Technical Appendix:
Growth Accounting

Benchmark Growth Accounting

In the growth-accounting exercise in our paper *We Don't Need No Education? The Case for Expanding Higher Education* (see chapter titled "Higher Education and Economic Growth"), we follow the approach of Vollrath (2020), which is itself based on the Solow growth model.[i] The aim is to decompose output per capita growth into the contributions of human capital, physical capital and total-factor productivity, that is the part of growth that cannot be explained by improvements in the quantity and quality of labour and capital inputs.

$$g_y = e_H g_H + e_K g_k + g_{tfp}$$

where g_H is per capita growth in a human capital index (explained below), g_k is per capita growth in physical capital and g_{tfp} is growth in total-factor productivity and e_H and e_K are the labour and capital shares of income respectively.[ii] Below we explain each of these components in turn.

HUMAN-CAPITAL INDEX

The per capita human-capital index is defined as follows:

$$H = \frac{\overline{h^{educ}} \times \overline{h^{exp}} \times Workforce \times Hours}{Population}$$

It consists of three components: the average education index h^{educ}, the average experience index h^{exp}, and total hours worked. These are estimated as follows using data from the Labour Force Survey. It should be noted that these are aggregate-level (economy-wide-level) components.

Education Index

The first component of the human-capital index is the education index:

$$\overline{h^{educ}} = \frac{\sum_{j=1}^{N} \frac{hrs_j}{\overline{hrs}} \times h_j^{educ}}{N}$$

where the contribution of each worker is weighted according to their hours worked, hrs_j (and non-workers' education is not counted at all, though they do add to the whole-population denominator N because we are interested in output per capita). Each worker's contribution is an increasing function of their years in education, s_j:

$$\ln h_j^{educ} = 0.1 \times s_j$$

That is to say, we assume that each additional year of education adds 10 per cent to the productivity of the individual.

We do not observe years of education directly in our Labour Force Survey data. Therefore, we use a variable capturing the age in which the individual completed full-time education. To map this onto a measure of an individual's years in education, we assume that the individual was studying continuously up to this age. This assumption will not be satisfied for those who repeated a year of schooling or were not in education continuously. This is not necessarily a problem because in our analysis we are interested in annual growth rates: it is reasonable to assume that the share of individuals who repeated a year or take breaks during their education has been broadly stable over time.

Experience Index

The second component of human capital is the experience index:

$$\overline{h^{exp}} = \frac{\sum_{j=1}^{N} \frac{hrs_j}{\overline{hrs}} \times h_j^{exp}}{N}$$

where similarly each worker's contribution is weighted according to their hours worked. The contribution of each worker is a quadratic function of their age:

$$\ln h_j^{exp} = 0.05 \times age_j - 0.0007 \times age_j^2$$

This function is increasing in age up to the age of 35, at which point it starts declining.

Total Hours Worked

The final component is total hours worked. We calculate this by multiplying the total number of workers by average hours worked. Note that we include self-employed and second-job hours.

Finally, since we are interested in output per capita, we divide by the total population obtained from ONS data.

PHYSICAL-CAPITAL COMPONENTS

For the physical-capital index, we use the ONS 1995–2020 chained volume measure of gross capital stock. As above, we use ONS population data to derive physical capital per capita and then calculate the annual growth rate.

TOTAL-FACTOR PRODUCTIVITY

Total-factor productivity is a residual and is calculated as shown in the above equation by subtracting the weighted contributions of human and physical capital from output per capita growth:

$$g_{tfp} = g_Y - e_H g_H - e_K g_k$$

Forward Projections

This section outlines the assumptions behind the forward projections in the last part of the paper chapter on Higher Education and Economic Growth, which explores the potential for education to propel future growth. The base data for the projections is from the 2019 Labour Force Survey.[iii]

EDUCATIONAL STAGNATION

In the scenario where educational attainment stagnates, the distribution of education levels of those aged 18 to 30 for future cohorts remain the same as in the 2019 cohort – those aged under 30 in 2019 will not all have finished their education. We assume this because educational attainment increases up to the age of 30 in the 2019 Labour Force Survey. We allow the current population to age, and hence, poorly educated cohorts retire and are replaced by better educated ones. In this sense, educational attainment continues to grow at older ages, but we keep employment rates by age and education level constant.

We assume that population will grow according to ONS 2020 projections and that workforce growth equals population growth. This is in line with the fact that employment rates per age and education level are kept fixed by assumption. Finally, we assume that average hours worked, the experience index, physical capital and total-factor productivity will continue growing at their 1997–2019 average rate.

70 PER CENT UNIVERSITY PARTICIPATION

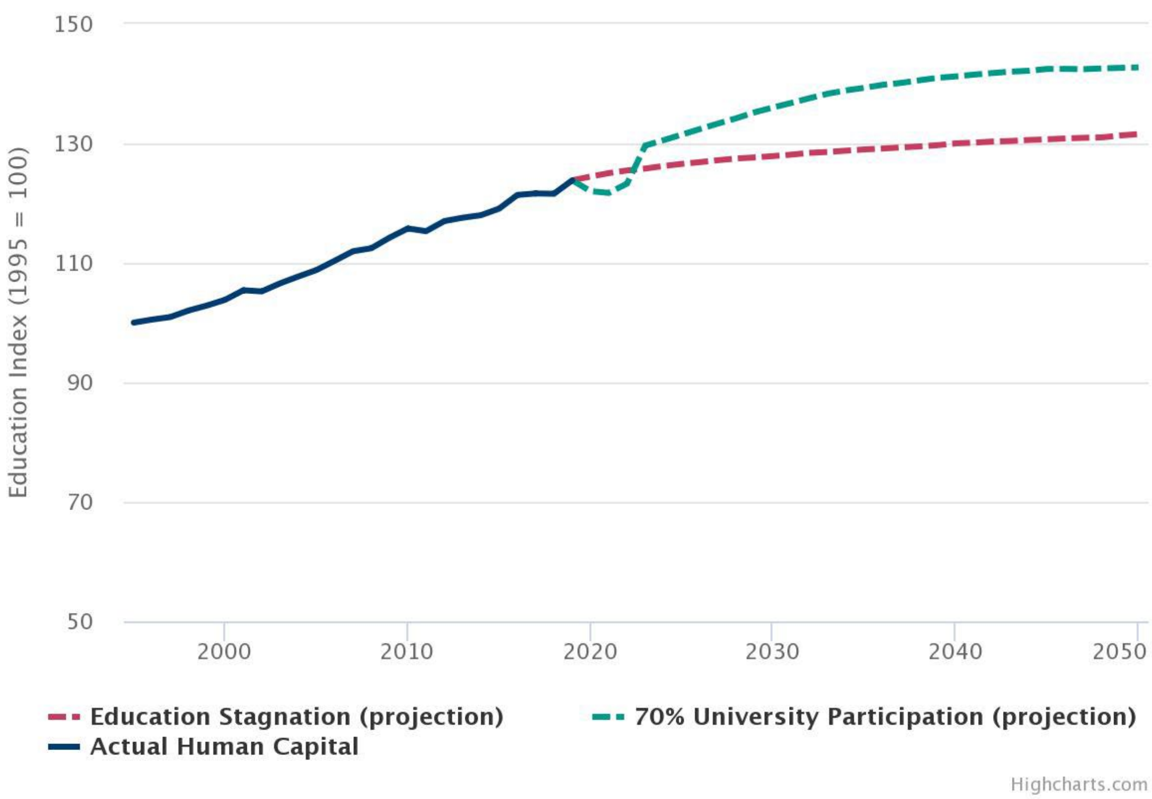
In the 70 per cent participation scenario we look at the growth rate of human capital and output per capita if university participation jumps to a permanently higher constant level. The aim is to see what happens if 70 per cent of those in their 20s get a university degree (in the form of a one-off jump followed by zero growth in university participation).

In practice we assume that in 2019 a number of individuals aged 18 to 29 without a degree drop out of the labour force to study for three years such that after this intervention university participation is 70 per cent. Three years later they re-enter the labour force with a higher educational attainment. In selecting these individuals, priority is given to school graduates (given that they are the most likely candidates). This means that all school graduates under 30 are assumed to get a bachelor's degree. To get to 70 per cent though, it must also be the case that some individuals who did not finish school get a bachelor's degree (after finishing school). Hence, some of the new graduates are drawn from those who left school before turning 18. Finally, in order to keep the share of those completing school to the age of 18 constant, we assume that some individuals who did not finish school go back to school in order to complete their school education.[iv]

Following this one-off jump, we impose that for every new cohort, university participation is 70 per cent. This is done in precisely the same way as above. This means that in all years up to 2050, 70 per cent of all new cohorts get a three-year bachelor's degree (while the shares of those doing a master's degree or PhD remain unchanged). Again, students are assumed not to be part of the labour force during the time they spend studying.

We assume average hours worked, the experience index, physical capital and total-factor productivity grow at their 1997–2019 average growth rates. As in the pessimistic scenario above, population grows according to ONS projections and employment rates by age and education level remain unchanged with the exception that the permanently higher levels of university participation leads to a lower employment rate for younger people, in order to take into account that more people will be studying for three years.

Figure 1 - Education index under different scenarios



The figure above shows the evolution of the education component of human capital until 2050 under the stagnation and 70 per cent scenarios. In the stagnation scenario, growth is sluggish and gradually declining because it is only driven by the retirement of relatively poorly educated older cohorts. If university participation jumps to 70 per cent, we first see a small slump as many people in their 20s drop out of the workforce to get educated. Subsequently, there is strong growth for about two decades until growth eventually slows down as the less well-educated older cohorts retire.

TAX REVENUE

Finally, we look at each scenario's implications for tax receipts and GDP levels in 2050. To derive the tax-receipt data, we use the most distant ONS forecast (2027) of tax receipts as a percentage of GDP. This is 40 per cent and hence we derive tax receipts by assuming they will be 40 per cent of GDP in 2050.

It should be noted that to estimate the 2050 GDP and tax receipt projections, we use OBR's March 2022 forecast of 2021-2022 GDP as a starting point and then apply the average growth rates of the respective scenario.

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[i] Goodridge et al (2016) and Riley et al (2018) have also used different versions of growth accounting methods in the UK. While our results are not directly comparable because the setup is different, they both find that the importance of what they call "labour composition" has increased since the financial crisis. This is in line with our finding regarding the growing role of education.

[ii] Assuming a Cobb Douglass production function, constant returns to scale and perfect competition, the weight of capital and labour in production is equal to their respective factor income share. Since income and physical capital are the only inputs, it must be the case that $e_H + e_K = 1$ so we identify both from 1997–2020 ONS data on the labour share.

[iii] We do not use 2020 data because data in this year are significantly affected by the impact of Covid-19.

[iv] Given that all 2019 school graduates are assumed to get a degree, our thought experiment would have implied that no student finishes school without getting a degree. Hence, students would either not finish school or have a bachelor's degree. Yet, it is reasonable to assume that a non-negligible share of young people finish school and do not get into university. This is why we also assume that some of the people who didn't finish school in the 2019 data do actually complete their school education.