The Productivity-Welfare Linkage:
A Decomposition

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Abstract

According to Paul Krugman (1994, chapter 1), "Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker." But productivity and the standard of living are different concepts and are measured in different ways, so the question is, what is the linkage between them? Productivity is typically measured by GDP per hour. The standard of living has potentially many aspects such as health, longevity, personal security, and relationships. But here I take a narrower view and stick to the national accounts. So the standard of living is measured by the household disposable income of the median individual. I use the median rather than the mean so that inequality is taken into account. I develop a decomposition of the growth of median household income which relates it to the growth of productivity via eight additional factors, one of which is inequality; four other factors are measures of labour market performance. I apply this decomposition to the UK over the period 1977 to 2019. I find that productivity growth was far and away the most important factor in accounting for the growth of living standards which was substantial up to 2007; rising inequality prior to 2007 retarded the growth of living standards but not by much. Since 2007 productivity growth has collapsed as has also the growth of living standards. The fall in the latter has been mitigated a bit by a fall in inequality.

1. Introduction[1]

According to Paul Krugman (1994, chapter 1), "Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker." Though this seems intuitively likely, the link between the two concepts is not straightforward. A standard measure of productivity is GDP per hour worked (an improvement on Krugman's GDP per worker). A reasonable measure of what might be termed economic welfare or the standard of living is what the UK's Office for National Statistics calls "median equivalised households disposable income". Households disposable income (HDI) is the income that people actually receive from all sources, including cash benefits, and after taxes on income. The median not the arithmetic mean is studied, since we are interested in the experience of the typical person and the mean may be distorted by the gains accruing to the rich (the top 1% or top 0.1%). We may also be interested in the welfare of other groups, say the bottom 20% or 5%. And in a welfare context household income per equivalent adult is better than just household income per person since households differ in size and by whether or not they contain children; use of an equivalence scale allows for the different needs of different groups.

The aim of this paper is to present a decomposition of the growth of economic welfare which links it through a series of factors to the growth of productivity. These factors include inequality, the relative prices of consumption and output, the share of households in national income, household composition, and a set of labour market factors including unemployment and labour force participation. The decomposition is then quantified on UK data for the period 1977-2019. So at the end we will be able to say how much of the growth of living standards is due to the growth of productivity and how much to the growth of these other factors, at least in a statistical sense.

Of course, welfare (or well-being) in the broad sense is multi-dimensional and amongst the aspects excluded from purely economic welfare as defined here are leisure, personal freedom and autonomy, a fulfilling emotional life, and economic security (which includes the value provided by the social safety net even to those who do not currently need to make any use of

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it). Good health and a long life expectancy are also clearly an important part of welfare in the broad sense. Though all these aspects of welfare may be linked to productivity in some way I do not pursue these issues here and focus solely on economic welfare.

In what follows I first discuss the relationship between GDP and welfare. I then focus in Section 3 on a particular concept of welfare, namely "Median equivalised households disposable income" (Median EHDI). This concept allows us to respond to two criticisms of GDP as a welfare measure, namely that it is remote from the incomes that ordinary people receive and it ignores inequality: GDP per head is the arithmetic mean of GDP but this can be rising even if it is only the rich who are getting richer; indeed rising GDP per head is compatible with the poor getting poorer. The Median EHDI concept has the advantage that it can be readily measured in practice, in the UK from 1977 onwards. Household disposable income is part of the System of National Accounts (SNA) and the median part comes from household surveys. Later in section 3 I present the decomposition which links our productivity measure, GDP per hour worked, with our welfare measure. Section 4 then presents and discusses the results of implementing the decomposition on UK data. Section 5 concludes.

2. GDP and welfare

GDP is and always was intended to be a measure of output and income, not of welfare. In current prices, it measures the value of goods and services produced for final consumption, private and public, present and future; future consumption is covered since GDP includes output of investment goods. Converting to constant prices allows one to calculate growth of GDP over time (or differences between countries across space).[2]

Though not a *measure* of welfare, GDP can be considered a *component* of welfare. The volume of goods and services available to the average person clearly contributes to welfare in the wider sense, though of course it is far from being the only component. So one can

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[2] The distinction between output and welfare can be seen very clearly when the effects of an exogenous, favourable change in the terms of trade are analysed in a small open economy. Under competitive assumptions this raises real consumption and welfare but leaves GDP unchanged. This is the conclusion of economic theory and also of the SNA when correctly applied (Oulton 2021).

imagine a social welfare function that has GDP as one of its components along with health, inequality, human rights, etc. (see comments below on the Stiglitz-Sen-Fitoussi Report).

GDP is also an *indicator* of welfare. In practice, in cross-country data, GDP per capita is highly correlated with other factors that are important for human welfare. In particular, it is positively correlated with life expectancy, negatively correlated with infant mortality, and negatively correlated with inequality. In other words, richer countries tend to have longer life expectancy, lower infant mortality, and lower inequality, although this last relationship is not a linear one: some middle-income countries have high inequality, but nonetheless the richest countries are also the most equal ones (Oulton 2008, 2012). Correlation is not necessarily causation, though one might certainly make the case that higher GDP per capita causes improved health (Fogel 2004; Deaton 2013).

I have argued that there is nothing wrong with the concept of GDP as long as it is correctly understood as a measure of output, though there is room for disagreement about where the production boundary should be set (Oulton 2021). But equally there is no need to stick with GDP as just an indicator of welfare if we can do better and measure welfare directly. A first step is to use the rest of the SNA, augmented by data on distribution, the approach taken in this paper. But some would go much further. According to the influential Commission on the Measurement of Economic Performance (the Stiglitz-Sen-Fitoussi Commission), policy should be concerned with well-being, and well-being is multi-dimensional (Stiglitz et al., 2009, page 15):[3]

"To define what well-being means a multidimensional definition has to be used. Based on academic research and a number of concrete initiatives developed around the world, the Commission has identified the following key dimension that should be taken into account. At least in principle, these dimensions should be considered simultaneously:
i. Material living standards (income, consumption and wealth);
ii. Health;
iii. Education;
iv. Personal activities including work;
v. Political voice and governance;
vi. Social connections and relationships;
vii. Environment (present and future conditions);
viii. Insecurity, of an economic as well as a physical nature."

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[3] The Stiglitz-Sen-Fitoussi Report led to the OECD's "Beyond GDP" programme, subsequently rebranded as "GDP and beyond".

Few will disagree that these dimensions of life are important for human welfare and no-one can object to improved measurement. There is clearly a role for government in measuring and tracking these dimensions. To what extent, however, a dimension like "social connections and relationships" should be objects of government policy is open to question. It is doubtful that effective policy levers exist. And, even if they did, the scope for a vast extension of the reach of government will not suit every taste.

A promising area that could lead to a wider concept of welfare is health. Life expectancy rose steadily throughout the 20th century if we ignore the world wars and the 1918 flu pandemic. Pre-Covid at least it was still rising on average in the 21st century. This means that people have more years in which to enjoy the higher consumption they now receive, an aspect of welfare which is not captured just by the GDP statistics. But recently the United States has seen a rise in mortality among less-educated, middle-aged whites due it seems to self-harming behaviour – drug and alcohol dependency, accidents and suicide (Case and Deaton 2017), so-called "deaths from despair". Whether this is a specifically American phenomenon, related perhaps to deficiencies in the US social safety net (Edin and Shaefer 2015), or whether the same phenomenon is appearing in other developed countries is not yet clear.[4]

If one sticks to measurement and is somewhat less ambitious than the Stiglitz-Sen-Fitoussi Report, then further progress is possible. Jones and Klenow (2016) use an expected utility framework to combine measures of life expectancy, inequality and consumption to construct what they call a consumption-equivalent welfare measure for a large sample of countries. Their measure turns out to be highly correlated with GDP per capita.

Should the welfare measure be explicitly adjusted for inequality?
A more ambitious path than the one followed in this paper is to construct a welfare measure which explicitly incorporates value judgements about inequality. One of the best-known of these measures is based on the Atkinson index of inequality (Atkinson, 1970):

$$Z = \left(\frac{1}{N} \sum\nolimits_{i=1}^{N} y_i^{1-\varepsilon} \right)^{1/(1-\varepsilon)}, \ \varepsilon \geq 0$$

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[4] Life expectancy has increased in the UK over the last 40 years, albeit at a slower pace in the last decade. This is of course compatible with considerable divergence in life expectancy across income groups and geographies. The years 2018 to 2020 saw a small decrease (7 weeks) in male life expectancy attributable to the Covid-19 pandemic; female life expectancy is so far unaffected. It is too early to say whether the reduction in male life expectancy will prove permanent or temporary (Office for National Statistics 2021).

where y_i is the income of the *i*-th person, *N* is the number of people, and ε is a parameter measuring "inequality aversion". If $\varepsilon = 0$ then society cares nothing for inequality, in which case the Atkinson measure reduces to GDP per head.

In the standard treatment, of which the Atkinson index is an example, inequality is bad *per se*, though people may differ in the extent to which they are inequality averse. I would argue that our moral intuitions about inequality are too complex to be wholly captured by this formulation. In particular, the crucial issue of merit or desert is omitted. If the Atkinson approach were the whole story, then social welfare would be raised by abolishing two institutions (among others): the national lotteries run in many countries and the Nobel prizes. Both increase inequality unambiguously. Indeed, Nobel prizes must be the most unequally distributed of all forms of income: only a dozen or so individuals receive one each year out of a world population of some 8 billion. Nobel prizes could be justified on Rawlsian grounds: monetary incentives are needed to induce the effort required to make discoveries that benefit everyone, including the worst off. But suppose that it could be conclusively shown that the monetary rewards are not necessary, and that the prize winners (and their less-successful colleagues) would have expended the same effort in exchange for just the honour and glory alone? I suspect that most people would still be quite happy to see the winners receive a monetary reward, even if it was not economically required. This is because they are perceived to deserve it. With national lotteries, a different form of desert comes into play. In the UK version, some winners receive £20 million or more, and, in one sense, no-one is worth this amount. But anyone can buy a lottery ticket and, as long as the lottery process is perceived as fair (not rigged), most people are quite happy with the outcome.

Merit or desert is a complex issue and it may be that people's views are not entirely consistent. Who gets the money and for what may well make a difference. The large rewards paid to professional footballers are seen by most people as justified (as long as they are playing well), but not the similar-sized rewards paid to bankers, especially after the global financial crisis.

In summary, it is not clear that the Atkinson index would meet with universal approval, even setting aside the issue of greater or lesser "taste" for inequality (the parameter ε).

Two arguments against using GDP and the SNA to measure welfare

Two arguments are often used to disparage GDP and related measures. The first is that raising GDP is irresponsible because of the environmental damage this would cause. A striking example of this argument is in a report from the UK's premier scientific association, the Royal Society (Royal Society 2012). There it was claimed that in order to allow for a modest increase in the material standard of living of the world's poorest, consumption in richer countries must be reduced, according to my calculations by about 37% in the UK case (Oulton 2012). However this type of argument should not be taken as a criticism of the validity of GDP (and the related national accounts concept of consumption), concepts which the argument itself deploys, but is really about the feasibility of future growth of GDP, however desirable this would otherwise be.

A second argument for the irrelevance of GDP to realistic policy debates relates particularly to the United States. It is often claimed that in the United States there has been a virtual disconnect between productivity and living standards since the 1970s: productivity has grown massively but living standards have stagnated. This claim is then often extended to other rich countries including Britain, without much evidence. It is non-controversial that income inequality has been rising for decades in the US, but does this mean that the typical household has received no benefit from growth? A comprehensive examination of these issues appears in Wolff *et al*. (2012). Their results, as interpreted by Oulton (2012), reveal quite a different picture.

They define a number of income concepts that are superior to GDP as a measure of household welfare. Their preferred measure is what they call the Levy Institute Measure of Economic Well-Being (LIMEW). This is household income after tax and benefits, including non-cash benefits, and also with an allowance for household production. They put their preferred measure on an equivalent basis; "equivalent" means that corrections are made for changing household size and composition. For LIMEW they report both the median and the arithmetic mean of equivalent income. Their measure is similar to but broader than the one in the present paper. They estimated the LIMEW over the period 1959–2007 and for various sub-periods. Since measuring economic welfare over time is the objective, they convert each measure to real terms using the CPI (actually the CPI-U).

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Over their whole period median equivalent LIMEW rose at 1.01% p.a. while GDP per capita rose at 2.18% p.a. So the typical American certainly benefited from a growth in living standards over this period. But on the other hand there is a big gap between these two growth rates. Some, but only some, of this gap is due to rising inequality. Mean equivalent LIMEW rose at 1.31% p.a. So if inequality had remained constant the standard of living of the typical American would have risen faster by 0.30 percentage points per year. Much of the remainder of the gap between their measure of welfare and GDP per capita is due to the choice of deflator. They mostly use the CPI-U but if they had used the deflator for personal consumption expenditure instead this would have knocked about another 0.45% percentage points per year off the gap, while raising the growth of living standards by the same amount. Arguably, the deflator for personal consumption expenditure is a better measure in this context since it has a wider coverage of what people are actually consuming.

The conclusion is that the median US individual has gained significantly from economic growth since 1959. This remains the case even though the median individual would have gained more (to the extent of 0.30% p.a.) if inequality had not widened. Furthermore, and contrary to a common view, the largest gains were in the 1980s. These gains continued, albeit at a slower rate, in the 1990s and even into the 2000s (Oulton 2012, Table 2).[5]

I now turn to an examination of welfare and productivity in the UK case.

3. Measuring economic welfare in the UK
Median equivalised households disposable income
A good starting point for the UK is the Office for National Statistics' (ONS) concept of "Median equivalised households disposable income", where disposable income can be more specifically defined as "Net Household Adjusted Disposable Income" (ONS 2014). This is defined as income from private sources (wages, pensions, dividends, interest), minus capital consumption (depreciation) attributable to households, plus cash benefits minus taxes, and plus "social transfers in kind" from the provision of state services which accrue to households such as free education and health care (this last is the "adjusted" part). In practice, the published series of "Median equivalised household disposable income" (MEHDI) are not

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[5] A parallel literature examines the relationship between wages and productivity and asks whether the two have become decoupled. For the UK Teichgräber and Van Reenen (2021) answer this question in the negative.

quite so ambitious: they are for *gross* household disposable income and they are *not* adjusted for social transfers in kind (ONS 2017); see ONS (2016) for a guide to data sources. Capital consumption and social transfers in kind are available in the national accounts but are not available at the level of individual households. Note that the data used here whether from the national accounts or from surveys are strictly for households only and do not include income accruing to Non-profit Institutions Serving Households (NPISH).

The equivalence scale which the ONS uses is "the modified OECD scale" (Anyaegbu 2010). Under this a couple has a weight of 1, a single adult a weight of 0.67. A second or subsequent adult has a weight of 0.33, as do dependents aged over 12. Children under 14 have a weight of 0.2. This is the way that the equivalisation process is described in the official documentation though it can lead to misunderstanding. In fact the incomes of all persons in a household are added together, then this total is assigned to *each* member of the household. Finally, each income is *divided* (not multiplied) by the total of the weights assigned to each person in the household.[6] The mean and median equivalised income (and other quantiles) for the whole sample are then calculated across individuals, not households. The median equivalised income is therefore that of the typical individual, not that of the typical household.[7]

HDI as a share of GDP at market prices averaged 64% over our period. So 36% of GDP is not assigned to households, suggesting that it has no impact on household welfare. This is clearly far too extreme a conclusion. To the contrary, it might be argued that all this 36% accrues to households one way or another. The strongest case here is with the undistributed profits of companies which on average raise share prices and therefore accrue to the owners, ultimately households, though usually ownership is mediated via pension funds or insurance companies. But the bulk of the 36% is "social transfers in kind", mainly free primary and

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[6] An example may help. Suppose a household has just one adult member whose income is £9,000. The weight for a single adult is 2/3, so this person is assigned an equivalised income of £13,500 (= £9,000 ÷ 2/3). Now consider a second household with two adults; the first adult has an income of £30,000 and the second one of £9,000. The total household income is £39,000. The sum of the weights is 2/3 + 1/3 = 1. So each of the two adults is assigned an income of £39,000 which is 4.33 times the income of the person in the first household. Without equivalisation and assuming income sharing in the second household, each person in the latter would receive £19,500 or 2.17 times the single person in the first household. So with equivalisation each person in the second household is calculated to be much better off than the single person, relative to the position without equivalisation. I am grateful to the ONS for helping me to understand this issue better.

[7] Though it is widely accepted that one should make some adjustment for household size and composition, the equivalence scale used here is rather crude. It would be preferable to have the scale vary with income and prices (Deaton and Muellbauer 1980, chapter 8). I am grateful to Rachel Soloveichik for helpful discussion on this.

secondary education and free health care; social transfers in kind constituted 23% of gross HDI in 2019.[8] Clearly if you are sick it is better to receive free health care than not. But it is better not be sick in the first place. So rising government expenditure on health care should not be translated automatically into higher welfare. Even so, some allowance for health and educational expenditures would be desirable. But this would require us to allocate these expenditures across households, which would be far beyond the scope of the present paper. Hence a pragmatic case can be made for focusing on income which accrues directly to households and which they are free to spend as they wish.

For comparisons over time we need to deflate nominal MEHDI by a price index for which the ONS uses a consumer price index or in practice the CPIH (i.e. the CPI with both owner-occupied and rented accommodation included) but with council tax excluded. This is in line with theoretical work suggesting that for a welfare measure the whole of income, the part saved as well as the part consumed, should be deflated by the price index of consumption since the purpose of saving is to change the time pattern of consumption (Weitzman 1976; Sefton and Weale 2006).

A more basic criticism of MEHDI as a welfare measure is that it makes no allowance for the utility of leisure: £10 (net of tax) earned through an extra hour of labour is counted as £10 of additional welfare, even though the additional consumption (current and/or deferred) is bought at the price of one hour less of leisure. This is the intuition behind the suggestion of Basu and Fernald (2002), see also Basu *et al*. (2012), that the growth of TFP is an appropriate measure of welfare change. That is to say, even if MEHDI is the appropriate measure of income, we should subtract from its growth the growth of labour input weighted by labour's share. This amounts to valuing an hour of leisure at the hourly wage. I have not chosen to go down this route due to doubts that the labour market is in equilibrium. One piece of evidence supporting this doubt is that a substantial fraction of part-time workers say that they would like to work longer hours than they do. Also, it turns out that in the UK case the leisure correction would have only a small impact (see below).

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[8] See Table 6.2.5 of the 2020 Blue Book, downloadable as bb20chapter06hnsectorfinal.xlsx from https://www.ons.gov.uk/economy/grossdomesticproductgdp/compendium/unitedkingdomnationalaccountstheblubook/2020. As mentioned earlier depreciation (capital consumption) is included in MEHDI though ideally it should be excluded. However it only constituted 3-5% of HDI in our period; see Table 6.2.1 of the 2020 Blue Book at the same URL.

The decomposition

To measure welfare we are focusing on Median Equivalised Households Disposable Income ($EHDI^{median}$) as defined above. Denote the corresponding arithmetic mean by $EHDI^{mean}$. Let us take our aggregate productivity measure to be GDP per head (below we extend the decomposition to GDP per *hour*).

The transformation between productivity on the right-hand side and welfare on the left-hand side can be written as the product of a set of factors as follows:

$$EHDI^{median} \equiv \left(\frac{EHDI^{median}}{EHDI^{mean}} \right) \left(\frac{EHDI^{mean}}{HDI / N} \right) \left(\frac{HDI}{GDP} \right) \left(\frac{GDP}{N} \right) \tag{1}$$

This relates median EHDI through a series of factors to GDP per capita (*GDP*/*N*) where *N* is the population. This is just an identity but the factors can be given an economic interpretation and also can be tracked over time. The factors are:

1. $\dfrac{EHDI^{median}}{EHDI^{mean}}$: a measure of inequality. If this rises, inequality is falling. If the distribution of *EHDI* is (approximately) lognormal, then this ratio equals $\exp(-\sigma^2 / 2)$ where σ^2 is the variance of log income. In the lognormal case all measures of inequality such as the Gini are monotonically related to the parameter σ^2.

2. $\dfrac{EHDI^{mean}}{HDI / N}$: a measure of household composition or of the effect of equivalisation. The numerator is the arithmetic mean of equivalised HDI while the denominator is the mean of HDI without equivalisation, where *N* is population. If household size is rising due to more single persons partnering up, with other things the same, then the mean of the equivalised HDI rises in relation to the mean of the unequivalised distribution. This is because the equivalence scale embodies the idea that two can live more cheaply than one.

3. $\dfrac{HDI}{GDP}$: the share of total income accruing to households. This is in part a measure of the size of the welfare state. The ratio rises if the government spends more on transfers or reduces tax. It also rises if net foreign income accruing to households rises

as a proportion of GDP. It falls if corporations distribute less of their profits back to households in the form of dividends.

So far the decomposition is similar to the one employed by Nolan et al. (2018). The main difference is that they use Gross National Income (GNI) rather than HDI for most of their analysis. GNI includes income accruing to sectors other than households (NPISH, corporations and the government). But we are not quite ready yet to analyse Krugman's contention since the right-hand side of equation (1) features GDP per capita not GDP per hour. These two concepts can be linked through a second identity:

$$\frac{GDP}{N} \equiv \left(\frac{H}{N}\right)\left(\frac{GDP}{H}\right)$$

$$\equiv \left(\frac{H}{(1-u)L}\right)(1-u)\left(\frac{L}{N^{wa}}\right)\left(\frac{N^{wa}}{N}\right)\left(\frac{GDP}{H}\right) \tag{2}$$

where H is aggregate hours worked, L is the number of people in the labour force (employed plus unemployed), u is the unemployment rate, and N^{wa} is the number of people of working age (defined here as those aged 16 and over). The factors on the right-hand side can be given the following interpretation:

4. $\dfrac{H}{(1-u)L}$: hours per worker, or labour intensity.

5. $1-u$: The employment rate or 1 minus the unemployment rate (u).

6. $\dfrac{L}{N^{wa}}$: the labour force participation rate.

7. $\dfrac{N^{wa}}{N}$: the proportion of the population which is of working age, defined here as those aged 16+ as a proportion of the total population. Traditionally the working age population has been defined as 16-59 for women and 16-64 for men but this seems unrealistic given that pension age is being aligned for both sexes, compulsory retirement has been abolished, and more people are working into their 70s.

These four additional factors all have a natural economic or demographic interpretation.

Putting equations (1) and (2) together the full decomposition is

$$EHDI^{median} \equiv \left(\frac{EHDI^{median}}{EHDI^{mean}}\right)\left(\frac{EHDI^{mean}}{HDI/N}\right)\left(\frac{HDI}{GDP}\right)\left(\frac{H}{(1-u)L}\right)(1-u)\left(\frac{L}{N^{wa}}\right)\left(\frac{N^{wa}}{N}\right)\left(\frac{GDP}{H}\right)$$

(3)

This decomposition is for median household income but could be adapted for any other quantile, such as equivalised HDI at the lowest quintile, the poorest fifth, or $EHDI^{quin1}$. With $EHDI^{quin1}$ on the left-hand side the first ratio on the right-hand side must then be changed to

$$\frac{EHDI^{quin1}}{EHDI^{mean}}$$

which can also be interpreted as a measure of inequality.

This decomposition applies at a point in time or in other words income and output are in current prices. But the main interest is in tracking changes over time, i.e. we want to relate real HDI to real GDP. Real GDP is related to nominal GDP by the implicit GDP deflator, P^{GDP}, while real HDI is related to nominal HDI by an index of consumer prices, P^{CE}: the ONS employs a version of the CPIH which includes owner-occupied and rented housing but excludes council tax (since the latter is subtracted from HDI). The decomposition now becomes

$$\frac{EHDI^{median}}{P^{CE}} \equiv$$

$$\left(\frac{EHDI^{median}}{EHDI^{mean}}\right)\left(\frac{EHDI^{mean}}{HDI/N}\right)\left(\frac{HDI}{GDP}\right)\left(\frac{H}{(1-u)L}\right)(1-u)\left(\frac{L}{N^{wa}}\right)\left(\frac{N^{wa}}{N}\right)\left(\frac{P^{GDP}}{P^{CE}}\right)\left(\frac{GDP}{P^{GDP}H}\right)$$

(4)

Now we have introduced an eighth factor:

8. $\dfrac{P^{GDP}}{P^{CE}}$: the price of GDP as a whole relative to the price of consumption. This can be thought of as reflecting technological trends, i.e. relative rates of productivity growth in different industries. For example the price of investment goods may be falling relative to that of consumption goods but the opposite may be the case for government services such as health and education (at least as conventionally measured). It may also reflect changes in the terms of trade: the price of consumption is influenced by the price of imports while the GDP deflator is influenced by the price of exports.

The (logarithmic) growth rate of living standards can now be thought of as the sum of the growth rates of the eight factors on the right-hand side of equation (4) plus the growth of

productivity. So equation (4) yields an additive decomposition relating the growth of living standards to the growth of productivity. An increase in any of the eight factors raises living standards in relation to productivity.

With the possible exception of the relative price factor, all the other factors in equation (4) have natural limits, whether logical or economic (e.g. the unemployment rate must lie between zero and one). Hence productivity is the only long run driver of living standards though the same may not be true in the short run.

There are a number of ways in which the decomposition could be expanded if that were thought likely to yield further insights. For example, the income share of households, HDI/GDP, could be broken down further to show the separate contributions of taxes and benefits to changes in this ratio. And productivity growth itself could be broken down into the contributions of TFP and capital deepening.

Of course the proposed decomposition is not unique. A silly alternative to equation (2) is the following:

$$\frac{GDP}{N} \equiv \left(\frac{H}{N}\right)\left(\frac{GDP}{H}\right) \equiv \left(\frac{H}{G}\right)\left(\frac{G}{N}\right)\left(\frac{GDP}{H}\right)$$

where G is goals scored in the English Premiership. So H/G is the number of (whole economy) hours required to score a goal in the Premiership and G/N is the number of goals per head of population. These two factors clearly yield no insights into productivity or welfare.

A second objection is that the decomposition of equation (4) is by definition just an identity. So a theory would clearly be preferable. But a theory covering all the factors in (4) would have to be very broad. Here is a sketch of one possibility to illustrate the difficulties. Suppose that technical progress has been biased towards skills which require more education. The wages of the less-skilled, particularly males, have therefore declined. These individuals find themselves at a disadvantage in the marriage (or partnership) market. Since partnership is assortative by education levels, less educated women are less likely to find satisfactory partners and so have fewer children. So fertility declines, accelerating the ageing process (which is due to greater longevity in the first instance). The less educated turn off from conventional politics because it seems less and less attuned to their interests, more to the

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interests of the better educated. This in turn sparks a reaction in the form of populism, which leads to policy changes affecting the size of the state, etc, etc. All of this is of course highly controversial. And it would take a great deal of work to check whether the evolution of the factors is consistent with the theory just sketched. Even if it is, one would also have to see whether some alternative theory could explain the same facts at least as well. In the meantime the decomposition can serve as a guide to further research.

4. Results for the UK

The UK data

Equivalised and non-equivalised household disposable income, mean and median, and by quintile, come from a spreadsheet entitled hdiireferencetables201920update.xlsx downloaded on 1st June 2021. These data underlie the regular *Statistical Bulletin on Household Income Inequality*.[9] The data are for calendar years up to 1993, thereafter for fiscal years (April to March); I have ignored this break. The source is the Living Costs Survey supplemented from Fiscal Year Ending (FYE) 2017 by the Household Finances Survey. Currently 17,000 private households are surveyed. Estimates of income from 2001/2002 onwards have been adjusted by the ONS for the under coverage of top earners, using data from Her Majesty's Revenue and Customs (HMRC). Both mean and median EHDI are deflated in the source by a special version of the CPIH (the CPI including both owner-occupied and rented accommodation) which excludes council tax; the council tax element of the CPIH is excluded since HDI excludes council tax payments. The data on EHDI go back only to 1977 so this is the starting point of the analysis. These data currently stop in 2019/2020 so this marks the endpoint (which is conveniently also the start of the Covid-19 pandemic).

GDP (in current prices and in chained volume form), HDI, population and the labour market (hours worked, employment, and unemployment) can be quantified using the UK's national accounts, all downloadable from the ONS website. The GDP deflator is calculated as the ratio of the current price measure of GDP to the chained volume measure, both at market prices. A full description is in the Appendix.

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[9] The latest version is at
https://www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/incomeandwealth/bulletins/householdincomeinequalityfinancial/financialyearending2020 .

Results

Table 1 shows the mean growth rates of the standard of living and of productivity over this period. It also shows growth over the sub-periods 1977-1990, 1990-2007, and 2007-2019. These sub-periods are so defined since 1990, 2007 and 2019 are all cyclical peaks. Over the whole 43-year period the standard of living actually grew somewhat faster than productivity (1.88% p.a. compared to 1.73% p.a.) but this was not true in the central sub-period (1990-2007). Across the three sub-periods the average growth rate of living standards (the overall median EHDI) has been falling.[10] But productivity grew at almost the same rate 1990-2007 as it did over 1977-1990. The years since the global financial crisis have seen a collapse in the growth of both measures.

To check whether there is anything unusual about the median, Table 1 also shows the growth of living standards in the lowest quintile (the poorest fifth) and in the highest (the richest fifth) of the distribution of EHDI. In the first sub-period, 1977-1990, the highest quintile did much better than the lowest one. In the subsequent two sub-periods the lowest quintile did a bit better than the highest. Nonetheless over the whole 43 years the highest quintile did best.

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[10] Margaret Thatcher, prime minister from 1979 to 1990, was of course an exceptionally wicked woman. Even so she failed to reduce the growth of living standards below that of productivity during her time in office. In fact these years saw faster growth of living standards than in either of the two subsequent sub-periods.

Table 1
Growth rates of the standard of living and of productivity, 1977-2019 (% p.a.)

	1977-1990	1990-2007	2007-2019	1977-2019
Standard of living	3.07	1.96	0.47	1.88
Productivity	2.35	2.34	0.21	1.73
Standard of living by quintile				
Lowest (poorest) quintile	1.21	2.41	0.14	1.39
Highest (richest) quintile	4.43	2.19	0.03	2.26

Source: Office for National Statistics; see text for details.
Note: Standard of living is measured by real Median Equivalised Household Disposable Income, productivity by real GDP per hour worked. The standard of living is deflated by the CPIH excluding council tax. Real GDP is the chained volume measure of GDP at market prices. The standard of living of the lowest quintile is the median EHDI in that quintile; similarly for the highest quintile.

Chart 1 shows the growth of our two main measures and also of an intermediate measure, GDP per head, over the whole period. (In this and subsequent charts grey bars mark recessions, defined as years in which on a quarterly basis GDP was mostly falling: 1980-1981, 1991-1992, and 2008-2009.) Broadly speaking all three measures move in line with each other. When productivity growth is high so too is the growth of living standards. And when productivity growth crashes in the most recent period, so too does the growth of living standards. However, despite the strength of the long-term relationship, at an annual frequency they are not closely related at all: the correlation between the annual growth rates of living standards and of productivity in the whole 43 year period is only 0.045 (which is not significant at conventional levels). Regressing the growth of living standards on its own lag and contemporaneous and lagged productivity growth does not improve things: neither contemporaneous nor lagged productivity growth is significant and the fit is poor.

Chart 1

Productivity and welfare, 1977-2019
£, 2018 prices, log scale

Note: Shaded bars mark recessions; MEHDI: real Median Equivalised HDI.
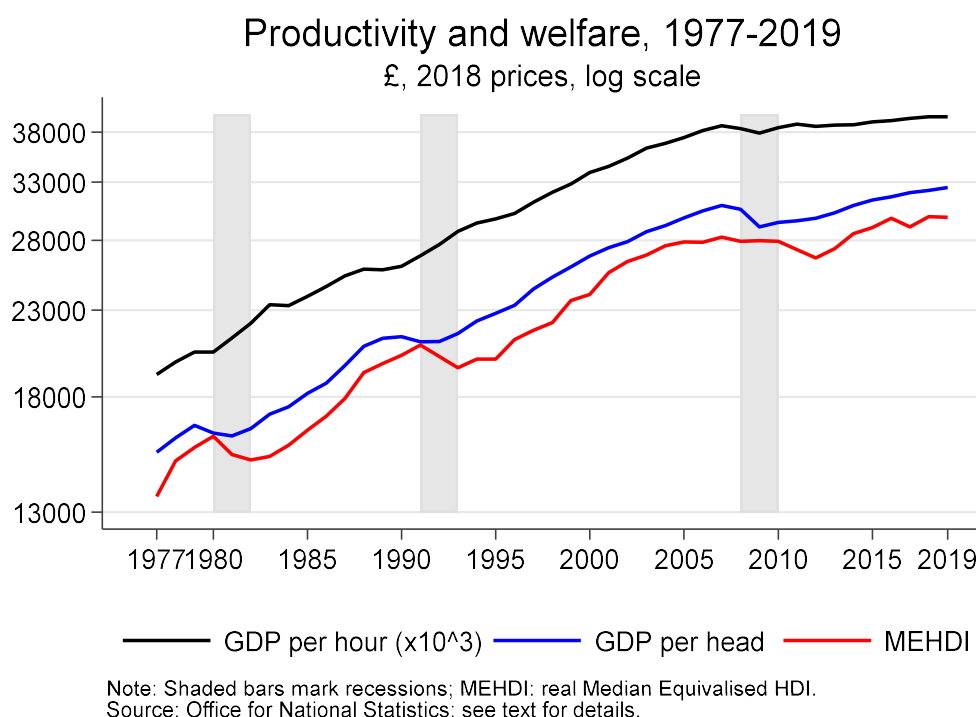Source: Office for National Statistics; see text for details.

Table 2 shows the decomposition for the median. The biggest single factor, and the only one apart from the demographic effect which is consistently positive, i.e. favourable to living standards, is productivity. Over the whole period it accounts for 92% of the growth of living standards. But since 2007 its contribution has been much smaller, only 45%. This figure is rather misleading though: it is 45% of a much smaller number than in the other sub-periods. The exceptional nature of the years since 2007 is also apparent from this table. Many of the other factors change sign and become larger in absolute value.

It is also interesting to compare the first sub-period (1977-1990) with the second (1990-2007) since living standards rose most rapidly in the first while productivity growth was virtually the same. Looking at the first two columns of Table 2, we can see that the largest changes in the factors between these two sub-periods were firstly in the relative price effect and secondly in the equivalisation effect. Rising inequality had a negative effect up to 2007; the size of this effect varied little between the two sub-periods.

Up to 2007 the four labour market variables (labour intensity, unemployment rate, labour force participation rate and the working age proportion) are not collectively very important. They accounted for +5.4% of growth in living standards in 1977-1990 and -7.8% in 1990-

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2007. But after 2007 with the collapse of productivity growth the picture changes. Collectively the labour market variables now account for nearly half (+46.3%) of the meagre growth in living standards that actually occurred.

Table 2
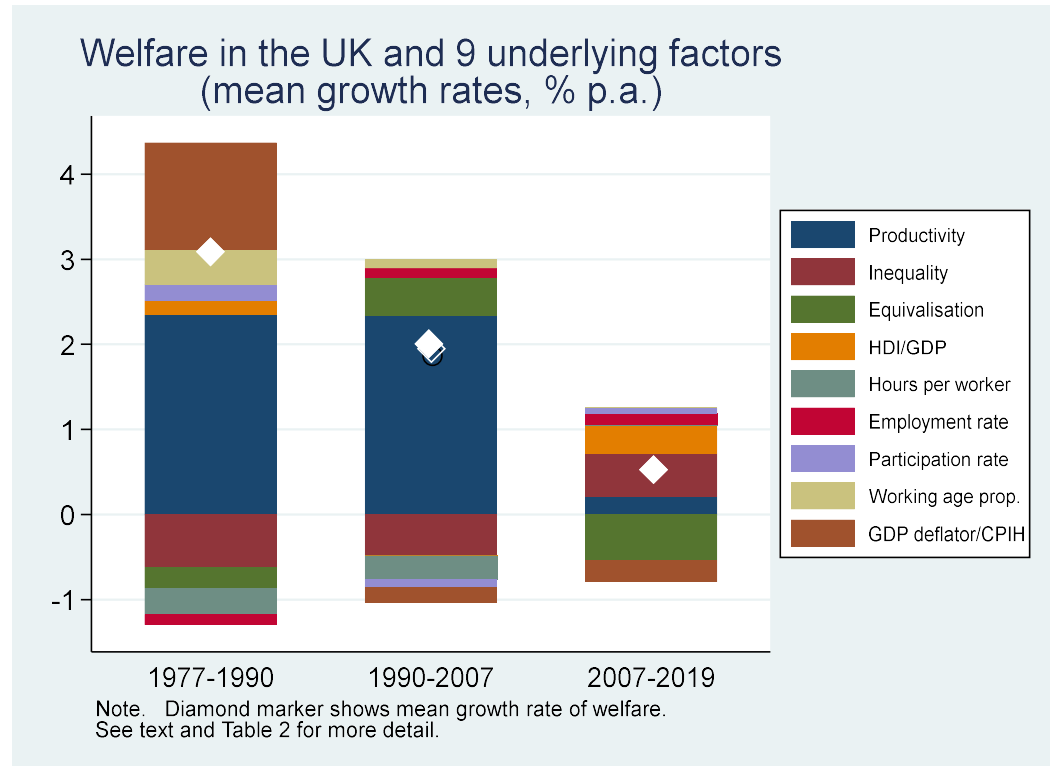Contributions to the growth rate of the standard of living, 1977-2019

Factor	Measure	1977-1990	1990-2007	2007-2019	1977-2019
Standard of living	Growth rate of Median EHDI (% p.a.)	3.07	1.96	0.47	1.88
Contributions (%)					
1. Inequality	Median EHDI/Mean EHDI	-20.2	-24.4	109.1	-12.8
2. Equivalisation	Mean EHDI/Mean HDI	-8.1	22.7	-115.7	-2.7
3. Share of households in total income	HDI/GDP (both in current prices)	5.5	-0.3	69.3	7.6
4.-7. Labour market	Sum of factors 4-7	5.4	-7.8	46.3	2.7
4. Labour intensity	*Hours per person employed*	*-10.0*	*-14.1*	*2.4*	*-10.8*
5. Employment rate	*1 minus the unemployment rate*	*-4.0*	*5.8*	*28.1*	*2.4*
6. Labour force participation rate	*Labour force/population aged 16+*	*6.2*	*-4.7*	*14.4*	*2.1*
7. Demographic effect	*Proportion of population aged 16+*	*13.2*	*5.2*	*1.4*	*9.0*
8. Relative price	GDP deflator/CPIH)	41.0	-9.0	-54.3	13.0
9, Productivity	GDP per hour worked	76.4	119.1	45.3	92.2
	TOTAL	100.0	100.0	100.0	100.0

Source: Office for National Statistics; see text for details.
Note: EHDI: Equivalised Household Disposable Income, deflated by the CPIH excluding council tax. Labour force: persons employed (employees plus self-employed) plus unemployed.

Another way of looking at the findings of Table 2 is shown in the stacked bar chart, Chart 2.

Chart 2

Welfare in the UK and 9 underlying factors (mean growth rates, % p.a.)

Note. Diamond marker shows mean growth rate of welfare.
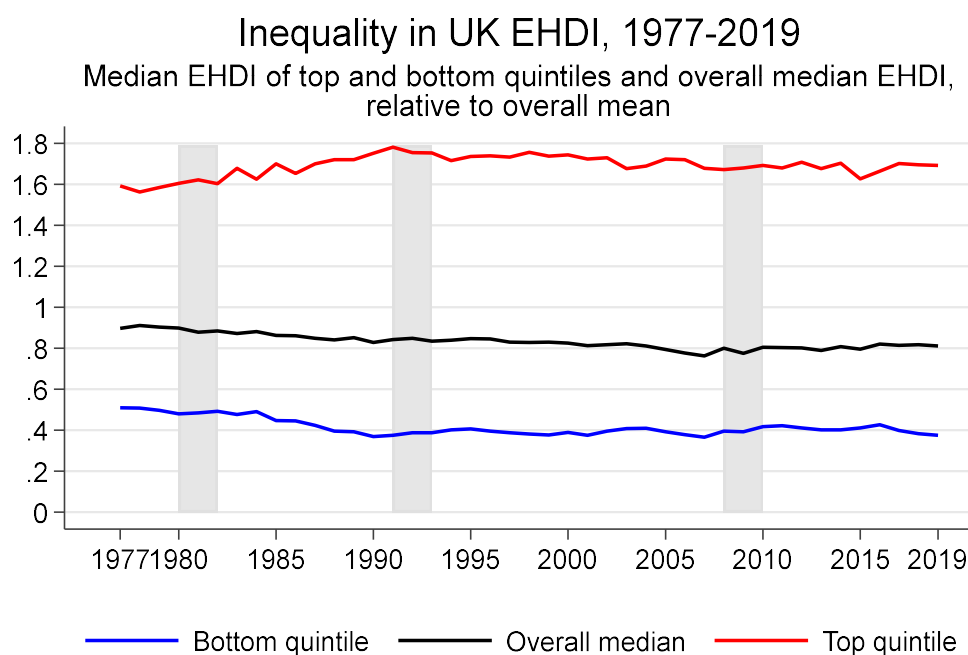See text and Table 2 for more detail.

Each of the eight factors in Table 2 will now be discussed in turn with the help of charts 3-9.

1. Inequality: Median EHDI relative to Mean EHDI (Chart 3)

Median EHDI fell relative to Mean EHDI from 1977 to 2007, in other words, inequality was rising, but since then the opposite has occurred, i.e. inequality has fallen. So rising inequality reduced living standards in relation to productivity from 1977 to 2007 but the opposite occurred during and after the Great Recession. If we were focusing on the experience of the poorest quintile, Chart 3 shows that inequality stopped rising earlier, in the early 1990s, and thereafter has remained fairly constant.

Chart 3

Inequality in UK EHDI, 1977-2019
Median EHDI of top and bottom quintiles and overall median EHDI,
relative to overall mean

Note: Shaded bars mark recessions; see text for definitions of variables.
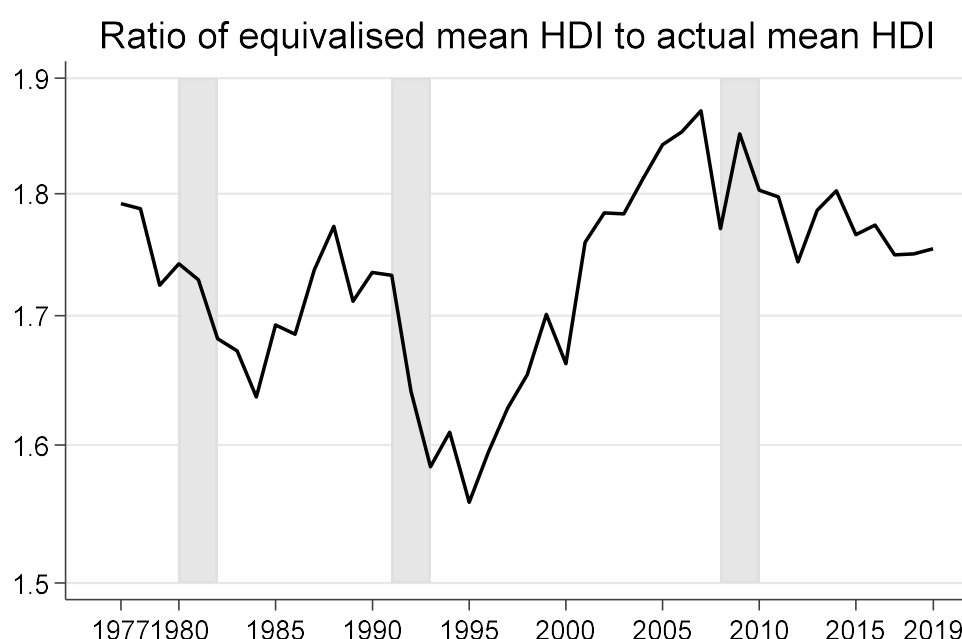Source: Office for National Statistics; see text for details.

2. Equivalisation: Equivalised mean HDI relative to actual mean HDI (Chart 4)

This factor compares two arithmetic means: the mean of equivalised HDI and the mean of actual (non-equivalised) HDI. In principle any changes in the ratio of the two means should be due to variations in household composition. For example, if household size is rising then more people are partnering up. So with the same incomes individuals are getting better off since two can live more cheaply than one: this is what equivalisation is designed to measure. Taken literally, the chart suggests that household size hit a low point around 1995 and thereafter rose till the onset of the Great Recession. But there may be another factor at work. "Equivalised mean HDI" is the arithmetic mean of equivalised incomes across individuals and comes from a sample survey (nowadays the Living Costs and Food Survey supplemented by the Survey on Living Conditions). "Actual mean HDI" is HDI from the national accounts divided by total population. Since the two series come from different sources they may not be fully consistent, despite the fact that all these series have the status of "National statistics", i.e. meet various quality standards as defined by the regulator, the Office for Statistics Regulation.[11]

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[11] The population covered by the national accounts is wider than that of the surveys which exclude the institutional population (residents of care homes, students in student accommodation (halls of residence), prisoners, NHS workers in NHS accommodation,

There is another reason for doubting whether this factor is actually measuring the effect of equivalisation. Mean equivalized HDI from the surveys is always substantially larger than actual mean HDI from the national accounts (the ratio of the two means over the whole period is 1.73); this by itself should not affect the analysis of growth rates. But mean HDI from the surveys, *without* equivalization, is also substantially larger than actual mean HDI from the national accounts and follows a very similar path to the *equivalized* mean from the surveys.[12] In fact, the average size of households did not change between 1990 and 2019: in both years it was 2.6 persons for the non-retired and 1.5 for the retired. So it appears that this factor is not in practice capturing the effect of equivalization and the issue requires further investigation.

Chart 4

Ratio of equivalised mean HDI to actual mean HDI

Note: Shaded bars mark recessions.
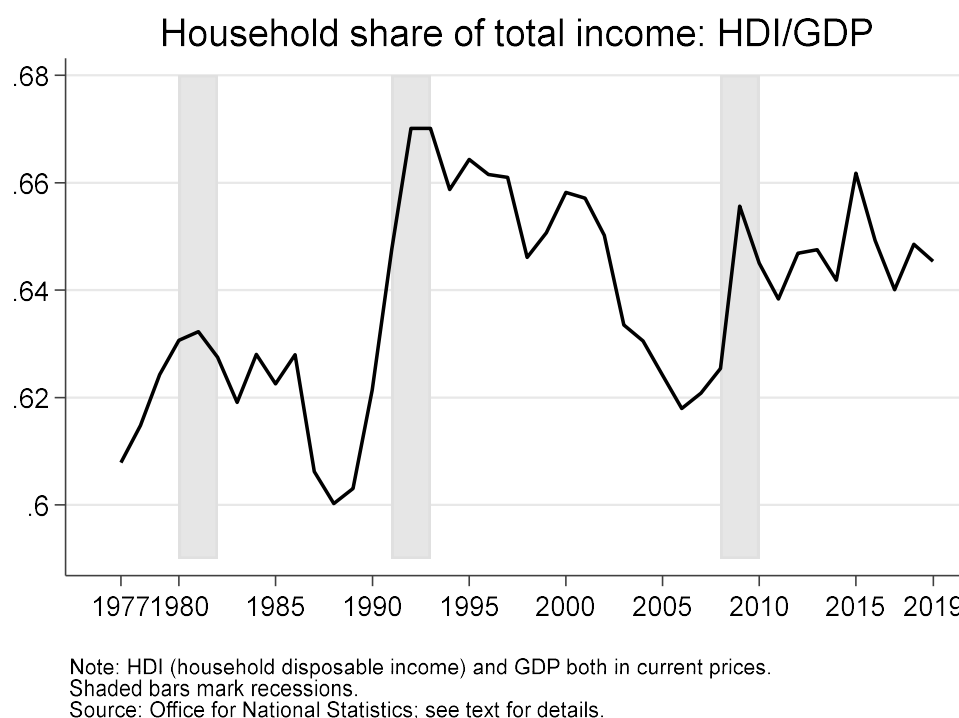Source: Office for National Statistics; see text for details.

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members of the Armed Forces living in barracks, and people living in hotels/B&Bs/homeless shelters as well as the homeless and travelling communities). But it is hard to believe that changes in the size of the institutional population could account for such wide swings as seen in Chart 4.

[12] I am grateful to the ONS for providing me with this series. See https://www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/incomeandwealth/adhocs/13864timeseriesofnonequivalisedhouseholddisposableincomeandhouseholdcharacteristicsuk.

3. Household share of total income: HDI/GDP (Chart 5)

This ratio rose sharply by some 7 percentage points between the late 80s and early 90s, before falling again till the Great Recession began; thereafter it has been rising again. Both HDI and GDP are in current prices and come from the national accounts. These large swings must therefore mainly reflect changes in taxes and cash benefits. After falling inequality, the rise in the household share was the largest single factor supporting living standards following the Great Recession. This presumably reflects the welfare state doing its job.

Chart 5

Household share of total income: HDI/GDP

Note: HDI (household disposable income) and GDP both in current prices.
Shaded bars mark recessions.
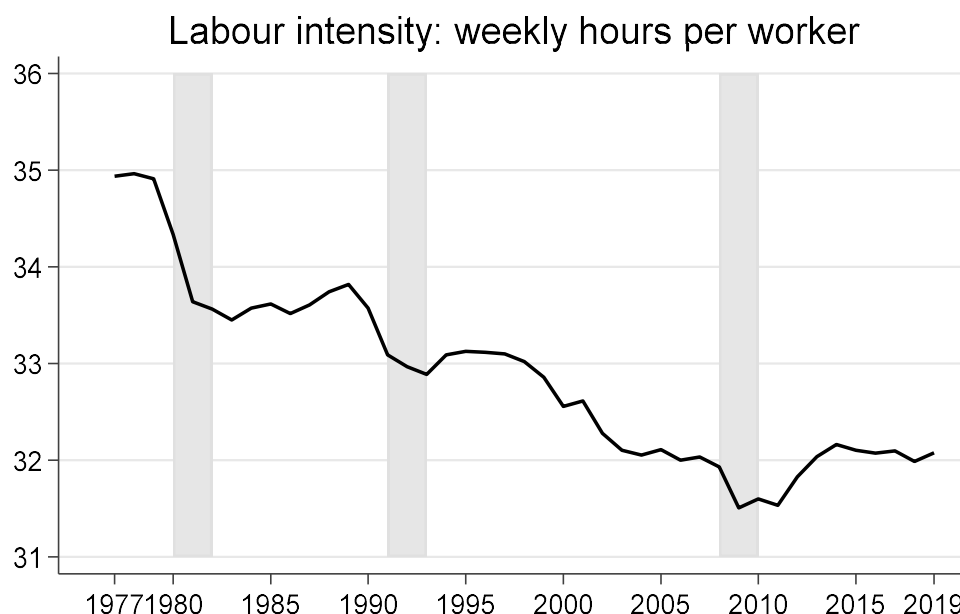Source: Office for National Statistics; see text for details.

The remaining factors cover different aspects of the labour market.

4. Labour intensity: Weekly hours per worker (Chart 6)

Labour intensity has fallen steadily over this period though a bit faster during the three recessions. British workers now work three hours per week less than they did in 1977. This no doubt reflects in part the growth of part-time working. Fewer hours per week reduces living standards in relation to productivity, though recall that there is no attempt here to put a value on additional leisure (assuming it to be voluntary).

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Chart 6

Labour intensity: weekly hours per worker

Note: Total weekly hours divided by total in employment (inc. self-employed).
Shaded bars mark recessions.
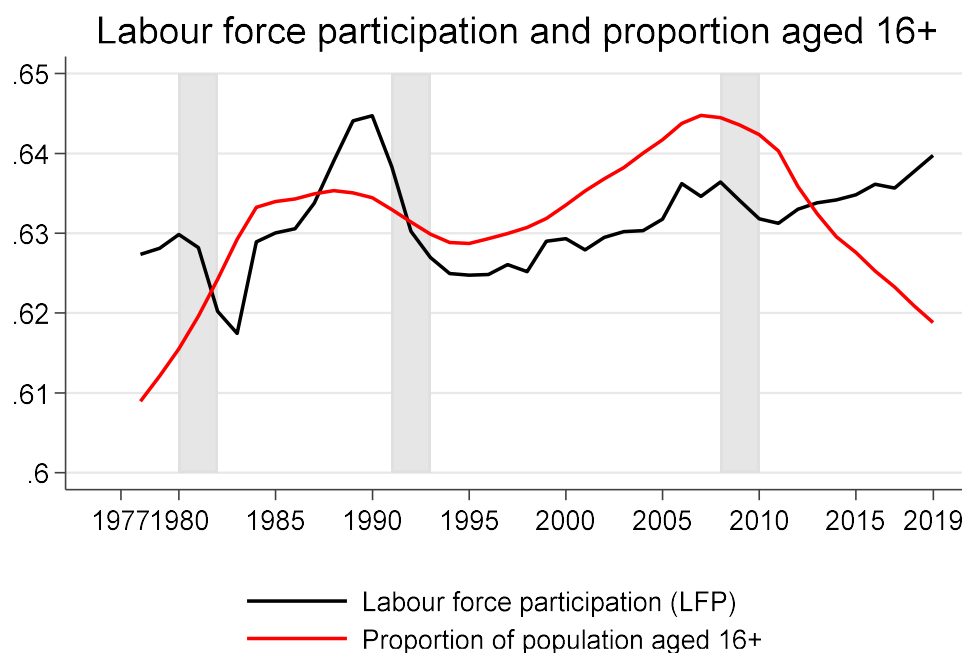Source: Office for National Statistics; see text for details.

5. Labour force participation (Chart 7)

Labour force participation (measured as the employed plus the unemployed as a proportion of the population aged 16+) peaked in 1988, then fell till 1995. After that it rose steadily till the end of our period. But in 2019 it was still lower than it had been in 1988. So changes in participation were broadly favourable to living standards from 1995 onwards, even though participation in 2019 was lower than it had been in 1988. This may seem a surprisingly downbeat assessment of the role of labour force participation given the amount of attention given to the so-called "jobs miracle" in the UK: from 1995 to 2019 employment rose by almost 7 million or 27%%. But most of these new jobs went to foreign-born workers (Oulton 2019), whose numbers also swelled the population. So there was comparatively little effect on economic welfare as measured here which is on a per capita basis.

6. Adult population (aged 16+) as proportion of total (Chart 7)

The proportion of the population aged 16+ rose up until the Great Recession. This was favourable to living standards but the effect was reversed after that.

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Chart 7

Labour force participation and proportion aged 16+

Note: LFP: Employed plus unemployed as proportion of all aged 16+
Source: Office for National Statistics; see text for details.

7. Unemployment rate (Chart 8)

Apart from hours worked this is the only variable which is markedly influenced by recessions. The rate rose sharply in all three recessions; during and after the 1980-81 recession it nearly doubled. But apart from these spikes it has been on a downward trend and by 2019 it was lower than it had been in 1977. So putting it the other way round, the employment rate has broadly increased and contributed positively to the growth of living standards. But given the amount of commentary and political attention devoted to unemployment it is surprising at first sight how small an effect it has had on economic welfare as measured here. The explanation is presumably that the welfare measure does not allow for the insecurity and loss of self-esteem that many people undoubtedly feel on becoming unemployed.

**Chart 8**

Unemployment rate, %

Note: Unemployed/(employed plus unemployed).
Shaded bars mark recessions.
Source: Office for National Statistics; see text for details.

8. Relative price: The price of output relative to that of consumption (Chart 9)

The relative price of output (GDP), the GDP deflator relative to the CPIH, increased sharply from 1977 to 1989, falling back a bit till 2000 and thereafter showing no clear trend. The sharp rise in the earlier years may be due to the strengthening of the real exchange rate. This occurred partly because of a rise in the price of petroleum products leading to a boom in exports of oil and gas from the North Sea (which was just then coming on stream) and partly because of high interest rates resulting from tight monetary policy. Either way, the price of exportables rose relative to that of importables. The CPI is influenced by the latter but not the former so it fell relative to the GDP deflator.

Chart 9

The GDP deflator relative to the CPIH
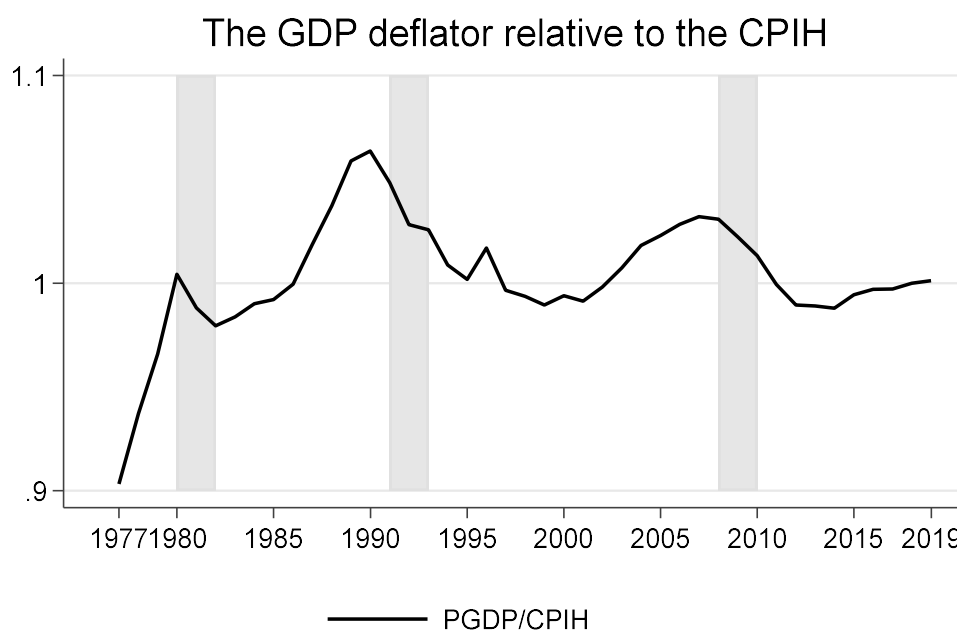
Note: CPIH: CPI including housing but excluding council tax. 2018=1.0.
Shaded bars mark recessions.
Source: Office for National Statistics; see text for details.

Finally, what effect would allowing for leisure have on these results (as suggested by Basu and Fernald (2002): see above)? If we consider the growth of annual hours worked per person aged 16+, then this has drifted down over most of the years since 1977, i.e. leisure has increased, though it rose a bit after 2007. From 1977 to 2007, hours worked per person aged 16+ were on average falling at 0.25% p.a. so multiplying by labour's share would raise the growth rate of the standard of living by only about 0.15 percentage points per annum.

Conclusion

A decomposition has been developed to relate the growth of living standards (or economic welfare), measured by median household disposable income per equivalised adult, to the growth of productivity, measured by GDP per hour worked. The decomposition involves eight factors, each of which can be given an economic or demographic interpretation. The decomposition has been quantified over the period 1977-2019.

The main findings ae as follows:

1. At an annual frequency there is essentially no relation between growth of productivity and growth of living standards.

2. Over a longer time horizon Krugman's intuition is verified. Productivity and living standards move together over the whole 43-year period 1977-2019 and also within the three sub-periods spanning these 43 years.

3. Applying the statistical decomposition developed here, productivity growth was much the most important factor accounting for living standards up till 2007. Over 2007-2019 it accounted for only 45% of the growth of living standards. But this was a period in which productivity grew very slowly (0.21% p.a.).

4. Up till 2007 inequality was increasing but had only a relatively minor effect on retarding the growth of living standards. After 2007 inequality declined and this had a modest effect in mitigating the effect of low productivity growth on living standards: living standards grew at 0.47% p.a. compared to 0.21% p.a. for productivity.

5. The labour market and demographic factors played only a minor role up to 2007. After 2007 they helped to support living standards.

6. The relative price effect (GDP deflator relative to the CPIH) was favourable to living standards in 1977-1990, unfavourable after 2007.

A decomposition by itself cannot explain anything. But it can be used as a diagnostic tool. If all the factors except productivity stayed constant then welfare and productivity would grow at the same rate. Or we might find that the factors are all changing, but in an offsetting fashion. Or the growth of the factors taken together may impart an upward or downward movement to welfare relative to productivity. But the message of Table 2 seems unequivocal: if you want to raise living standards you have to raise productivity.

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APPENDIX

All UK variables were downloaded from the ONS website (ons.gov.uk). Further details on the sources for the UK statistics used in this paper now follow.

National accounts variables	*cdid*
GDP, at current market prices, £m	YBHA
GDP, at market prices, CVM, £m, 2018 prices	ABMI
Household disposable income (gross), £m	HABN
Capital consumption of households, £m	HAZH
Population, mid-year, usually resident, number	UKPOP

These variables are from the 2020 Blue Book, available for download online as bb20chapter01naataglancefinal-1.xlsx and bb20chapter06hnsectorfinal.xlsx.

Labour market variables	
Total weekly hours worked, millions	YBUS
Employment, age 16+, thousands	MGRZ
Unemployment, age 16+, thousands	MGSC
Unemployment rate, age 16+, %	MGSX
Inactive, age 16+, thousands	MGSI

Derived variables	
GDP per hour (productivity)	$1000*ABMI/(52*YBUS)$
GDP deflator (2018=1)	$YBHA/ABMI$
Labour force participation rate	$(MGRZ+MGSC)/$ $(MGRZ+MGSC+MGSI)$
Proportion of population aged 16+	$(MGRZ+MGSC+MGSI)/$ $UKPOP$

Household level variables

The following variables are taken from a spreadsheet entitled hdiireferencetables201920update.xlsx downloaded on 1st June 2021. These data underlie the regular *Statistical Bulletin on Household Income Inequality*. At the time of writing the latest

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version is at

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Real median equivalised household disposable income, all people, £ per year, 2019/2020 prices (Sheet "Table 1")

Real mean equivalised household disposable income, all people, 2019/2020 prices (Sheet "Table 1")

Real median equivalised household disposable income of people in the lowest quintile of equivalised income, £ per year, 2019/2020 prices (Sheet "Table 2")

Consumer price index including owner-occupiers' housing costs (CPIH) excluding council tax (Sheet "Table 31")