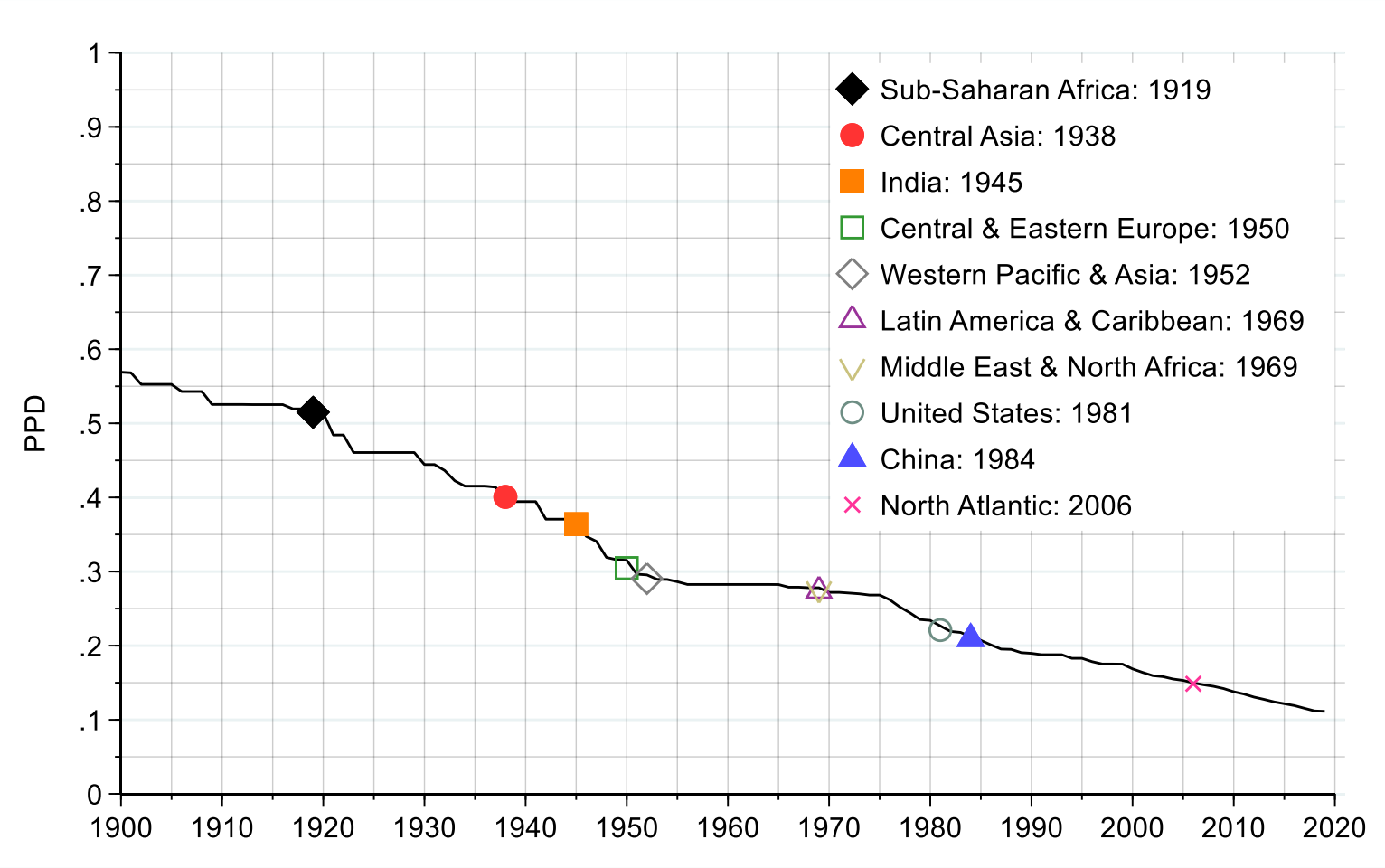
Figure S6. Years behind or ahead relative to PPD predicted by current GDP: 30 most populous countries in 2019



Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Missing bars indicate being further behind than 1950 (the earliest available data). See Sensitivity analyses section for details. Data source: UN WPP and the Maddison Project.

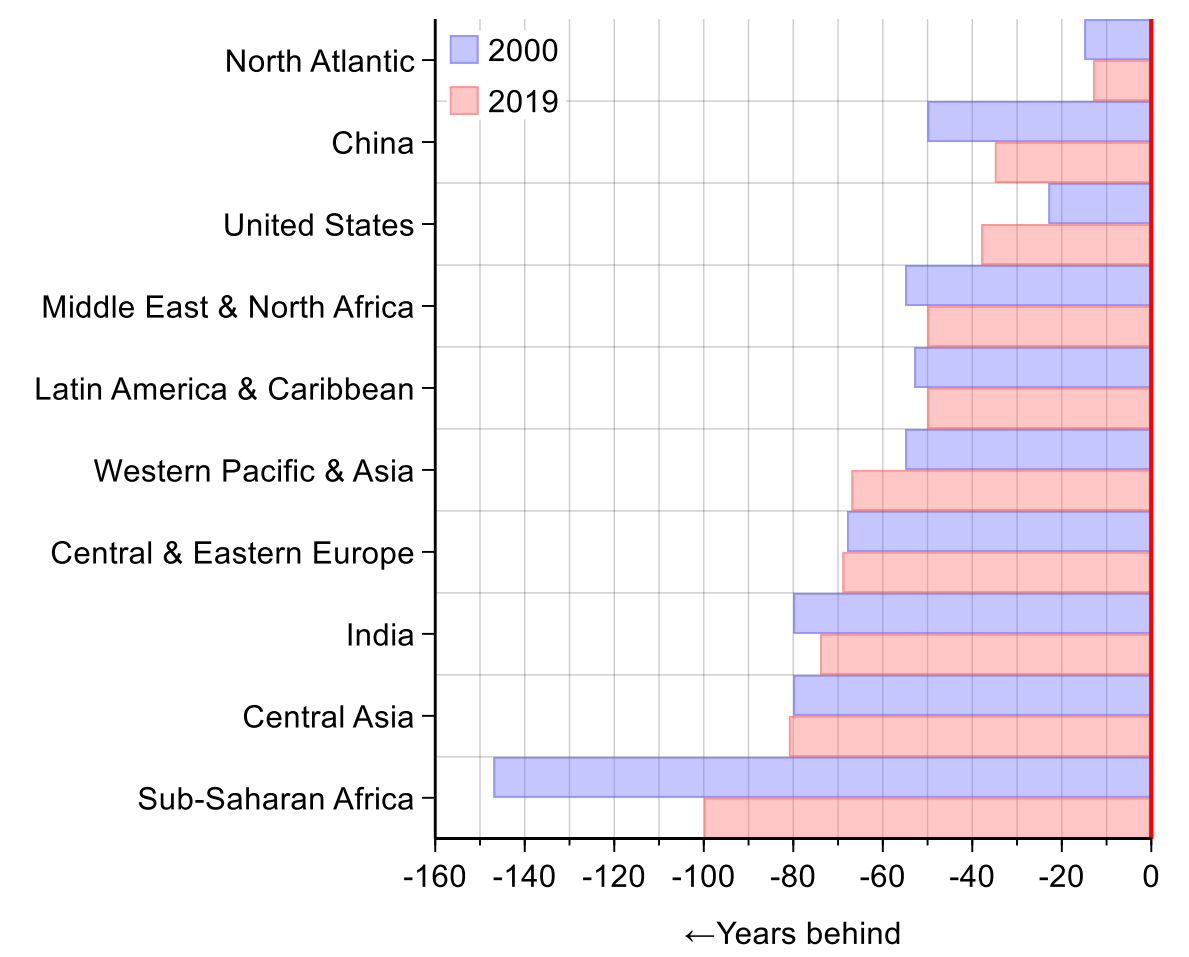
Frontier as benchmark

Figure S7. Frontier PPD across time (line) and for regions in 2019 (markers)



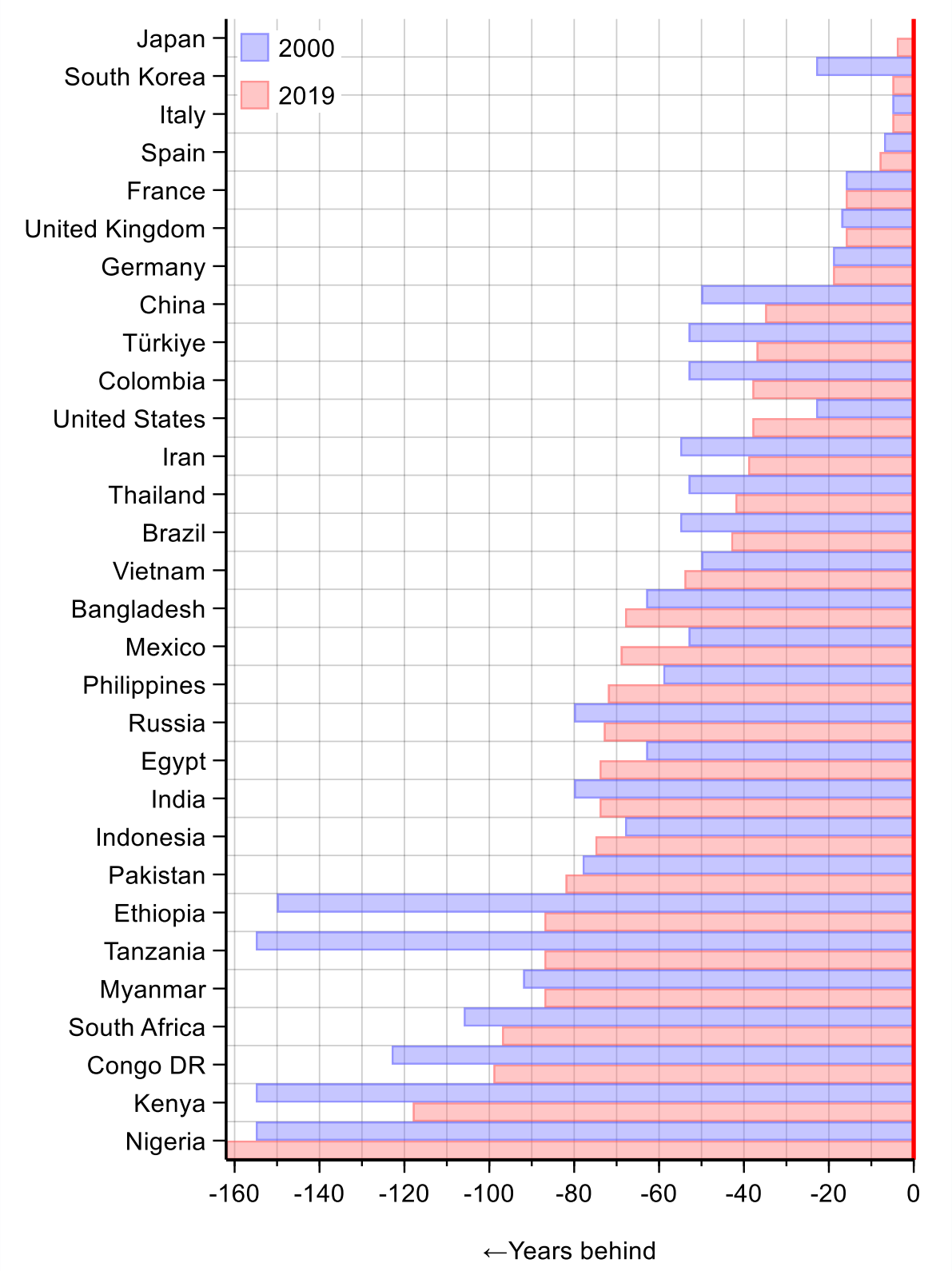
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. The frontier is the lowest PPD ever observed. Countries with a population below 3 million in 2019 were not considered for being a frontier. Data source: UN WPP after 1950 and HMD before 1950.

Figure S8. Years behind the frontier PPD



Notes: Probability of premature death (PPD) was defined as dying before age 70 years. The frontier is the lowest PPD ever observed. Countries with a population below 3 million in 2019 were not considered for being a frontier. Data source: UN WPP after 1950 and HMD before 1950.

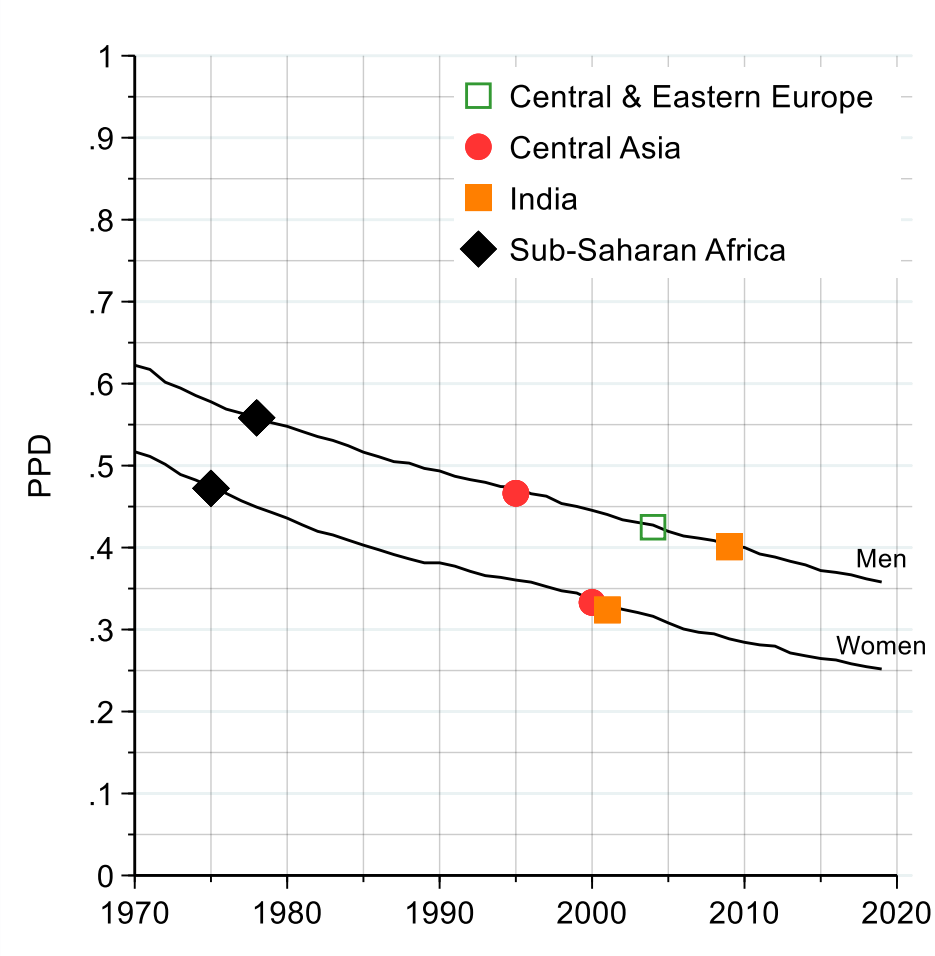
Figure S9. Years behind the frontier PPD: 30 most populous countries in 2019



Notes: Probability of premature death (PPD) was defined as dying before age 70 years. The frontier is the lowest PPD ever observed. Countries with a population below 3 million in 2019 were not considered for being a frontier. Data source: UN WPP after 1950 and HMD before 1950.

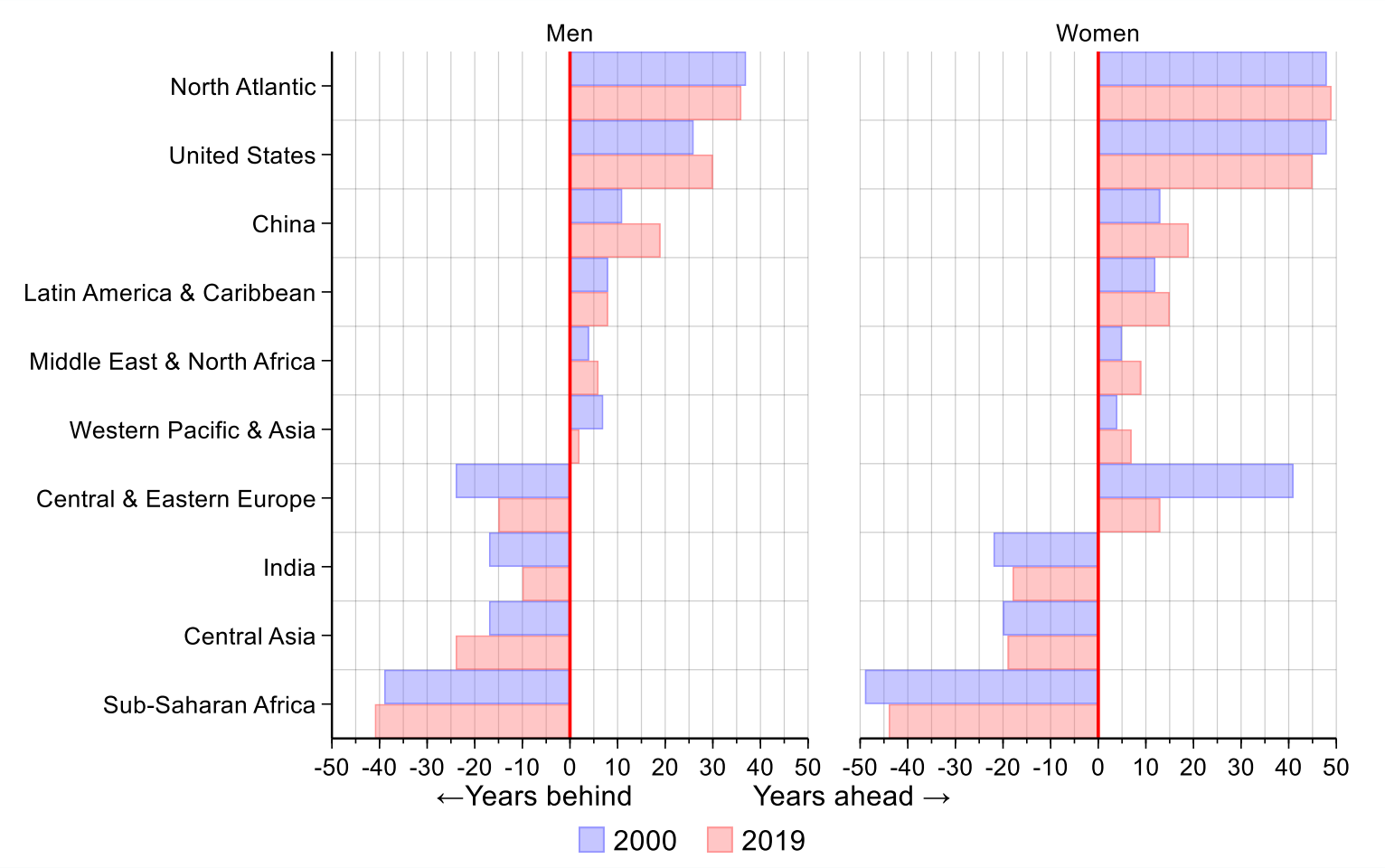
Results by sex

Figure S10. Global PPD across time (line) and for regions in 2019 (markers): by sex



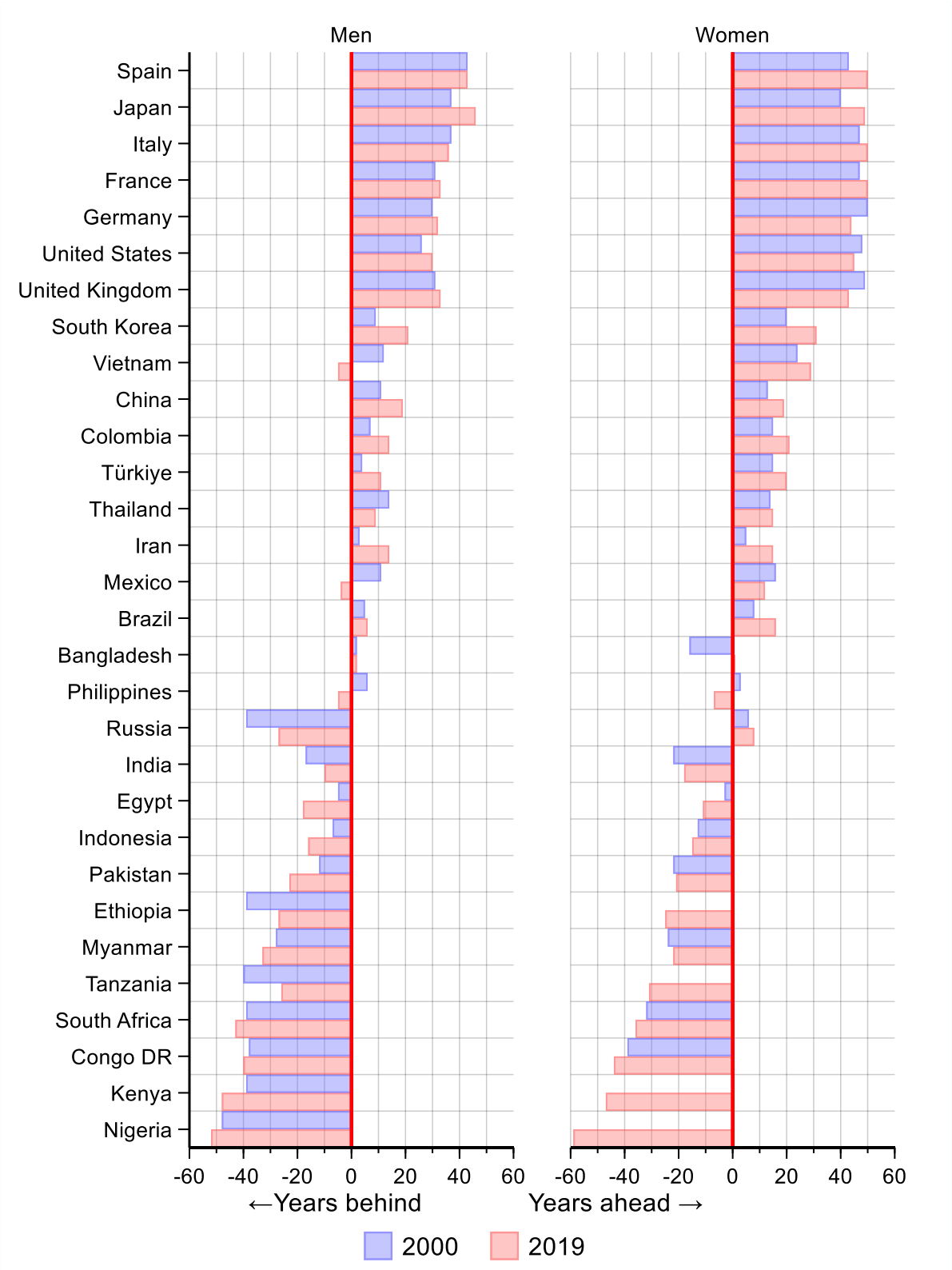
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Regions with lower PPD than the global average are not shown. Data source: UN WPP.

Figure S11. Years behind or ahead of the global PPD by sex



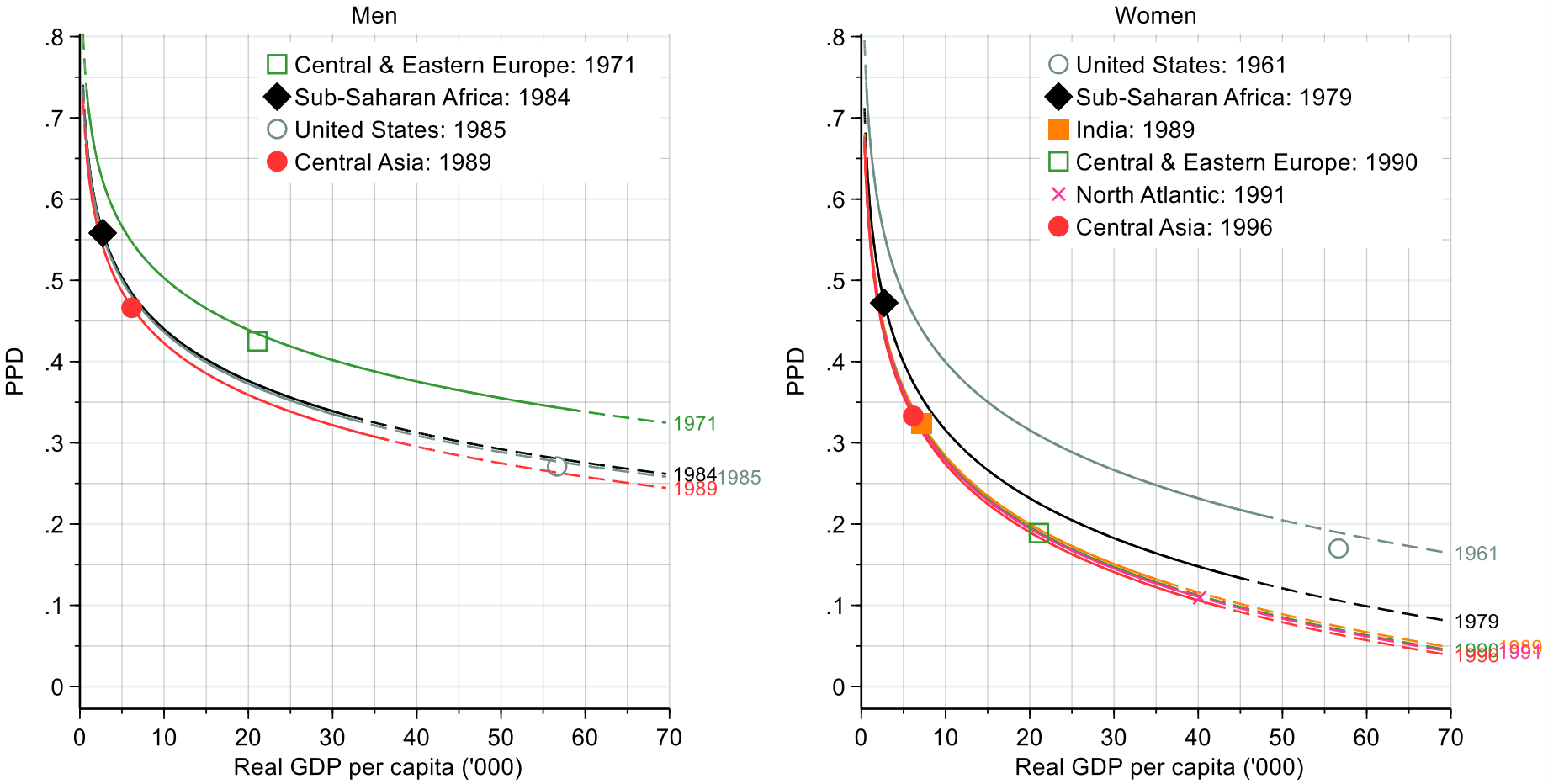
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Data source: UN WPP.

Figure S12. Years behind or ahead of the global PPD by sex: 30 most populous countries in 2019



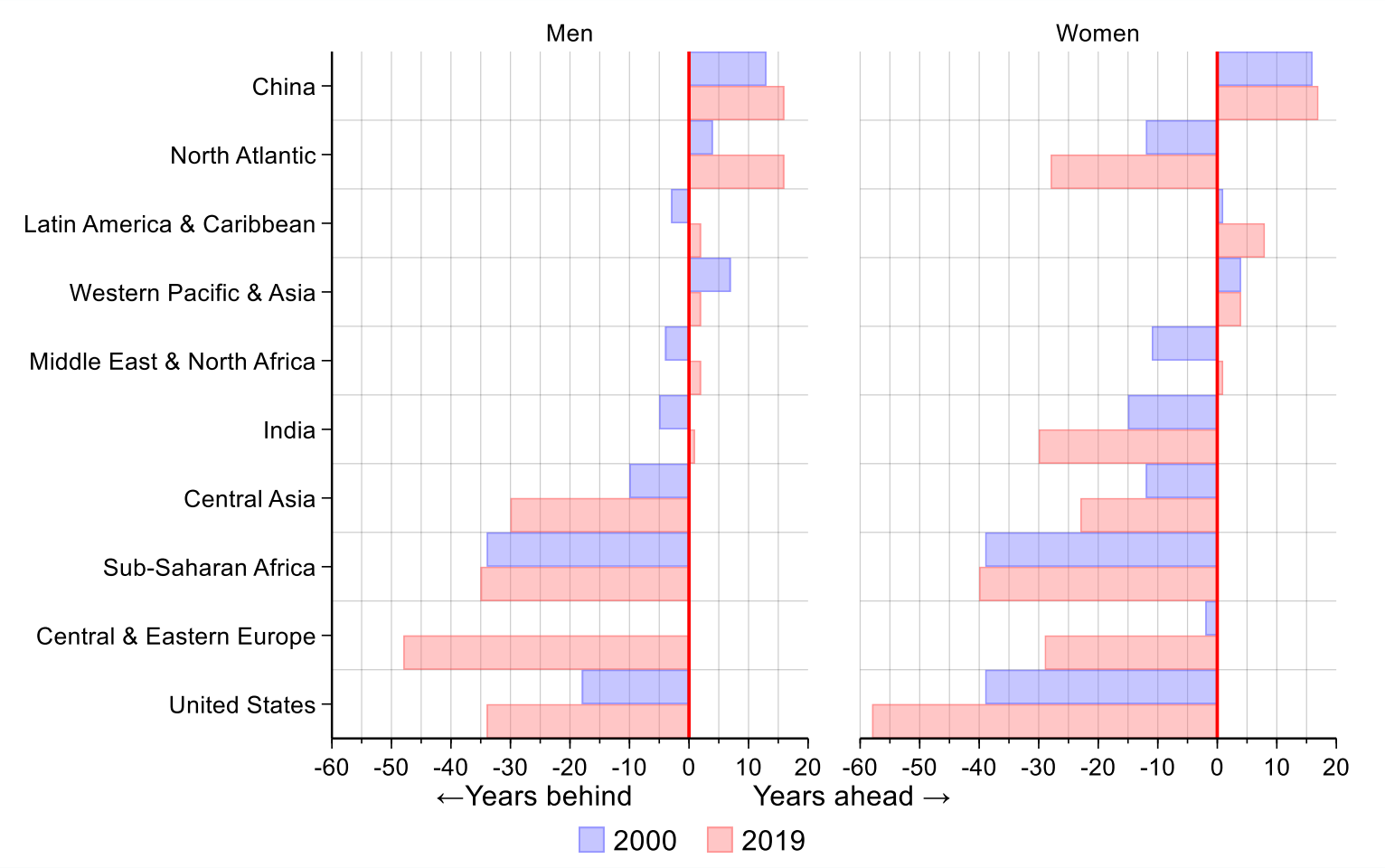
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Missing bars indicate being further behind than 1950 (the earliest available data). Data source: UN WPP.

Figure S13. Preston curves for different years (lines) and observed PPD and GDP for regions in 2019 (markers) by sex



Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Preston curves were estimated for each year by regressing PPD on log of GDP with a separate intercept for each year. The slope for GDP is constant across years while the intercept varies across years. The intercepts were adjusted such that they never increased across years. The dashed line indicates GDP beyond what was observed in that year. Regions with probability below the 2019 Preston curve are not shown. Data source: UN WPP and the Maddison Project.

Figure S14. Years behind or ahead of the Preston curve by sex



Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Data source: UN WPP and the Maddison Project.

Table S4. Results from linear regressions of PPD on log of real GDP per capita: by sex

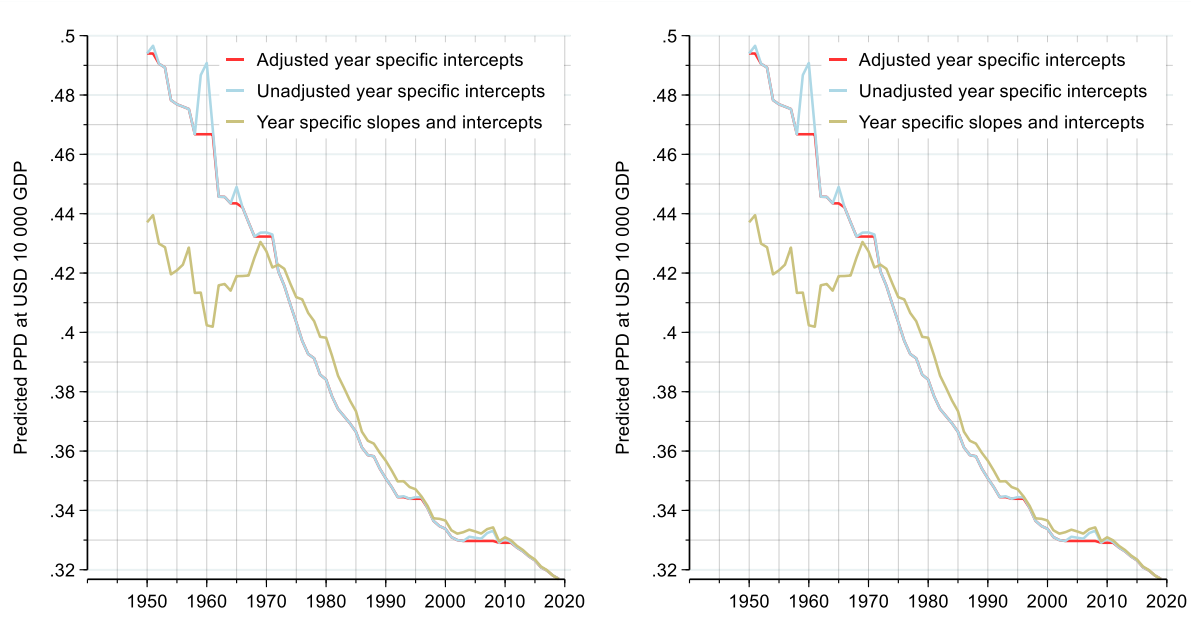
Year	Men				Women			
	Main model		Sensitivity check		Main model		Sensitivity check	
	Intercept	Coefficient	Intercept	Coefficient	Intercept	Coefficient	Intercept	Coefficient
1950	1.403	-0.092	1.646	-0.124	1.543	-0.121	1.796	-0.155
1951	1.405 (1.403)	-0.092	1.646	-0.124	1.546 (1.543)	-0.121	1.829	-0.158
1952	1.399	-0.092	1.661	-0.126	1.540	-0.121	1.856	-0.162
1953	1.398	-0.092	1.659	-0.126	1.540	-0.121	1.880	-0.165
1954	1.387	-0.092	1.644	-0.125	1.528	-0.121	1.850	-0.163
1955	1.387	-0.092	1.634	-0.124	1.526	-0.121	1.844	-0.162
1956	1.386	-0.092	1.620	-0.122	1.525	-0.121	1.842	-0.162
1957	1.386	-0.092	1.582	-0.117	1.523	-0.121	1.814	-0.159
1958	1.378	-0.092	1.619	-0.123	1.514	-0.121	1.832	-0.162
1959	1.396 (1.378)	-0.092	1.726	-0.135	1.536 (1.514)	-0.121	1.977	-0.178
1960	1.402 (1.378)	-0.092	1.795	-0.142	1.540 (1.514)	-0.121	2.107	-0.194
1961	1.383 (1.378)	-0.092	1.681	-0.130	1.515 (1.514)	-0.121	1.925	-0.174
1962	1.363	-0.092	1.484	-0.107	1.489	-0.121	1.685	-0.146
1963	1.363	-0.092	1.478	-0.107	1.489	-0.121	1.698	-0.148
1964	1.360	-0.092	1.480	-0.107	1.488	-0.121	1.708	-0.149
1965	1.367 (1.360)	-0.092	1.491	-0.108	1.491 (1.488)	-0.121	1.721	-0.150
1966	1.359	-0.092	1.438	-0.102	1.486	-0.121	1.683	-0.146
1967	1.354	-0.092	1.408	-0.099	1.481	-0.121	1.640	-0.141
1968	1.349	-0.092	1.338	-0.090	1.476	-0.121	1.567	-0.133
1969	1.350 (1.349)	-0.092	1.309	-0.087	1.477 (1.476)	-0.121	1.552	-0.130
1970	1.349	-0.092	1.324	-0.089	1.479 (1.476)	-0.121	1.581	-0.134
1971	1.349	-0.092	1.370	-0.094	1.477 (1.476)	-0.121	1.596	-0.136
1972	1.335	-0.092	1.253	-0.082	1.467	-0.121	1.509	-0.126
1973	1.331	-0.092	1.215	-0.078	1.462	-0.121	1.480	-0.123
1974	1.323	-0.092	1.211	-0.078	1.456	-0.121	1.456	-0.121
1975	1.317	-0.092	1.189	-0.076	1.450	-0.121	1.444	-0.120
1976	1.311	-0.092	1.147	-0.072	1.444	-0.121	1.389	-0.114
1977	1.307	-0.092	1.145	-0.072	1.439	-0.121	1.376	-0.113
1978	1.306	-0.092	1.151	-0.073	1.436	-0.121	1.378	-0.114
1979	1.301	-0.092	1.147	-0.073	1.430	-0.121	1.365	-0.113
1980	1.301	-0.092	1.126	-0.071	1.427	-0.121	1.348	-0.111

Year	Men				Women			
	Main model		Sensitivity check		Main model		Sensitivity check	
	Intercept	Coefficient	Intercept	Coefficient	Intercept	Coefficient	Intercept	Coefficient
1981	1.296	-0.092	1.128	-0.071	1.421	-0.121	1.339	-0.111
1982	1.291	-0.092	1.146	-0.074	1.416	-0.121	1.352	-0.113
1983	1.289	-0.092	1.157	-0.076	1.414	-0.121	1.362	-0.115
1984	1.286	-0.092	1.174	-0.078	1.412	-0.121	1.369	-0.116
1985	1.282	-0.092	1.179	-0.079	1.410	-0.121	1.369	-0.116
1986	1.277	-0.092	1.194	-0.082	1.405	-0.121	1.373	-0.117
1987	1.274	-0.092	1.200	-0.083	1.403	-0.121	1.368	-0.117
1988	1.273	-0.092	1.207	-0.084	1.402	-0.121	1.369	-0.117
1989	1.269	-0.092	1.191	-0.083	1.398	-0.121	1.357	-0.116
1990	1.266	-0.092	1.185	-0.082	1.395	-0.121	1.347	-0.115
1991	1.262	-0.092	1.186	-0.083	1.393	-0.121	1.353	-0.116
1992	1.258	-0.092	1.191	-0.084	1.389	-0.121	1.347	-0.116
1993	1.259 (1.258)	-0.092	1.195	-0.084	1.389	-0.121	1.349	-0.116
1994	1.256	-0.092	1.210	-0.086	1.389	-0.121	1.358	-0.117
1995	1.256	-0.092	1.226	-0.088	1.390 (1.389)	-0.121	1.369	-0.119
1996	1.255	-0.092	1.257	-0.092	1.392 (1.389)	-0.121	1.394	-0.121
1997	1.251	-0.092	1.259	-0.093	1.389	-0.121	1.372	-0.119
1998	1.247	-0.092	1.263	-0.094	1.384	-0.121	1.354	-0.117
1999	1.244	-0.092	1.239	-0.091	1.384	-0.121	1.331	-0.115
2000	1.242	-0.092	1.230	-0.090	1.383	-0.121	1.326	-0.114
2001	1.240	-0.092	1.238	-0.092	1.379	-0.121	1.324	-0.115
2002	1.239	-0.092	1.240	-0.092	1.379	-0.121	1.320	-0.114
2003	1.238	-0.092	1.227	-0.091	1.379	-0.121	1.300	-0.112
2004	1.239 (1.238)	-0.092	1.234	-0.091	1.381 (1.379)	-0.121	1.306	-0.112
2005	1.238	-0.092	1.238	-0.092	1.381 (1.379)	-0.121	1.302	-0.112
2006	1.237	-0.092	1.244	-0.093	1.381 (1.379)	-0.121	1.298	-0.112
2007	1.239 (1.237)	-0.092	1.253	-0.094	1.384 (1.379)	-0.121	1.299	-0.112
2008	1.239 (1.237)	-0.092	1.259	-0.094	1.385 (1.379)	-0.121	1.298	-0.111
2009	1.235	-0.092	1.283	-0.097	1.381 (1.379)	-0.121	1.302	-0.112
2010	1.235	-0.092	1.283	-0.097	1.384 (1.379)	-0.121	1.298	-0.111
2011	1.233	-0.092	1.275	-0.096	1.383 (1.379)	-0.121	1.277	-0.109
2012	1.231	-0.092	1.274	-0.097	1.382 (1.379)	-0.121	1.268	-0.108
2013	1.229	-0.092	1.277	-0.097	1.381 (1.379)	-0.121	1.257	-0.107
2014	1.226	-0.092	1.271	-0.097	1.381 (1.379)	-0.121	1.257	-0.107
2015	1.224	-0.092	1.258	-0.096	1.381 (1.379)	-0.121	1.246	-0.106

Year	Men				Women			
	Main model		Sensitivity check		Main model		Sensitivity check	
	Intercept	Coefficient	Intercept	Coefficient	Intercept	Coefficient	Intercept	Coefficient
2016	1.221	-0.092	1.248	-0.095	1.379	-0.121	1.234	-0.105
2017	1.221	-0.092	1.243	-0.094	1.377	-0.121	1.225	-0.104
2018	1.218	-0.092	1.244	-0.095	1.377	-0.121	1.213	-0.103
2019	1.217	-0.092	1.246	-0.095	1.376	-0.121	1.201	-0.102

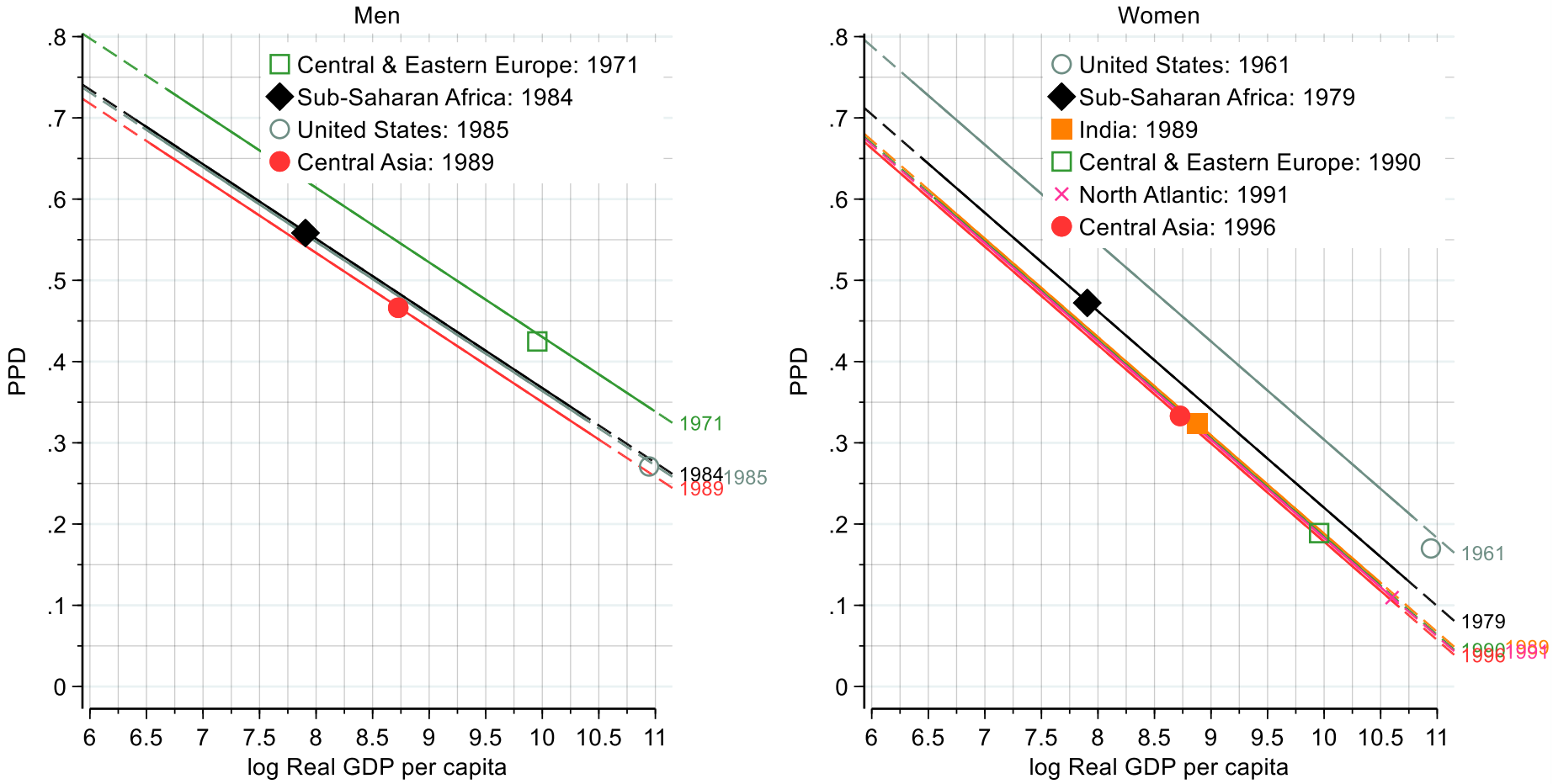
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Main model: Preston curves were estimated for each year by regressing PPD on log of real GDP per capita with a separate intercept for each year but a coefficient for GDP that was constant across years. In the main model, the intercepts shown in parenthesis were adjusted such that they never increased across years. The sensitivity check estimated the same models allowing the coefficient for GDP to vary across year. No adjustments were made to the intercepts in the sensitivity checks. Data source: UN WPP and the Maddison Project.

Figure S15. Predicted PPD at USD 10 000 GDP per capita from main model (before and after adjusting the year specific intercepts) and the sensitivity specification: by sex



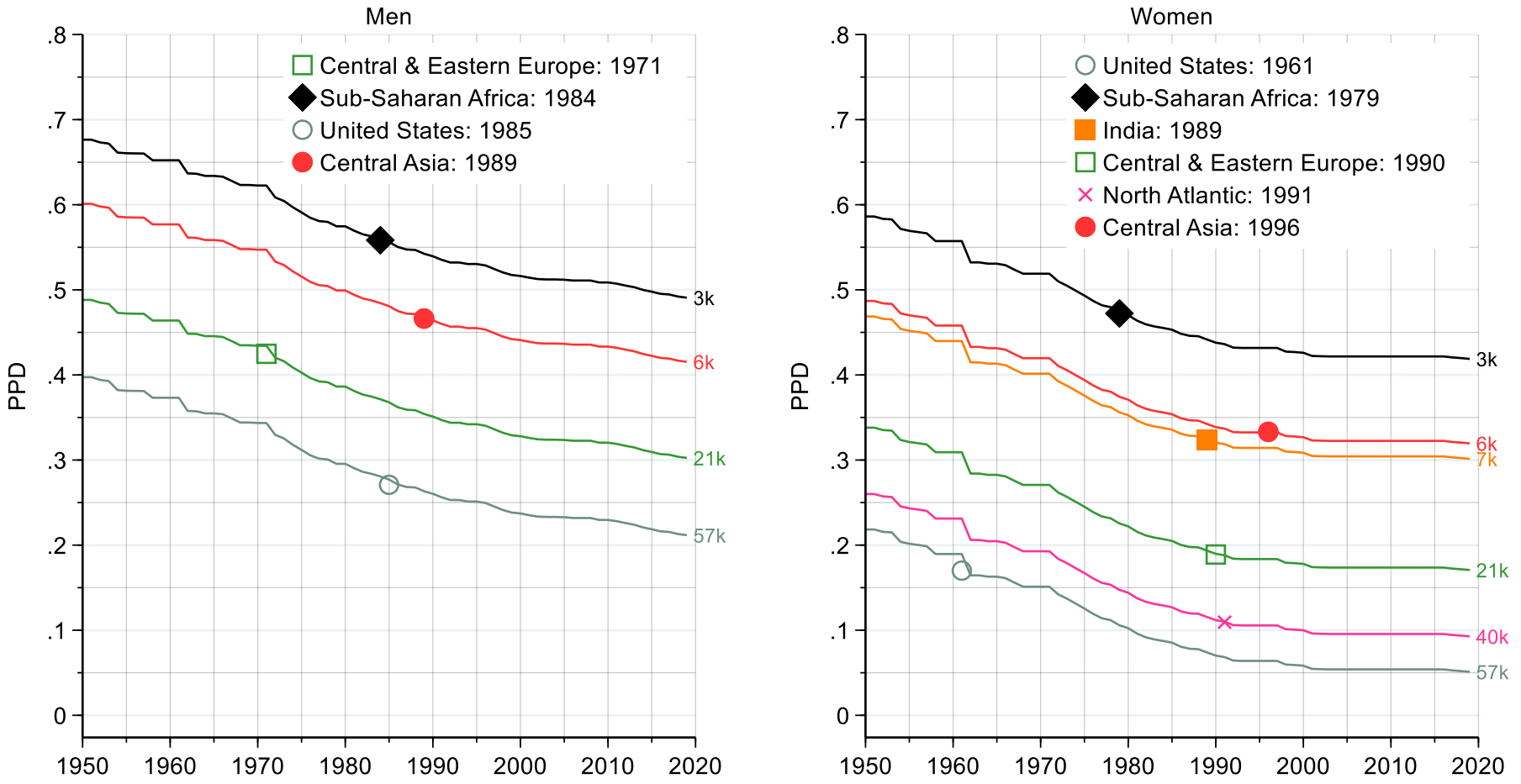
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Predicted PPD was estimated as PPD on log real GDP per capita and a separate intercept for each year. The year specific intercepts were adjusted such that they never decreased across years.

Figure S16. Preston curves for different years (lines) and observed PPD and log GDP for regions in 2019 (markers) by sex



Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Preston curves were estimated for each year by regressing PPD on log of GDP with a separate intercept for each year. The slope for GDP is constant across years while the intercept varies across years. The intercepts were adjusted such that they never increased across years. The dashed line indicates GDP beyond what was observed in that year. Regions with probability below the 2019 Preston curve are not shown. Data source: UN WPP and the Maddison Project.

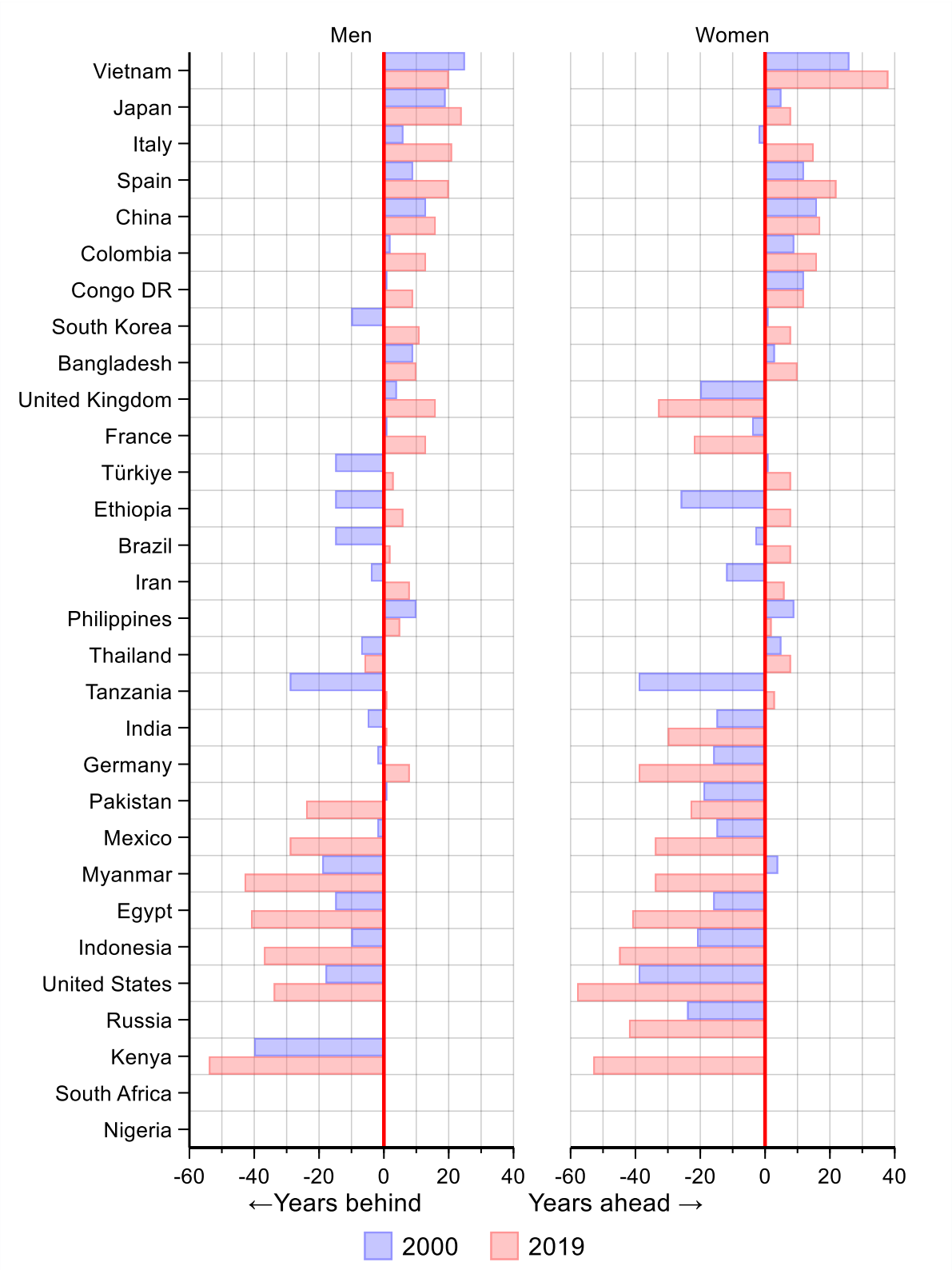
Figure S17. PPD predicted by Preston curves across years for different levels of GDP (lines) and observed PPD for regions in 2019 (markers) by sex



Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Preston curves were estimated for each year by regressing PPD on log of GDP with a separate intercept for each year. The slope for GDP is constant across years while the intercept varies across years. The intercepts were

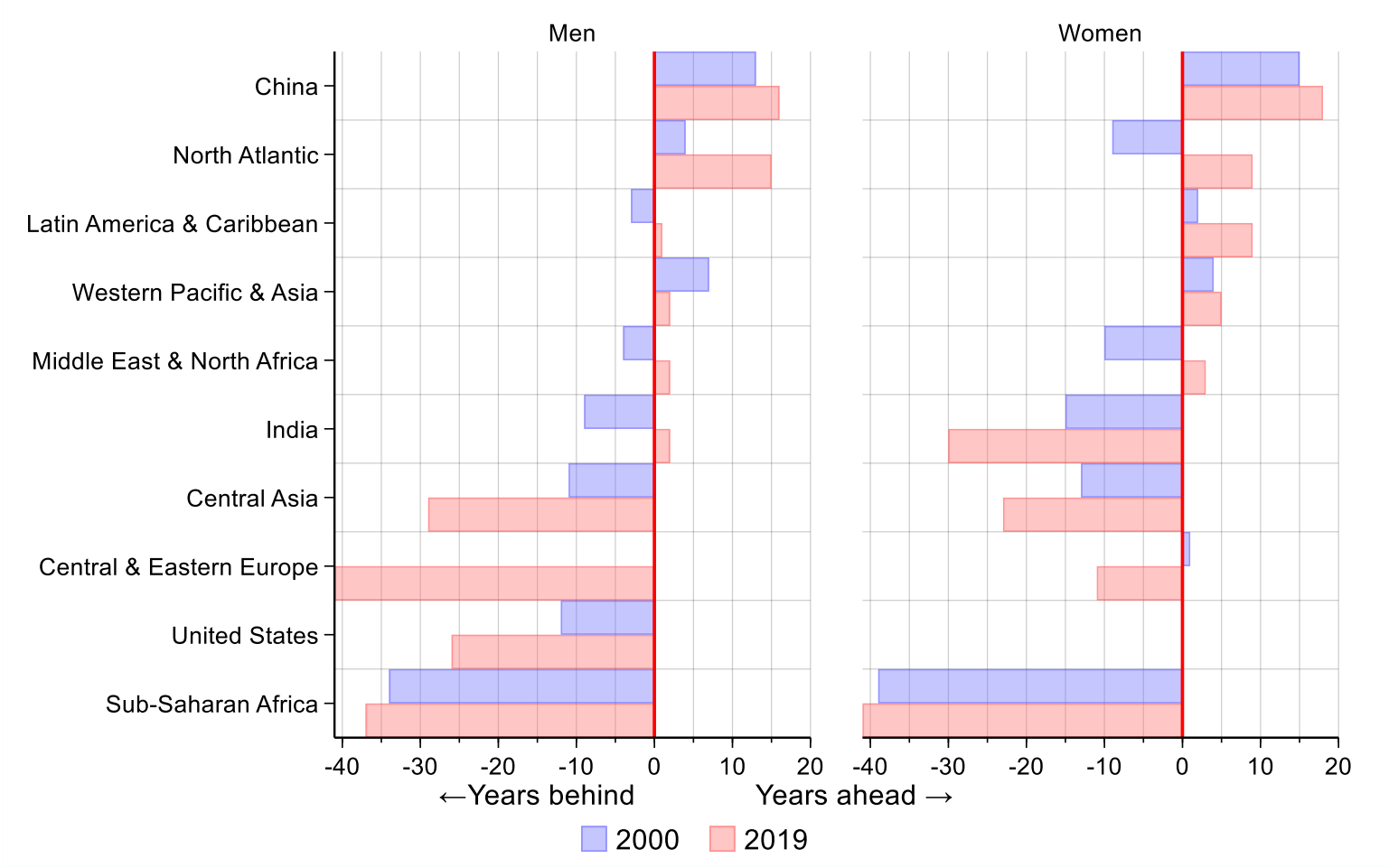
adjusted such that they never increased across years. Regions with probability below the 2019 Preston curve are not shown. Data source: UN WPP and the Maddison Project.

Figure S18. Years behind or ahead of the Preston curve by sex: 30 most populous countries in 2019



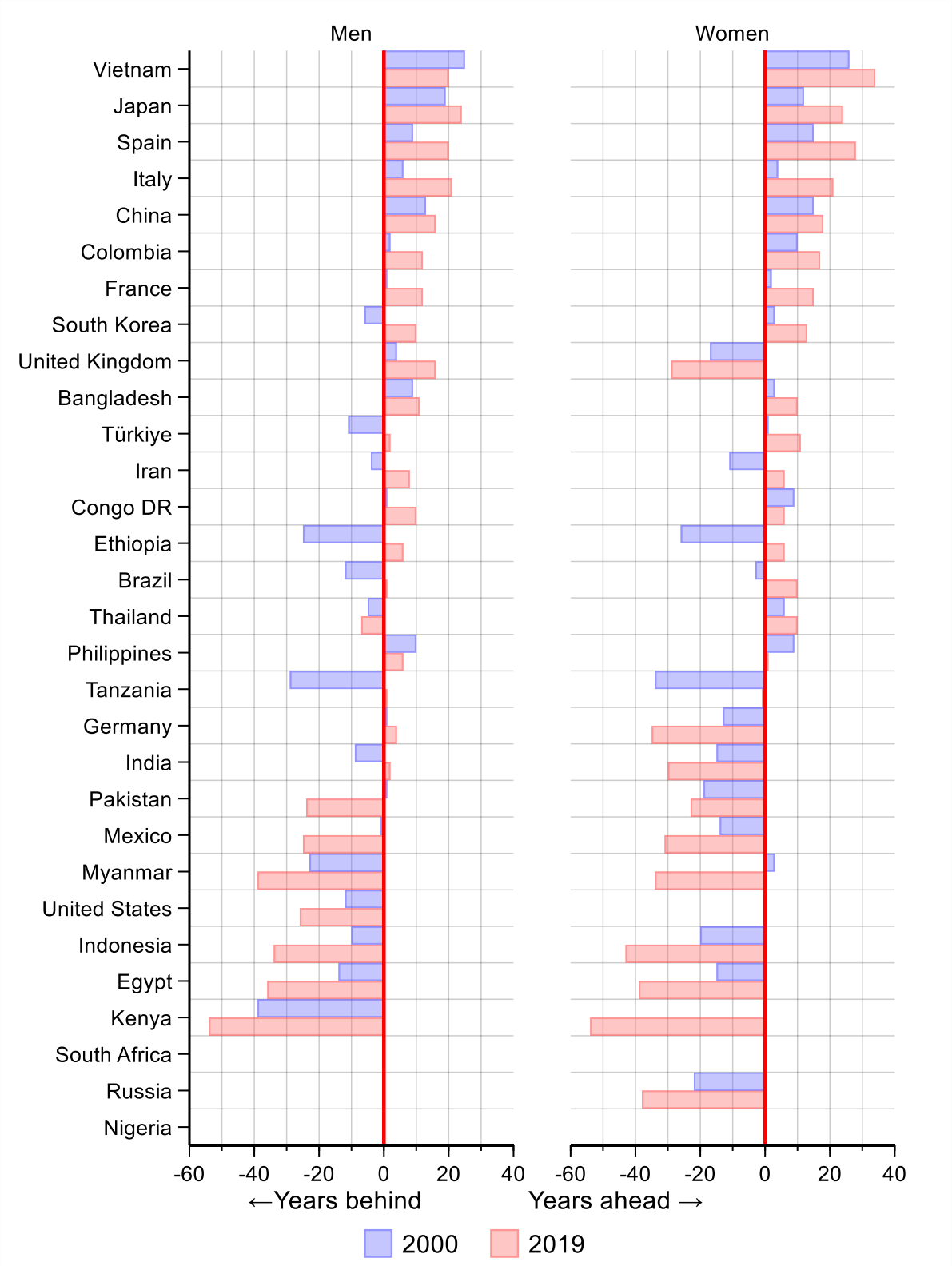
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Missing bars indicate being further behind than 1950 (the earliest available data). Data source: UN WPP and the Maddison Project.

Figure S19. Years behind or ahead relative to PPD predicted by current GDP by sex



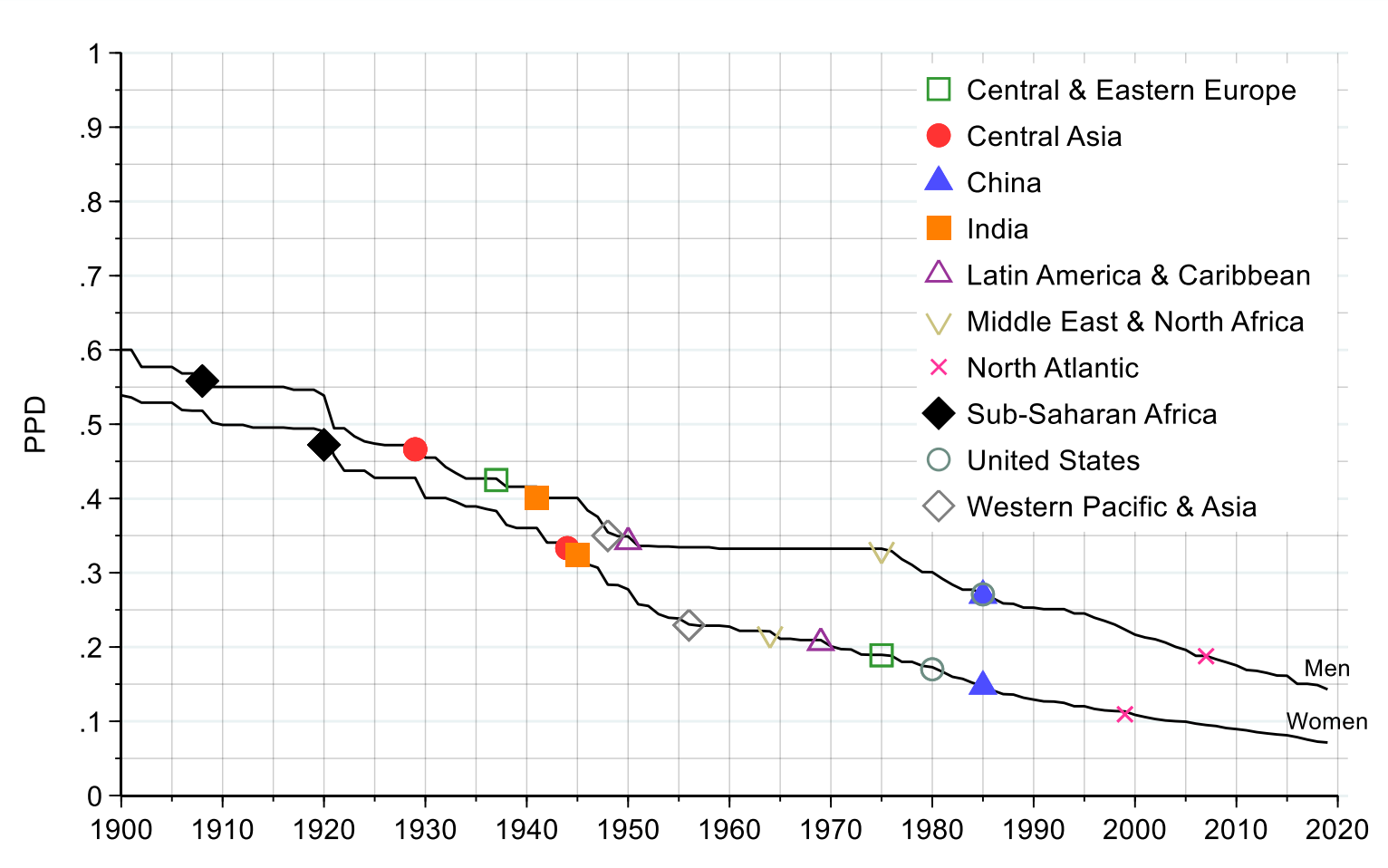
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. See Sensitivity analyses section for details. Data source: UN WPP and the Maddison Project.

Figure S20. Years behind or ahead relative to PPD predicted by current GDP by sex: 30 most populous countries in 2019



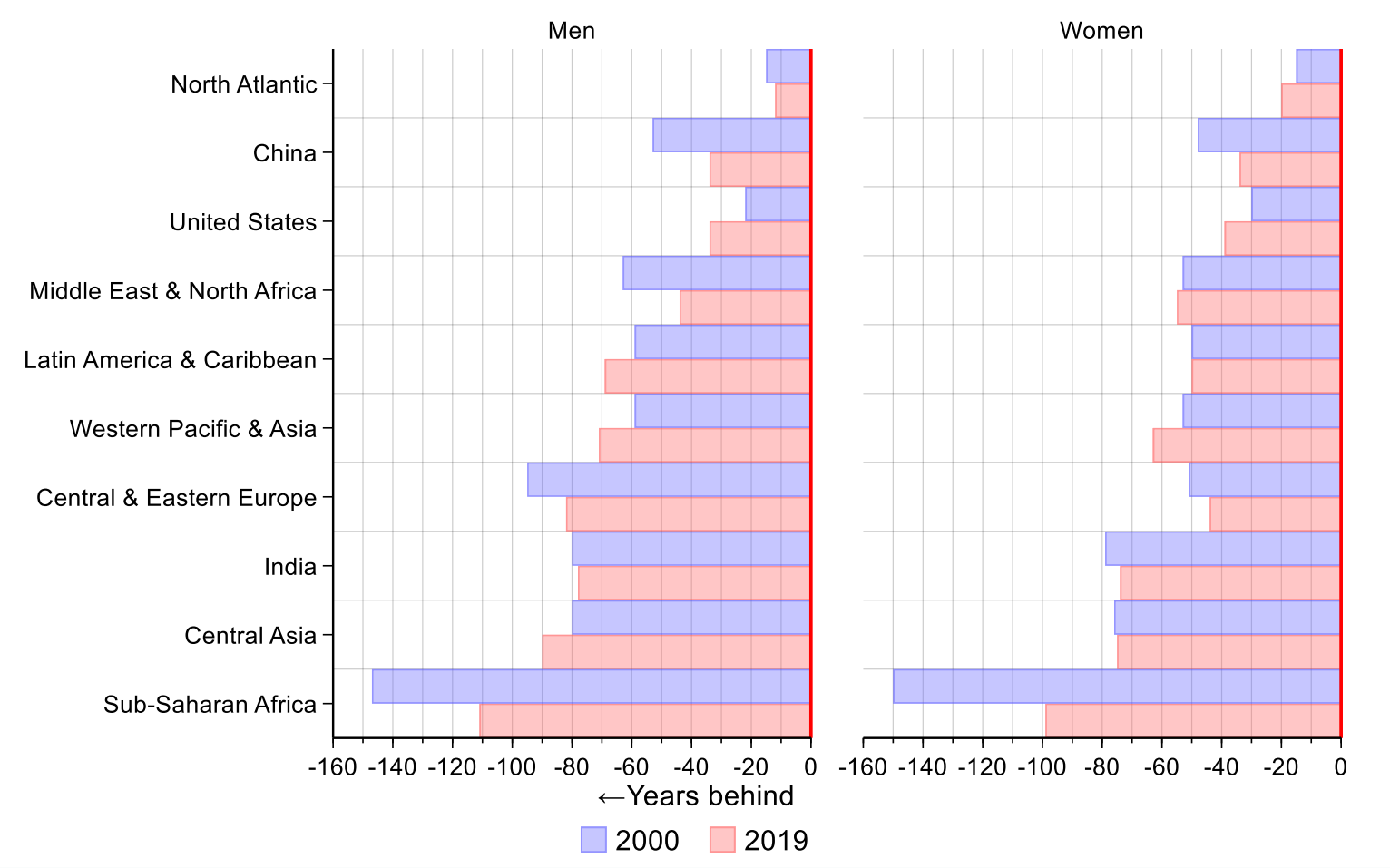
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. Missing bars indicate being further behind than 1950 (the earliest available data). See Sensitivity analyses section for details. Data source: UN WPP and the Maddison Project.

Figure S21. Frontier PPD across time (line) and for regions in 2019 (markers): by sex



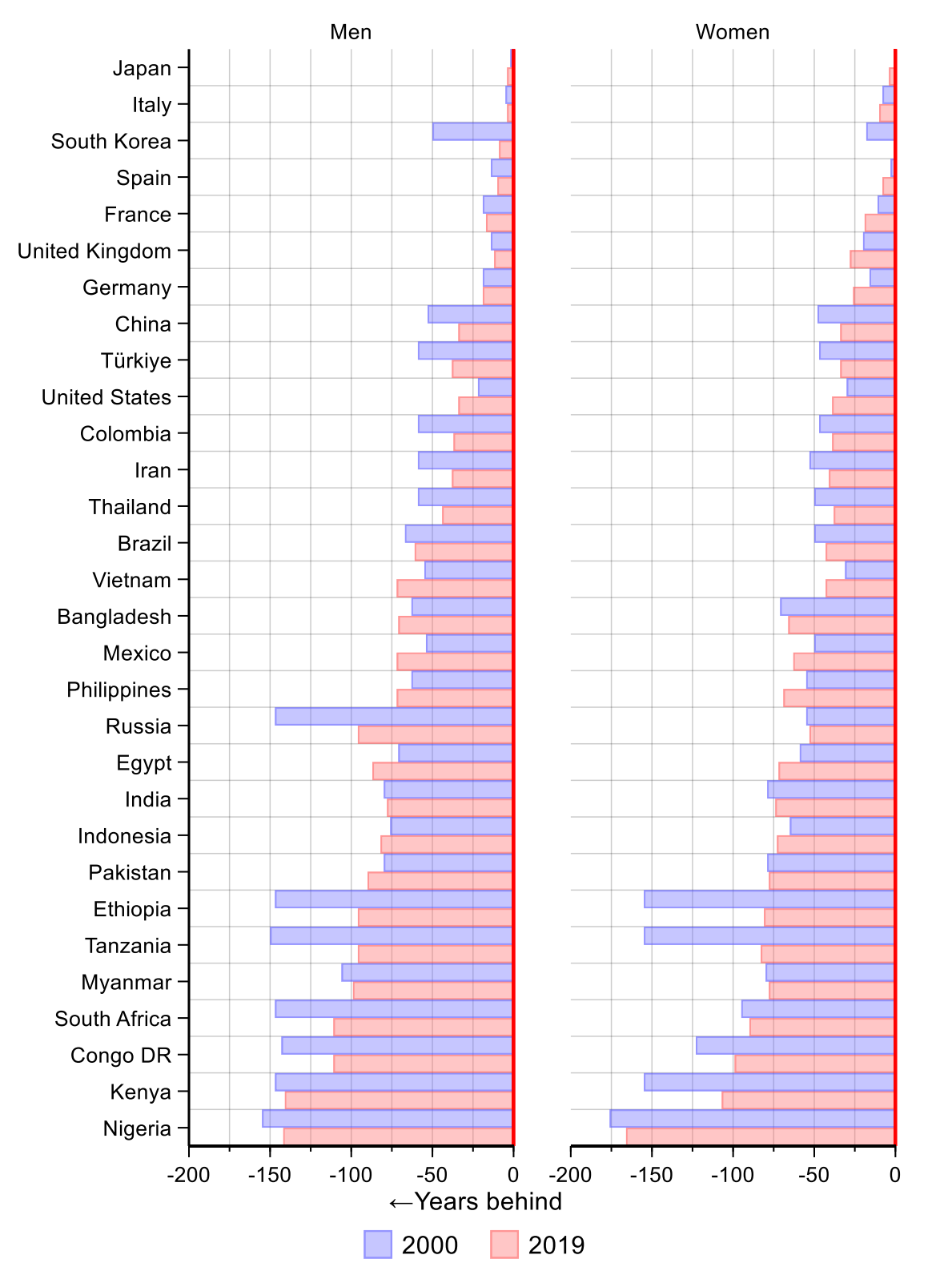
Notes: Probability of premature death (PPD) was defined as dying before age 70 years. The frontier is the lowest PPD ever observed. Countries with a population below 3 million in 2019 were not considered for being a frontier. Data source: UN WPP after 1950 and HMD before 1950.

Figure S22. Years behind the frontier PPD by sex



Notes: Probability of premature death (PPD) was defined as dying before age 70 years. The frontier is the lowest PPD ever observed. Countries with a population below 3 million in 2019 were not considered for being a frontier. Data source: UN WPP after 1950 and HMD before 1950.

Figure S23. Years behind the frontier PPD by sex: 30 most populous countries in 2019



Notes: Probability of premature death (PPD) was defined as dying before age 70 years. The frontier is the lowest PPD ever observed. Countries with a population below 3 million in 2019 were not considered for being a frontier. Data source: UN WPP after 1950 and HMD before 1950.