Centre for Global Economic History
RECONSTRUCTING THE HISTORY OF GLOBAL INEQUALITY

Universiteit Utrecht

CGEH Working Paper Series

What can't money buy? Wellbeing and GDP since 1820

Auke Rijpma, Utrecht University and IISH

January 2017

Working paper no. 78

www.cgeh.nl/working-paper-series/

What can't money buy? Wellbeing and GDP since 1820

Auke Rijpma, Utrecht University and IISH

Abstract: This paper provides a overview of developments in wellbeing in the world since 1820 using seven indicators. To this end, a composite indicator is constructed using a latent variable model able to deal well with missing data and measurement error issues. Overall, this composite indicator gives an optimistic, if divergent picture of developments in wellbeing. Wellbeing increased substantially in most regions of the world since at least the early twentieth century. At the same time, the divergence of Western Europe and its offshoots with the rest of the world in the nineteenth century is stronger. Convergence in the past decades, however, is also more pronounced. In more recent decades, low-income countries have made more progress in the composite indicator than in per capita GDP. The composite indicator also shows a segmented relation with income, suggesting diminishing returns to income. Improvements in wellbeing indicators over time exogenous to GDP and country-specific characteristics were an important part of this.

Keywords: wellbeing, long-term economic growth, economic history.

JEL Codes: N30, O10, I30.

Corresponding author: Auke Rijpma, a.rijpma@uu.nl.

Acknowledgements: This paper elaborates on Rijpma, "Composite view of wellbeing" and Van Zanden et al., *How was life*. Helpful suggestions were given by Romina Boarini, Jutta Bolt, Peter Foldvari, Kyoji Fukao, Michalis Moatsos, Conal Smith, Marcel Timmer, Jan Luiten van Zanden and participants at the OECD/Clio-Infra workshop "A long-term perspective on global well-being and development", the E-frame Final Conference, and the WEHC.

1 Introduction

The development of the world economy in the very long-run is known and understood better than ever. Building on the work of Angus Maddison from the 1980s onwards,[1] economic historians have learned a great deal about economic performance in the past.[2] However, what is ultimately important is not economic growth, but the extent to which it improves peoples' lives, their well-being. GDP, the total production of goods and services in an economy, is not a good measure of wellbeing.[3] This was already understood by the pioneer of national accounts, Simon Kuznets who stated that "the welfare of a nation can scarcely be inferred from a measure of national income".[4]

Recently, however, there has been a new wave critique on the usage GDP as a measure of wellbeing and the progress of nations. Among GDP's shortcomings is its inability to say anything about distributional issues. Moreover, GDP is ill-equipped to say much about the contribution to wellbeing of non-market goods and services such as the provision of health care, education, and security. It is likewise silent on such as issues, as well as the the quality of government and the environment.[5] At best, GDP and other aggregate income measures give an indication of a country's possibilities to attain high wellbeing outcomes.

Statistical offices and researchers have not been deaf to these critiques and have gathered other statistics that can provide more information on wellbeing. Moreover, economic historians themselves are well aware that a complete picture of wellbeing in the past requires more than income estimates. A recent report has given an overview of the state of the art in this field.[6] Globally, there has been progress in most indicators of wellbeing. Income (measured by per capita GDP and real wages), health (life expectancy, stature), education (educational attainment, average years of education, literacy), governance (democracy), personal security (homicide rates), and income inequality all showed improvements. The one exception is the environment (measured by biodiversity, CO_2, and SO_2 emissions), which in most countries and most times deteriorated during the development process. Moreover, while there was progress in most measures of wellbeing across the world, between-country inequality is an issue. Though a slow convergence process has begun in recent decades, divergence, especially in income, was the norm for most of the 1820–2000 period. Many

1. Maddison, *World economy*, *Monitoring the world economy*, *Phases of capitalist development*.
2. Bolt and Zanden, "Maddison Project", for an overview.
3. Sen, *Commodities and Capabilities*, *Development as Freedom*, *Standard of living*.
4. Attributed to Senate Document No. 124, 73rd Congress, 2nd Session.
5. Stiglitz, Sen, and Fitoussi, *Measurement of economic performance and social progress*.
6. Van Zanden et al., *How was life?*

other wellbeing indicators also displayed divergence due to progress beginning earlier in Europe and its offshoots, but the convergence process for these indicators started earlier and was stronger.[7]

Although this line of research has enriched our our understanding of wellbeing in each of these dimensions, the overall picture is not yet clear. What do developments in wellbeing look like when we consider all the indicators together? Do countries compensate a bad performance in one aspect of wellbeing with a good performance in another? Socialist countries are a good example of this possibility. For instance, Cuba's income is modest and it lacks political freedoms, but the island has nonetheless managed to achieve impressive health outcomes.[8] On the other hand, it might also be that a low score in one wellbeing measure is accompanied by low scores on other measures as well. The multitude of problems in countries in sub-Saharan Africa are a good example of this possibility.

This paper attempts to reconstruct overall wellbeing developments since 1820 and their relation to economic growth. After discussing the relevant empirical literature on composite indicators of wellbeing in section 2, the global long-term developments of separate indicators of objective wellbeing since 1820 are sketched (section 3). Next, to assess overall wellbeing developments, a composite indicator is constructed. Though they are popular, composite indicators are not without problems and these are also discussed (section 4). Finally, after presenting the developments of this composite indicators, its relationship with GDP per capita is assessed (sections 5 and 6).

7. A similar message of divergence but progress in Easterlin, "The Worldwide Standard of Living since 1800".

8. Cooper, Kennelly, and Orduñez-Garcia, "Health in Cuba".

2 Literature

This section will briefly review the empirical literature using composite indicators to capture wellbeing. While the focus will be on long-term, historical indicators, some of the more prominent contributions to the general literature will also be discussed.

A pioneering contribution was by Nordhaus and Tobin.[9] They constructed a "measure of economic welfare", or MEW. It is a consumption-oriented correction of GNP made by reclassifying (government) expenditures as consumption, investment, or intermediate inputs; by imputing the value of leisure, household work, and consumer capital services; and by subtracting social costs that are not internalised (depletion of the environment and urban disamenities). Moreover, they also calculate a sustainable measure of economic welfare, defined as the amount of consumption consistent with enough investments to allow steady state growth at the rate of technological progress. These corrections lead to different estimates of welfare than GNP would give, but Nordhaus and Tobin still find that GNP broadly convey the correct picture of progress in the USA between 1929 and 1965.

The UNDP's *Human Development Reports* gave an important boost to the use of composite indicators. They introduced the so-called Human Development Index (HDI) which combines income, life expectancy, and education into one indicator.[10] Although these and other composite indicators have come in for substantial criticism,[11] the popularity of indicators capturing multiple dimensions of wellbeing has hardly diminished in past the years.

More recent efforts to correct GDP figures for the contribution of other sources of wellbeing include the work by Becker, Philipson and Soares. They show that including life expectancy in growth figures results in lower between-country inequality in the period 1960–2000.[12] Another consumption-oriented correction of GDP was made by Jones and Klenow. They compute a consumption-equivalent measure, showing how much extra consumption would be required in a given country to compensates for differences in life expectancy, inequality, leisure and consumption compared to the United States. While they find that

9. Nordhaus and Tobin, "Is growth obsolete?"
10. UNDP, *Human Development Report*; it resembles the indicator developed in 1980 by Morris, "The Physical Quality of Life Index (PQLI)"; in 2010 UNDP, *Human Development Report 2010*, introduced a number of substantial changes to the HDI.
11. See section 4 for a discussion as well as Ravallion, "Human development index"; Klugman, Rodríguez, and Choi, "HDI 2010"; Ravallion, "Multidimensional indices"; as well as Srinivasan, "Human Development"; McGillivray, "The human development index"; a more general critical assessment of composite indices in Ravallion, "Mashup indices".
12. Becker, Philipson, and Soares, "Quantity and quality of life".

per capita GDP overall gives a good impression of welfare across the world, they also find that global improvements in life expectancy generally result in a upwards revision of welfare growth compared to growth in GDP. Moreover, the gap between the United States and Europe is smaller than GDP shows while the gap with developing countries, typically characterised by high inequality and relatively low life expectancy, is larger.[13]

A number of scholars has tried to construct historical composite indicators in order to assess long-term trends in wellbeing. As the most familiar methodology, many of them use the HDI-approach. Nicholas Crafts authored one of the earliest of these papers, presenting estimates for selected countries in 1870, 1913, 1950, 1973, and 1992/9.[14] Among his findings was that developing countries in the 1990s exceeded Western Europe and its offhoots in human development.

Pamuk and Van Zanden discuss a variety of living standards indicators and also calculate HDI-scores for European countries during the period of the Industrial Revolution, showing little progress between 1820—1870.[15] Voth reaches a similar conclusion for Britain.[16] These results suggest there indeed was a so-called "early growth puzzle", coined by Komlos.[17]

Williamson corrections to GDP for life expectancy for Britain between 1781 and 1931 however suggest differently.[18] Building on the methodology of Usher, he augments growth in consumption by the willingness to pay for improved chances of survival.[19] After (generously) subtracting the endogenous contribution of added consumption to life expectancy, he finds that growth in living standards (real wages combined with living standards) was faster than income alone would show. Costa and Steckel used a similar method to estimate growth in wellbeing in the United States, finding that growth in GNP underestimates growth in wellbeing (consumption augmented by the chances of survival) since 1880. They also calculated a variant of the HDI for the United States since 1800, finding that Americans were already well off before industrialisation, but that their wellbeing as measured by the HDI stagnated until c. 1870.[20]

Crafts calculated alternative growth rates between 1870 and 1992 for a selection of countries by using Usher's method as well as a correction for hours

13. Jones and Klenow, *Beyond GDP?*
14. Crafts, "Human Development Index and changes in standards of living"; revisions due to the UNDP's (2001) change in methodology in Crafts, "Human development index, 1870–1999".
15. Pamuk and Zanden, "Standards of living".
16. Voth, "Living standards".
17. Komlos, "Shrinking in a Growing Economy?"
18. Williamson, "British mortality".
19. Usher, "Imputation to the measure of economic growth", *Measurement of economic growth*.
20. Costa and Steckel, "Long-term trends"; in Steckel and Floud, *Health and welfare during industrialization*.

worked (to assess the value of leisure time).[21] This approach showed that while GDP growth is still responsible for most growth in welfare, reductions in mortality and hours worked also had a large contribution to development: one third of the total adjusted growth.

More recently, Prados de la Escosura has explored human development in the world since 1870. His point of departure is again the HDI-methodology, though he transforms the indicators so that improvements at higher levels result in higher scores on the index. He arguest that these improvements are more difficult to attain than those at lower levels, so they should have larger contribution to an overall index of human development).[22] He finds strong improvements in human development since 1870, much of it attributable to gains in life expectancy and education. He also observes convergence between today's OECD countries and the "rest", though his transformations result in slower convergence after 1970 than other composite indicators tend to show.

Overall, the picture of historical wellbeing developments in the literature is fragmented by the use of different methods and by looking at different parts of the world. Moreover, given the issues of measurement and missing observations in historical data, there is surprisingly little attention for these issues in the literature. By drawing on new harmonised historical wellbeing data and applying recent methodological advances, this paper will construct an indicator using a coherent framework that can deal with these issues with almost global coverage.

21. Crafts, "Human Development Index and changes in standards of living", 313–318; see also Crafts, "Living standards".
22. Escosura, "Improving Human Development", "World Human Development"; see also Escosura, "Human development in Africa"; the transformations from Kakwani, "Performance in living standards".

3 Dimensions of wellbeing

This paper uses six dimensions of wellbeing. Although historical data availability is an important constraint, the dimensions and indicators used in the OECD's *How's life* and *How was life* reports.[23] To measure income, real wages are used; life expectancy and stature are used to measure health; average years of education is used for education; Gini coefficients for income inequality; the Polity IV index for the quality of political institutions; and homicide rates for personal security.[24] Compared to the contemporary *How's life* approach, it was not possible to include information on work-life balance, social connections, subjective wellbeing, housing, and unemployment. Table 1 presents summary statistics for the seven wellbeing indicators used here and per capita GDP.

	Mean	SD	Min	Max	Miss	N
Lab. real wage	24.5	32.3	0.5	349.4	0.8	1023
Height	167.8	4.6	152.4	183.2	0.7	1357
Life exp.	56.0	14.6	18.9	82.2	0.7	1612
Av. years edu.	3.7	3.3	0.0	13.1	0.7	1638
Inequality	43.2	8.7	16.1	73.7	0.8	895
Polity	7.7	7.2	1.0	21.0	0.6	1896
Homicide rate	5.9	8.6	0.0	71.8	0.8	812
GDPpc	3702.6	4763.1	225.1	34440.9	0.7	1500

Table 1: Summary statistics of wellbeing indicators, 1820–2000

Figure 1 shows the optimistic picture of wellbeing indicators briefly discussed in the introduction. By and large, world averages in all wellbeing indicators improved throughout the period. The one exception to the trend of improvement is within-country inequality, which after a few decades of declining income inequality has witnessed a substantial upswing in the past decades.

Since all indicators show strong improvements over time, they are likely to be correlated. Figure 2 explores the correlation of each wellbeing variable per decade with per capita GDP. Overall, many of the indicators display a high correlation, between 0.7–0.8 in the case of real wages, life expectancy, stature, average years of education, and the Polity IV index. Seeing we would prefer to

23. OECD, *How's Life?*; Van Zanden et al., *How was life?*

24. Baten and Blum, "Human height since 1820"; Baten et al., "Personal security since 1820"; Foldvari and Buzasi, "Political institutions since 1820"; Leeuwen and Leeuwen-Li, "Education since 1820"; Moatsos et al., "Income inequality since 1820"; Zijdeman and Silva, "Life expectancy since 1820"; Zwart, Leeuwen, and Leeuwen-Li, "Real wages since 1820"; per capita GDP is from Bolt, Timmer, and Zanden, "GDP per capita since 1820".

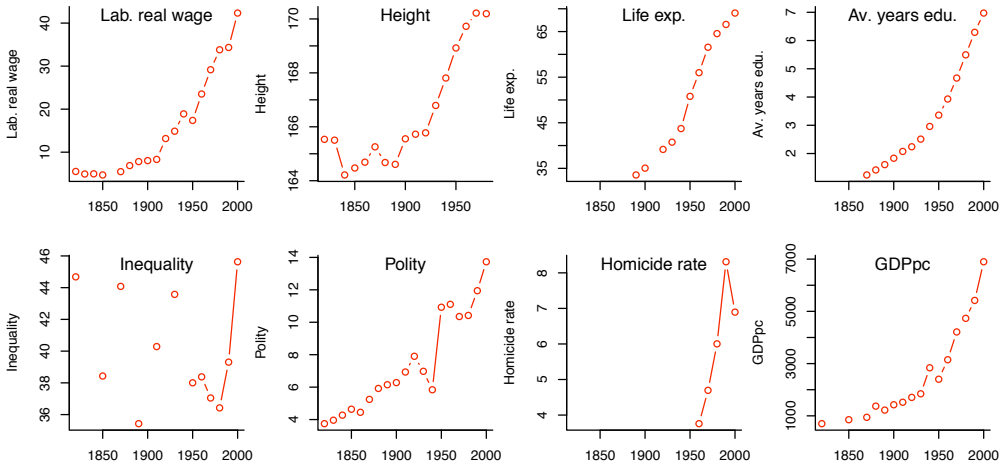

Figure 1: Development of world averages of wellbeing indicators, 1820–2000.

have less homicides rates, homicide rates too improve when per capita GDP is higher. Its correlation is much closer to zero, however. The correlations of the indicators change over time as well. Before the mid-nineteenth century, correlations tended to be closer to zero, sometimes even negative. The correlations are estimated with much less precision as well. The largest change can be found for income inequality. In the nineteenth century it had a positive correlation with per capita GDP, which means that countries with high incomes also had high inequality. Since at least the Second World War, the correlation is positive, so higher inequality is now mostly found in low-income countries.

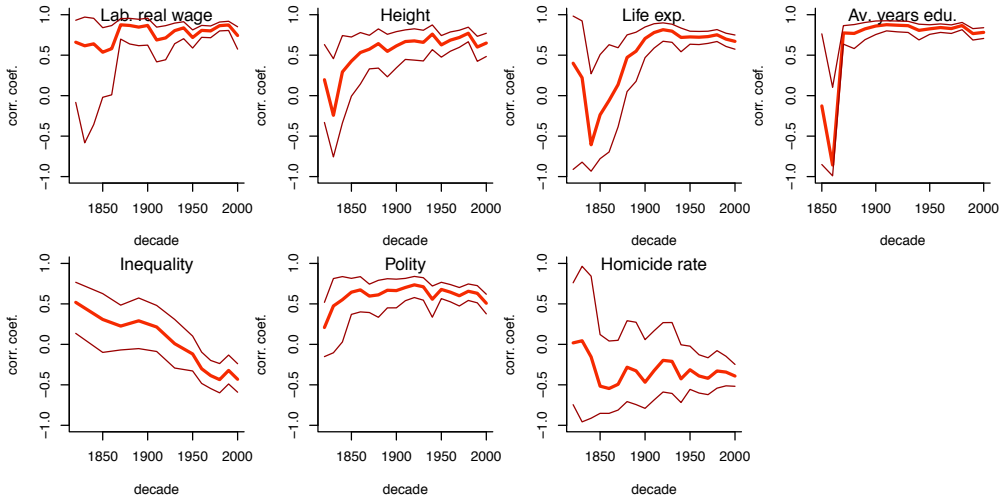

Figure 2: Cross-sectional correlation coefficients and 95 percent confidence intervals of wellbeing indicators with per capita GDP per decade, 1820–2000

These changes in the correlations may in part be due to less accurate mea-

surement in the first half of the nineteenth century.[25] Broadly speaking, however, the results are not unexpected. Many economic historians have found evidence of an "early growth puzzle". For example, wages, nutrition, stature, health and educational attainment all deteriorated in the early stages of industrial growth.[26] Technology is probably key to understanding many of these phenomena. For example, while improvements in health technology improved health regardless of income, the opposite may have been in play in the nineteenth century when health technology was unable to translate higher incomes in better health at all.[27] Technology could also matter for education. Early industrial technology did not require many skilled workers and this could have depressed educational attainment in this period.[28]

4 Method

While the long-term trends in the separate wellbeing indicators gives reason for optimism, the overall developments are yet to be determined. This section discusses the options available to this end. The most straightforward way of combining multiple indicators into one composite indicator is to take their average. However, the different ranges and different units of measurement of the indicators need to be addressed. For example, if schooling is measured by average years of education and health by life expectancy, the latter's range of 19–82 years would have a much larger contribution than the former's 0–13 years. For this reason, the indicators are often put on a commong range by normalising or standardising them.[29]

However, normalisation does not fully resolve the aggregation and weighting issue. Tradeoffs remain in the composite indicator and this issue has sparked a substantial debate.[30] The core of the problem is that combining two or more indicators into one means it is somehow possible to exchange an amount of one indicator for an amount of another while keeping the overall score on the composite indicator equal. This means that aggregation amounts to a statement on

25. Changes in the sample size are a further possibility, but the trends are qualitatively the same when analysing the same sample over the entire period.
26. Komlos, "Shrinking in a Growing Economy?"; Nicholas and Nicholas, "Male Literacy, 'Deskilling', and the Industrial Revolution"; Szreter, "The Population Health Approach in Historical Perspective"; Allen, "Engels' pause"; Segers, "Oysters and rye bread".
27. Preston, "Changing relation".
28. Goldin and Katz, "The Origins of Technology-Skill Complementarity".
29. E.g. Boarini and D'Ercole, "Going beyond GDP"; Morris, "The Physical Quality of Life Index (PQLI)"; Nardo et al., *Handbook on Constructing Composite Indicators*; UNDP, *Human Development Report 2010*.
30. Ravallion, "Mashup indices", "Human development index", "Troubling tradeoffs".

the relative importance of the indicators, for instance four years of education being worth as much as one additional year of life expectancy. It is very difficult to find a completely satisfying solution to the issue of the tradeoffs.

One potential solution to this problem is to gather subjective information on the determinants of wellbeing. Surveys among the public or experts are one way to provide information on the relative importance of indicators of wellbeing.[31] The study of happiness or life satisfaction and its determinants is another way to gather such insights.[32] However, it is not straightforwrad to measure happiness and link it to objective measures. For example, Deaton has found in a country-level study that conditional on income, additional life expectancy, generally considered a key component of wellbeing, has no impact on life satisfaction.[33] Appendix A reports similar results regressions of the wellbeing indicators considered here on reported life satisfaction in the World Value Surveys. Accurately estimating the contribution of objective wellbeing indicators to subjective wellbeing would probably require individual-level survey data.[34] Comparing subjective wellbeing across cultures and time presents further challenges. Finally, while these methods hold great promise, historical data on subjective wellbeing or public opinion is not available, thus limiting its use for the historical data discussed in this paper.

Research in welfare economics has also made contributions by calculating corrections to GDP with a strong grounding in economic theory.[35] To achieve this goal, it is necessary to express other wellbeing indicators in money. The consistency with economic theory and the expression of the resulting indicator as a correction to GDP or another money metric are useful properties of this approach. However, setting prices on other dimensions of wellbeing has strong data requirements and may make the resulting indicator more difficult to communicate.

Another line of research into composite indicators considers poverty measures from a multidimensional perspective.[36] Poverty measures are constructed by taking a poverty line and counting the number of people falling below it and, optionally, the extent of their poverty. The point of a multidimensional poverty line is to consider multiple indicator of poverty at once. Since such measures are

31. Boarini and D'Ercole, "Going beyond GDP".
32. Fleurbaey, Decancq, and Schokkaert, "What good is happiness?"; Schokkaert, "Capabilities and satisfaction".
33. Deaton, "Income, Health and Wellbeing Around the World".
34. Boarini et al., *What makes for a better life*.
35. E.g. Becker, Philipson, and Soares, "Quantity and quality of life"; Dowrick, Dunlop, and Quiggin, "Social indicators and comparisons of living standards"; Fleurbaey and Gaulier, "International comparisons of living standards"; Jones and Klenow, *Beyond GDP?*
36. Alkire and Foster, "Counting and multidimensional poverty measurement".

designed to count the number of poor, they are not well suited to country-level data. Moreover, these poverty measures still require a decision on the weights and, additionally, the poverty cutoff for each indicator.

A way to circumvent the issue of weighting altogether is to rank countries, rather than assigning an exact number to each of them, an approach going back to Sen.[37] This approach has been analysed in some detail.[38] The basic idea is to rank a country higher than another country only if it scores as good or better on all indicators and better on at least one. In that case the country scores higher than the other regardless of the aggregation procedure. An issue with this approach is that rankings can be incomplete. This would happen when a country score better on one indicator but worse on another. As the number of indicators and observations increases, an unambiguous ranking becomes more difficult to achieve.[39]

Another group of methods is data-driven. Principal components analysis (PCA) is one popular example of these techniques.[40] Latent variable techniques such as factor models are similar in spirit and also widely used in the construction of composite indicators.[41] These models aim to aggregate observed variables by finding one underlying, unobserved variable through the statistical properties of the indicators.

The main disadvantage of a latent variable approach is that a statistical property, the correlation between the variables for instance, does not necessarily capture the right tradeoffs between the indicators. Moreover, the statistical justification behind a latent variable model is not without issues. That each indicator should capture only part of wellbeing seems to fit well with a multidimensional concept of wellbeing. Other concepts such as health condition, cognitive ability, ideological disposition, and democracy are measured in a similar way.[42] However, this does require that the underlying concept is reflected in the correlation structure of the observed variables. If instead it is believed that each indicator measures a distinct and unique part of wellbeing, a latent variable model be-

37. Sen, *Standard of living*, 32–3, *Commodities and Capabilities*.

38. Atkinson and Bourguignon, "The Comparison of Multi-Dimensioned Distributions of Economic Status"; Duclos, Sahn, and Younger, "Robust Multidimensional Poverty Comparisons".

39. Van Zanden et al., *How was life?*, provides nine indicators and almost 14 000 observations in which only 728 unambiguous rank relations could be established among 40 200 possible complete-case comparisons (there are over 22 million comparisons if incomplete cases are also considered).

40. E.g. Chakravarty, "Generalized human development index"; Slottje, "Measuring the quality of life".

41. Høyland, Moene, and Willumsen, "International index rankings"; Kaufmann, Kraay, and Mastruzzi, "Governance Matters III".

42. Lee, *Structural Equation Modeling*; Treier and Jackman, "Democracy as a Latent Variable".

comes problematic.

A statistical approach has a number advantages. For one, a statistical model provides coherent way of thinking about the issue of aggregation. Given assumptions about the relations between the indicators, an indicator can be constructed that reflects the shared information between the indicators and that differentiates between countries as best as possible.[43] Moreover, statistical models give the possibility to account for sources of uncertainty in a composite indicator, such as measurement error.[44] Allowing for the possibility of measurement error is, of course, of great importance when working with historical data.[45]

In this paper the main approach is to estimate a latent variable model because of these advantages: the variant used here allows for the handling of measurement error and missing data. To make the best use of the historical datasets, it is crucial that this is done as best as possible. Moreover, because the resulting composite indicator is a linear combination of the observed variables, Ravallion's critique that non-linear transformations can result in problematic tradeoffs is also addressed.[46] Appendix C presents the tradeoffs implicit in the composite indicator constructed here. Appendix B furthermore assesses the sensitivity to the weighting procedure implied by the latent variable model.

The model used here is a factor model, consisting of y_{ij}, the observed data for country i and indicator j. The unobserved, latent variable for country i is χ_i and β_{1j} is a parameter reflecting how well observed indicator j differentiates between countries. β_{0j} is an intercept and ω_j^2 the variance.

$$y_{ij} \sim N(\beta_{0j} + \beta_{1j}\chi_i, \omega_j^2)$$
$$\chi_i \sim N(0, 1)$$

This model requires an identification constraint. It is common to do this by standardising the latent variable to have a mean of zero and a standard deviation of one.[47] Because the composite indicator has no natural unit of measurement and because relative performance is the main point of interest, these linear transformation are relatively harmless.

43. Høyland, Moene, and Willumsen, "International index rankings"; Nardo et al., *Handbook on Constructing Composite Indicators*.
44. Treier and Jackman, "Democracy as a Latent Variable".
45. Feinstein and Thomas, "Plea for errors".
46. Ravallion, "Troubling tradeoffs".
47. Jackman, *Bayesian analysis*, 440–1; Høyland, Moene, and Willumsen, "International index rankings"; Kaufmann, Kraay, and Mastruzzi, "The Worldwide Governance Indicators".

Some of the indicators might be correlated with each other for other reasons than their correlation with the latent variable. This might be the case for the indicators measuring similar dimensions, such as health (measured by life expectancy and stature). The model can account for this by splitting the error into a term for the individual countries and a term $\delta_{i,k[j]}$ for the groups of variables, allowing for higher correlation between indicators of the same group k.[48]

The model is estimated in a Bayesian framework, which has a number of advantages. For one, a Bayesian framework can deal with the multilevel structure of the data well. Countries at the same point of time or in the same region are expected to be more similar and the model should account for this. However, these regional and time characteristics should not directly be part of the composite indicator. In a Bayesian multilevel model this information enters through the priors. Rather than using the same $N(0, 1)$ prior for all countries, the prior, $\alpha_{m[i]}$, is allowed to vary by region-year combination m. Using this approach has the additional advantage of allowing the direct estimation of the regional trends with the appropriate confidence intervals.[49]

$$\begin{aligned} \chi_i &\sim N(\alpha_{m[i]}, 1) \\ \alpha_{m[i]} &\sim N(0, 1) \end{aligned}$$

Missing data is also handled well in the Bayesian framework. This is an important feature as historical data inevitably contains missing observations and the data on wellbeing is no different. By estimating the model through Gibbs sampling, the parameters, latent variables, and missing values in the left hand side-varaible are all estimated by the same model. This means that any information included in the model is also used to estimate the missing values.[50]

A Bayesian model requires the specification of priors. These distributions should capture the researcher's beliefs about model parameters before seeing the data (likelihood). Because priors introduce subjective beliefs into modeling, it is often seen as a disadvantage. For this reason, uninformative priors are commonly employed to minimise the impact of the researcher's beliefs. The same approach has been used here.[51]

48. Høyland, Moene, and Willumsen, "International index rankings".
49. Gelman and Hill, *Data analysis*; Jackman, *Bayesian analysis*.
50. Merkle, "Comparison of imputation methods"; Little and Rubin, *Statistical analysis with missing data*; Gelman and Hill, *Data analysis*.
51. The estimation was implemented in JAGS: Plummer, "JAGS"; building on procedures from Jackman, *Bayesian analysis*; Merkle, "Comparison of imputation methods"; and code kindly provided by Bjørn Høyland: Høyland, Moene, and Willumsen, "International index rankings" The following priors were used: $N(0, 10^7)$ on the loadings, $G(0.01, 0.01)$ on the country vari-

5 Results

The factor loadings of the indicators on the composite variable are presented in table 2. They show how much each indicator contributes to the composite indicator. Most of the loadings on the indicators have the expected sign. The are also all of the same magnitude (0.7–0.9) and significantly different from zero. However, because two of the indicators (stature and life expectancy) measure one dimension (health), it can be said that health has a higher weight in the composite indicator than the other variables. As expected, income inequality and homicide ratios negatively impact the composite indicator. Their loadings are also of a smaller magnitude than the other variables.

	mean	q05	q50	q95
Real wage	0.68	0.64	0.68	0.72
Height	0.70	0.66	0.70	0.74
Life exp.	0.86	0.83	0.86	0.89
Av. years edu.	0.90	0.88	0.90	0.92
Inequality	-0.22	-0.27	-0.22	-0.17
Polity	0.66	0.63	0.66	0.69
Homicide rate	-0.13	-0.19	-0.13	-0.07

Table 2: Factor loadings for the composite indicator of wellbeing

A good place to begin considering the developments in the composite indicator is by looking at regional developments (figure 3). Wherever possible, the figures are presented with 90 percent confidence intervals. In the case of the regional developments, this shows that it is difficult to state with high certainty that certain regions of the world were different from others in their scores on the composite indicator for much of the nineteenth century. In this person it is only possible to distinguish between the best and worst performing regions. A big source of this uncertainty is the high number of missing observations in this period, which greatly widens the confidence intervals.

Nonetheless, some trends can be discerned. As was the case for the individual indicators of wellbeing, there is substantial progress in the composite indicator around the world. Western Europe and its offshoots get the highest scores on the composite indicator in the early nineteenth century. Because countries in these regions continued to experience improvements, they remained the leaders throughout the period. Moreover, because the development process began

ance, $N(0, \sigma^2)$, $\sigma^2 \sim U(0, 100)$ on the group specific error terms. The Raftery-Lewis diagnostic showed that 50 000 iterations sufficed.

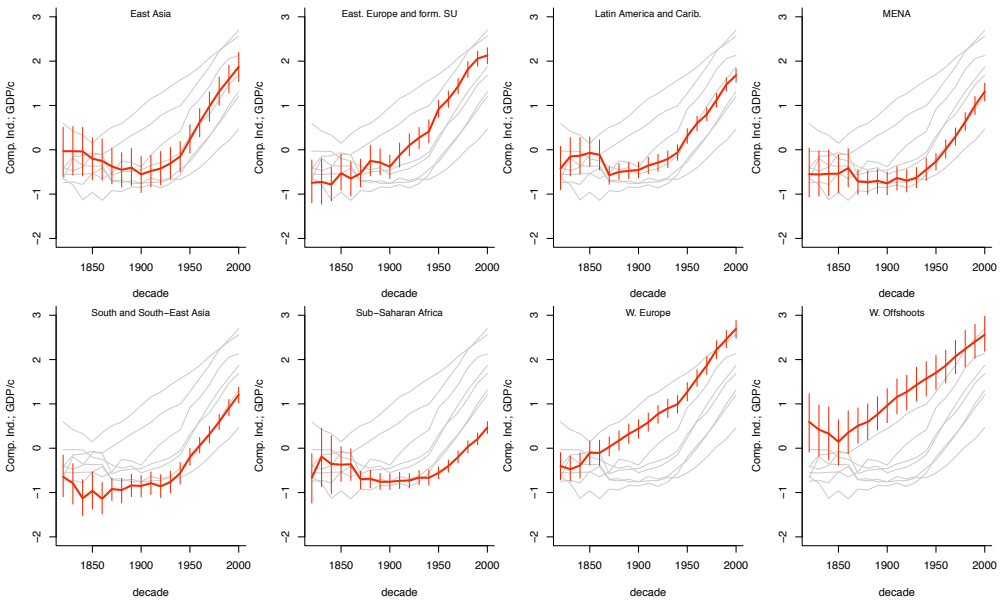

Figure 3: Estimates and 90 percent confidence intervals of a composite indicator of wellbeing by region, 1820–2000.

earlier in these regions than in the rest of the world, a gap came into being in the second half of the nineteenth century.

In the twentieth century, other regions began to catch up. Countries in Eastern Europe and the former Soviet Union started making substantial progress from c. 1900 onwards and continued to do so until the final decades of the twentieth century. Despite some of the flaws of socialist countries, notably in political freedoms, in many of the wellbeing indicators discussed here they performed well. Asia, Latin America, and the Middle East and North Africa also began making up ground with the West in the first half of the twentieth century. However, while some of the gap that arose in the nineteenth century had been closed, substantial differences remained.

The worst performers are Sub-Saharan Africa and South and South-East Asia. While there is too much uncertainty about the estimates of the composite indicator to make precise statements about these regions in the nineteenth century, it does seem that wellbeing in Sub-Saharan Africa was higher than it was in South and South-East Asia – or at least not measurably worse. However, South and South East Asia did begin catching up to the West in the twentieth century. While some progress has been made in Sub-Saharan Africa since the 1950s (more so than only looking at per capita GDP would show), it did not catch up to any significant degree.

Figure 4 looks up close at a number of key countries in the debate about the Great Divergence. It compares the process of divergence and convergence in

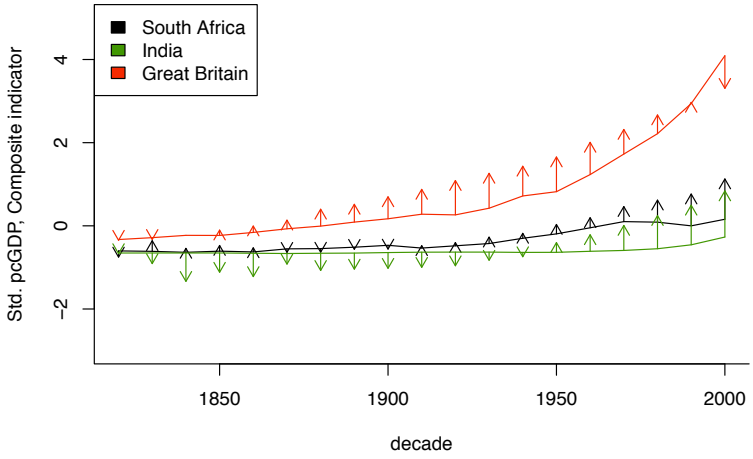

Figure 4: Standardised per capita GDP (line) and a composite indicator of well-being (arrow head) in South-Africa, India, and Great Britain, 1820–2000.

the past two centuries in terms of per capita GDP and the composite indicator. Strikingly, it suggests that divergence up until the 1970s was more pronounced once multiple wellbeing indicators are considered. Lagging countries did not only have low income, but had poor health, education, governance, safety, and inequality as well. From 1970 onwards the picture changes. The composite indicators shows more progress than per capita GDP and by the 2000s the composite indicator actually implies a relative downward revision in highly-developed countries such as Great Britain.

Figure 5 looks at the distribution of scores on the composite indicator across countries at four moments in time. Again, progress, strong divergence, followed by some convergence can be seen. In c. 1850, differences existed between countries, but they were not large and it is difficult to make precise statements other than that the countries with the very highest scores on the composite indicator like the USA and Switzerland were doing better than the worst-scoring group. By 1900 this picture has changed. A clear group of leaders had arisen, mostly in Western Europe and its offshoots. As there were hardly any improvements in wellbeing in most other countries, between-country inequality had increased greatly.

Substantial progress in the composite indicator can again be seen. By 1950, countries in southern Europe and Latin America as well as the Soviet Union and Japan had already begun closing the gap, a process that continued in the second half of the twentieth century.[52] At this point in time, most countries scored

52. This occurred earlier than income suggests, see Zanden et al., "The Changing Shape of Global

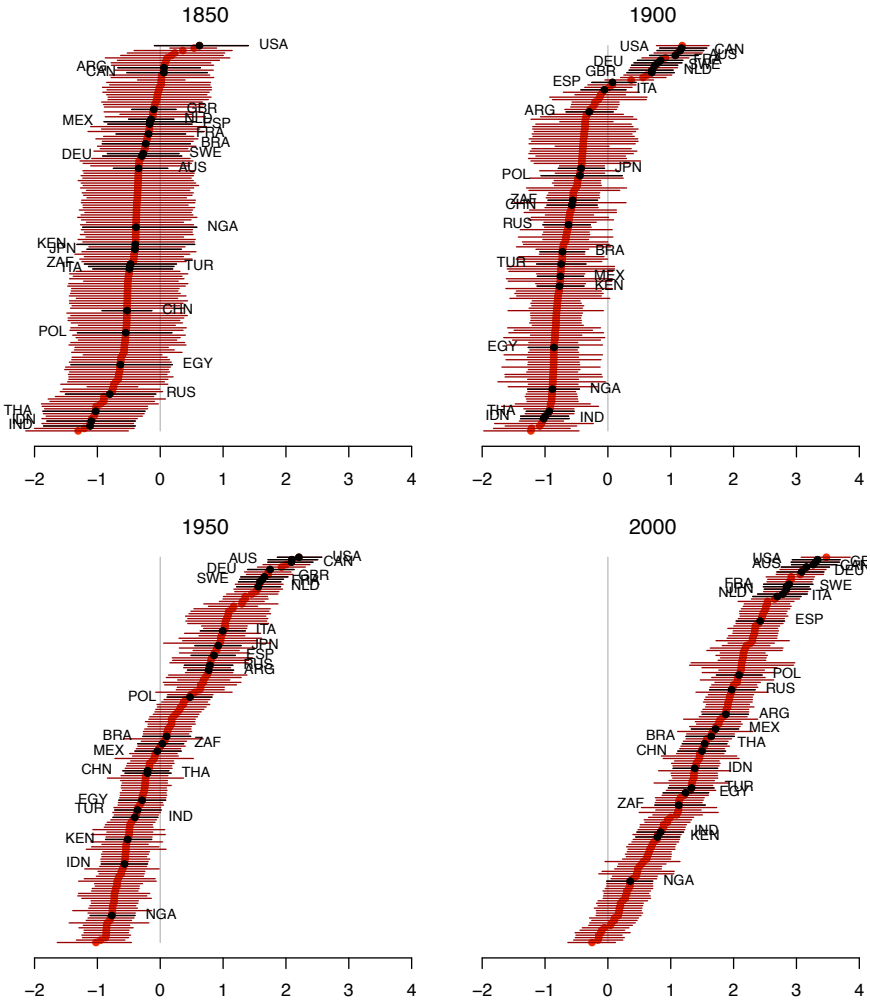

Figure 5: Estimates and 90 percent confidence intervals of a composite indicator of wellbeing by country in four decades: 1850, 1900, 1950, and 2000.

above zero, the overall mean of the indicator for the entire period. By the 2000s, nearly all countries had seen increases of at least one standard deviation (equal to one point on the scale of the indicator) of the global 1820–2000 distribution of the composite indicator. This meant that even the worst-performing countries did better than they did before the 1950s, which cannot be said for all countries when looking at GDP.

Inequality 1820–2000; Exploring a New Dataset".

6 GDP and wellbeing

Figure 6 provides a further look at the relation between per capita GDP and other wellbeing indicators, both the individual indicators and the composite indicator. The comparison of regional estimates of the composite indicator with unweighted regional averages of standardized per capita GDP show diverse trends.[53] In the developed West, and, to a lesser extent, East Asia, growth in per capita GDP in recent decades outstrips growth in the composite indicator. This is probably because growth at higher levels in the other indicators is harder to achieve.[54] Conversely, in the past 60 years developing regions had more growth in the composite indicator than they did in per capita GDP.

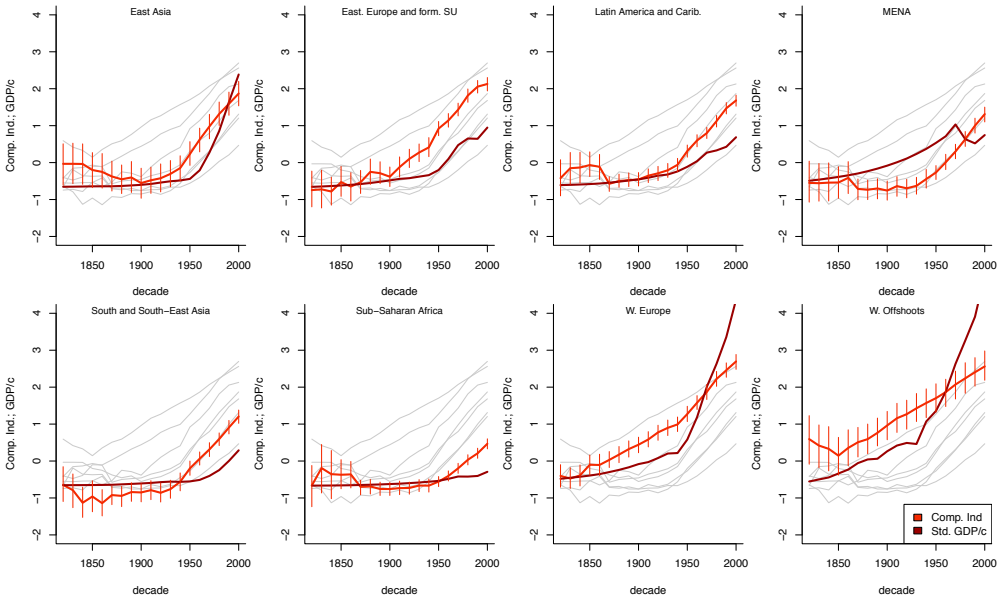

Figure 6: Standardized per capita GDP and estimates and 90 percent confidence intervals of a composite indicator of wellbeing by region, 1820–2000.

These developments suggest the possibility of a decoupling of per capita GDP and wellbeing as measured by the composite indicator in recent decades. Moreover, while lack of precision prevented firm conclusions, it also seemed that the link between per capita GDP and wellbeing indicators in the early nineteenth century was not strong and maybe even negative. A further test of the possibility of a decoupling of per capita GDP and the composite indicator is presented in figure 8.

Indeed, there seems to be a break in the relation between per capita GDP and the composite indicator, estimated to lie at c. $ 5 000 (at 1990 PPPs).[55] A loga-

53. Results using population-weighted regional averages are qualitatively similar.
54. Escosura, "World Human Development".
55. Muggeo, "Estimating regression models with unknown break-points."

rithmic relationship fits the observed pattern better, albeit it with considerable outliers. It suggests that a each doubling of income results in a 0.8 point increase on the composite indicator (almost one standard deviation of the global 1820–2000 distribution).[56] Overall, substantial additional income is required to improve wellbeing at higher income levels.

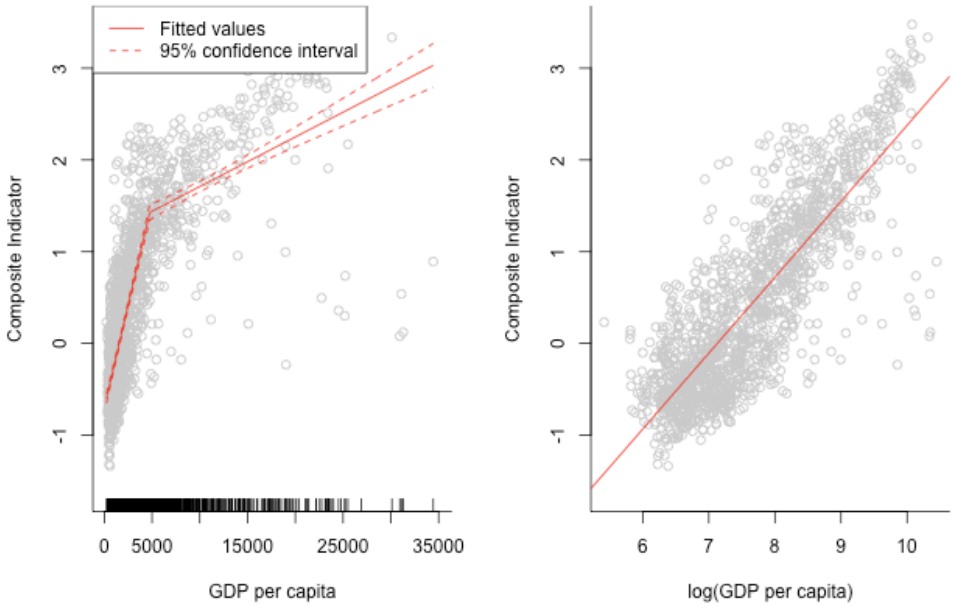

Figure 7: Segmented relationship between per capita GDP and the composite indicator.

If country and time fixed effects are included in the estimation of the breakpoint, it rises to approximately $ 7 000. This suggests that country-specific characteristics and changes over time make a substantial contribution to wellbeing as measured by the composite indicator. To investigate this possibility further, estimates of exogenous increases in the composite indicator exogenous contributions. This exercise is similar in spirit to Easterly's "Life during growth" paper, though more parsimonious thanks to the use of a composite indicator.[57] The (standardised) log of GDP per capita is regressed on the composite indicator with time and country fixed effects. The coefficients of the time fixed effects can then be interpreted as the global progress on the composite indicator regardless of increases in per capita GDP and differences between countries, while the country fixed effects reflect the performance of countries that is not

56. Deaton, "Income, Health and Wellbeing Around the World".
57. Easterly, "Life During Growth"; Croissant and Millo, "Panel Data Econometrics in R: The plm Package".

accounted for by per capita GDP and global progress.

Figure 8: Estimates and approx. 90 percent confidence intervals of unexplained time effects on the composite indicator given standardized log(GDPpc), 1820s–2000s.

Figure 8 shows the global progress on the composite indicator not attributable to per capita GDP and country-specific characteristics. It shows a strong increase, mostly occurring after 1950, but already beginning in the first half of the twentieth century. Since 1900 there has been a c. 1.5 point increase in the composite indicator which cannot be explained by income levels or country-specific characteristics. This is a very large increase which could explain, for example, almost all of the progress for the lowest-scoring countries seen in figure 5.

These strong exogenous increases are reminiscent of Preston's observations on the improvements over time in life expectancy at similar income levels.[58] Indeed, higher levels of life expectancy due to improved health technology are probably part of the explanation of what is seen here as well. However, given that it is only one part of the composite indicator, the contribution of health-technology cannot explain the full increase not accounted for by GDP and country-specific characteristics.

58. Preston, "Changing relation".

Like the technology concept in growth accounting, many things could be hidden in this residual. Besides improved health technology, the egalitarian revolution in the twentieth century could have contributed. The reversal in the relationship between per capita GDP and inequality could have had two effects. Directly, it lessened the negative impact of income inequality in the composite indicator. Indirectly, the more equitable distribution of income meant more people were included in income growth. This is especially relevant for society's most vulnerable members and people in the the early stages of their life course. The increases in social spending in the twentieth century, especially after the Second World War, could have had a similar impact.[59] More generally, states throughout the world began assuming responsibility for the wellbeing of their citizens in the twentieth century, which could result in improvements in wellbeing at lower levels of per capita GDP. A final possibility is that international aid led to increases in wellbeing in low-income countries.

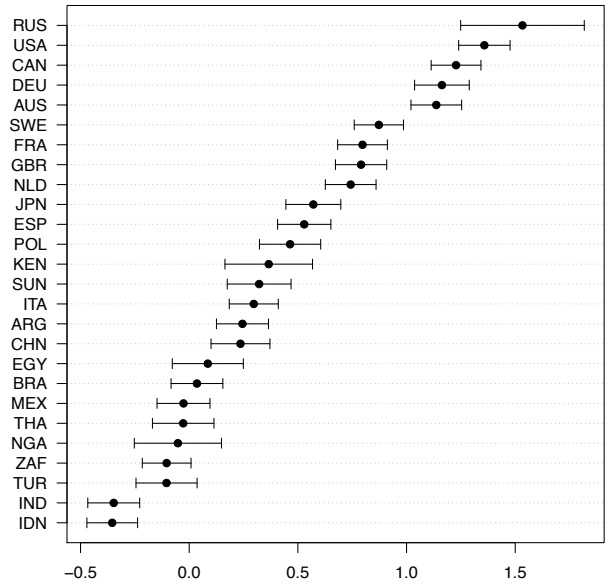

Figure 9: Estimates and approx. 90 percent confidence intervals of unexplained country-specific on the composite indicator given standardized (log) per capita GDP for selected countries

To further explore which of these mechanism is at play, a look at the country-fixed effects might be useful (figure 9). They show that part of the composite indicator that is not accounted for by per capita GDP or the global exogenous improvements over time. Russia gets the highest scores on the composite in-

59. Lindert, *Growing public*.

dicator for its income, but this estimate is based on very few observations (as indicated by the error bars). The Soviet Union, for which there are more observations, is actually a middling performer in this regard. Many countries in the developing world score low, even negative, which means they score less on the composite indicator than would be expected given their level of income. This is largely be due to controlling for time fixed effect, which captures any international improvements due to the diffusion of technology or international aid. The high position of the USA is also striking. In part this could be due to the country's strong performance in the early nineteenth century, but it could hint that other things might be at work than decreasing inequality and growing welfare states. The USA is after all a high-income, but relatively unequal country with a modest welfare state.

7 Conclusion

Given the dissatisfaction with per capita GDP as a measure of wellbeing, renewed efforts are being made to find alternative ways to assess the progress of nations. This paper has tried to make a contribution to this effort. With the recent availability of a wide range of wellbeing-indicators for a large number of countries for the 1820–2000 period, it is now possible to provide a long-term, comprehensive perspective of wellbeing. Seven indicators measuring six dimensions were investigated here: income by real wages, health by life expectancy and stature, education by average years of education, quality of political institutions by the polity IV index, income inequality by Gini coefficients, personal security by homicide rates.

These indicators show an optimistic picture. There has been great progress, though it was also characterised by increasing between-country inequality. The correlations between the indicators were generally high, suggesting that high wellbeing in various dimensions often went hand-in-hand. To investigate these issues further, a composite indicator of wellbeing was constructed. While such indicators are not without their problems, they are a useful tool to summarise developments. The composite indicator used here is a latent variable that can account for measurement error, missing data issues, and the nested structure of the data.

The long term picture shown by the composite indicator is again generally optimistic, in some cases more so than looking at income alone would show. Low-income countries in particular made more progress in the composite measure of wellbeing than in per capita GDP. The picture of wellbeing revealed by the composite indicator is also more accentuated. Divergence in the late nine-

teenth century was more pronounced. Western Europe and its offshoots started at a higher level and started making progress earlier than the rest of the world. This progress was stronger than per capita GDP alone would suggest. Convergence, on the other hand was also more pronounced. After a cautious start of a catch-up progress in the first half of the twentieth century, convergence since the 1970s in the composite indicator happened faster than in terms of per capita GDP. This shows that the reduction in between-country inequality found when looking at composite measures such as the HDI is a recent phenomenon.

The relationship of the composite indicator with per capita GDP was assessed in more detail. The composite indicator showed diminishing return to per capita GDP. Exogenous, global increases in wellbeing over time, not caused by higher levels of GDP or country-specific characteristics were an important part of this. Improvements in technology, the possibilities to translate more resources into higher wellbeing, were probably at play, though the exact content of this technology is hard to identify at the moment.

References

Alkire, Sabina and James Foster. "Counting and multidimensional poverty measurement". In: *Journal of Public Economics* 95.7 (2011), pp. 476–487. DOI: 10.1016/j.jpubeco.2010.11.006.

Allen, Robert C. "Engels' pause: Technical change, capital accumulation, and inequality in the British Industrial Revolution". In: *Explorations in Economic History* 46.4 (2009), pp. 418–435. DOI: 10.1016/j.eeh.2009.04.004.

Atkinson, A. B. and F. Bourguignon. "The Comparison of Multi-Dimensioned Distributions of Economic Status". In: *The Review of Economic Studies* 49.2 (1982), pp. 183–201. DOI: 10.2307/2297269.

Baten, Joerg and Matthias Blum. "Human height since 1820". In: *Global well-being since 1820*. Organisation for Economic Co-operation and Development, 2014, pp. 117–137.

Baten, Joerg, Winny Bierman, Jan Luiten van Zanden, and Peter Foldvari. "Personal security since 1820". In: *How Was Life?* Organisation for Economic Co-operation and Development, 2014, pp. 139–158.

Becker, Gary S., Tomas J. Philipson, and Rodrigo R. Soares. "The Quantity and Quality of Life and the Evolution of World Inequality". In: *The American Economic Review* 95.1 (2005), pp. 277–291.

Boarini, Romina and Marco Mira D'Ercole. "Going beyond GDP: An OECD Perspective*". In: *Fiscal Studies* 34.3 (2013), pp. 289–314. DOI: 10.1111/j.1475-5890.2013.12007.x.

Boarini, Romina, Margherita Comola, Conal Smith, Robert Manchin, and Femke de Keulenaer. *What Makes for a Better Life? The Determinants of Subjective Well-Being in OECD Countries – Evidence from the Gallup World Poll*. OECD Statistics Working Papers. Paris: Organisation for Economic Co-operation and Development, 2012.

Bolt, Jutta, Marcel Timmer, and Jan Luiten van Zanden. "GDP per capita since 1820". In: *How Was Life? Global well-being since 1820*. Organisation for Economic Co-operation and Development, 2014, pp. 57–72.

Bolt, Jutta and Jan Luiten van Zanden. "The Maddison Project: collaborative research on historical national accounts". In: *The Economic History Review* 67.3 (2014), pp. 627–651. DOI: 10.1111/1468-0289.12032.

Chakravarty, Satya R. "A Generalized Human Development Index". In: *Review of Development Economics* 7.1 (2003), pp. 99–114. DOI: 10.1111/1467-9361.00178.

Cooper, Richard S., Joan F. Kennelly, and Pedro Orduñez-Garcia. "Health in Cuba". In: *International Journal of Epidemiology* 35.4 (2006), pp. 817–824. DOI: 10.1093/ije/dyl175.

Costa, Dora and Richard H. Steckel. "Long-term trends in health, welfare, and economic growth in the United States". In: *Health and welfare during industrialization*. University of Chicago Press, 1997, pp. 47–90.

Crafts, N. "The Human Development Index, 1870–1999: Some revised estimates". In: *European Review of Economic History* 6.3 (2002), pp. 395–405.

Crafts, N.F.R. "Living standards". In: *Work and pay in twentieth-century Britain*. Ed. by N. F. R. Crafts, Ian Gazeley, and Andrew Newell. Oxford: Oxford University Press, 2007, pp. 11–34.

Crafts, N.F.R. "The Human Development Index and changes in standards of living: Some historical comparisons". In: *European Review of Economic History* 1 (1997), pp. 299–322.

Croissant, Yves and Giovanni Millo. "Panel Data Econometrics in R: The plm Package". In: *Journal of Statistical Software* 27.2 (2008).

Deaton, Angus. "Income, Health and Wellbeing Around the World: Evidence from the Gallup World Poll". In: *The journal of economic perspectives* 22.2 (2008), pp. 53–72. DOI: 10.1257/jep.22.2.53.

Dowrick, Steve, Yvonne Dunlop, and John Quiggin. "Social indicators and comparisons of living standards". In: *Journal of Development Economics* 70.2 (2003), pp. 501–529. DOI: 10.1016/S0304-3878(02)00107-4.

Duclos, Jean-Yves, David E. Sahn, and Stephen D. Younger. "Robust Multidimensional Poverty Comparisons". In: *The Economic Journal* 116.514 (2006), pp. 943–968. DOI: 10.1111/j.1468-0297.2006.01118.x.

Easterlin, Richard A. "The Worldwide Standard of Living since 1800". In: *The Journal of Economic Perspectives* 14.1 (2000), pp. 7–26.

Easterly, William. "Life During Growth". In: *Journal of Economic Growth* 4.3 (1999), pp. 239–276. DOI: 10.1023/A:1009882702130.

Escosura, Leandro Prados de la. "Human development in Africa: A long-run perspective". In: *Explorations in Economic History* 50.2 (2013), pp. 179–204. DOI: 10.1016/j.eeh.2013.01.001.

— "Improving Human Development: A Long-run View". In: *Journal of Economic Surveys* 24.5 (2010), pp. 841–894. DOI: 10.1111/j.1467-6419.2010.00639.x.

— "World Human Development: 1870–2007". In: *Review of Income and Wealth* 61.2 (2015), pp. 220–247. DOI: 10.1111/roiw.12104.

Feinstein, Charles H. and Mark Thomas. "A Plea for Errors". In: *Historical Methods: A Journal of Quantitative and Interdisciplinary History* 35.4 (2002), pp. 155–165. DOI: 10.1080/01615440209601205.

Fleurbaey, M., K. Decancq, and E. Schokkaert. "What good is happiness?" 2009.

Fleurbaey, Marc and Guillaume Gaulier. "International Comparisons of Living Standards by Equivalent Incomes". In: *Scandinavian Journal of Economics* 111.3 (2009), pp. 597–624. DOI: 10.1111/j.1467-9442.2009.01578.x.

Foldvari, Peter and Katalin Buzasi. "Political institutions since 1820". In: *How Was Life? Global well-being since 1820*. Organisation for Economic Co-operation and Development, 2014, pp. 159–177.

Gelman, Andrew and Jennifer Hill. *Data analysis using regression and multilevel/hierarchical models*. Analytical methods for social research. Cambridge etc.: Cambridge University Press, 2007. 625 pp.

Goldin, Claudia and Lawrence F. Katz. "The Origins of Technology-Skill Complementarity". In: *Quarterly Journal of Economics* 113.3 (1998), pp. 693–732. DOI: 10.1162/003355398555720.

Høyland, Bjørn, Karl Moene, and Fredrik Willumsen. "The tyranny of international index rankings". In: *Journal of Development Economics* 97.1 (2012), pp. 1–14. DOI: 10.1016/j.jdeveco.2011.01.007.

Jackman, Simon. *Bayesian analysis for the social sciences*. Wiley series in probability and statistics. Chichester: Wiley, 2009. 564 pp.

Jones, Charles I. and Peter J. Klenow. *Beyond GDP? Welfare across Countries and Time*. Working Paper 16352. National Bureau of Economic Research, 2010.

Kakwani, N. "Performance in living standards: An international comparison". In: *Journal of Development Economics* 41.2 (1993), pp. 307–336. DOI: 10.1016/0304-3878(93)90061-Q.

Kaufmann, Daniel, Aart Kraay, and Massimo Mastruzzi. "Governance Matters III: Governance Indicators for 1996, 1998, 2000, and 2002". In: *The World Bank Economic Review* 18.2 (2004), pp. 253–287. DOI: 10.1093/wber/lhh041.

— "The Worldwide Governance Indicators: Methodology and Analytical Issues". In: (2010).

Klugman, Jeni, Francisco Rodríguez, and Hyung-Jin Choi. "The HDI 2010: new controversies, old critiques". In: *The Journal of Economic Inequality* 9.2 (2011), pp. 249–288. DOI: 10.1007/s10888-011-9178-z.

Komlos, John. "Shrinking in a Growing Economy? The Mystery of Physical Stature during the Industrial Revolution". In: *Journal of Economic History* 58.3 (1998), pp. 779–802. DOI: 10.1017/S0022050700021161.

Lee, Sik-Yum. *Structural Equation Modeling: A Bayesian Approach*. John Wiley & Sons, 2007. 460 pp.

Leeuwen, Bas van and Jieli van Leeuwen-Li. "Education since 1820". In: *How Was Life? Global well-being since 1820*. Organisation for Economic Co-operation and Development, 2014, pp. 87–100.

Lindert, Peter Harrison. *Growing public: social spending and economic growth since the eighteenth century*. Cambridge etc.: Cambridge University Press, 2004.

Little, Roderick JA and Donald B. Rubin. *Statistical analysis with missing data*. New York: Wiley New York, 1987.

Maddison, Angus. *Monitoring the world economy, 1820-1992*. Development Centre studies. Paris: Organisation for Economic Co-operation and Development, 1995. 255 pp.

— *Phases of capitalist development*. Oxford: Oxford University Press, 1982. 298 pp.

— *The World Economy: A Millennial Perspective*. Development Centre Studies. Paris: OECD Publishing, 2001. 384 pp.

McGillivray, Mark. "The human development index: Yet another redundant composite development indicator?" In: *World Development* 19.10 (1991), pp. 1461–1468. DOI: 10.1016/0305-750X(91)90088-Y.

Merkle, E. C. "A Comparison of Imputation Methods for Bayesian Factor Analysis Models". In: *Journal of Educational and Behavioral Statistics* 36 (2011), pp. 257–267. DOI: 10.3102/1076998610375833.

Moatsos, Michail, Joerg Baten, Peter Foldvari, Bas van Leeuwen, and Jan Luiten van Zanden. "Income inequality since 1820". In: *How Was Life? Global well-being since 1820*. Organisation for Economic Co-operation and Development, 2014, pp. 199–215.

Morris, M D. "The Physical Quality of Life Index (PQLI)". In: *Development digest* 18.1 (1980), pp. 95–109.

Muggeo, Vito M. R. "Estimating regression models with unknown break-points." In: *Statistics in Medicine* 22 (2003), pp. 3055–3071.

Nardo, Michela et al. *Handbook on Constructing Composite Indicators: Methodology and User Guide*. OECD Statistics Working Paper 2005/3. OECD Publishing, 2005.

Nicholas, Stephen J. and Jacqueline M. Nicholas. "Male Literacy, 'Deskilling', and the Industrial Revolution". In: *The Journal of Interdisciplinary History* 23.1 (1992), pp. 1–18. DOI: 10.2307/205479.

Nordhaus, William D. and James Tobin. "Is growth obsolete?" In: *Economic research: Retrospect and prospect Vol 5: Economic growth*. Nber, 1972, pp. 1–80.

OECD. *How's Life?* How's Life? Paris: OECD Publishing, 2011.

Pamuk, Sevket and Jan-Luiten van Zanden. "Standards of living". In: *The Cambridge economic history of modern Europe*. Ed. by Stephen Broadberry and Kevin H. O'Rourke. Vol. I: 1700–1870. Cambridge: Cambridge University Press, 2010, pp. 217–234.

Plummer, Martyn. "JAGS: A program for analysis of Bayesian graphical models using Gibbs sampling". In: *Proceedings of the 3rd international workshop on distributed statistical computing*. Vol. 124. Technische Universit at Wien, 2003, p. 125.

Preston, Samuel H. "The Changing Relation between Mortality and Level of Economic Development". In: *Population Studies* 29.2 (1975), pp. 231–248. DOI: 10.2307/2173509.

Ravallion, Martin. "Mashup Indices of Development". In: *The World Bank Research Observer* 27.1 (2012), pp. 1–32. DOI: 10.1093/wbro/lkr009.

— "On multidimensional indices of poverty". In: *The Journal of Economic Inequality* 9.2 (2011), pp. 235–248. DOI: 10.1007/s10888-011-9173-4.

— "The human development index: a response to Klugman, Rodriguez and Choi". In: *The Journal of Economic Inequality* 9.3 (2011), pp. 475–478. DOI: 10.1007/s10888-011-9193-0.

— "Troubling tradeoffs in the Human Development Index". In: *Journal of Development Economics* 99.2 (2012), pp. 201–209. DOI: 10.1016/j.jdeveco.2012.01.003.

Rijpma, Auke. "A composite view of well-being since 1820". In: *How Was Life? Global well-being since 1820*. Ed. by Jan Luiten Van Zanden et al. Paris: OECD Publishing, 2014.

Schokkaert, Erik. "Capabilities and Satisfaction with Life". In: *Journal of Human Development* 8.3 (2007), pp. 415–430. DOI: 10.1080/14649880701462239.

Segers, Yves. "Oysters and rye bread: Polarising living standards in Flanders, 1800–1860". In: *European Review of Economic History* 5.3 (2001), pp. 301–336. DOI: 10.1017/S1361491601000120.

Sen, Amartya. *Commodities and Capabilities*. OUP India, 1999. 102 pp.

— *Development as Freedom*. Oxford [etc.]: Oxford U.P, 2001. 366 pp.

— *The standard of living: the Tanner Lectures*. Cambridge: Cambridge University Press, 1987.

Slottje, Daniel J. "Measuring the Quality of Life Across Countries". In: *The Review of Economics and Statistics* 73.4 (1991), pp. 684–693. DOI: 10.2307/2109407.

Srinivasan, T. N. "Human Development: A New Paradigm or Reinvention of the Wheel?" In: *American Economic Review* 84.2 (1994), pp. 238–243.

Steckel, Richard Hall and Roderick C. Floud, eds. *Health and welfare during industrialization*. A National Bureau of Economic Research project report. Chicago, IL etc.: The University of Chicago Press, 1997. 465 pp.

Stiglitz, J.E., A. Sen, and J.P. Fitoussi. *Report by the commission on the measurement of economic performance and social progress*. 2009.

Szreter, Simon. "The Population Health Approach in Historical Perspective". In: *American Journal of Public Health* 93.3 (2003), pp. 421–431. DOI: 10.2105/AJPH.93.3.421.

Treier, Shawn and Simon Jackman. "Democracy as a Latent Variable". In: *American Journal of Political Science* 52.1 (2008), pp. 201–217. DOI: 10.1111/j.1540-5907.2007.00308.x.

UNDP. *Human Development Report 1990: Concept and Measurement of human development*. New York: United Nations Development Programme, 1990.

— *Human Development Report 2010: The Real Wealth of Nations: Pathways to Human Development*. New York: United Nations Development Programme, 2010.

Usher, Dan. "An Imputation to the Measure of Economic Growth for Changes in Life Expectancy". In: *The Measurement of Economic and Social Performance*. Ed. by Milton Moss. Cambridge, MA: NBER, 1973, pp. 193–232.

— *The measurement of economic growth*. Columbia University Press New York, 1980.

Van Zanden, Jan Luiten et al., eds. *How Was Life? Global well-being since 1820*. Paris: OECD Publishing, 2014.

Voth, Hans-Joachim. "Living standards and the urban environment". In: *The Cambridge Economic History of Modern Britain*. Ed. by Roderick C. Floud and Paul Johnson. Vol. 1 1700–1860. 2004, pp. 268–294.

Williamson, J. G. "British Mortality and the Value of Life, 1781-1931". In: *Population Studies* 38.1 (1984), pp. 157–172. DOI: 10.2307/2174361.

Zanden, Jan Luiten van, Joerg Baten, Peter Foldvari, and Bas van Leeuwen. "The Changing Shape of Global Inequality 1820–2000; Exploring a New Dataset". In: *Review of Income and Wealth* 60.2 (2014), pp. 279–297. DOI: 10.1111/roiw.12014.

Zijdeman, Richard L. and Filipa Ribeiro de Silva. "Life expectancy since 1820". In: *How Was Life?* Organisation for Economic Co-operation and Development, 2014, pp. 101–116.

Zwart, Pim de, Bas van Leeuwen, and Jieli van Leeuwen-Li. "Real wages since 1820". In: *How Was Life? Global well-being since 1820*. Organisation for Economic Co-operation and Development, 2014, pp. 73–86.

A Objective wellbeing indicators and life satisfaction

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Log(GDPpc)	0.69***	0.36***	0.37*	0.59***	1.21***	0.71***	0.56***	0.81***
	(0.08)	(0.13)	(0.20)	(0.15)	(0.14)	(0.09)	(0.09)	(0.09)
1981-4	0.92	3.75***	7.45	0.72	−1.94**	−0.95	1.79**	−0.31
	(0.77)	(1.13)	(5.46)	(0.81)	(0.98)	(0.91)	(0.76)	(0.87)
1990-3	0.32	3.33***	6.80	0.10	−2.31**	−1.43	1.51**	−0.92
	(0.74)	(1.10)	(5.36)	(0.79)	(0.93)	(0.88)	(0.72)	(0.85)
1999-2001	0.26	2.93**	6.16	0.02	−2.44**	−1.80*	1.05	−0.91
	(0.75)	(1.13)	(5.39)	(0.81)	(0.95)	(0.92)	(0.74)	(0.85)
Lab. real wage		0.01***						
		(0.00)						
Height			−0.02					
			(0.04)					
Life exp.				0.02				
				(0.02)				
Av. years edu.					−0.22***			
					(0.05)			
Inequality						0.04***		
						(0.01)		
Polity							0.02	
							(0.01)	
Homicide rate								0.01
								(0.01)
R^2	0.98	0.99	0.99	0.98	0.98	0.99	0.99	0.98
Adj. R^2	0.98	0.99	0.99	0.98	0.98	0.99	0.99	0.98
Num. obs.	152	81	61	151	138	124	131	146
RMSE	0.90	0.80	0.76	0.90	0.85	0.82	0.80	0.88

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 3: Regression of wellbeing indicators on country-average life satisfaction responses in the WVS.

B Sensitivity of the composite indicator

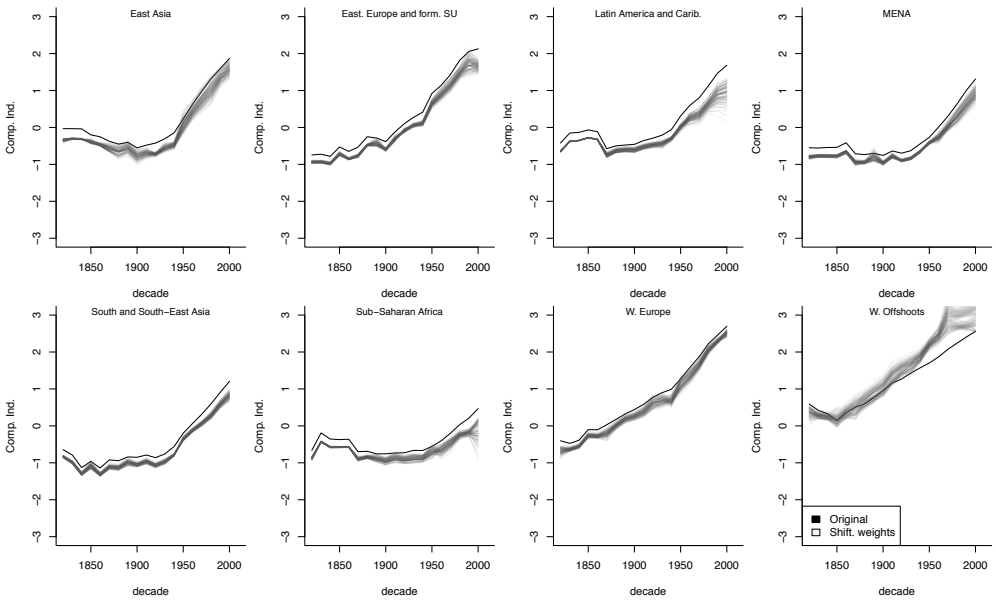

Figure 10: Regional trends of composite indicators constructed from varying weights (setting all combinations of one to all but one of the weights to 25 percent of an equal weight), 1820–2000.

C Tradeoffs in the composite indicator

In a series of important papers, Ravallion has pointed out the importance of specifying the tradeoffs implicit in a composite indicator.[60] Because the composite indicator here is a linear combination of standardised indicators, the loadings presented in table 2 give the tradeoffs in terms of the distribution of the data. The loadings can be interpreted as giving the effect of a one standard deviation increase in the indicators on the composite indicator. The ratio of two loadings gives the tradeoff between these indicators in terms of standard deviations. It is nonetheless useful to know the tradeoffs in in the actual units of The tradeoff between two indicators is given by the ratio of the partial derivatives of the composite indicator to each indicator: $\frac{\partial CI}{\partial x} / \frac{\partial CI}{\partial x}$. This means the he tradeoff for two indicator x and y in the composite indicators is given by $\frac{\beta_x}{\sigma_x} / \frac{\beta_y}{\sigma_y}$. These tradeoffs are presented in table 4.

	lab	hgt	lif	edu	ine	pol	hom
Real wage	1.00	0.14	0.36	0.08	-0.83	0.23	-1.36
Height	7.25	1.00	2.59	0.57	-6.04	1.66	-9.85
Life exp.	2.79	0.39	1.00	0.22	-2.33	0.64	-3.80
Av. years edu.	12.83	1.77	4.59	1.00	-10.69	2.93	-17.44
Inequality	-1.20	-0.17	-0.43	-0.09	1.00	-0.27	1.63
Polity	4.37	0.60	1.56	0.34	-3.64	1.00	-5.94
Homicide rate	-0.74	-0.10	-0.26	-0.06	0.61	-0.17	1.00

Table 4: Tradeoffs in the composite indicator

60. Ravallion, "Mashup indices", "Multidimensional indices", "Human development index".