New Medical Treatments, Quality Improvements and Public Health Measures in the National Accounts: the Effects of the Diabetes Prevention Programme

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May 2025

Outline

Motivation

- There is a general view that economic statistics do not adequately represent the value generated by some forms of spending such as health spending.
- And a particular concern that the benefits of preventative treatment are not shown in national income statistics

Introduction

- This paper explores the treatment of new medical services in the national accounts.
- It sets out a framework for managing the introduction of new services whose benefit may be several times their cost.
- It shows that the proposed treatment is completely consistent with existing approaches to managing quality improvement and cost reduction.
- It discusses the particular case of preventative public health measures.
- And it applies this to the Diabetes Prevention Programme.
- The effects of the programme on the gross output of medical services are shown to be small.

Issues with Medical Treatment

- Beneficial medical treatment may be resource-saving or resource-using.
- E.g. in the 1950s TB hospitals were replaced by cheap drugs.
- Now expensive drugs and treatments tend to add to costs.

Also

- The value of life years cannot be represented in the standard national accounts.
- A satellite account based on quality-adjusted life years (QALYs) may be needed (Cutler et al., 2022).
- Changes in QALYs associated with particular treatments can be adopted as a quality measure (Schreyer, 2012). But the answer depends on the way in which the components are aggregated, because different components are cost-weighted, not QALY weighted. The only safe way is to apply an aggregate adjustment to overall consumption of medical services.

A New Service

- General principles are set out by Fisher and Shell (1972) who distinguish an output price index from a cost of living index.
- The first focuses on supply and the second on demand- the theory is clearer in the second case.
- Compute a price index with the assumption that the service was priced at its reservation price in the period before introduction.
- Work with a Törnqvist price index. The change in the log price from the previous period is weighted by the average of the expenditure shares in the previous and current periods.
- The expenditure share in the previous period is zero so the contribution to the change in the overall price index is given by the change in the log price from the previous period weighted by half of the current expenditure share.
- The volume measure is calculated from value data and the Törnqvist price index.

Quality Improvements and New Services

- A quality improvement can be seen as the replacement of a low quality product by a high quality product.
- Or, with an index of quality, it can be represented as a price reduction and (with spending unchanged) a volume increase.
- The two methods give the same answer if the low quality service is assumed, once it has been replaced, to have a reservation price reflecting its poor quality.
- Then use of a symmetric index (Törnqvist or Fisher) will record the same increase in output with both approaches.
- Similarly a straight fall in costs (prices) will give the same result as replacement of an expensive service by one which is cheaper but otherwise similar.

The Reservation Price

- Two possible reservation prices: the first based on discounted cost savings and the second based on the discounted QALY gain.
- Health policy is based on QALYs so it is more natural to use the money value of the discounted QALY gain, less the discounted costs of future treatment of those exposed to the public health measure as the reservation price.

An Algebraic Framework

Q^n	Discounted *per capita* QALYs of unaffected population
Q^t	Discounted *per capita* QALYs of treated population
ρ	Risk of disease without public health measure
ρ^h	Risk of disease with public health measure
n_1	Relevant population in first year
C	discounted cost of treatment
H	Cost of Public Health Measure per participant

	No Public Health Measure		Public Health Measure	
	Welfare	Cost	Welfare	Cost
Not affected	$(1-\rho)Q^n$	0	$(1-\rho^h)Q^n$	$(1-\rho^h)H$
Treated	ρQ^t	ρC	$\rho^h Q^t$	$\rho^h(H+C)$

Table: Costs and Benefits with and without the Public Health Intervention

The Reservation Price Again

q Value of QALY (£60,000)	
Cost component of reservation price	$(\rho - \rho^h)C$
QALY component of reservation price	$q(Q^n - Q^t)(\rho - \rho^h)$
Total reservation price, H_{res}	$(\rho - \rho^h)(C + q(Q^n - Q^t))$

Withdrawn Treatment

- We also need to allow for the fact that notional treatment is withdrawn from the patients who do not develop diabetes following the public health programme.
- For these people the cost of continuing treatment has fallen to its reservation price.
- Treatment comes as a package, and not on a year by year basis.
- Assume all costs fall by the ratio H/H_{res}.
- If c_t is the cost of the treatment in year t, then the reservation cost of this is $c_t H/H_{res}$, and this is used to measure the price (cost) reduction associated with the withdrawn treatment.

Prices and Quantities in the First Year

- Measure with reference to a situation without the public health measure

M_t Consumption of Medical Services in year t
excluding Public Health Measure

c Annual cost of treatment assumed constant

Share of public health measure in year 1 $\frac{n_1 H}{M_1 + n_1(\rho^h c + H)}$

Share of withdrawn treatment in year 0 $\frac{n_1 c(\rho - \rho^h)}{M_0}$

The change in P, the price, and Y the quantity of medical services are

$$\Delta log P_{0,1} = \frac{1}{2}\left(\frac{n_1 c(\rho - \rho^h)}{M_0} + \frac{n_1 H}{M_1 + n_1(\rho^h c + H)}\right) log\left(\frac{H}{H_{res}}\right) \quad (1)$$

$$\Delta Log Y_{0,1} = log\frac{n_1(\rho^h c + H) + M_1}{M_0} - \Delta log P_{0,1} \quad (2)$$

Prices and Quantities in Subsequent Years

- Again measure with reference to a situation without the public health measure
- In subsequent years there is a saving of $n_1 c(\rho - \rho^h)$ and treatment is withdrawn from $n_1(\rho - \rho^h)$ people.
- The fall in costs for those who do not need treating is H/H_{res} and the remainder of the fall in value is a volume change.
- Output elsewhere in the economy will increase as the savings on medical treatment are spent on other things
- But this does not show the welfare gains from a reduced need for medical treatment.

A Sequence of Cohorts

- So far we have looked at a single cohort
- In practice there is a population sequence. The public health measure will have to remain in place for there to be no change relative to the previous year.
- Some judgement will be needed, depending on the nature of the public health programme

The QALY Gain in a Satellite Account

- The satellite accounts for the health sector proposed by Cutler et al. (2022) are based on QALYs with costs of production deducted.
- The discounted QALY gain is the QALY reservation price, $Nq(Q^n - Q^t)(\rho - \rho^h)$.
- It is not clear what this should be measured as a percentage of.
- Cutler suggests using half of the expected discounted QALYs accruing to sixty-five year olds in 1999, as an estimate of the gross output of health services then.
- We use *faut de mieux* half the expected discounted QALYs accruing to people aged 65 and over in 2018

Type 2 Diabetes (T2D)

- A chronic inability to control blood sugar levels.
- It can result in wounds, especially to feet, being slow to heal or not healing and resulting in amputation.
- It also increases risk of kidney disease, heart disease and stroke.
- Excess weight is a major risk factor.
- Prevalence of diagnosed diabetes rose from 2% in 1990 to 6% in 2021. Among those over 75 it rose from 6% to 16%. Part of the increase in prevalence may be because mortality rates of diabetics have declined but rising weight (BMI increased from 25.8 to 27.6) is probably more important.
- Hex et al. (2024) put the cost of diagnosis and management at £3.2bn and the treatment of complications at £5.6bn in 2021/22

Costs of Treatment

- 4mn people have T2D and there are thought to be 1.2mn people not yet diagnosed.
- Implies an average cost of £800 for diagnosis and management and £1400 for treatment of complications.
- Complications are more likely at a late stage.
- A detailed study in the Irish Republic, (Doyle et al., 2022) put annual costs at about E1000 or £850 for a patient with no complications. For patients with foot or kidney disease it was put at about £3200 while in the year after a heart attack it amounted to £18600.

The Diabetes Prevention Programme

- A training programme with 15 classes offered to people with blood sugar levels above normal but not at a level regarded as diabetic (41 mmol/mol $<$ HbA1c$<$ 48 mmol/mol).
- ONS suggest that 1 in 9 English adults is pre-diabetic. Grossing up to the whole country this gives 5.8mn people in 2018.
- The programme encourages weight loss and regular exercise; it also offers dietary advice.
- A pilot scheme was run in 2017 in England.
- NHS England (2016) assumed *ex ante* that 4.5 cases per 100 participants would be delayed or avoided.
- A Finnish study suggested 7.4 cases per 100 participants (Lindström et al., 2006)
- Some argue that there are selection effects and there is no significant impact from the programme.

Participation Rates

Table: Key Programme Statistics

Referred	1000
Attended initial assessment[1]	530
Attended at least one session	340
Completed Course	180
Diabetic at three years per thousand referrals	127[2]
Cases of diabetes delayed or avoided per thousand referrals	27

- The definition of a participant is not clear. Assume it to be cost per person attending the initial assessment. This gives a figure of $27/0.53 = 50$ cases avoided per thousand participants
- The programme was run on line during the epidemic. On-line costs are presumably lower, but it is not clear whether the remote programme is less or more effective than the test programme.

[1] Valabhji et al. (2020)

[2] Ravindrarajah et al. (2023)

Costs and Benefits

- Cost put at £300 per participant or £159 per referral.
- NHS England (2016) assumes 1 QALY generated by each case delayed or avoided.
- ONS uses a discount rate of $3\frac{1}{2}\%$ p.a.
- If benefit is assumed to come in twenty years and with $q =$£60,000, discounting implies a current benefit of £30,000 per case delayed or avoided.
- With 27 cases avoided or delayed per 1000 referrals, there is an expected gross benefit of £810,000 for an outlay of £159,000.
- There are also savings in treatment costs. If we set these at £1000 p.a. for 20 years, the discounted sum is £14,600, per patient giving further benefit of £394,000.
- But NHS England (2016) implied much smaller savings in costs, for reasons that are not clear.
- Anyway we work with total benefits of £810,000+394,000= £1,204,000 per 1000 referrals

The Initial Fall in Prices and the Increase in Output

- Total government health spending in 2018-2019 was £151,573mn
- A programme of diabetes prevention with 100,000 referrals would raise this by £15.9mn or 0.01%.
- The change in the log price is, on introduction,

$$log(H/H_{res}) = log\frac{15.9}{120.4} = -2.02$$

- The share of expenditure is 1×10^{-4}.
- There is also a saving of £2.7mn from patients who do not need treating. The share of this in total expenditure is 0.18×10^{-4}
- The change in the Törnqvist price index is

$$\Delta log P_{0,1} = \frac{-2.02 \times (0.18 + 1) \times 10^{-4}}{2} = -1.2 \times 10^{-4} \quad (3)$$

and in the resulting quantity index change is:

$$\begin{aligned} \Delta log Y &= log\frac{151589}{151573} - \Delta log P \quad (4) \\ &= 2 \times 10^{-4} = 2 \times 10^{-2}\% \end{aligned}$$

The Subsequent Fall in Output and the Insurance Problem

- The programme referring 100,000 people prevents/delays 2700 cases reducing spending needs by £2.7mn p.a. or 0.18×10^{-4}.
- $$\Delta log P_{t-1,t} = -\frac{0.18 \times 10^{-4}}{2} \times 2.02 = -0.18 \times 10^{-4} \quad (5)$$
- This happens to be almost equal to the fall in the value of output as a share of the total because $log(H/H_{res}) = -2.02$.
- In this case there is no change in the volume of output but a reduction in price.

A Satellite Approach- Gross

- Per 100,000 referrals we gain 2700 QALYs or 1350 discounted QALYs.
- To work out an increase in health output we need an estimate of the total discounted QALYs generated by medical services.
- We assume that half of the QALYs accruing to people aged 65 and over represent the outcome of medical services.
- We value a year in good health as one QALY and a year in poor health at 0.75 QALY (Palmer et al., 2021).
- In 2018 there were 12,165,000 people alive aged 65 and older and we estimate they expected 88.8mn discounted QALYs in total.
- We attribute 44.4mn QALYs to medical services
- The total increase in expected QALYs is $3.04 \times 10^{-3}\%$
- Note that this is smaller than the short-term increase in output measured using the new service approach- because the QALY base is so large.

Conclusions

- The impact of a single preventative programme used to address a widespread disease is small.
- ...although with 5.8 million pre-diabetics we could imagine 1.5 million participants adding 0.4% to health service output.
- Expert advice is needed on whether there are more significant preventative programmes.
- The fact that savings on medical treatment do not appear in national accounting welfare indicators suggests an alternative definition of national income (insurance-adjusted national income) may be needed.
- We should not assume that measuring output as the percentage increase in QALYs will lead to a larger impact than would a conventional national accounting treatment.

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