APPENDIX 4: MODEL STRUCTURE AND RESULTS

This Appendix summarises:

- **The nature and purpose of the model** – it is a model which enables policy-makers to base their decisions on a sound understanding of the interactions between the healthcare system and the wider economy;
- **The structure of and assumptions behind the model** – the most critical assumptions in the model relate to policy decisions on funding, poverty reduction and prevention;
- **The conclusions we can draw from the model** – without a healthcare system which provides good health outcomes, the UK economy would fail.

THE NATURE AND PURPOSE OF THE MODEL

The model we developed is a system dynamics **model of the interactions between the healthcare system and the wider economy**. To model these interactions effectively, it is important to be clear about the scope of the model.

It should neither attempt to be a complete model of the economy, nor a detailed model of the healthcare system. A complete model of the economy would need to include, for example, a complete analysis of the UK's productivity slump – something that no economist has yet managed to achieve. A detailed model of the healthcare system would be unimaginably complex and probably impossible to build.

What the model must do instead is to enable us to look at certain policies – especially those to do with the funding of and load on the healthcare system – and **understand the implications of those decisions on the economy.**

The model looks forward, but it is not a predictive model of the economy. As Simon Wren-Lewis, Oxford Professor of Economics puts it[77]:

"Macroeconomic forecasts produced with macroeconomic models tend to be little better than intelligent guesswork. That is not an opinion – it is a fact. It is a fact because for decades, many reputable and long-standing model-based forecasters have looked at their past errors, and this is what they find."

Instead, what the model does is to enable us to answer questions like: *if all other factors affecting productivity were constant and we decided to fund Healthcare at a given rate, what impact would that have on the economy?* It is, in other words, **a policy-analysis model.**

[77] (Wren-Lewis, 2014)

THE STRUCTURE OF AND ASSUMPTIONS BEHIND THE MODEL

The fundamental assumptions underlying the model are that the healthcare system is universal: access is not determined by personal finances or ability to secure insurance – this assumption is critical if the system is to score well on equity. The healthcare system is, however, limited by physical capacity. The population can be simplified into Young and Adult (<70) and Elderly (>70) for the purposes of modelling the costs of healthcare: the OBR data[78] on healthcare costs by age suggest that this is reasonable. There is always a cause of death, either illness or injury: nobody dies in perfect health. We further assume that funding determines capacity, capacity determines treatments given, age and poverty determine morbidity[79] and policy choices determine both healthcare funding and poverty levels. All figures are real (i.e. inflation-adjusted), not nominal.

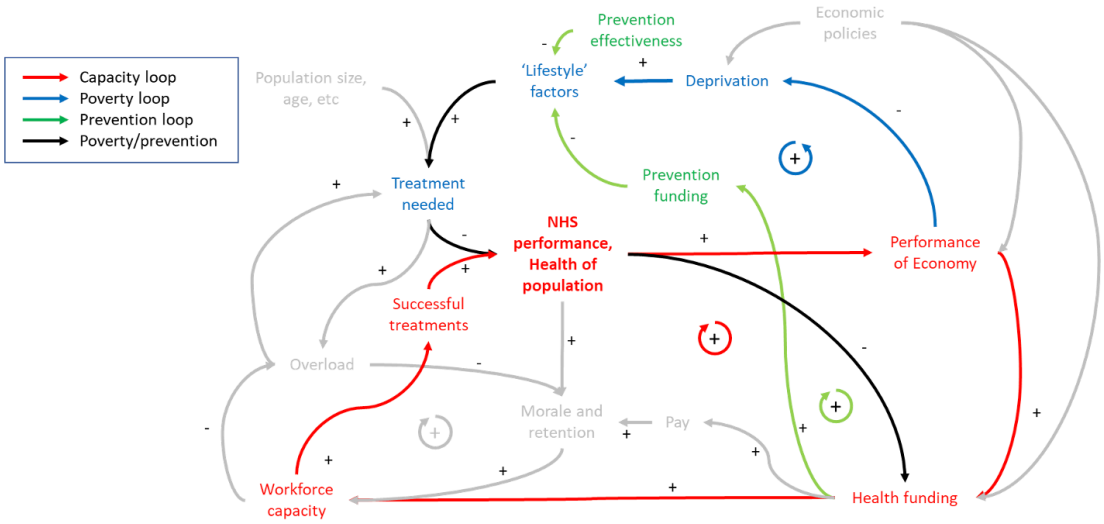
There are two more detailed sets of assumptions:

- **Initial conditions** such as the size and composition of the population at the start of the modelling period – these are things for which reliable data can be obtained;
- **Rules for determining** the state of the world at some point in time (t_n) given the state at the previous point in time (t_{n-1}). These rules are of three types:
    - **Facts of life:** For example, the number of healthy people at any time is equal to the number of healthy people in the previous period, plus the net number of healthy additions to the population,plus the number of ill people recovering, minus the number injured or falling ill;
    - **Policy choices:** For example, the policy determining the rate of spending in period t_n could be driven by the number of unhealthy people in period t_{n-1} (or it could be driven by a policy of reducing healthcare spending each period, or a variety of other policy options);
    - **Exogenous variables:** For example, the underlying rate of productivity growth in the economy.

The structure of the model is a subset of the structure shown in the diagram below (the coloured parts are modelled).

[78] (Office for Budget Responsibility, 2022)
[79] (Barnett, et al., 2012)

Figure 24: Structure of the model



The natural reaction of many people on seeing a diagram like this is to shake their heads in disgust, and say, *I can't begin to understand that.* At one level, they are right: the human mind cannot grasp all the implications of such a model (rather as in physics, we cannot comprehend the three-body problem,[80] and nor is there a simple mathematical solution to it). But the reality does not change simply because our minds cannot fully comprehend it. A rational policy-maker cannot afford to take this natural view, and in the modern world, they do not need to.

All of the arrows in the diagram represent real-world cause-effect relationships, but **only those in the three loops above** have been modelled. In particular, the overload loop has not been modelled – and that could make the effects of underfunding even more severe than the model shows. These are the three looping chains of cause and effect set out in Section 5:

- **Chain 1: the Capacity Loop :**
  - Economic output enables economic decisions to fund;
  - Funding drives capacity to treat;
  - Capacity to treat (staff, hospital beds, etc) drives treatment provided;
  - Treatment provided drives rates of recovery and hence number of healthy people – a huge number of working age adults are currently unable to work due to ill-health;
  - Number of healthy people of working age drives economic output;

- **Chain 2: the Poverty Loop:**
  - Economic output enables economic decisions to address poverty;
  - Poverty drives morbidity;
  - Morbidity drives demand for treatment;
  - Excess demand causes untreated illness;
  - Untreated illness drives (negatively) number of healthy people;
  - Reduced number of healthy people of working age decreases economic output;

- **Chain 3: the Prevention Loop**
  - Spending on prevention reduces illness;
  - Reduced illness reduces need to treat;
  - Reduced need to treat reduces funding requirement for treatment capacity;
  - Reduced funding requirements make facilitates adequate spending.

[80](Wikipedia, 2023)

These chains allow us to determine the effect of policy decisions on funding a restoration of capacity, and also in relation to poverty reduction and spending on prevention.

KEY RESULTS FROM THE MODEL

Looking first at the funding issue, we have **modelled three possible policy options.** The first two are intended to capture the UK government's revealed[81] (though not avowed) policy of reducing the expenditure on healthcare as a percentage of GDP, described in Appendix 3. Of course, spending cannot be reduced to zero, so we have taken two variants as options 1 and 2 as extreme points between which current government policy is likely to lie; option 3 is an alternative, which a new government might like to compare:

1. **Continue with the reduction in spending** on healthcare as a percentage of GDP until it has reached 6%;

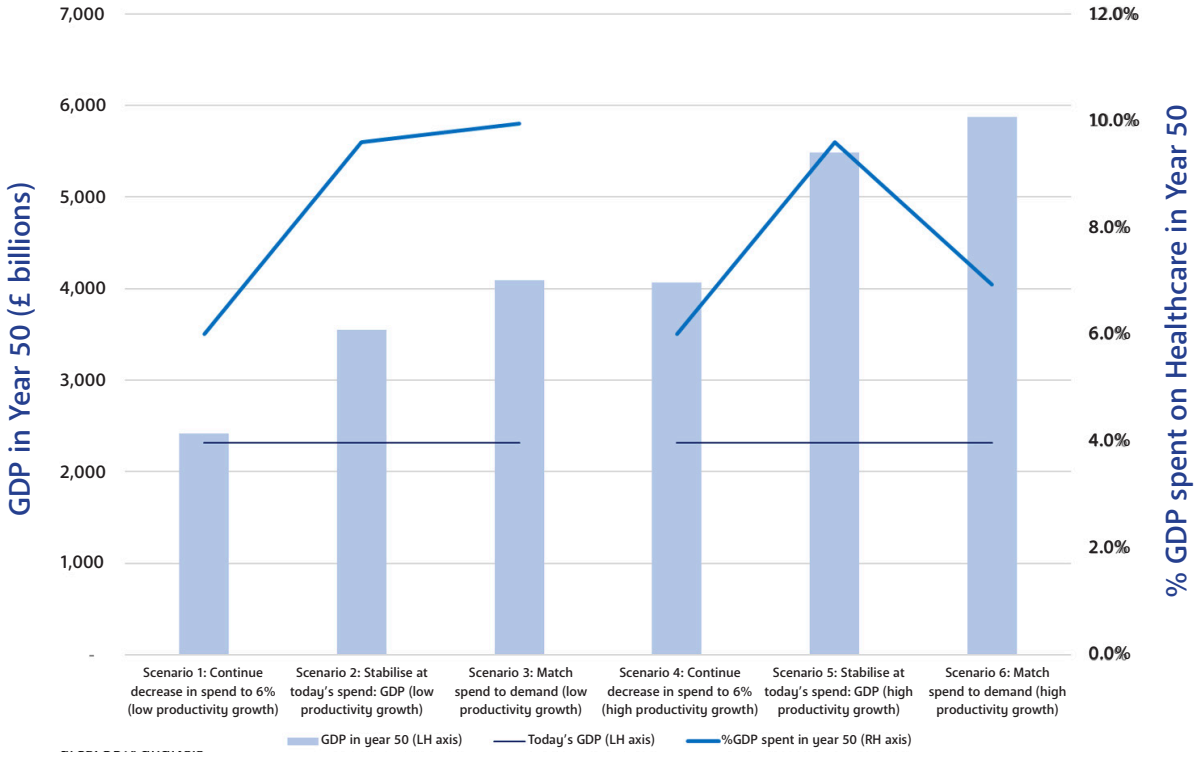
2. **Fix spending at current levels;**

3. **Adjust spend to ensure capacity meets need.**

As GDP growth is largely determined by underlying productivity growth in the economy, which itself has many causes, we have modelled each of these policy choices both in a low-productivity scenario (which reflects the last 12 years and the OECD's long-term forecast for UK GDP growth[82]) and in a higher-productivity scenario (which the UK experienced leading up to the Global Financial Crisis). The results are summarised below.

[81] See Appendix 3 for details of the reduction since 2010.
[82] (OECD, 2023)

Figure 25: Comparison of different scenarios



Source: 99% analysis

It is clear from the chart (Figure 25) that the worst policy choice would be to attempt to continue with the reduction in spend on GDP regardless of its impact on the health of the nation. In the low productivity economy, this would mean that growth would be very close to zero over the next 50 years. This is because it results in ballooning waiting lists and unhealthy people dropping out of the workforce altogether or remaining in it but being less productive. UK health would be so poor that population would actually decline under this scenario. **In short, this is not a credible policy option** (though it has been the apparent policy since 2010).

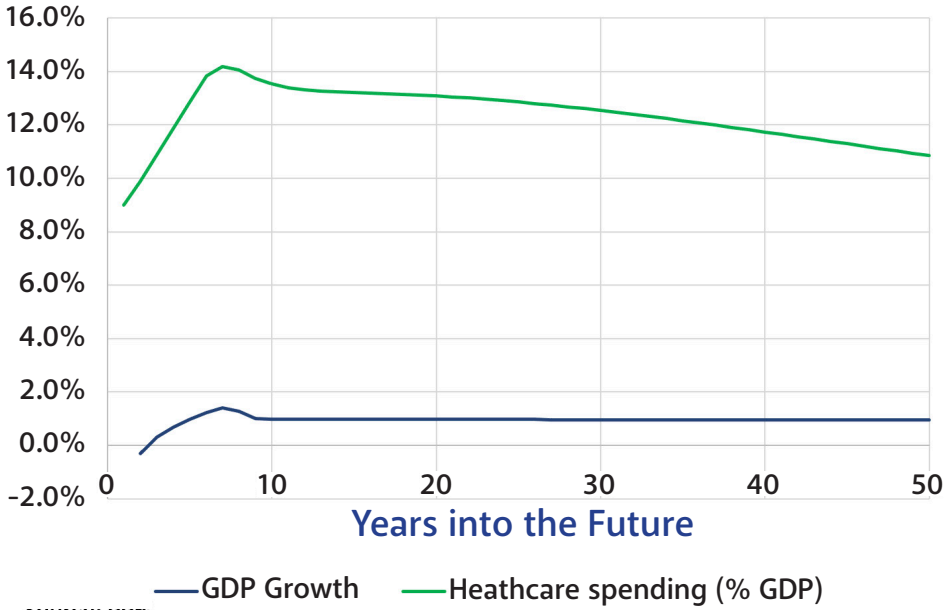
The option of **stabilising NHS expenditure at the current percentage of GDP** is vastly better, but still far from optimal. Under this option, the economy would reach over £3 trillion by year 50. But from the perspective of UK citizens it is still disastrous: waiting lists would not clear and the personal and economic cost would be very high.

The policy option that produces the **best results** is to adjust **NHS spending in line with need.** In the low productivity case, it takes only five years to clear the backlog, and this means both significantly greater economic output and – more importantly – it prevents an explosion in ill-health.

All of these results, of course, look far better in the high productivity scenarios, but the policy conclusion remains the same. Furthermore, since we have not modelled the overload loop, the model results almost certainly flatter the first two policy options, possibly very considerably.

One reason that policy makers may fear to choose the best option is a perception that it would require an explosion in healthcare costs. This is an unfounded fear: it would indeed require a large short-term increase in spending, rather like the spending increases the last Labour government had to enact to rebuild the NHS after 1997, but spending will stabilise and then decline over time (in percentage terms). The graph below shows total UK healthcare spend, of which around one quarter is private sector spend (i.e. spend which does not go through the NHS), so expenditure on the NHS alone could be expected to rise sharply from around 8% of GDP today[83] to around 11% and decline back towards 8% of GDP over time.

Figure 26: Alternative scenario without added prevention and poverty elimination policies



Source: 99%

Note: This scenario assumes: 1) that NHS spending is adjusted to meet need; 2) that only 0.1% of GDP is spent on prevention and 3) that there are no effective poverty reduction policies in place

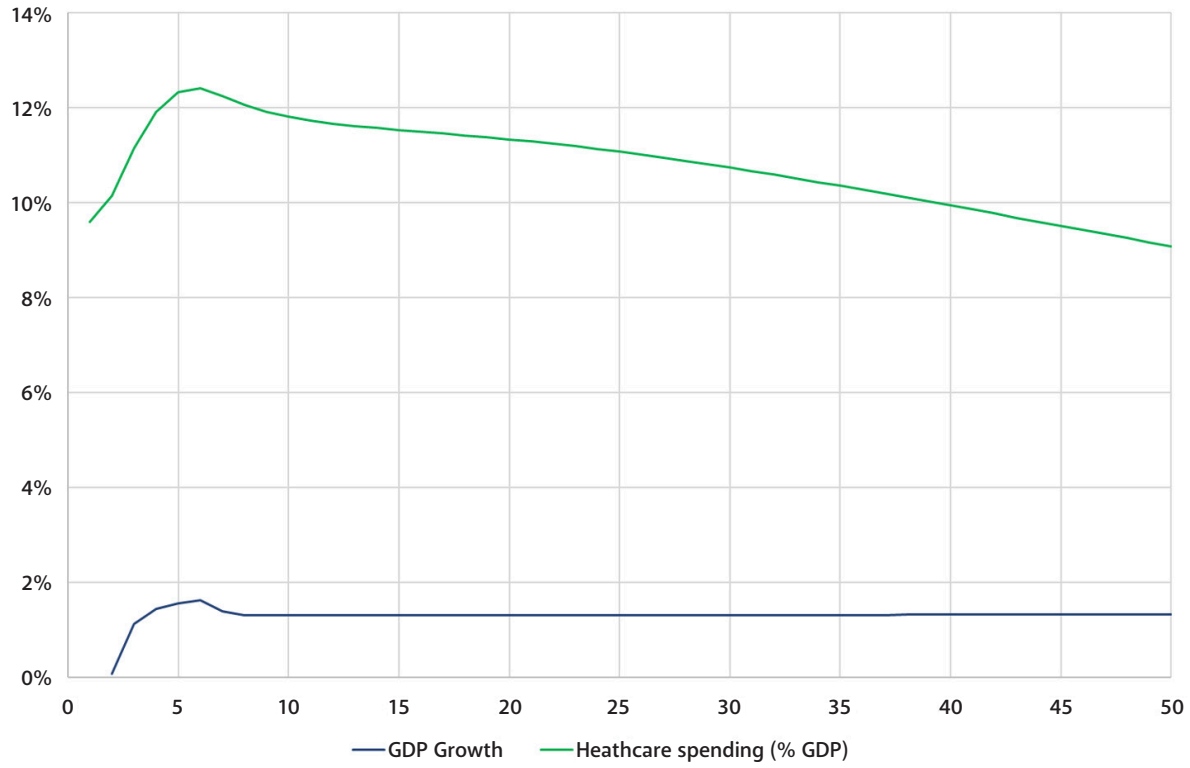
Moving on to look at poverty, and again taking *Scenario 3: Match spend to demand (assuming low productivity growth)* as the base, we can see the economic and health impacts of different poverty reduction policies. We have modelled a situation where, with zero growth, there would be a gradual increase of 0.5% in the poverty rate, but policy choices determine how growth in the economy is used to reduce poverty (or not).

[83] (Burn-Murdoch, 2022)

The difference between a policy of poverty reduction and one which allows poverty to rise makes a difference of around £400 billion in GDP or 10% of the total. The impact on ill-health is even greater. The same policy changes can produce an additional 4 million unwell people – almost 20% of the total.

Finally, the model shows that, again under *Scenario 3: Match spend to demand (assuming low productivity growth)*, preventive spending can significantly but not dramatically reduce the need for healthcare spending on treatment. In year 50, the total cost of healthcare spending is around 9% of GDP vs almost 11% in the previous chart.

Figure 27: Alternative scenario with added prevention and poverty elimination policies



Note: This scenario assumes: 1) that NHS spending is adjusted to meet need; 2) that there is increased spending on prevention; and 3) that there are effective poverty reduction policies in place which, over time, reduce socially-determined morbidity

CONCLUSION

In short, our analysis shows that despite the inherent complexity of considering the UK healthcare system as part of the wider economy, it is not impossible for rational policy-makers to recognise the reality of the interactions and to take them into account. It shows that policy choices on health will have a very material impact on economic growth and that in the low-productivity scenarios, rational health policy is needed to prevent economic disaster.