

The Net Human Capital of Nations

Robert I. Gal¹ (Corvinus University & CIAS, Budapest)

Pieter Vanhuyse (University of Southern Denmark & Danish Institute for Advanced Study)

Csaba G. Toth (ELTE, Budapest)

ABSTRACT:

We live in the age of human capital. Postwar accounts of growth and prosperity consider human capital to be the key driver of the economic welfare of persons and nations. But unlike for physical capital, standard estimates of *human* capital employ a ‘gross’ definition that does not take into account how humans, too, require maintenance costs to be productive. We employ National Transfer Accounts to calculate the *net* human capital of nations. We estimate present values of labour income over the remaining lifetime, *minus* four novel, lifecycle-based, definitions of human maintenance costs. Two definitions can be estimated on a global dataset for 81 countries around 2010; all four definitions for 25 EU countries. Our results for net human capital are lower than standard gross estimates by respectively 51 and 79 per cent globally, and by 56, 102, 41 and 69 per cent in Europe. Our approach relates to a prewar macroeconomic tradition that was abandoned by the Kendrick-Jorgenson-Fraumeni program to revise the System of National Accounts and reconceptualise education as investment, not consumption. We applaud the aims of that program. However, we caution that current estimates of the value of human capital – and, incidentally, of macroeconomic value-added (GDP) – are exaggerated, since human maintenance costs are ignored.

Keywords: value of education, social investment, productivity, human capital paradigm, beyond GDP, National Transfer Accounts

JEL classification: E01, E24, I25, O40, E22, O15

1. Introduction: the *gross* human capital paradigm

Already present in book II of Adam Smith’s 1776 *Wealth of Nations*, the concept of human capital has made a meteoric rise in academic and policy thinking about economic prosperity and growth only after World War II. If the twentieth century could be termed ‘the human capital century’ (Goldin and Katz 2008), this process was accelerated by the seminal contributions by Mincer (1958), Schultz (1961) and Becker (1964). When Becker (2002, p. 3) proclaimed ‘the age of human capital’ around the turn of the twenty-first century, he meant that ‘human capital is by far the most important form of capital in modern economies. [...] while all forms of capital are important, including machinery, factories and financial capital, human capital is the most significant.’

Today many speak of a dominant ‘human capital paradigm’ (Goldin and Katz 2023) with ‘the knowledge capital of nations’ as the motor (Hanushek and Woessmann 2015). Theories of growth have established that human capital – the knowledge, information, skills and health inalienably embodied in humans – is a key, even *the* key, driver of the economic welfare of persons and nations.¹ The aggregate value of human capital is considered to be much larger than that of nonhuman capital (henceforth, ‘physical capital’). ‘Unified growth theory’ even sees human capital as the key to humanity’s historical escape from Malthusian high fertility/low-income traps (Galor 2022). Reviewing the postwar rise of the human capital concept within economics, Goldin and Katz (2023, p. 16, original italics) conclude, rather definitively: ‘*we are all human capitalists now.*’

¹ Corresponding author: robert.gal@uni-corvinus.hu

One reason behind these claims is the cumulative work demonstrating the consistently positive and often high private and social returns to public investments in education across many countries, levels of education and stages of development (Psacharopoulos 1981; 1994; Psacharopoulos and Patrinos 2018). This academic work on human capital and its policy offshoots (e.g. also World Bank xxx 2008a, 2008b) strongly influenced a parallel shift toward the related but distinct ‘social investment’ paradigm, spearheaded in economics by James Heckman (Heckman 2000, Carneiro and Heckman 2003, Cunha and Heckman 2009, Deming 2022), in sociology and welfare state analysis by Gøsta Esping-Andersen (Esping-Andersen *et al.* 2002, Esping-Andersen 2008, Morel *et al.* 2012) and in public policy models by the European Union’s 2000 Lisbon Agenda (Vanhuyse 2015, Busemeyer *et al.* 2018). This paradigm emphasised how, especially early in the lifecycle, pre-distributive interventions in education and skills can boost individuals’ future earning power in labour markets, allowing welfare states to prevent social problems (‘preparing’) rather than dealing with them later (‘repairing’). It carried straightforward policy prescriptions: more public spending on human capital is a cost-efficient (and literal) investment with large future benefits not just for individuals but also for societies.

A second major reason is what might be called the Kendrick-Jorgenson-Fraumeni project to revise the entire System of National Accounts (SNA) so as to include human capital and consider education as investment rather than consumption (Kendrick 1976; Jorgenson and Fraumeni 1989; Jorgenson and Landefeld 2006). The SNA, a United Nations-sanctioned accounting standard used across economies worldwide, considers education expenses as a form of consumption. To capture the growth-enhancing nature of education expenses (to reclassify them as investments) the accounting system had to be made to include an estimate of the value of human capital and had to be able to capture the changes in the value of human capital as a result of such investments in an integrated stock-flow framework.

The cumulative results of the Kendrick-Jorgenson-Fraumeni ‘revising SNA’ project have been remarkable. In highly influential early work Jorgenson and Fraumeni state that ‘the share of human wealth dwarfs the share of nonhuman wealth’ and estimate the aggregate value of human capital in the US to be *between 12 and 17 times* larger than the aggregate value of nonhuman capital (Jorgenson and Fraumeni 1989, p. 268 and table 5.32). Fraumeni *et al.* (2017, p. S393-4) reconfirm this result: ‘Private national human wealth is by far the largest component of full private national wealth, accounting for over 90 per cent of the nominal total.’² Other country studies concur. The human capital stock is estimated to exceed the value of the physical capital stock about four times in Canada (Gu and Wong 2010), more than two-and-a-half times in the United Kingdom (Jones and Chiripanhura 2010), six to ten times in Sweden (Ahlroth *et al.* 1997), 2.2-3.1 times in Australia (Wei 2004) and 2.2-2.7 times in New Zealand (Le *et al.* 2006).

Clearly, such claims about the contribution of human capital to the development and wealth of nations carry momentous implications for the allocation of scarce resources to different uses. However, here we suggest that these claims may be exaggerated.³ They are based on a biased comparison, as they compare a net present value (physical capital) with a gross present value (human capital). The returns to physical capital are based on a *net* concept. When one invests in a machine, estimates for the value of this investment (and consequently its market value) are calculated as the discounted stream of future income from the machine, net of the discounted maintenance costs of keeping the machine running productively throughout its expected productive lifespan. After all, during its active years, the machine will need to be oiled, fuelled, kept up and repaired. Any calculation of its value naturally deducts these maintenance costs from the income stream. By contrast, the leading contemporary accounts of the value of human capital mentioned above are all based on a *gross* concept. These accounts also estimate

a discounted stream of future income, from labour, but they do not deduce any maintenance costs. Yet clearly humans, too, need to be maintained over the duration of their entire lifespan. They need to consume resources for food, heating, shelter and clothing.⁴

This article argues that the value of human capital should be measured in a way consistent with physical capital. We therefore introduce a new lifetime earnings method and new conceptual approaches for calculating the *net* human capital of nations. We mobilise the rich datasets of the National Transfer Accounts (NTA) project, a new chapter in national accounting that goes down from the level of institutions to individuals (R. Lee 1994a; 1994b; R. Lee and Mason 2011). The units of NTA are not households, corporations or the government, but people who are introduced to the accounting system by their current age (and sometimes by other socio-economic characteristics such as gender and education level). NTA databases include, among others, age profiles of labour income and consumption. We use the former to estimate the value of gross human capital in line with the mainstream ‘lifetime income approach,’ which identifies human capital with the present value of labour income over the remaining lifetime.

We then provide estimates of *net* human capital by deducing the maintenance cost of humans according to four different definitions of maintenance cost. Two of our definitions are estimated on a global dataset for 81 countries; all four on a dataset of 25 countries of the European Union (EU).⁵ While we are sympathetic to the Kendrick-Jorgenson-Fraumeni project, we demonstrate that the net method nontrivially lowers estimates of the value of human capital as compared to the gross approach that is prevalent today. We end by noting that introducing the maintenance cost of human capital and classifying it as intermediate consumption in national accounting would also significantly modify how we interpret the concept of macroeconomic value-added (that is, GDP) and would point to yet further ways in which societies need to move ‘beyond GDP’ (see for example Stiglitz et al. 2010; Coyle 2015; 2025; Folbre 2026).

2. Human capital measurement for what purpose? A short conceptual history

The idea of considering the maintenance cost of human capital was largely abandoned during the postwar revising-SNA project, but it has a strong historical pedigree (Kiker 1966). William Farr is widely seen as the first to publish estimates on the value of human capital with scientific rigor (see for example Dublin and Lotka 1930, Kiker 1966, Le *et al.* 2003). His aim was to quantify the outcome of his proposed tax shift from income taxation to property taxation (Farr 1853). The twist in Farr’s proposal was that property included not only physical but also human capital. The value of the former was set by capital markets; that of the latter had to be estimated from scratch. For that purpose, Farr developed a lifetime income approach still in use today. He drew the cross-sectional per-capita age profile of labour income, applied it as a stylised age schedule over the lifetime (a period-to-longitudinal shift), adjusted it with a survival schedule and a discount rate, and summed it up by age to get to the present value of the lifetime labour income of an individual. Weighting with population and repeating the procedure for all age groups results in an estimate of the total human capital in a society. For Farr’s exercise, this gross value of human capital was inadequate. A tax code charging levies on physical and human capital equally would overtax the latter if its value is not reduced with maintenance costs while such cost items are part of the valuation of physical capital. Farr, therefore, attempted to net out the lifetime labour income with maintenance costs, that is, consumption.

Farr was aware of both equivalences with and limitations in the ownership of (and trade in) human capital. At his time of writing, the UK had abolished both slave trade and slavery, but markets for human capital, where supply and demand set prices similarly to capital markets,

still existed in the United States and elsewhere. Farr noted the similarity between the calculation of real-life slave traders who actually bought and sold human capital and his estimations of the value of human capital. ‘The characteristic of this property’, as Farr referred to human capital, ‘is that it is inherent in man, and is the value of his services – of the direct produce of his skill and industry. In slaves it is vendible and transferable; in freemen it is inalienable; but is not the less on that account property’ (Farr *ibid.*, p. 38).⁶

Using the net concept is not self-evident. It was an adequate choice in Farr’s tax proposal, but it can be misleading in other human capital estimates. Weisbrod (1961) introduced the choice between the net and gross concepts by asking, ‘capital value to whom?’ His answer is that ‘the value of a person to others is measured by any excess of his contribution to production over what he consumes from production – this difference being the amount by which everyone else benefits from his productivity. Of course a broader definition of society, which included the person being valued, would imply a measure of value as gross productivity without deducting his consumption’ (*ibid.*, p. 426). This is made clear by Dublin and Lotka (1930, p. 102-103 and Appendix Table 52), who distinguished between compensations for death from accidental injury (to be based on net human capital) and non-fatal personal injury (to be based on gross future earnings). In the latter case the disability insurance policy has to ensure that both the consumption expenditures of the insuree and those of the people who depend on her can be covered in the future. In the former case, however, when the accident kills the insuree, the compensation has to cover only the lost source of income for ‘persons who have a direct interest in his earnings’ (*ibid.*, p. 5), but not for the employee who passed away.

As applied to the Kendrick-Jorgenson-Fraumeni ‘revising SNA’ program, both the Weisbrod question and the Dublin and Lotka distinction would suggest that the deduction of maintenance costs is unnecessary. True, human capital investments would increase not only future income but also future consumption and, with it, maintenance costs. However, none of the investors (whether the beneficiary’s family, her employer, the government or the beneficiary herself) cares if the increment in the value of human capital (the higher earnings capacity) results in higher consumption or is burnt up within the production process.

To sum up, human capital can be given both in gross terms as the present value of labour income over the remaining lifetime or netted out of its maintenance costs (the present value of consumption). Some research questions or policy and institutional designs require the use of the gross concept, and others require the net concept. Since net estimates have been largely missing from the literature in the last decades, we revisit this important but mostly forgotten tradition, especially in light of the fact that frequently repeated calculations, such as comparing the values of physical and human capital, fit the net concept better.

3. Defining the maintenance cost of humans: a novel approach

Graham and Webb (1979, p. 213) reveal both why maintenance costs are so central to the question of human capital estimation and why they have nevertheless been largely ignored in the postwar period: ‘If our valuation of human capital is to be strictly analogous to that of physical capital, then our earnings should really be net of maintenance expenses. Unfortunately this raises some potentially unresolvable problems. How much of human consumption expenditure represents pure maintenance costs?’ Below we propose solutions to this allegedly unresolvable problem.

The standard approach: consumption 'of what'?

Defining maintenance costs must proceed in two steps. The first is distinguishing between human capital investments and consumption. For this problem representatives of the 'cost approach,' notably Kendrick (1976), measure the value of human capital by the amounts invested in it. The list of cost items considered includes expenses on education, on-the-job training (including informal education and training outside the formal education system, such as family teaching and self-education) and healthcare expenditures. With some simplification, consumption is what gives immediate satisfaction, and investment is what provides returns in the long run. Importantly, Kendrick (1976), but also Jorgenson and Fraumeni (1989) and other lifetime income approach applications consider all costs of raising and supporting children – their entire consumption package – as investments with future returns. This reflects the viewpoint not of the consumer (the child) but of the spender, parents and taxpayers, for whom transfers to children are also investments. The child is supposed to reciprocate in the form of financial support, care and taxes once she grows up (R. Lee and Mason 2011; Vanhuyse et al. 2023).

The second step is sorting what remains after investment into, on the one hand, 'maintenance consumption' (for productive 'survival,' 'necessary consumption') and, on the other, discretionary consumption' (for pure 'joy,' 'hedonism,' 'luxury.')

This is a perennial problem of moral philosophy. Which items and what quantities of goods and services are necessary to maintain the long-term ability to work? Food is essential to survive, but how much and what kind? People need shelter, but how many square meters are required per person? Is spending on culture part of survival consumption? And buying wine? Do we live to work or work to live? In other words, to what extent do we consume to be able to work (for 'production'), and to what extent do we work to be able to consume (for 'joy')? Puritan theologians of the 16th and 17th centuries tried to make the split based on the purpose of consumption and rejected it if it served exclusively sensual pleasure, vanity or pride. In this view, consumption is justified by enabling work. However, how to separate necessary from 'luxury' consumption is not just a moral question but also a recurrent methodological conundrum, to which we propose four solutions below.

A novel approach: consumption 'at what life stage'?

Kendrick's list above merits further consideration. First, there is a significant overlap between various components. The vast majority of expenses on education, as well as a substantial part of health spending, are included in the consumption package of children, which is an extensive part of the human capital investment package on its own. Second, the characteristic age pattern of health expenditures casts doubts about their classification as investments. Post-retirement, people consume a disproportionate part but do not participate in the market production process. In fact, the age above which health expenses give returns in labour income (rather than in well-being) is lower than the age of leaving the labour market. So, most healthcare is either counted twice among investments and consumption (such as healthcare for children) or is discretionary consumption that improves the quality of life and increases longevity but does not pay back in terms of labour income (such as healthcare for the older working-aged and older people).

Table 1: Four lifecycle-based definitions of human maintenance costs

	Definitions			
	1	2	3	4
Consumption in childhood	Savings/investment in human capital			
Consumption in working age	necessary consumption	necessary consumption	necessary consumption up to poverty line, luxury consumption above	necessary consumption up to poverty line, luxury consumption above
Consumption in old age	luxury consumption		luxury consumption	

Notes: **Definition 1:** Workers as pure cost items, all old-age consumption as a societal luxury. **Definition 2:** All adults as pure cost items. **Definition 3:** Workers enjoy luxury consumption above a maintenance minimum; all old-age consumption is a societal luxury. **Definition 4:** All adults enjoy luxury consumption above a maintenance minimum.

These considerations shift the distinction between investment and consumption away from the question of consumption ‘of what,’ to the question of consumption ‘at what life stage’? Is the consumer a child, a person of working age (henceforth a ‘worker’) or an older person? This shift from ‘what’ to ‘when’ (what life stage) leads us to offer four definitions of net human capital based on the subtraction of four alternative concepts of maintenance costs over the lifecycle (see Table 1).

Definition 1: Workers as pure cost items, all old-age consumption as a societal luxury. Maintenance costs here are the resources used to keep human capital productive. Definition 1 extends the current practice of national accounting, which classifies consumption items provided by the employer in kind and consumed during working hours (for instance protective clothing) as intermediate consumption, to commodities consumed outside working hours and paid for by the workers themselves, but needed to keep them fit to work. Intermediate consumption is a part of economic output that is absorbed by the production process. The rationale behind definition 1 is that even if workers have the opportunity to choose among commodities, they cannot choose not to eat or take shelter.

This productivity-focused definition applies maintenance only to those who participate in the production process – workers. It is only workers whose human capital is mobilised; it is the age pattern of their labour income that serves to calculate gross human capital in the first place. Workers alone are seen here as mere production machines whose consumption will be absorbed by the products and services provided by the economy. By contrast, the consumption of older persons, whose labour income is insufficient to finance this consumption, is seen here as a form of discretionary ‘luxury,’ in the specific sense that society has in one way or the other arranged for people to survive beyond net-productive age. In contemporary societies, this is institutionalised over the lifecycle by having workers contribute or save, and then arranging for such contributions/savings to be used up as consumption in old age, through a combination of private pensions (market-based ‘piggy banks’) and public pensions (government-based ‘piggy banks’) (Barr 2001, Vanhuyse *et al.* 2021). While such old-age consumption arrangements are taken for granted today, traditional societies, such as hunter-gatherers, frequently could not afford old age. Adults who could not support themselves could not survive (R. Lee 2000). Geronticide, forced suicide or abandonment of the old are part of the history of many cultures (Pousset 2023).

Definition 2. All adults as pure cost items. Workers who are net contributors to the inter-age resource reallocation system will become net resource recipients after retirement. Human capital investment pays back in terms of higher labour productivity and wages, which in turn generate higher taxes and contributions. But crucially, this also implies higher pension eligibilities. The total balance of human capital investment programs must, therefore, take into account increased consumption in old age as a cost for the investor. The actuarial planning of a pay-as-you-go pension scheme does so. Several pension schemes even institutionalise this consideration by establishing social security supervisory boards with the mandate of actuarial supervision or by introducing automatic balance mechanisms (de Tavernier and Boulhol 2021). Historical examples similarly point to the investor's responsibility for old-age consumption. If other people's human capital can be freely traded, as in slave markets in the past (Conrad and Meyer 1958; Fogel 1989), the old-age consumption of the traded humans is a pure cost item for the buyer. Prospective owners must take into account the productive output, the costs of living while the enslaved person works and the cost of living while she is no longer productive but still consumes. In other words, the trading value of even a productive worker must include the cost of the worker's future consumption after she is no longer productive. As long as human capital owners do not kill or starve the adults they own when they are too old to work, but keep maintaining them, as was the case historically with enslaved people (Fogel 1989), all consumption by all adults is a maintenance cost. In definition 2 workers are still considered as pure cost items, but old-age consumption too is now seen as the investor's responsibility.

Definition 1 splits consumption into necessary and 'luxury' parts between life stages. Within life stages, consumption is homogeneous, either necessary or discretionary. We want to refine the life-stage-based approach so that we can distinguish between necessary and 'luxury' consumption also within life stages. In a further refinement, our consumption '*at what life stage*' approach can now be combined with standard consumption '*of what*' elements. This allows us to better refine the meaning of maintenance by splitting consumption into necessary and discretionary parts, also within lifecycle stages. Necessary consumption can be viewed in light of the need to consume a bare minimum basket of goods and services to remain productive, and whatever is left beyond this minimum can be purely 'enjoyed.'

To estimate this maintenance minimum, we use country-specific poverty thresholds to specify the value of necessary consumption. Up to the poverty line, consumption will then be considered necessary; above it, it will be deemed discretionary. This combined approach gives us definitions 3 and 4 of maintenance costs:

Definition 3: Workers enjoy luxury consumption above a maintenance minimum; all old-age consumption is a societal luxury. Maintenance here is viewed in light of the need for only working-age people to consume a bare minimum to keep going while enjoying the rest, whereas all consumption in old age is discretionary in the sense of being allowed by society to be pure consumption.

Definition 4: All adults enjoy luxury consumption above a maintenance minimum. Here, the consumption of all adults is taken as part of necessary consumption, but only up to a minimal level, above which all of them can enjoy purely 'discretionary' consumption.

4. Data and methods: National Transfer Accounts

To operationalise our four definitions of maintenance costs we will exploit the opportunities offered by the NTA project. NTA allows a data-driven separation of age groups based on resource independence. By this inductive definition, an age group is of working age if its labour income exceeds its consumption. Children are those who are younger and older people are those who are older than them. In our 81-country global sample of countries, people are children up to age 23 and become old at 59. The age separating the three major age groups varies across countries. We can take into account this cross-country variation in our calculations.

We follow the lifetime income approach to estimate the value of human capital first in gross terms and then in four variants of net values. First, we give a brief description of the data used and the methods employed to make it easier to position our choices on the map of comparative research (Fraumeni and Liu 2014; Lange et al. 2018; Abraham and Mallatt 2022) and compare the results with similar studies.

Before proper estimates on lifetime production and consumption schedules were available, they had to be approximated through theoretical calculations based on crude birth rates, population growth rates, saving rates and the capital share in total output (R. Lee 1980). The NTA project has collected such estimates. This article relies on two freely available international datasets, the Global NTA database and the AGENTA European database.⁷ The former consists of various age distributions prepared and uploaded by national expert teams who follow a standardised methodology (United Nations 2013). The AGENTA project was limited to European countries and exploited the unique opportunity of comparative analysis offered by the European data infrastructure (Istenič et al. 2017). If a country provided data to the global database and was also included in the AGENTA project, we used the former. If data from more than one year were available, we used the latest.

National NTA labour income age profiles are based on administrative or survey information and are adjusted to the total, age-specific population and the aggregates of the SNA. In this way the age profiles characterise the entire society and economy. Adjustment to the total population implies that those with no labour income enter the age-specific average with zero labour income. So, the NTA labour income age profile differs from the regular age-earnings profile, which includes only those with earnings. The NTA profile covers two effects at once: per-capita earnings of those working and labour market activity. This feature solves one of the recurrent problems of income-based estimations of human capital: depreciation. Human capital, like physical capital, loses some of its value by becoming less up-to-date. Since the NTA labour income curve is consistent with the entire population, its shape reflects the age-related decline of labour efficiency and the gradual exclusion from the labour market.

The NTA income concept is gross-gross: it includes all labour-related taxes and contributions paid by the worker as well as those paid by the employer (for further details see United Nations 2013). To keep it simple we include only market labour income. The per-capita national labour income curves are smoothed and re-scaled to make them comparable. Instead of directly comparing countries, as in the comparison of prices of commodity baskets, NTA re-scales age distributions of the relevant variable (here, labour income and consumption) as expressed in the local currency by dividing them by their respective national average labour income of the 30-49-year-old age group, also given in the same local currency.⁸

Altogether we could collect labour income age profiles from 81 countries, 65 from the global database (including the United States, Canada, Japan and Australia but also middle-income countries, such as Mexico, Brazil, South Africa, Türkiye and Vietnam and low-income nations, such as Benin, Chad, Mozambique and Niger) and 16 from the AGENTA project (covering the EU). Between them, these 81 countries represent three-quarters of the global

population in 2010. The reference years of the national data vary, but their average is 2010. The AGENTA data also reflects 2010.

5. Estimating *gross human capital globally*

We present the global labour income age profile in the left panel of Figure 1. The chart follows a characteristic hump shape. On average, labour income starts taking off globally at age 15. It reaches one-fifth of the labour income of the age group 30-49 at age 18, one-third at age 20, half at age 22, two-thirds at age 24 and three-quarters at age 25. The rapid increase is more the consequence of school leaving and entry into the labour market, but productivity growth due to learning-by-doing is also at play. The first year group reaching the average of the prime-age earners is the 32-year-olds. The curve peaks at age 35. Its subsequent descent is more gradual than its increase. At age 60 an average person collects only about half of the labour income of prime-age earners. By age 70 this has gone down to about 15 per cent (for cross-country comparisons of NTA labour income curves see Lee and Ogawa 2011).

The left panel of Figure 1 is constructed as the population-weighted average of 81 national labour income age profiles. In the next step we use these 81 age profiles to estimate the value of age-specific gross human capital separately for each country. We take the cross-sectional profiles as synthetic cohort profiles and assume that the age group aged k in calendar year t will have the same labour income in year $t+1$ that the age group aged $k+1$ had in year t . The profiles are adjusted with economic growth, g , 1.5 per cent per annum in the base case and age-specific survival rates (separately for each country, matching the reference year of the labour income profile), which we take from the Population Division of the United Nations Department of Economic and Social Affairs. The adjusted values are discounted by r , 5 per cent in the base case. The resulting values are summed up for each age group over their remaining lifetime. The age-specific sums that make up the human capital curve read as years of labour income of the 30-49-year-old age groups. Once the 81 age-specific national human capital profiles are completed (see Appendix 1), they are summed up as a global population-weighted average. We present it in the right panel of Figure 1.

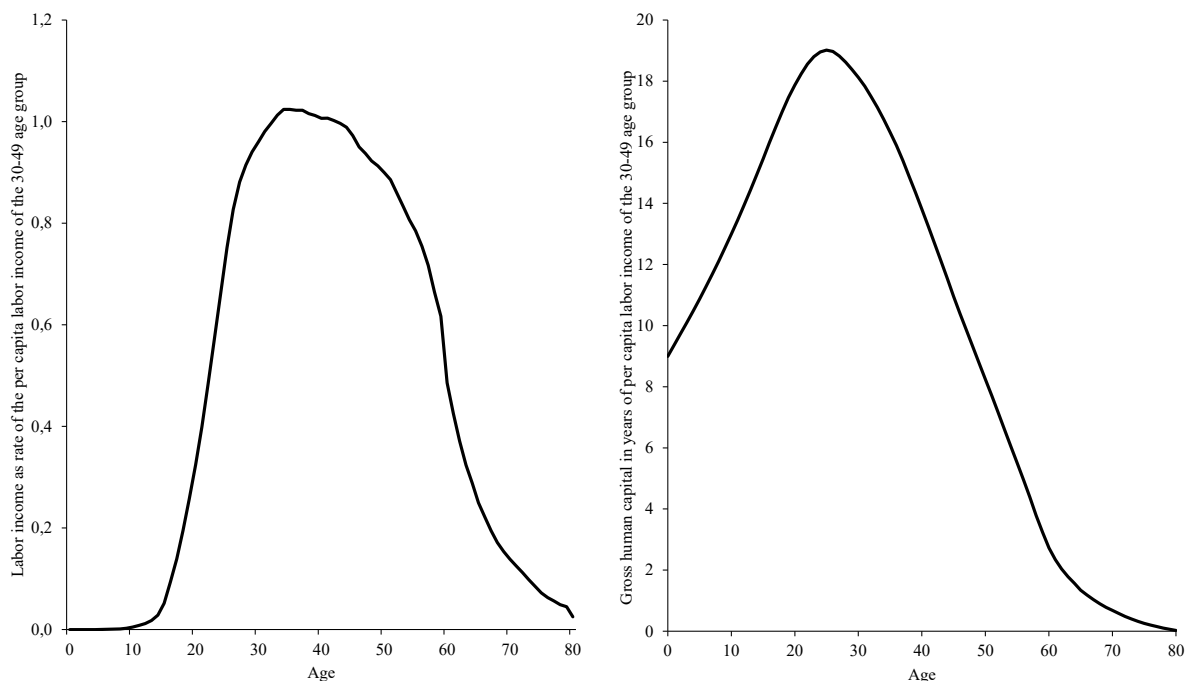


Figure 1: Global per-capita labour income (left panel) and per-capita gross human capital (right panel), 81 countries, by age, around 2010

Note: For methodological notes, see the main text.

Sources: Authors' calculations based on data from www.ntaccounts.org, Istenič et al. (2016).

Globally, the gross human capital of a newborn is about 9 years' worth of labour income of prime-age earners. The results, naturally, depend largely on the parameters of the exercise. If the base case discount rate is reduced from 5 per cent to 3 per cent, the gross human capital at birth doubles from 9.0 to 18.7, all else equal. If only the growth rate is changed from 1.5 per cent to 2.5 per cent, the gross human capital of newborns would increase to 13.0 years of prime-age labour income. But crucially, the key indicator of this paper, the rate of net human capital to gross human capital is not sensitive to the parameter settings, since both the numerator and the denominator are exposed to the same changes. We present calculations using alternative parameters in Appendix 3. Newborns are not the age group with the highest gross human capital because people start working only 15-25 years after birth so the newborn's future labour income is more heavily discounted. Gross human capital peaks at age 25 with 19.0 years' worth of prime-age labour income using the base-case parameters, more than twice that of an average newborn. Note that the peak age of gross human capital is about ten years younger than the peak age of labour income. The longer remaining lifetime compensates for the discounting effect. The gross human capital of an average person, across all age groups, is equivalent to 11.9 years of prime-age labour income globally. We measure human capital in years of prime-age labour income. While this facilitates cross-country comparisons, it complicates the comparison of our results with previous research. As a robustness check, we conduct a quick comparison between our results and previous estimates for the USA (Christian 2014).⁹

6. Estimating investments, maintenance costs and discretionary consumption globally

The left panel of Figure 2 shows the global age patterns of consumption in the reference year. It is prepared in a way similar to Figure 1: each of the 81 national consumption curves is normalised by its respective average of labour income in the age group of 30-49 and summed up into a global average using population weights. The curve contains all forms of consumption (final consumption expenditures in national accounting terminology) of households and the public sector (the general government, which includes federal, state and local governments as well as the various social insurance funds). It is net of consumption-related taxes.

The curve climbs rapidly between newborns and children around age 15 but essentially flattens above that age. The increasing section of the curve is affected by the age-based NTA equivalence scale.¹⁰ NTA methodology assigns 0.4 for those aged four or younger and 1 for adults aged 20 and older. Between age four and 20 the scale increases linearly (Lee *et al.*, 2008).

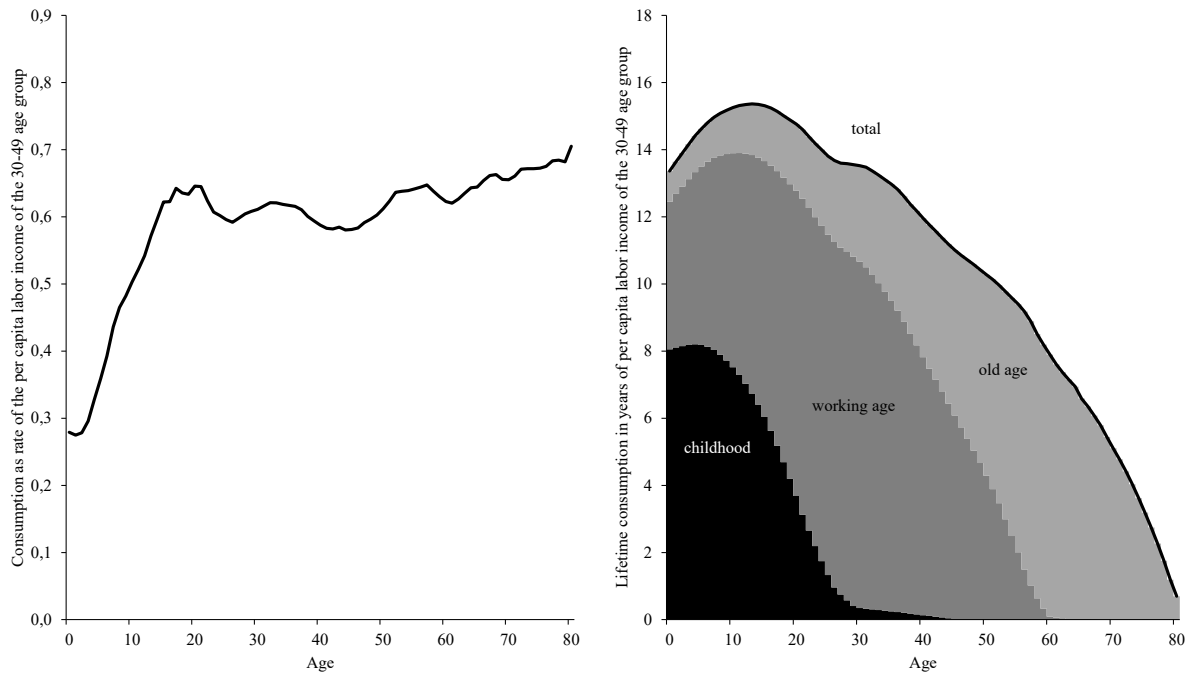


Figure 2: Global per-capita period consumption (left panel) and per-capita lifetime consumption (right panel), 81 countries, by age, around 2010

Note: For methodological notes, see the main text.

Sources: Authors' calculations based on data from www.ntaccounts.org, Istenič et al. (2016).

The solid line enveloping the chart in the right panel of Figure 2 shows the present value of consumption over the remaining lifetime by age. It is derived from the consumption age profiles in the same way as gross human capital was derived from labour income: we took the cross-sectional profiles as synthetic cohort profiles and applied the same survival trajectories and parameters as above. Also, the chart reads as the right panel of Figure 1: the values represent years' worth of labour income of prime-age earners. Globally, lifetime consumption of an average newborn is equivalent to 13.4 years of prime-age earnings (for national profiles see Appendix 2). The global peak age is 13, when the present value of remaining lifetime consumption is 15 per cent higher than at birth. The mechanics behind the ascending path among children are the same as before: the somewhat longer consumption path is suppressed by the stronger discounting effect. Above age 13, the relatively flat consumption curve results in an ever-declining lifetime consumption.

The right panel of Figure 2 is decomposed by life stage. For instance, a newborn consumes an amount worth 8.1 years of prime-age earnings during her childhood, 60 per cent of her discounted lifetime consumption. Her consumption in later life stages is more strongly discounted: 4.4 years (33 per cent) in working age and only 0.9 years (7 per cent) in old age under the baseline parameters. As before, both the amounts and the percentages depend on the parameters.

As summarised in Table 2, the average per-capita lifetime consumption in childhood is equivalent to 2.7 years of prime-age labour income. We consider this value our estimate of the average per-capita lifetime human capital investment. Accordingly, human capital investment is about 22 per cent of total consumption over a lifecycle (2.7 years of prime-age labour income out of 12.1 years). Cross-country variations depend largely on the length of childhood, which in turn depends primarily on enrollment rates in education.¹¹

7. Estimating *net* human capital globally: definitions 1 and 2

Recall that definition 1 views the consumption of only workers (and all of it) as maintenance cost, whereas definition 2 considers all consumption of all adults as maintenance cost. Figure 3 shows the age distributions of the two versions of net human capital. For easier comparison, we added the gross human capital curve of Figure 1. Figure 3 shows that lifetime net human capital can be negative, at least for some age groups, by definition 2. While the gross human capital approach would imply that everybody has positive human capital, our definition 2 of net human capital demonstrates that beyond age 44, there are no age groups with positive values. The net concept includes consumption in old age, when people no longer work, so they will incur costs during their remaining lifetime that exceed their earnings. By this logic, as people age, they cannot return the investment because they leave or have already left the labour market (for country-specific results, see Appendix 4).

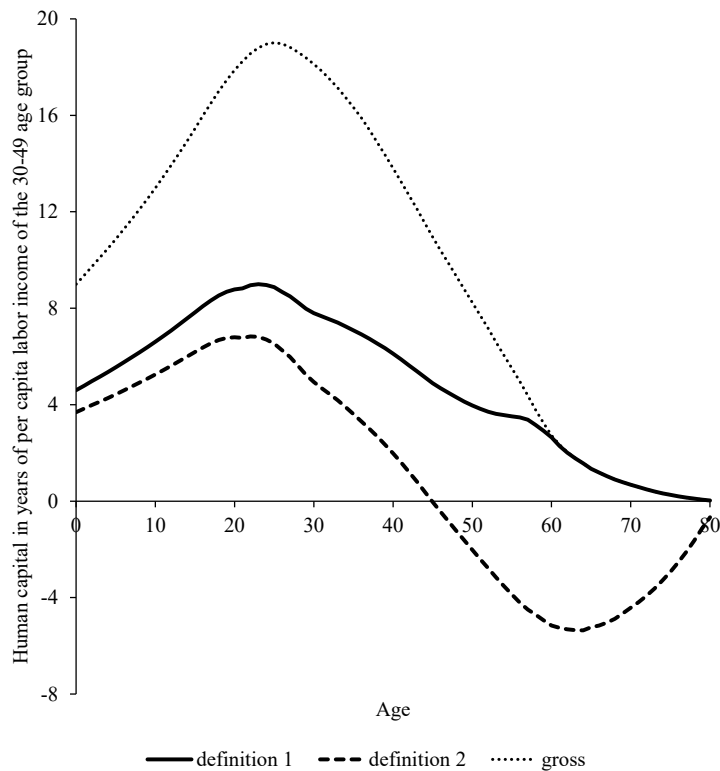


Figure 3: Global net human capital per capita, 81 countries, by age around 2010: definitions 1 and 2

Notes: Definitions 1 and 2: see Table 1. Gross: gross human capital (see Figure 1)

Sources: Authors' calculations based on data from www.ntaccounts.org, Istenič et al. (2016).

The Definition 2 curve takes its lowest value among fresh retirees at age 64 when the remaining lifetime promises little labour income but a relatively long consumption path. It is noteworthy that by this definition net human capital turns negative some two decades before people actually retire. The peak value of the curve, at age 22, is just above *one-third* of the peak value of gross human capital (6.8 years of prime-age earnings against 19.0 years). As Table 2 shows, globally, the average net human capital (definition 2) equals 2.5 years of prime-age labour income, 21

per cent of gross human capital. In other words, net human capital, by this definition, is lower than standard gross human capital *by 79 per cent*.

As the curve drawn by definition 1 embodies somewhat more conservative assumptions, it runs closer to the gross curve. It takes up no negative value at any point, and its peak value is higher than that of the first curve. By this alternative estimation, as Table 2 shows, the average person's net human capital is 5.8 years of prime-age earnings, which is still about half of the average person's gross human capital. Globally, net human capital by definition 1 is lower than gross human capital *by 51 per cent*.

Table 2: Summary table

	Global			gross human capital	European			
	Net human capital		Definition 2		Net human capital			
	Definition 1	Definition 2			Definition 1	Definition 2	Definition 3	Definition 4
in years of prime-age labour income of population-weighted synthetic persons								
Human capital of average person	11.9	5.8	2.5	10.5	4.6	-0.2	6.2	3.2
Lifetime human capital investment	2.7			1.7				
Lifetime maintenance cost		6.1	9.4		5.9	10.7	4.3	7.3
Lifetime discretionary consumption		3.3	0.0		4.8	0.0	6.4	3.4
Human capital at peak age	19.0	9.0	6.8	19.2	7.7	5.0	10.6	8.9
Human capital of newborn	9.0	4.6	3.7	9.1	4.0	2.7	5.4	4.6
	as % of gross human capital							
Net human capital		49	21		44	-2	59	31
	as % of lifetime consumption							
Lifetime human capital investment	22			14				
Lifetime maintenance cost		50	78		48	86	35	59
Lifetime discretionary consumption		27	0		38	0	51	27
	in years							
Peak age	25	23	22	27	21	20	23	22

Notes: Definitions 1-4: see Table 1. Population-weighted synthetic persons: National age distributions of labour income and consumption are re-scaled by the respective national average labour income of the 30-49-year-old age group and used to estimate gross and net human capital. The re-scaling procedure creates synthetic individuals who represent the various age groups of their nation; these synthetic national representatives are then merged using population weights into global or European average individuals.

8. Estimating *net* human capital in Europe: Definitions 1 to 4

We apply poverty lines to distinguish between necessary and ‘luxury’ consumption, not just between but also within life stages. Global data do not allow this, but a subsample of 25 EU countries gives an opportunity to better narrow down the meaning of maintenance by splitting consumption into necessary and discretionary. Eurostat, the EU’s statistical agency, publishes country-specific poverty thresholds for all member states and several other countries over various years (variable name: *ilc_li01*). We use the standard poverty threshold, 60 per cent of the median equalised income.¹²

The left panel of Figure 4 replicates the calculations for Figure 3, but now on just the European subsample. The most important differences between the global and the European results are that a significantly lower share of lifetime consumption is spent on investment and a higher share on maintenance in Europe than globally. Under definition 2 the average European person’s net human capital falls slightly below zero (globally, the corresponding value was 2.5 years of prime-age earnings; see Table 2). Net human capital in Europe, by this definition, is negative on average, and it is lower than gross human capital *by 102 per cent*.

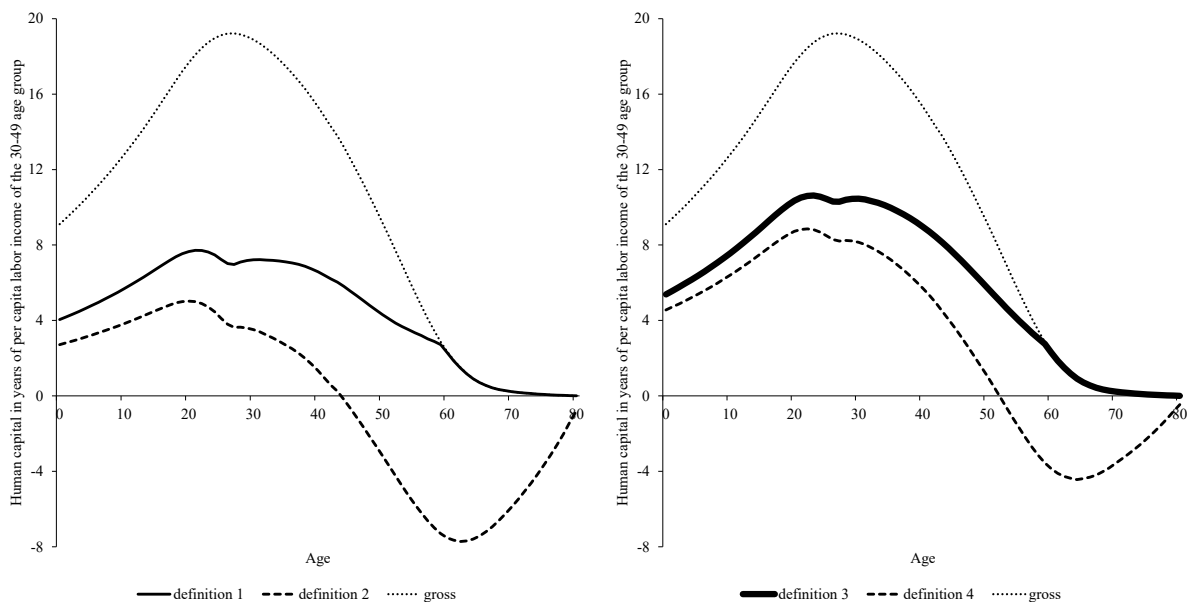


Figure 4: European net human capital per capita by age, 25 EU countries, around 2010: definitions 1 and 2 (left panel) and 3 and 4 (right panel)

Notes: Definitions 1, 2, 3, 4: see Table 1. Gross: gross human capital.

Sources: Authors’ calculations based on data from www.ntaccounts.org, Istenič et al. (2016).

Even under the milder assumptions of Definition 1 net human capital values are now so much reduced that the average European person’s net human capital still falls by more than half, to 4.6 years of prime-age earnings (globally, the corresponding value was 5.8 years; see Table 2). By this alternative definition net human capital in Europe remains positive throughout, but it is lower than gross human capital *by 56 per cent*.

The right panel of Figure 4 presents the two poverty-adjusted net human capital age distributions. The dashed line shows our definition 4 whereby the consumption of all adults is a cost item up to a bare minimum level (60 per cent of median income), but they can enjoy the

rest. This curve runs significantly below the gross curve. As Table 2 shows net human capital by this fourth definition amounts to 3.2 years of prime-age earnings in Europe. This is below one-third of the gross human capital (10.5 years). Net human capital in Europe, by this fourth definition, is lower than gross human capital *by 69 per cent*.

The solid line (definition 3) represents our preferred third concept of net human capital. Here only workers' consumption is taken into account as maintenance cost, and even that only in part, up to 60 per cent of the median income. This further reduction brings net human capital closer to gross values, 6.2 years of prime-age labour income. As Table 2 shows, this is equivalent to 59 per cent of gross human capital. Net human capital in Europe, by this third, most conservative definition, is still lower than gross human capital *by 41 per cent*.

9. Conclusions and wider implications for the wealth of nations

Taking into account the maintenance cost of humans – a net approach more consistent with calculations of physical capital – leads to significantly lower estimates of the human capital of nations compared to the gross approach that is currently standard practice. We have conceptualised four ways to define human maintenance costs and estimated that net human capital is lower globally by respectively 51 and 79 per cent (definitions 1 and 2) and lower in Europe by respectively 56, 102, 41 and 69 per cent (definitions 1 to 4). Our approach relates to an earlier macroeconomic tradition that was largely abandoned by the Kendrick-Jorgenson-Fraumeni program, which aimed to revise the System of National Accounts and consider education as investment.¹³ We reconfirm the importance of this aim, but caution that policy statements about the value of human capital, especially relative to that of physical capital, are significantly exaggerated since the maintenance cost of humans is ignored.

While this is not the focus of this article, the return to the net approach also has larger implications for how we measure the creation of macroeconomic value-added in the SNA – GDP (Stiglitz et al. 2010; Coyle 2015; XXX Coyle 2025). The Kendrick-Jorgenson-Fraumeni program mainly focused on setting apart a fraction of final consumption and reclassified it as saving and investment in human capital. With some simplification we have identified this fraction with consumption *in childhood*. Then we argued that re-introducing the maintenance cost of human capital would cut off yet another segment of final consumption in the SNA and reclassify it as *intermediate* consumption. Intermediate consumption (SNA code: P.2) is a part of the total output of the economy that is used to produce further output during the accounting period. A screw can be the output in January, but if it is built into a car in March its value is counted twice. Social statisticians and macroeconomic accountants, therefore, use the P.2 category to avoid distortion by double or triple counting the value of some parts of the total output. The best-known aggregate of the SNA, the domestic product (SNA code: B.1), of which the gross version, the GDP or gross domestic product (B.1g), is a standard reference in social debates about the state of the economy, is the *value-added* part of the total output, net of such double counting.¹⁴ In other words, B.1 is the part of production counted only once.

However, at present, intermediate consumption includes only a tiny fraction of human consumption, namely the work-related commodities consumed by workers during working hours and provided by employers in kind (such as the hard hats of construction workers). In our view, this is inconsistent with the full extent of maintenance costs and indeed with the concept of human capital. Intermediate consumption, as measured today, already represents the bigger half of the total output in most countries, most of the time. Maintenance costs, which also include commodities financed by the consumer herself and consumed beyond working hours, would shift the balance even further to intermediate consumption. If human maintenance costs are necessary and unavoidable for producing some output, then the services and commodities

consumed by workers are double-counted in the GDP. A loaf of bread is then equivalent to the screw above. The value added to the economy is overestimated as long as those parts of human consumption without which production would be impossible are not subtracted.

A more consistent way of introducing human capital investments into the SNA and introducing a measure of human capital itself that is comparable to physical capital would redefine the concept of value-added, too. This approach would split final consumption into three parts: human capital investments (which provide returns beyond the accounting period), intermediate consumption (human consumption of outputs used in the production process during the accounting period) and final consumption ‘proper’ (the remaining part of consumption, which is neither invested nor used up in the production process). In other words, greater consistency would also lead to greater accuracy in how we interpret the macroeconomic value-added. A large part of GDP that is currently considered to be value-added is actually merely being used up to keep production going. In sum, not netting out human capital with maintenance costs leads us also to overestimate the true development of the wealth of nations.

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Notes

Robert I. Gal is head of research centre at the Corvinus Institute for Advanced Studies, senior researcher at the Hungarian Demographic Research Institute and associated professor at the Institute of Social and Political Sciences, Corvinus University of Budapest; correspondence to be sent to: robert.gal@uni-corvinus.hu. Pieter Vanhuysse is professor of political economy and public policy at the Department of Political Science of the University of Southern Denmark and Chair of Business and Social Sciences at the Danish Institute for Advanced Study. Csaba G. Toth is senior researcher at the Institute of Economics, HUN-REN Centre for Economic and Regional Studies and Corvinus Institute for Advanced Studies. This work was supported by the European Union's Horizon Europe Research and Innovation Programme [SUSTAINWELL project, Grant Agreement number 101095175]; the Hungarian National Academy IDGT MTA National Program [NP2025-IDGT-3/2025]; the Hungarian National Research, Development and Innovation Office (NKFIH, Project No. FK-145991); and the Corvinus Institute for Advanced Studies [Family, Fertility and Human Development Initiative].

The authors would like to thank Jana Belschner, James Heckman, Antónia Hüttl, Ronald Lee, Robert Miller, Javier Olivera, Vera Tröger and seminar participants at the universities of Bergen, Chicago and Southern Denmark for valuable comments and suggestions and Lajos Bálint and Julianna Boros for research assistance.

¹ Influential work in economics further includes Acemoglu and Autor (2012), Barro (2002), Becker (2000), Hall (2002), Mankiw et al. (1992), and World Bank (2018), Gethin (2025). An empirical critique is Pritchett (1999); conceptual critiques are Yarrow (2022) and Folbre (2026).

² Jorgenson and Fraumeni (1989) introduce two major innovations. They include human capital but also extend the SNA with a household satellite account that is the output of unpaid domestic labour. This explains why their estimates exceed similar calculations in other countries.

³ For important critical reviews of the commodified labor biases and 'economistic fallacies' implied by current human capital accounting approaches and the policy prescriptions derived from them, see Yarrow (2022), Coyle (2025), Folbre (2026).

⁴ The costs we discuss here (maintenance) are the costs of *operating* human capital (for example food, clothes, shelter and other items workers need to be able to work) – not costs of *investing* in it (for example childrearing or education).

⁵ The World Bank's human capital project covers even more countries (164) but it uses education-related indicators instead of measuring the value of human capital directly (Angrist et al. 2020).

⁶ Obviously, this does not mean that Farr was ignorant or indifferent about the horrors of slavery. Farr notes that it is the state's task to free them as much as it is to 'avert wrongs, redress violations of the law of nations' (Farr 1853, p. 4).

⁷ See, respectively <https://www.ntaccounts.org/web/nta/show/Browse%20database> and <https://dataexplorer.wittgensteincentre.org/nta/>.

⁸ Since NTA focuses on comparing age distributions in cross-sections or across entire lifecycles, it employs a method for cross-country comparisons that is conceptually distinct from currency-based methods, such as the use of purchasing power parities. Purchasing power parity (PPP) is the price of a commodity basket in one country divided by the price of a commodity basket in another country. It is designed to filter out the effect of price differences across countries. In effect, PPP revises the market exchange rates of national currencies and converts them to a currency specifically designed to facilitate certain forms of cross-country comparisons, such as per capita GDP, labour productivity or the cost of living. However, while PPP handles the difference in price levels, it still includes the differences in living standards. The labour income profile of a rich country still runs significantly above that of a low-income country, and, consequently, a global average based on PPPs is disproportionately influenced by rich countries. The entries of the resulting distribution are thus unitless (not expressed in any currency): the numerator and the denominator are measured in the same currency, hence cancel out. In this way (akin to a standardisation procedure), the NTA re-scaling procedure creates synthetic individuals who represent the various age groups of their nation (e.g. a synthetic 50-year-old Chinese, American or Nigerian) and are directly comparable with the synthetic individuals of another nation. These synthetic national representatives are then merged using population weights into global or European average individuals.

⁹ Christian (2014, p. 488) presents estimates for human capital in the United States for each year between 1998 and 2009 based on a slightly revised version of the original Jorgensen-Fraumeni framework. He applies a gross concept of human capital and distinguishes between market and non-market labour income. He puts the value of market-only human capital at \$231.6 trillion in 2009, which is the closest point in his time series to 2011, for which we can provide an estimate. Using the NTA definitions and the methodology described in the main text, we find that the gross human capital of an average US person is equivalent to 12.8 years of prime-age labour income, which increases to 16.7 years when applying Christian's parameters ($g = 2$ per cent and $r = 4$ per cent). Since a year's prime-age labour income was \$53,628 in 2011 in the US by the NTA definition (based on data from the global NTA database, <https://ntaccounts.org/web/nta/show/Browse%20database>), our estimation gives \$278.5 trillion for a population of 311.7 million. This number is quite close to Christian's estimate, especially if the annual growth in Christian's time series (\$1.8 trillion on average between 1998 and 2009) is used to cover the gap between 2009 (Christian's results) and 2011 (NTA results).

¹⁰ Most equivalence scales are designed to account for economies of scale in household finances. For instance, the so-called modified OECD scale assigns a weight of 1 to the first adult in the household and 0.7 to each additional adult. The lower weight reflects that the expenditures of a single-person household do not double with a second adult moving in. However, such scales are inadequate to describe the distribution of resources among household members. Even if the expenses increase only by 70 per cent with a second person moving in, there is no reason to believe that the second person will consume 30 per cent less than the original household member.

¹¹ It is also affected by emigration. The NTA methodology considers remittances by emigrant workers as labour income in the country of origin, but the aggregates of remittances are sometimes underestimated. Such a bias creates a statistical artefact by elevating the consumption curve relative to the labour income curve and generates a larger-than-real gap between them. As a consequence, we somewhat overestimate human capital investments and underestimate net human capital in countries characterised by a combination of large-scale outmigration and less reliable remittance figures.

¹² Since 2013, Eurostat has published at-risk-of-poverty thresholds separately for three types of households: single person, two adults, and two adults and two children younger than 14 years (Eurostat code: *ilc_li01*). Since the calculations of this paper required one single threshold, we used the 2011 census data on household structure (Eurostat code: *cens_11htts_r2*) as weights. The *cens_11htts_r2* variable includes equivalents for the first two household types above: one-person; two adults (composed of three subtypes, such as married couples, couples in registered partnership, and couples in consensual union, all three without resident children). However, its definition of household with resident child differs from what variable *ilc_li01* uses for households with children. For the weighting procedure, we used the number of households with at least one resident child below age 25.

¹³ Jorgenson and Fraumeni (1989) design a satellite account for human capital. Production is the process of expanding the skill set of workers; output is the increment of the present value of remaining lifetime labour income. Intermediate consumption is education services, including the wages of teachers.

¹⁴ The terms gross versus net refer to the inclusion or exclusion of maintenance costs like in the gap between gross and net output in national accounting but unlike in the gap between gross and value added (which equals the consumption of fixed capital).