The Economic Impact of Health Care Provision: A CGE Assessment for the UK[1]

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Abstract

The paper presents the results from a CGE model of interactions between public and private health care, outputs of non-health goods and national welfare in a small open economy applied to the UK. The effects on welfare of higher provision come through direct gains, affecting the well-being of households, and indirectly, through increases in the effective (i.e. 'able to work') endowments of skilled and unskilled labour for use in non-health activities. The paper is innovative in that there have been few applied studies on the multi-sectoral general equilibrium effects of health provision on the non-health economy, in particular the working time effect, and few studies where the endogeneity of labour supplies is not modelled on a wage response function. Evidence, however, suggests that, although the health sector is small, there are strong linkages between health care, other product and labour markets, and policy making. We find that an increase in public health provision leads to higher overall welfare levels through increased worker incomes and direct increases in the well-being of the population, which are reduced if health care - specific skilled labour and capital is accounted for. Also, a rise in the price of pharmaceuticals has adverse overall welfare effects, which are mitigated if the health budget grows so as to maintain previous treatment levels in the public sector. Distributional effects are shown to differ across sectors, labour types and households.

JEL Classification: D58, H51, I18, J21

Keywords: CGE Modelling, Health Care, Labour Markets

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1. Introduction

The paper presents the results from a comparative-static CGE model of the interactions between public and private health care, outputs of non-health goods and national welfare in a small open economy applied to the UK. Our purpose is to analyse the macro-economic effects of changes in levels of health provision whilst recognising simultaneous impacts upon the effective labour force and resource claims made by the health sector.

In our model, the effects on welfare of higher health provision come through two main channels: (a) the direct gain from increasing the 'well-being' of the population, and (b) the indirect effects of an increase in the size of the effective (i.e. 'able to work') endowments of skilled and unskilled labour for use in non-health activities. A higher level of health provision enlarges effective labour supply in the short term by augmenting the aggregate working time of current workers (including wastage by premature death). It does so in the longer term by reducing death rates among those young who are destined to enter the work force. However, it also increases the number of people who are not part of the work force (the young and the retired).[5] These are an additional source of demand for health services, so reducing the availability and/or level of treatment for the current work force and thus its effective size. Moreover, both groups of non-workers are usually recipients of transfers from the working population (e.g. state benefits for children, state pensions for the retired), with the associated distortions.

We believe the analysis is innovative in two respects. First, there have been few applied studies of the multi-sectoral general equilibrium effects of health care provision on the non-health economy, in particular the working time effect. Nearly all health economics modelling is done in a partial equilibrium setting, and as such tends to focus on the impact of policy on current and prospective patients. Rationalisations for the partial equilibrium approach include the relative smallness of the health sector and the high degree of specialisation (i.e. intersectoral immobility) of highly skilled staff and high-tech capital. While these may hold true, there are other strong interactions with the rest of the economy and with policy-making, certainly in the longer term, so that it is arguable that general equilibrium modelling may be more appropriate for the analysis of some issues. With respect to the labour market, the majority of health sector staff, even those that are skilled, is in practice inter-sectorally mobile (managers and associated staff, laboratory technicians, ancillary workers). Thus expansion or contraction of the health sector will impact on other sectors. Some sectors will expand while others contract, depending on the relative factor-intensity of the health sector. Similar comments

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5 The dominant users of health care are those under 5 years of age, those over 60, and the 'long-term ill'.

apply to sectors producing intermediate inputs for the health sector (pharmaceuticals and medical, precision and optical instruments). Econometric analysis, although often applied to the macro level and including feedback effects from improved health to the economy, is highly aggregated in nature and conceals differential effects across sectors, factors and households.[6]

Second, while there is a strong literature on endogenous labour supply models (e.g. Martin, 1976, Martin and Neary, 1980), these have in the main been based on direct labour supply responses to higher wages. In this model, changes in the effective supply of skilled and unskilled labour come from changes in the size of health provision (which in this UK-centred example is mainly determined by the government). Using a theoretical extension of the standard Rybczynski theorem, the relative changes in outputs of non-health sectors are shown to depend on the sign and magnitude of the 'scale effect' of increased factor supplies and the 'factor-bias' effect of changes in the ratio of skilled to unskilled labour.

The CGE model is calibrated to a database for the year 2000, with considerable refinement in terms of health data (distinguishing public and private health care demand and the main input suppliers), labour types (skilled and unskilled) and household types (based on age and labour market participation of household members). The model is subsequently employed in two types of simulations which cover current health issues in the UK, specifically the economy-wide repercussions of a pharmaceutical price rise under alternative government budget closure rules and the effects of a rise in public health expenditures under alternative factor market closures.

The rest of the paper is organised as follows. Section 2 presents a literature review of CGE models applied to health care. Section 3 uses standard diagrammatic analysis for a low dimension general equilibrium model to provide some insight into the Rybczynski type effects of changes in health provision on production of non-health sectors. Section 4 gives a brief overview of government provision of and policy towards health care in the UK. Section 5 discusses the data used in the calibration of the CGE model and the structure of the model itself. Section 6 presents and discusses the results of some counterfactuals and section 7 contains a sensitivity analysis. Finally, section 8 offers some conclusions and discusses planned future work.

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[6] Illustrative of this type of literature are: Bhargava et al. (2001), Bloom and Canning (2000), Bloom et al. (2001), Crémieux et al. (1999), Ettner (1996), Hamoudi and Sachs (1999), Hitiris and Posnett (1992), Knowles and Owen (1997), Pritchett and Summers (1996) and Strauss and Thomas (1998).

2. Review of CGE models applied to health care

The applied literature focusing on general equilibrium effects of changes in health and health care on the economy is small but diverse in terms of application area. The earliest type of models that acknowledge the economy-wide effects of improved health, Basic Needs models[7], were designed to implement the basic needs approach to development of the 1970s into a comprehensive framework, with its overarching goal of basic needs satisfaction. Health and health policy fulfil only a minor role and it has proven virtually impossible to disentangle the effect of improved health within counterfactual simulations. Furthermore, Basic Needs models typically are recursive dynamic and applied to developing countries and by virtue of the latter, suffer from lack of data, a rather ad hoc approach to modelling of economic behaviour and abstraction from several general equilibrium elements (such as the endogeneity of prices and the government budget).

Externality models account for the presence of external effects, such as health, education and environmental effects, in a CGE framework. To our knowledge only one CGE model of health externalities exists, that by Savard and Adjovi (1997).[8] Health improvements appear in the form of improved labour productivity by implementing labour-augmenting technological progress in production (as a function of government expenditures on health relative to the base year), which influences the optimal combination of inputs in production and relative wages. The main aim of the model, and indeed of most externality models, is to verify whether the standard CGE result of (small) economic benefits from trade liberalisation holds in the presence of externalities. The conclusion is negative, as cuts in government expenditure on health and education, aimed at maintaining the government deficit, have negative spill-over effects on domestic product and public sector employment, household income and welfare. In contrast to Basic Needs models, this model is firmly grounded in microeconomic optimisation behaviour and accounts for various inter-sectoral linkages; however, it too is applied to developing country issues in which health is only of secondary importance. Further caveats are a lack of dynamic effects, no distinction between working and non-working or age groups, and absence of endogenous labour supply effects (i.e. the impact of better health on working time).

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[7] Examples are: Vianen and Waardenburg (1975), van der Hoeven (1987, 1988) and Kouwenaar (1986).

[8] A selection of environmental CGE models featuring side effects on health care are: Vennemo (1997), Beghin et al. (1999), Bruvoll et al. (1999), Garbaccio et al. (2000) and Li (2002).

The recent class of models of HIV/AIDS[9] assesses the economic impact of HIV (Human Immunodeficiency Virus) and AIDS (Acquired Immune Deficiency Syndrome) using (recursive) dynamic CGE analysis. Generally, this literature models the negative health consequences of the pandemic by imposing exogenous demographic and behavioural scenarios on the economy. Typical features of the pandemic are that it reduces labour supply by skill type, lowers factor productivity, and increases household and government expenditures on health care at the cost of expenditures on other goods and savings. Under these assumptions the literature's main finding is that the slow-down in physical capital accumulation (due to lower savings and investments), productivity growth, population growth and human capital accumulation (due to a fall in supply and demand for education) reduces economic growth and results in a fall in per capita income in the long term compared to a fictional "No-AIDS" scenario. Relative to Basic Needs and Externality models, HIV/AIDS models are relatively sophisticated in the sense that they model in greatest detail the various channels through which changes in health, albeit negative, affect the economy. Nevertheless, and most likely due to the incurable nature of the disease, the HIV/AIDS studies abstract from any positive feedback from health (and other) expenditures to population health and labour supply.

A related strand of Health Sector models[10] claims to be of the general equilibrium type, but since the model domain spans health care markets only and abstracts from the "rest of the world" they are truly partial in nature. These models are typically applied to developed countries and feature the behaviour of patients, general practitioners, medical specialists, pharmacists, drug producers (brand name and generic), parallel importers, insurance companies and hospitals and the various interrelationships between them. Special attention is devoted to the presence of market failures such as information asymmetries between patients, physicians and pharmacists (principal-agency problems) and imperfect competition in the market for pharmaceuticals enabled by patenting. Although the detailed level of analysis of medical care represents a constructive addition to the previously discussed CGE studies, their partial character precludes general equilibrium aspects such as resource claims of health care (i.e. competition for scarce factors of production such as capital and labour), government budget implications and the impact on effective labour supply of improved health, which are crucial for our understanding of the economic impact of health provision.

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9 This class contains the models of Kambou, Devarajan and Over (1992), Arndt and Lewis (2000, 2001), Arndt and Wobst (2002) and Arndt (2003).

10 Chatterji and Paelinck (1991) develop a purely theoretical general equilibrium model. Other examples of applied models are: Canton and Westerhout (1999a, b) and Folmer et al. (1997).

3. Effective labour endowments and the health sector: some low-dimension analytics

Consider a small open 'Heckscher-Ohlin' economy, endowed with two types of labour, skilled (*S*) and unskilled (*U*) both subject to illness at given rates. There are four sectors ('uses' for factors): Good 1 and 2 are conventional tradables, H is the non-tradable health sector treating the ill (modelled as adding value to the ill) and W is an artificial 'waiting list sector'. The waiting list records those who are ill and not yet (successfully) treated by the health sector and are so unable to work. We assume that health care is provided by the government and that its expenditure is determined politically (and so exogenous to this model). The exogenous product prices determine the factor prices and hence skilled-unskilled labour ratios in the three production sectors.

Within the period concerned, certain numbers of skilled and unskilled workers become ill (unable to work). However, the health service successfully treats all but S_W and U_W of these respectively (the loss of working time for those successfully treated is taken, for simplicity of exposition, as negligible). Accounting for factor use (paralleling the full employment conditions for conventional models) gives:

$$S_1 + S_2 + S_H + S_W = S \qquad (1)$$

$$U_1 + U_2 + U_H + U_W = U \qquad (2)$$

We are interested in the *effective* labour forces, S_E and U_E, where

$$S_E = S - S_W \qquad (3)$$

$$U_E = U - U_W \qquad (4)$$

and S_W and U_W are the numbers of potential workers that remain unable to work.[11]

Figure 1 shows one possible initial equilibrium. It is drawn on the assumptions that the health sector H is the most skill-intensive sector, and sector 2 is the least skill-intensive, that the incidence of illness is the same for both groups of workers[12], and that the health sector allocates its output of health treatment in proportion to the numbers of each labour type becoming ill.[13]

The maximum possible endowments of skilled and unskilled labour are S and U respectively. Inputs into the health sector are measured from O_H, while those unable to work are measured from O_W. The government health budget purchases S_H and U_H of labour inputs at given wages. At that level of health provision the numbers of potential workers remaining on the 'waiting list' are S_W and U_W

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[11] We could equally well work in terms of the numbers of 'worker-hours' lost. It is more convenient to discuss the issues in terms of 'workers'.

[12] There is evidence that the incidence of illness is higher in the low-income groups, but we ignore this for simplicity of exposition.

[13] In the sense that there is no ill health, and hence no need for health provision.

(and by virtue of the previous assumptions are in the same proportion as the economy's endowment ratio). The inner box then gives the skilled and unskilled labour available to work in the two tradables sectors. Measuring inputs into sector 1 from the north-east corner of the 'health' box and inputs into sector 2 from the south-west corner of the 'waiting list' box allows us to determine the equilibrium allocation at point A (where the production isoquants of sector 1 and 2, not drawn for simplicity, are tangent with a slope equal to the absolute value of the relative wage of unskilled to skilled labour).

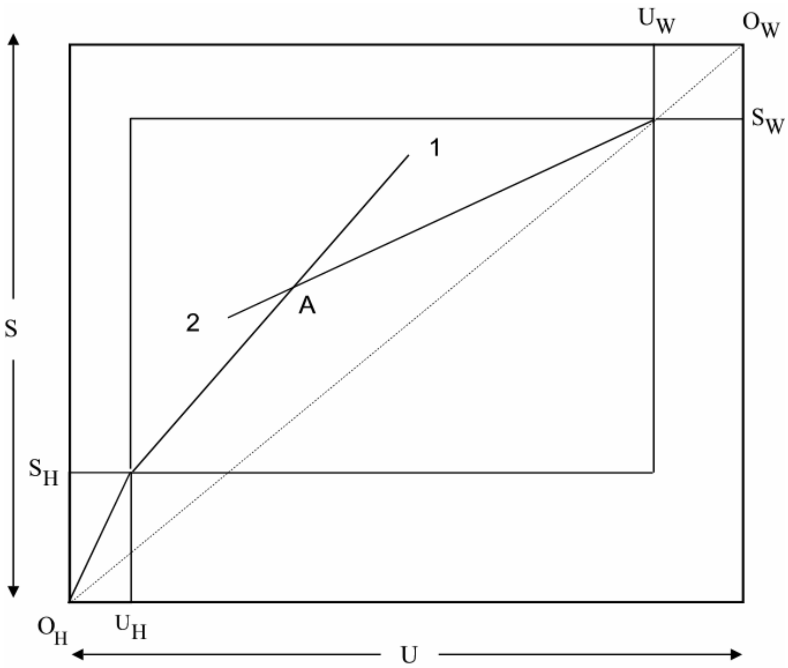

Figure 1: An initial equilibrium

Figure 2 illustrates the consequences of the government increasing the health budget in the case where there is no change in the overall endowments. Inputs of skilled and unskilled labour in the health sector increase to S_H^* and U_H^* respectively. The provision of extra health care reduces the numbers on the waiting lists to S_W^* and U_W^*. The remaining labour inputs are allocated to sectors 1 and 2 which, given relative wages, yields equilibrium point C.

The expansion of the health sector and the contraction of the waiting list changes both the total amounts of factors available to the two tradables sectors and the relative skilled-unskilled ratio. It is convenient to decompose these into a 'scale effect' (increasing the effective endowments of both skilled and unskilled labour due to improved health) and a 'factor-bias' effect (changing the effective endowment ratio due to differences in skill-intensities between health and non-health sectors). Splitting the changes into the two components allows us to draw some insights from standard trade theory results.[14] Since the health sector is, in this example, the most skill-intensive sector, its expansion will lead to a reduction in the skilled-unskilled labour endowment ratio available to the rest of the economy, so that, on the basis of the Rybczynski theorem, the output of the relatively skill-intensive good (sector 1) will fall and the output of the other good (sector 2) will rise. This is the factor-bias effect, depicted in Figure 2 by the move from A to B. The scale effect, from B to C, shows the effect of reducing the amounts of skilled and unskilled labour on the waiting lists, i.e. increasing effective labour supplies, which in this example increases the production of both goods.

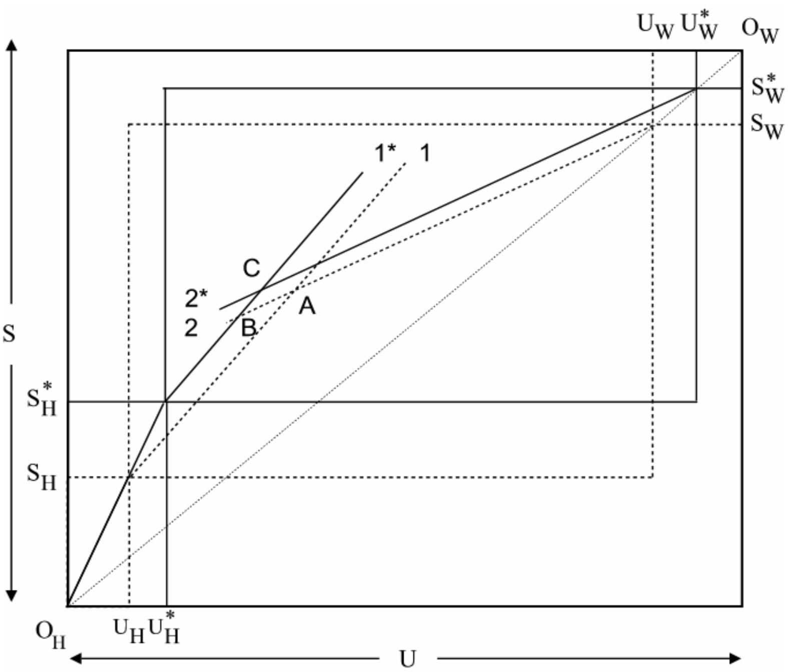

Figure 2: Expansion of the Health sector with unchanged endowments: example 1

In the Figure 2 example it is evident that the net effect is a contraction of sector 1 and an expansion of sector 2. However, it will also be evident that in general the effects on the tradables sectors depend on the ordering of factor intensities of the three production sectors and the endowment ratio, on the incidence of illness and of the provision and effectiveness of treatment for the two types of labour.

For example, Figure 3 shows a case where the health sector is smaller than the waiting list sector (both having the same factor intensities as in Figure 2), but with the health sector having much greater 'leverage' on the size of the waiting list sector. Here the 'scale effect' dominates the 'factor-bias' effect: the former leads to an increase in the outputs of both tradable goods, and the increase in the output of sector 1 from the former is greater than the decrease in output of sector 1 due to the 'factor-

[14] These results have their origin in the seminal paper by Rybczynski (1955).

bias' effect (which also leads to a further increase in the output of sector 2). Thus outputs of both tradables increase.

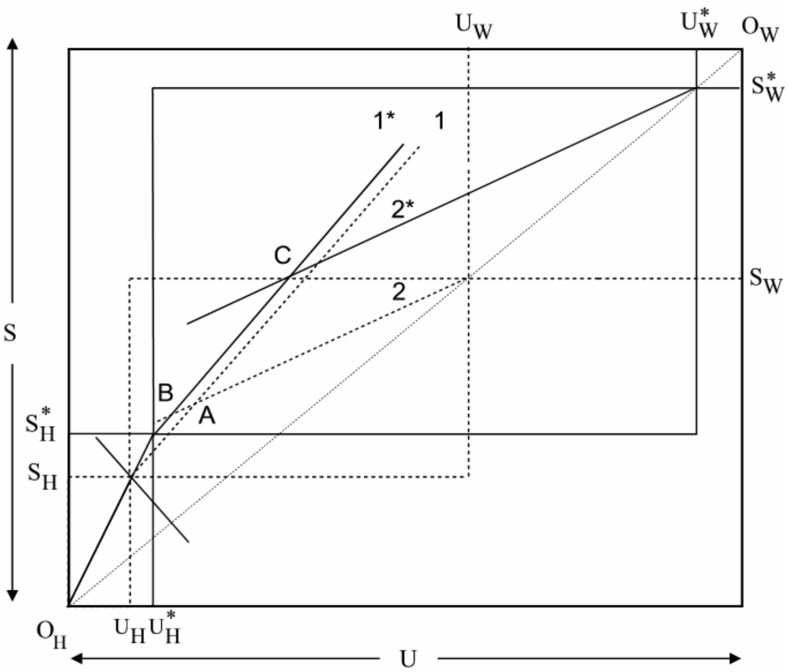

Figure 3: Expansion of the Health sector with unchanged endowments: example 2

Whether the health sector is, in fact, more skill-intensive than all other sectors is an empirical question, as is that of whether the incidence of illness and the provision and effectiveness of health care are both independent of labour type. In a multi-sectoral model with more than two factors the foregoing predictions are most unlikely to be wholly true. Nevertheless, they give a useful guide to the interpretation of the outcomes of such a model.

4. The UK health system and health policy

The UK health system is dominated by state provision via the National Health Service (NHS), devolved to regional health authorities with responsibility for hospitals, general practitioners and ancillary services. There is some private provision via insurance schemes that use private facilities, but also buy facilities and skills from the state sector. Private provision is mostly of secondary (hospital) care and covers approximately 12 per cent of cases. All NHS medics working in the secondary sector have contracts that allow them to provide private treatment, some 75 per cent doing so, and many NHS facilities are available for hire by private providers.

Financial provision for the NHS is set by the government over a five-year planning period, and the responsible department, the Department of Health, must bid for a share of the overall budget in competition with departments responsible for the armed forces, education, law enforcement etc.. The

NHS administration itself works to a rolling three-year planning horizon, and may seek marginal adjustments to state finance on an annual basis.

UK governments (of both major political parties) have been exercised by the escalating costs of the NHS. They have some control of some inputs, (e.g. salaries of staff, working practices, capital provision) but less control of others (e.g. pharmaceuticals prices). More importantly, they are faced with longer-term problems such as the increasing longevity of population and the demand for the use of new, and usually more costly, technologies.

Evidence of pressure on secondary treatment facilities is provided primarily by the length of the 'waiting lists' for treatments – the so-called 'rationing by delay' policy operated by the NHS. Some non-life-threatening complaints are subject to long delays before treatment, and the existence of such queues may in itself act as a disincentive to seek treatment. As part of its longer term strategy, the NHS also 'rations by denial' in blocking, or at least delaying, the adoption of new technologies.[15]

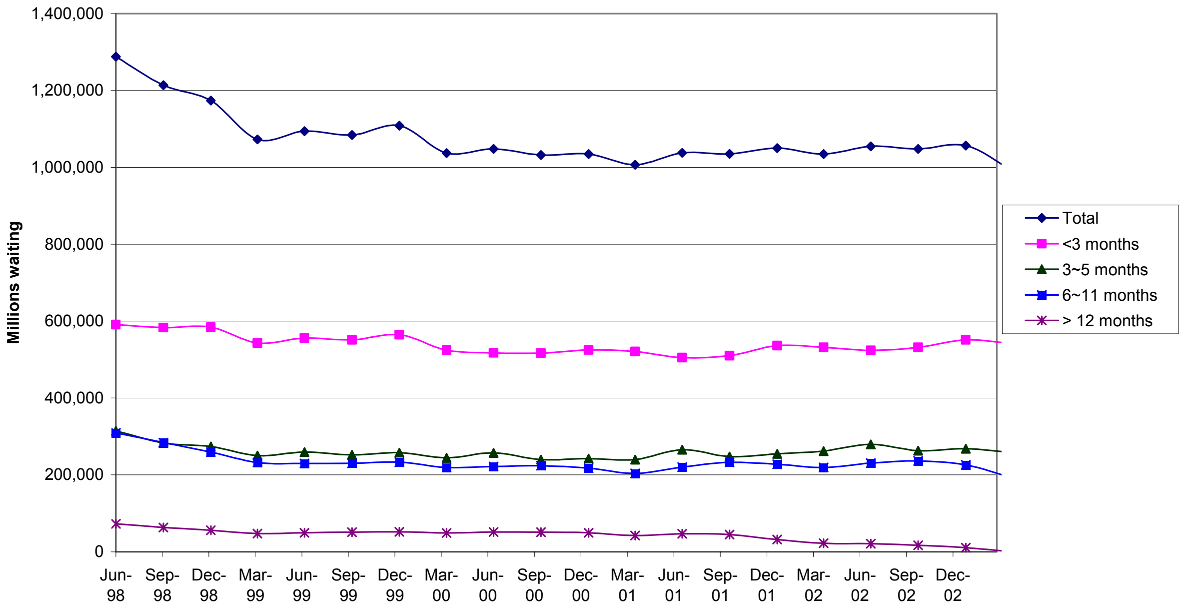

Figure 4: In-patient waiting lists (ordinary and day case admissions), England[16]

Waiting lists in the NHS have always carried negative connotations, giving out mixed signals to the public of insufficient resources to match demand and inefficient use of resources. With respect to the latter, government policy on medical procedures and associated inputs does not always focus on 'best'

[15] The fear is that if a new, superior, technology is approved then there will be a significant increase in demand, whereas if it is not available then patients 'will not miss what they don not have'. This is analogous to the effects on recruitment of 'firing costs' discussed in the labour economics literature; see for example Garibaldi (1998).

[16] Department of Health (1999/00, 2000/01, 2001/02).

provision, even within existing technologies. For example, empirical evidence suggests that some surgeons use procedures that lie well above the lower envelope of existing efficient cost-outcome procedures.[17] Evidence on funding shortages is observable from health data for the UK and similar EU countries. Although health expenditures in the UK have risen steadily since the 1960s, health expenditures as a share of GDP (7.6% in 2001) are lower than the EU average (8.3% in 2001). Another indication is that the UK continues to face acute doctor shortages (in 2000, the UK reported 2 practicing physicians per 1000 population, compared to the EU average of 3.3).[18]

The UK government's unwillingness to tackle the more intractable inefficiencies in the system (e.g. working practices), coupled with the (political) necessity of restricting costs, has led them to focus on more controllable costs. In parallel with (generally successful) efforts to restrict medical salaries, maintain current working practices, etc, the government has sought to limit the ever-increasing cost of pharmaceuticals. The chosen instruments have been to negotiate price agreements - the Pharmaceutical Price Regulation Scheme for brand name drugs and the Maximum Price Scheme for generics - with providers and to require doctors to prescribe only from approved lists[19] of mostly generic drugs, which being 'out of patent' are cheaper (but arguably less effective). Nevertheless, prices of pharmaceuticals are not within direct government control. Therefore, an increase in the price of drugs poses problems for the government. The extreme options are to: (a) maintain the official budget expenditure, implying a reduction in expenditure on other treatment costs (numbers treated, time spent in hospital), or (b) to expand the health budget at the cost of offsetting cuts elsewhere.

The economy-wide effects of a rise in the price of pharmaceuticals under the aforementioned policy alternatives is one of the issues investigated in the model. Another simulation looks at the general equilibrium effects of an increase in the NHS budget, as part of the government's commitment to improve the health service (in particular to reduce waiting lists), under two alternative factor market closures: (a) perfectly mobile factors and (b) health-specific skilled labour and capital.

5. The database and the CGE model

The analysis is based on a small open economy comparative static model of the UK, calibrated to 2000 data. The Social Accounting Matrix (SAM) underlying the model is predominantly compiled from the United Kingdom Supply and Use Tables for 2000,[20] supplemented with data from the General

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17 The Health Technology Assessment unit in the UK and the National Institute for Clinical Excellence in the USA seek to identify and promote best practice.
18 Data are from the OECD Health Indicators (2003).
19 The UK government operates a system of 'black', 'grey' and 'white' lists of pharmaceuticals.
20 Office for National Statistics (2002).

Household Survey for 2000-2001.[21] The structure of production, output, demand and trade is provided by the former data source, in the form of a 123 commodity-by-industry use matrix, which is aggregated to eleven sectors for the purposes of this analysis (among which are health care, the pharmaceutical industry and a sector producing medical, precision and optical instruments). A commodity-by-industry make matrix is derived from data on industry and commodity output in 2000 and the most recent published make matrix for the UK, for 1990.[22] The latter data source provides detailed information on a range of topics, including health, the use of health care, earnings and benefit variables for people living in private households in Great Britain and, for the purpose of this analysis, is also employed in the disaggregation of labour payments into two types (skilled and unskilled) and household data into five types (pensioners, non-working households with and without children and working households with and without children). The UK National Accounts Blue Book is used to ensure that household aggregates are correct.[23] The model classifications are summarised in Table 1.

Table 1: The CGE model classifications

FACTORS OF PRODUCTION (f)		HOUSEHOLDS (h)	
LABOUR (l)	Skill. Skilled	Hse1.	Pensioners
	Unsk. Unskilled	Hse2.	Non-working, children
	Cap. Capital	Hse3.	Non-working, no children
		Hse4.	Working, children
		Hse5.	Working, no children
SECTORS (i) / COMMODITIES (j)			
1.	Primary	7.	Distribution and transport
2.	Pharmaceuticals	8.	Finance
3.	Medical instruments	9.	Public administration and defence
4.	Other manufacturing	10.	Health care
5.	Energy	11.	Other services
6.	Construction		

The model has in most respects a standard structure, the novelty coming from the explicit modelling of the health sector. The equations concerning the latter are therefore presented in detail, whereas the remaining part of the model is summarised diagrammatically.[24]

Health provision effects: It seems a reasonable simplification to model health provision as a non-tradable output (using traded intermediates) that adds value to the ill, who are treated as an intermediate input (Figure 5). The given health budget limits inputs of factor services and intermediates, usually to a level insufficient to treat all those presenting themselves as ill. The output

21 Office for National Statistics (2001a). The responsibility for the analysis or interpretation of the data as laid out in this paper remains with the authors.
22 Office for National Statistics (1995).
23 Office for National Statistics (2001b).
24 The complete set of model equations is available from the authors upon request.

WELL is thus, in terms of people, less than the input ILL. The WELL output could be viewed in two ways: (a) it is the number of people treated and 'cured', the remainder being added to the waiting list; or (b) it is the proportional reduction in the degree of illness of all groups, with the proportion of 'semi-cured' workers becoming an addition to the effective workforce.

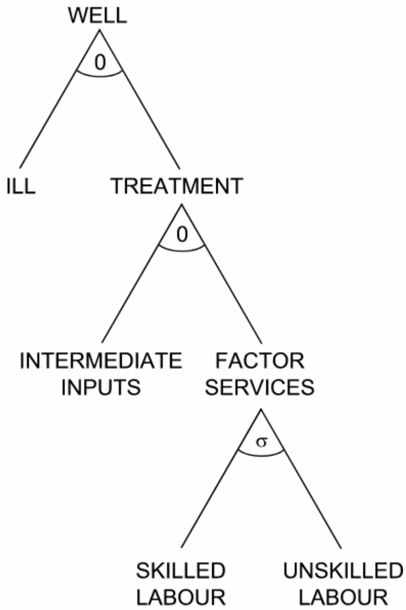

Figure 5: Modelling health provision

In this paper we report on a comparative static analysis, the easiest formulation. The obvious gains from this approach are that we need not model longer-term population processes (births, deaths, transitions from young to working and from working to retired), nor do we have to model the decomposition of those moving from young to working into skilled and unskilled. The major disadvantage is that we have to 'translate' the health transition from ILL to WELL, which is less than 100% in a dynamic framework, into a one-period model. However, an offsetting advantage is that we can gain insights into the implications of policy changes from our earlier low-dimension analytical model.

We model the interaction between health and labour supply in the static CGE model by the use of a non-participation rate for each type of labour. Non-participation can be interpreted as being on the waiting list, whereas participation implies employment in one of the sectors of the economy. The effective supply of factor endowments f by households h, FE_{hf}, is specified in equation (5), and the waiting list for factor f by household h, WL_{hf}, is displayed in equation (6).

$$FE_{hf} = \overline{F}_{hf} - WL_{hf} \qquad (5)$$

$$WL_{hf} = \eta_f \overline{F}_{hf} \qquad (6)$$

where $0 < \eta_f < 1$ for labour types $f \in l$, $l = \{Skill, Unsk\}$; otherwise (for capital) $\eta_f = 0$. The waiting list is a fraction of total given factor endowments of household h ($\overline{F}_{hf}$), and is defined positively only for labour ($f \in l$) whereas capital is always fully effective and fully employed.[25]

The non-participation rate is assumed identical across all households and is defined as a constant elasticity function of a health composite:

$$\eta_{f \in l} = \eta_{0f} HC_f^{-\varepsilon_f} \qquad (7)$$

where $\eta_{0 f \in l} > 0$ is a scale parameter, which measures the effectiveness of a given level of health care in treating and/or curing people and is calibrated so that $\eta_{f \in l} < 1$.[26] $HC_{f \in l}$ is a health composite and $\varepsilon_{f \in l} > 0$ is the waiting list elasticity, which measures the effectiveness of a change in health provisioning in treating and/or curing people. The latter is defined as the proportionate change in the size of labour type l's waiting list for household h following a change in the health composite, $\varepsilon_{f \in l} = -\left(\partial WL_{hf} / \partial HC_f\right) \cdot \left(HC_f / WL_f\right) > 0$.

The health care composite for labour type l is a measure of the 'healthiness' or health status of this labour type and is a Cobb-Douglas (CD) function of its public and/or private health care consumption:

$$HC_{f \in l} = G_{"10"}{}^{\upsilon_f} \left(\sum_h C_{"10"h}\right)^{(1-\upsilon_f)} \qquad (8)$$

where $0 \leq \upsilon_l \leq 1$ denotes the share of public health care in the health status of labour type l. $G_{"10"}$ denotes health care (commodity "10" in Table 1) provided via the NHS - as given by government consumption of health care, G_j - and $\sum_h C_{"10"h}$ represents the level of private health care provisioning - as given by the sum of household consumptions, C_{jh}, of private health care.

Given equations (5) to (8), waiting lists (effective labour supplies) are decreasing (increasing) in the health composites, at a decreasing rate. Figure 6 illustrates (subscripts are ignored for simplicity).

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[25] This does of course ignore the loss in effective capital when, for instance, machines break down. However, the cost of repairing a machine is internal to the firm, and is assumed to be assimilated into the cost of capital services, whereas the repair (treatment) of ill workers is a cost to the state or to the worker's insurers.

[26] Note that $\lim_{HC_f \to \infty} \left(\eta_f\right) = 0$, but that the upper constraint for η_f is not automatically satisfied. $\eta_{0 f \in l}$ also measures the non-participation rate for $\varepsilon_{f \in l} = 0$. Health care is then completely ineffective (i.e. does not cure people) and therefore does not affect waiting lists.

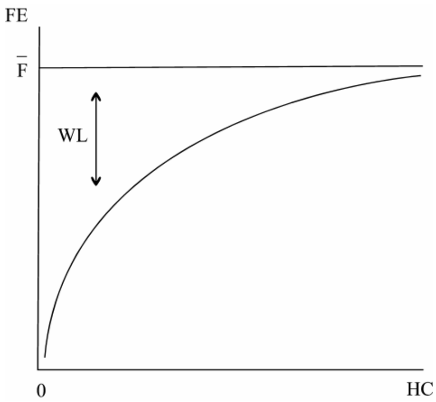

Figure 6: Waiting lists and effective endowments

Production: The structure of production in each of the eleven sectors is shown in Figure 7. Production in each sector is a Leontief function of value added, itself a CD function of factor demands, and intermediate inputs. Domestic sectors are multi-product industries so that a sector's production volume is a CD composite of the commodities it produces.

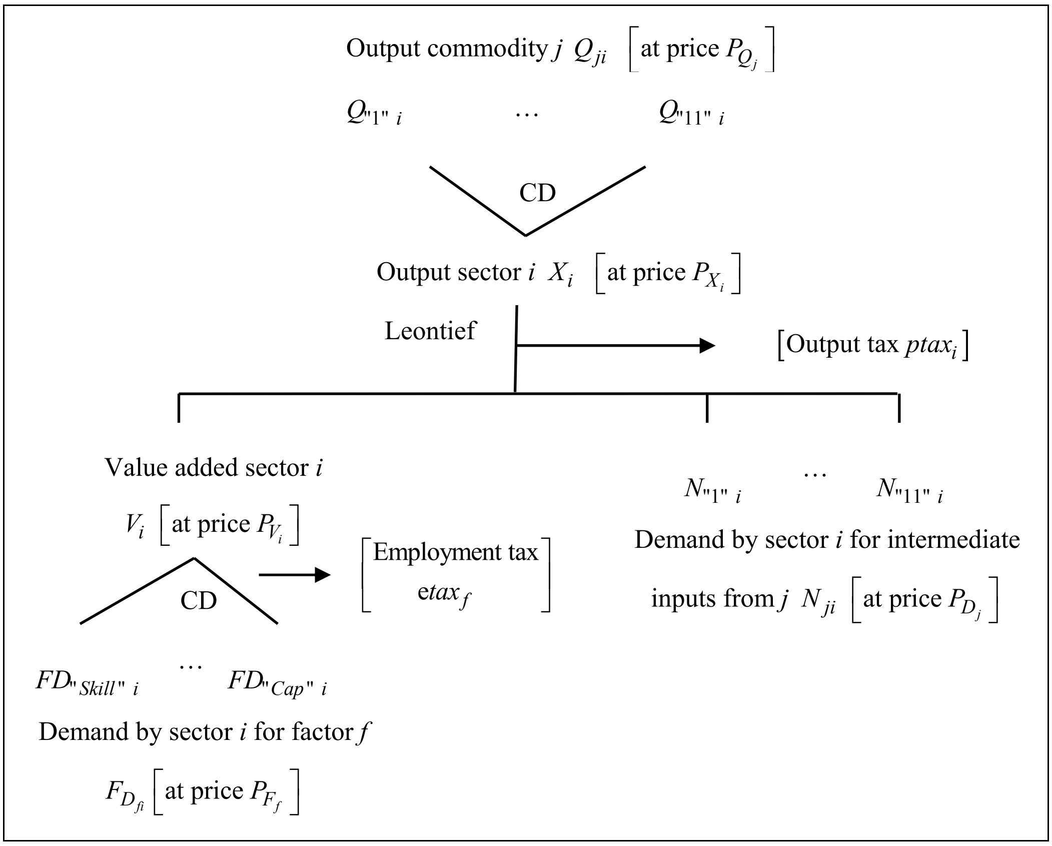

Figure 7: The nested production function

Domestic supply, exports and imports: Domestic and foreign supplies of commodities in terms of exports and imports are summarized in Figure 8. Aggregate market supply and demand for commodity j embody the *Armington assumption* (Armington, 1969), whereby goods are differentiated according to country of origin and destination (so-called 'double Armington'). On the demand side, domestic demand and foreign demand (i.e. exports) for a commodity are combined in a constant elasticity of transformation (CET) function and, on the supply side, imports and domestic supply of a commodity are combined in a constant elasticity of substitution (CES) function. The domestic demand originates from demand for intermediate inputs, private consumption demand by households, government consumption demand and investment demand. In order to account for transport costs incurred when delivering goods for domestic or export demand, aggregate supply for a commodity is combined with transport and trade margins in a Leontief function to meet aggregate demand .[27]

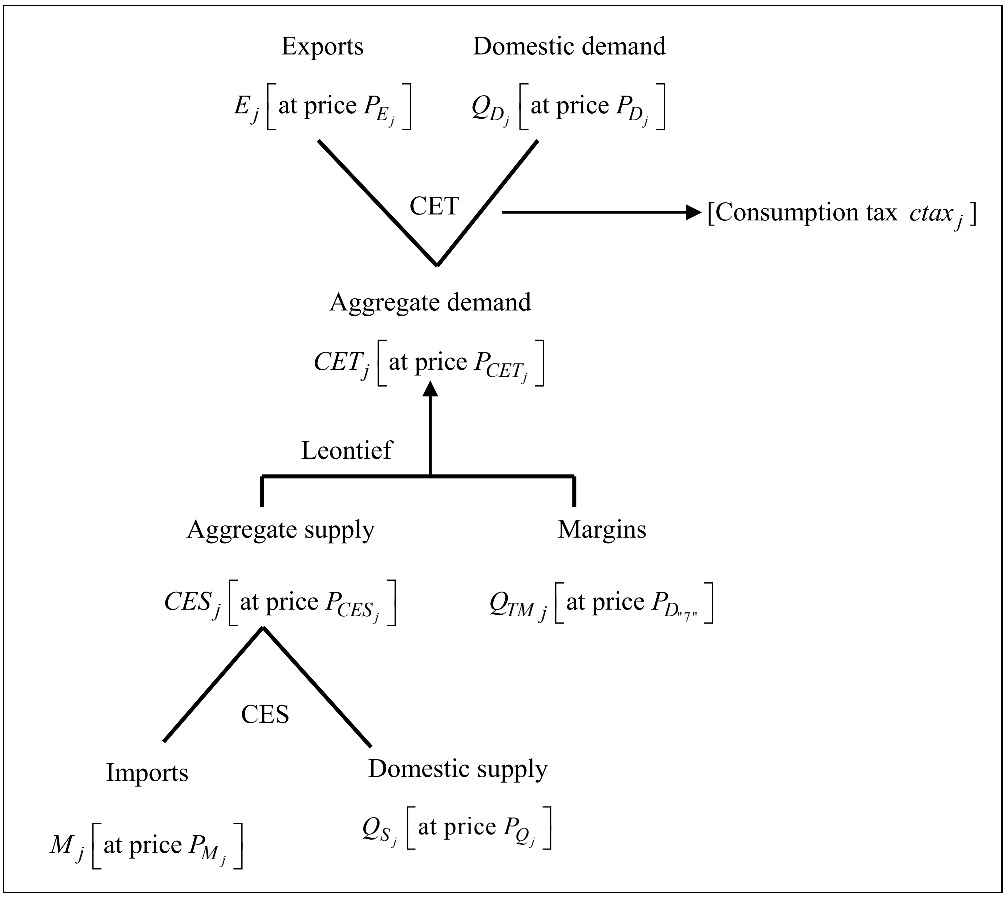

Figure 8: Market supply and demand

[27] This construction essentially states that aggregate market supply of commodities, combined with fixed transport and trade margins, equals aggregate market demand for commodities. The market clearing condition is 'unusual' in that it accommodates 'entrepôt' trade, i.e. the re-exporting (re-importing) of imported (exported) goods.

Prices: The structure of production and thus of market supply and of demand generates a system of price equations. The total value of output(s) at each stage of the trees depicted in Figure 7 and Figure 8 equals the total value of input(s). This includes the *ad valorem* taxes where relevant; output taxes ($ptax_i, ctax_j$) are defined as a net tax so that producers receive $(1-taxrate)\cdot market\ price$, whereas input taxes ($etax_f$) are defined as a gross tax so that producers purchase inputs at $(1+taxrate)\cdot market\ price$. With respect to trade the UK, being modelled as a small country, has no influence on world prices so that the world import and export prices are exogenous.

Households and government: The income generated in the production and supply of commodities is allocated to the representative agents in the model, five households and the government, who spend it on consumption, savings and transfers. Figure 9 summarises the flow of income and expenditures.

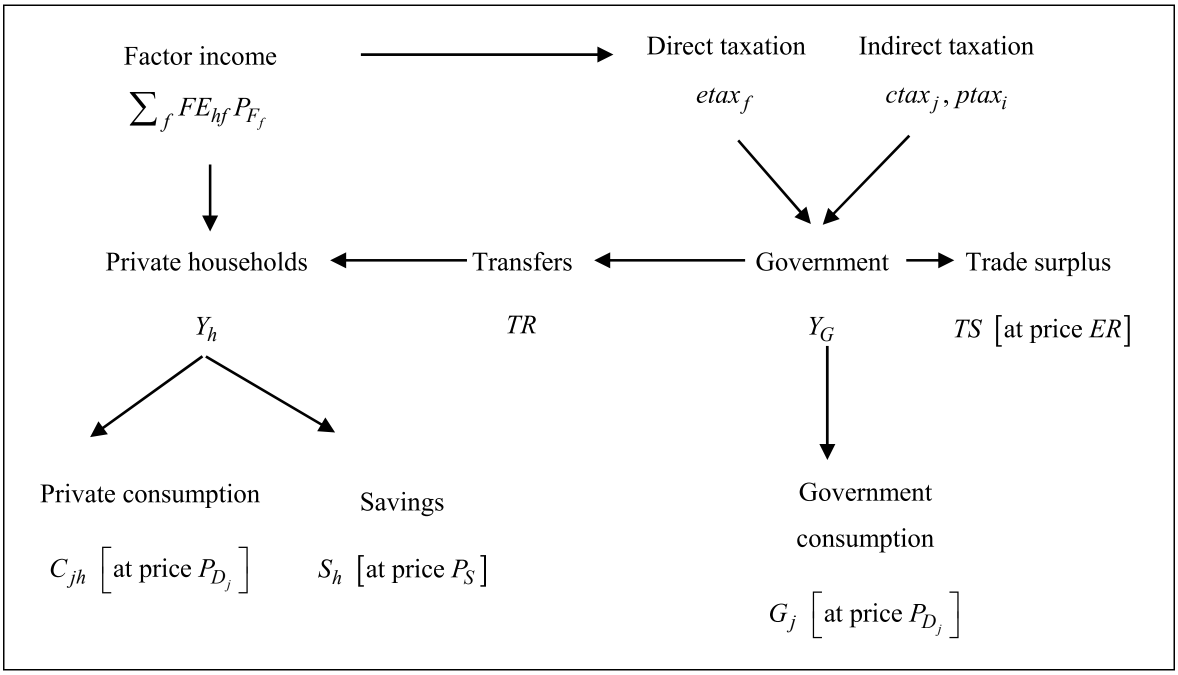

Figure 9: Flow of income, savings and expenditures

Households generally receive income from two sources, the employment of factors of production (capital, skilled and unskilled labour) and transfers from the government at a constant share of total government transfers. Working (and pensioner) households receive income from labour, whereas the remaining non-working household types rely solely on income from capital and government transfers. Household income is subsequently spent on the consumption of goods and savings. Consumption of goods and real savings by household follow from the optimisation of a CD utility function of consumption and savings, subject to the household budget constraint. It is assumed that only working households save.

The government receives income from direct taxation of factors of production (via the employment tax $etax_f$) and indirect taxation of sectoral and commodity outputs (via the consumption and production taxes $ctax_j$, $ptax_i$). The government allocates its income to expenditures on good j ('health care', 'public administration and defence' and 'other services'), household transfers and purchases a fixed amount of foreign exchange at the exchange rate in order to accommodate the trade surplus. Government expenditures on good j, defined as (real) government consumption multiplied by its domestic consumption price, are fixed relative to the numéraire at benchmark expenditure levels.

Market clearing: All factor and product markets clear through price adjustments. Equilibrium in the capital goods market requires that the value of total (household) savings equals the value of total investments (total real investments in the economy are a Leontief function of investment demands for commodities).

Welfare: The model includes two measures of household welfare and one measure of overall welfare changes. Firstly, changes in household welfare are calculated from private household utility using the equivalent variation. The equivalent variation reveals the income to which a particular change that has taken place between equilibria is equivalent.[28] Secondly, overall welfare changes are computed as the sum of household equivalent variations plus the sum of changes in real government consumption of goods (i.e. public good provisioning, including health services). Finally, a second measure of household welfare is reported, which allocates the welfare change related to government consumption of goods (including public provision of health care via the NHS) to households.[29]

Closure: The macro-closure adopts a neoclassical approach by postulating that total savings determine total investments. Foreign savings are fixed in foreign currency thereby avoiding 'free lunches' taken from or given to the rest of the world after a shock is applied to the model.[30] With respect to the government account, government expenditures on goods are fixed at benchmark levels, whereas transfers to households adjust to equate government income with expenditures on commodities and the trade surplus. Since households save and consume fixed proportions of their income, changes in private and hence total savings originate from adjustments in household income. Alternative closure

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28 Shoven and Whalley (1992, p125).

29 Note that private health care is already included in the utility function and thus incorporated in household welfare. The current welfare specification postulates that an increase in public health care provision corresponds to an increase in health. In addition, constant weights are given to welfare changes from private consumption and savings, and public goods, rather than giving a higher weight to, for example, public health care provisioning. Welfare effects resulting from the counterfactual simulations can therefore be considered as 'conservative' estimates of welfare changes.

30 The term 'free lunch' is used by De Melo and Tarr (1992, p42) to describe a sudden in- or outflow of foreign capital following a policy shock, which complicates the evaluation of the welfare effects of a policy change.

rules, especially those affecting the government account and labour markets, are experimented with when performing simulations. Since in general equilibrium models absolute prices cannot be determined, the price of foreign exchange, ER, acts as the numéraire.

Calibration: The model is implemented in MPSGE (Mathematical Programming System for General Equilibrium analysis), using the SAM as the benchmark dataset and by specifying values of remaining parameters and behavioural elasticities so that the SAM is replicated as an equilibrium solution of the model. The 'Harberger convention' is used throughout, so that prices that are unaffected by taxes (including the world price of exports and imports) are equal to one in the benchmark and quantities can be derived from the SAM.

Employment tax rates are derived from the National Accounts Blue Book, yielding average values of 0.25, 0.277 and 0.169 for capital, skilled and unskilled labour respectively. Production and consumption taxes, $ptax_i$ and $ctax_j$ respectively, are displayed in Table 2.

Table 2: Production and consumption taxes

Tax	**Sector i / commodity j**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
$ptax_i$	0	0.004	0.007	0.006	0.026	0.005	0.020	0.007	0.005	0	0.011
$ctax_j$	-0.036	0.068	0.081	0.107	0.021	0.072	0.024	0.034	0	-0.002	0.045

Leontief and CD functions are defined by a substitution elasticity of 0 and 1 respectively. The CES and CET functional forms respectively have substitution and transformation elasticities equal to σ_{S_j} and σ_{T_j}, which are set to 2 in this model.[31]

Welfare changes related to public good provisioning are allocated to households in proportions $\alpha_{G_{jh}}$, which for health care correspond to each household's share of the total number of NHS GP consultations and for other goods (public administration and defence, and other services respectively) correspond to each household's share in the population. The resulting parameter estimates, including savings rates, s_h, and household shares in government transfers, α_{TR_h}, are shown in Table 3.

The contribution of public health care to the health status of labour types, measured by υ, is obtained from Emmerson et al. (2000, Table 5.1). Using Family Resource Survey data for 1994/95 to 1997/98, they calculate by social class the percentage of adults with private medical insurance. By applying population weights corresponding to each social class from the General Household Survey, the

[31] The majority of goods produced in the UK is traded with similar high-income countries and are of the same high quality so that substitution and transformation elasticities are reasonably high. At the multi-commodity level elasticity values in GTAP version 5 (http://www.gtap.org) are around 2 to 2.5.

proportions of skilled and unskilled labour having private medical insurance are estimated at 0.166 and 0.040 respectively, yielding a residual of 0.834 and 0.960 of skilled and unskilled labour for whom health care is financed via the NHS. The latter serve as proxies for υ.

Table 3: Rates and shares by type of household

Parameter	s_h	α_{TRh}	$\alpha_{G_{jh}}$		
Household type			Public administration and defence	Health care	Other services
Pensioners		0.523	0.176	0.251	0.176
Non-working, children		0.102	0.064	0.087	0.064
Non-working, no children		0.106	0.054	0.076	0.054
Working, children	0.303	0.234	0.370	0.306	0.370
Working, no children	0.303	0.035	0.336	0.280	0.336

The scale parameter η_0 is calibrated to the benchmark non-participation rate. Its value is based on the Barmby et al. (2002, 2003) measure of sickness absence, calculated as the ratio of the number of hours absent due to sickness to the number of hours contracted to work. Using Labour Force Survey data, Barmby et al. find a fairly stable long-run average for the (yearly) sickness absence rate in the UK of around 3.20%. These and other studies[32] find that sickness absence varies by socio-economic characteristics. Typically, the higher the wage and the higher the level of responsibility involved in the job, the lower the absence from work. Illness-related absence from work is approximately 1.5 times higher for manual than that for non-manual workers. Assuming that the non-participation rate in the base year for unskilled workers is 1.5 times that of skilled workers and postulating an overall benchmark non-participation rate of 3.20% yields $\eta_0 = 2.89\%$ for skilled and $\eta_0 = 4.34\%$ for unskilled workers.

The waiting list elasticity parameter, ε, is set to 2 for both labour types, so that a 10% increase in health status leads to a 20% decrease in waiting lists. Given the remaining parameter estimates in Table 4, this implies that the elasticities of effective (labour) endowments with respect to the health composite in the benchmark are 0.06 and 0.09 approximately for skilled and unskilled labour respectively.[33] These numbers are consistent with health care elasticity estimates of around 0.1 based

[32] See for example the Confederation of British Industry (2001) and Barham and Leonard (2002) for an overview.

[33] These elasticities measure the proportionate change in the size of effective (labour) endowments of skilled and unskilled labour following a change in the health composite, and are calculated as $\left(\partial FE_{hf} / \partial HC_f\right)\left(HC_f / FE_{hf}\right) = \varepsilon_f \, WL_{hf} / FE_{hf} = \varepsilon_f \, \eta_f / \left(1 - \eta_f\right)$.

on US data (Folland et al. 2001, p108-109). The elasticity of effective labour supply with respect to the health composite is higher for unskilled labour due to the fact that a relatively higher proportion of the unskilled suffer illness, so that health expenditure's 'leverage' is greater for this labour type. Alternative values of the waiting list elasticities are considered in the sensitivity analysis.

Table 4: Waiting list parameters

Parameter	Skilled labour	Unskilled labour
υ	0.834	0.96
η_0	0.0289	0.0434
ε	2	2

6. The counterfactual simulations

In order to illustrate the functioning of the SCGE model and potential areas of application two shocks are simulated under alternative assumptions regarding the closure of the government budget and the factor market. Results are compared with the benchmark equilibrium values for 2000. The first shock examines the impact of a 10% rise in government expenditures on health care, i.e. NHS expenditures (experiment 1) equivalent to the average yearly increase in NHS expenditures from 1999-2000 and planned up to 2007-2008.[34] The expansion of public health care, while drawing resources away from other sectors in the economy, improves both worker income, through increased labour market participation, and welfare, via direct increases in the well-being of the population. Results are reported for two different labour market closures. Experiment (1a) assumes capital and labour are fully mobile across sectors, in line with the original model specification, whereas experiment (1b) reports results assuming that parts of skilled labour and capital are specific to the health care sector. The latter assumption limits factor movements between the health sector and other sectors and puts upward pressure on specific factors' remunerations.

Experiment (2) simulates a 20% increase in the domestic consumer price of pharmaceuticals. This figure corresponds to the increase in the average cost per prescription item dispensed in the community in England from £9.48 to £11.37 over the period 1999-2000 to 2002-2003, reported in the Annual Report of the NHS Chief Executive.[35] Here, the assumptions regarding the closure of the government account are that either the government keeps its (overall) health budget fixed in value (2a) according to the original model specification, or that the government increases expenditures on the NHS, so that total *real* public health expenditures and the number of treatments (of a certain quality

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[34] See the Department of Health's Expenditure Plans for the NHS (Department of Health, 2003a, p3 and p20).
[35] Department of Health (2003b, p9).

and cost) provided by the NHS are maintained at benchmark levels (2b). For a given nominal health budget as in (2a), the increase in the cost of pharmaceutical inputs implies lower levels of health care provisioning and that, given the cost-effectiveness of treatments, less people are being treated and cured. This has repercussions on welfare, both directly and through reduced household income (via changes in effective labour supply).

Experiment 1a: increasing the NHS budget with mobile factors

Government expenditures are fixed in terms of foreign exchange, so that the immediate effect of a 10% increase in government expenditures is, given tax revenues, to reduce transfer payments to households by 4.3%. The additional NHS resources result in an increase in public health care provision by 10% and, via input-output linkages, increase the demand for and production of pharmaceutical products (by 4.9%), and medical, precision and optical instruments (by 1.9%). As a consequence health care, pharmaceuticals and instruments become slightly more expensive, which increases the costs to and hence reduces the size of private health care provision (by 0.3%).

The increase in public health care boosts the health of unskilled labour by 9.6%, which is more than the improvement of 8.2% in the health of skilled labour, as the former is affected primarily by changes in public health care, whereas the latter also responds to changes in private health care provision. In agreement with this pattern, participation in the labour market increases by 0.43% and 0.76% for skilled and unskilled labour respectively, equivalent to reductions in the waiting lists (across all households) of 14.6% and 16.7% for skilled and unskilled labour respectively.

The expansion of health and related sectors (and contraction of other sectors), combined with the increase in labour market participation due to improved health, induces changes in factor remunerations: unskilled wages fall by 0.5%, whereas skilled wages and capital rents rise (by 0.02% and 0.18% respectively).

The fall in income from state benefits and unskilled wages leads to reductions in income for working households with children (0.2%), but relatively more so for pensioners (1.3%), non-working households with children (3.6%) and childless non-working households (1.4%). Only childless working households, who own 63% of skilled labour endowments - generating 67% of their household income - and rely least on government transfers, gain slightly (by 0.3%) from higher treatment levels in the NHS.

The same pattern emerges from absolute (and relative) changes in household welfare; excluding public goods, pensioners suffer a welfare loss of £2.389 billion, and all other households (except for childless working households who gain by £955 million) lose around £500 million on average. Adjusting these figures for changes in levels of public good provisioning (including health care) reduces each household's welfare loss, especially for pensioners and working households who receive a large share of public good provisioning (see

Table 3), so that only pensioners still experience a significant deterioration in welfare of £1.04 billion. Non-working households with and without children lose by £36 million and £80 million respectively, whereas their working counterparts gain by £1.17 billion and £2.46 billion. Overall welfare (including government consumption of goods) increases by £2.474 billion (a relative gain of 0.26%).

Experiment 1b: increasing the NHS budget with health-specific factors

Experiment (1a) overlooks the fact that a large part of the labour and capital employed in the health sector are, respectively, highly trained or highly specialised and therefore specific to health care and immobile. This scenario provides an alternative specification more suited to the short run by introducing health-specific skilled labour and capital. The former type consists of mainly doctors and nurses (85% of skilled labour employed in the NHS)[36] and the latter consists of buildings and land (approximately 90% of capital employed in the NHS)[37], and both earn a health-care-specific remuneration.[38]

Key findings are that, unsurprisingly, the presence of health-specific skilled labour and capital constrains the production and supply expansion of health care and related sectors. A 10% increase in the public health care budget leads to a lesser increase in levels of provisioning, of 4.4%, so that the domestic outputs of pharmaceuticals and medical instruments rise by 1.7% and 0.7% respectively (less than half of the rise in experiment 1a).

The mounting pressure on health-care-specific sectors translates into higher remunerations - health-care specific skilled wages and rents rise by 11.7% and 11.9% respectively - which drive up unit costs

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36 Calculated as the share of professionally qualified clinical staff relative to the total of professionally qualified clinical staff, managers and senior managers and central functions for 1999-2000 in the NHS in England (Department of Health, 2004, Table D1).

37 Calculated as the share of land, buildings and assets under construction relative to the total net book value of capital including equipment in the NHS for 1996-1997, from Department of Health (1998, Annex 1).

38 When modifying the model for this assumption, total endowments of health-care-specific capital and skilled labour (90% and 85% of capital and skilled labour employed in health care respectively) are apportioned to individual households according to each household's share of, respectively, mobile capital and skilled labour endowments. Health-care-specific factors of production are also assumed to have the same labour market characteristics, i.e. same non-participation rate and health status, as their mobile counterparts.

and prices for public *and* private health care (by 5.4%), so that the public health expenditures increase crowds out private health care by approximately the same percentage.[39]

Within the health sector, some substitution towards (relatively cheaper) mobile factors takes place to relieve the constraint of specific factors. The relative changes in production levels across sectors induce changes in factor remunerations of opposite sign to (1a); unskilled wages rise by 0.2%, whereas wages of mobile skilled labour and rents on mobile capital fall (by less than 0.1%). Labour remunerations, of course, also respond to health-induced changes in effective labour supply. The health status of both unskilled labour and skilled labour increases by 4% and 2.8% respectively - much smaller health improvements than in (1a) due to relatively lower levels of health care provisioning - so that labour market participation increases by 0.16% and 0.34%, equivalent to reductions in the waiting lists (across all households) of 5.3% and 7.6% for *all* skilled and unskilled labour respectively.

Government transfers to households fall by slightly (0.3%) less than before to finance a (smaller) expansion of public health care, so that compared to (1a) income losses (gains) of households fall (rise). The same is true for absolute and relative changes in household welfare excluding government consumption of goods. However, once public provision of goods (including public health care, which expands by much less in the presence of health-care specific factors) is accounted for in household welfare, losses are higher and gains are lower relative to (1a). Overall welfare (including government consumption) increases by £920 million (a relative gain of 0.1%).

Experiment 2a: a pharmaceutical price rise under an exogenous NHS budget

The price simulation is implemented by increasing the domestic consumption price for pharmaceuticals to a level of 120% of the numéraire. Pharmaceuticals are an Armington composite of imported and domestic varieties. In order to obtain a 20% increase in the price of this composite, the exogenous (world) price of imported pharmaceuticals was increased by 42%, which in turn increases the price of the domestic variety by 4% and the price of the composite by 20%.[40]

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[39] One could argue that the government exerts more or less direct control on wages of NHS personnel, whereas capital rents are given on the market. If wages of health-care-specific skilled labour are kept at pre-shock levels so as to control labour costs of extra health care, provision of NHS care increases by 9%, approximately equal to the rise in public provision when factors are fully mobile. The results of such a scenario are therefore equivalent to those reported in (1a).

[40] These figures refer of course to an assumed Armington elasticity of 2. Note that this is a different simulation from one which investigates a rise in the world price of imports directly, as this will lead to a rise in domestic consumer price of less than 20% as the latter is the Armington composite of domestic and import prices (see nesting Figure 8).

The simulation results demonstrate by how much the world import price (and in fact all other endogenous prices) of pharmaceuticals needs to change in order to generate a rise in the domestic consumption price of 20%; the former rises by 42% whereas, for example, the domestic producer price of pharmaceuticals rises by 4%. As pharmaceuticals become more expensive, imports fall by 43% and domestic production of pharmaceuticals grows by 6.5%. Confronted with higher unit costs of intermediate inputs, public and private health care commodity prices increase by 1.8%. Consequently, private health care demand falls by 2.1% and, given the government closure rule, the production of public health care via the NHS decreases by 1.7%.

Lower levels of public and private health care imply a fall in the level of health for skilled and unskilled labour by 1.8% and 1.76% respectively. The change in health status is slightly more pronounced for skilled labour as they consume relatively more of private health care, which contracts relatively more. Labour market participation rates fall by 0.11% and 0.16% for skilled and unskilled workers respectively, leading to a relative rise in waiting lists (across all households) of 3.7% and 3.6% for skilled and unskilled labour respectively. The changes in factor supply and demand lead to a fall in all factor rewards (including rental rates of capital) in the range of 0.2% to 0.3%.

Government income from taxes falls by 0.3%. In order to keep its finances balanced the government reduces transfers to households by 0.7%. Given that factor rewards and effective labour endowments fall, income from employment and capital falls as well so that all households experience a deterioration in income (of 0.6% or less). Pensioners and non-working households are relatively worse off compared to other households as they rely heavily on state benefits.

A similar picture is obtained from absolute (and relative) changes in household welfare; excluding public goods, the welfare loss for pensioner households is relatively high and equal to £554 million. Next to the reduction in state benefits, a major contributor to this decline is the falling rents on capital, of which pensioner households own 47% in total. Working households with and without children experience a similar welfare loss of £564 million and £638 million respectively. The welfare loss for the remaining non-working households is much less pronounced in absolute terms - losses of £69 million and £120 million for non-working household with and without children respectively - because they do not enter the labour market so that the deterioration in health does not affect their labour supply. When including public good provisioning, notably the decrease in levels of public health care, in household welfare, the overall welfare loss rises by £2.64 billion, a deterioration of 0.28%.

Experiment 2b: a pharmaceutical price rise under exogenous NHS provision

In contrast to the previous experiment, the government increases its health care expenditure in order to maintain real provision levels under the NHS. This scenario is implemented by changing the original government closure so that, instead of government expenditures, real government consumption of health care is exogenous. The results of (2a) show that the price of health care increases by approximately 1.8% following a 20% pharmaceutical price rise. Hence, in order to maintain original levels of public health care provision the government matches the price increase by the appropriate increase in expenditures on public health care. As this is such a minor change, results differ marginally and a short summary is given below.

Domestic production of pharmaceuticals rises by an additional percentage compared to (2a) as more intermediate inputs from the pharmaceutical industry are needed to produce the additional public health care. For identical reasons, production of medical, precision and optical instruments expands slightly (instead of contracting as in 2a). By construction, the level of public health care remains constant, whereas private health care contracts by 2.13% relative to the base (2.1% in 2a).

In contrast to previous results, the health of unskilled labour, which depends primarily on levels of NHS provisioning, is maintained approximately at its original level. Thus, unskilled labour participates at a similar rate as before and supplies approximately the same amount of labour. In contrast, skilled labour is worse off in terms of health (health status falls by 0.4%) and labour participation (falls by 0.02%), leading to a rise in the waiting list of 0.7% relative to the base; compared to (2a) these changes are however small.

In order to maintain levels of public health care following an increase in the cost of provisioning, the government reduces transfer payments to households by more compared to (2a), given expenditures on other goods. Since factor rewards are falling - rents on capital fall by slightly less, whereas wages for unskilled labour fall by almost twice as much relative to (2a) as effective unskilled labour supply is maintained close to pre-shock levels - most households are worse off compared to (2a). The loss in income transfers especially affects welfare of pensioners and non-working households, but when levels of public (health care) provisioning are taken into account the loss is mitigated. Overall, welfare (including public good provisioning) falls by £2.14 billion, a deterioration of 0.23% relative to the benchmark; £508 million or 0.05 percentage points less compared to (2a).

Table 5 and Figure 10, 11 and 12 summarise the key results of the experiments.

Table 5: Welfare changes measured in Equivalent Variations (including public goods)[41]

Scenario	EXP1A		EXP1B		EXP2A		EXP2B	
	Millions £	%	Millions £	%	Millions £	%	Millions £	%
HSE1	-1040	-0.49	-1460	-0.69	-747	-0.35	-909	-0.43
HSE2	-36	-0.13	-248	-0.93	-135	-0.50	-140	-0.52
HSE3	-80	-0.17	-270	-0.59	-178	-0.39	-188	-0.41
HSE4	1169	0.40	657	0.22	-763	-0.26	-537	-0.18
HSE5	2460	0.67	2244	0.61	-821	-0.22	-363	-0.10
Overall	**2474**	**0.26**	**920**	**0.10**	**-2640**	**-0.28**	**-2140**	**-0.23**

Figure 10: Change in Health Status

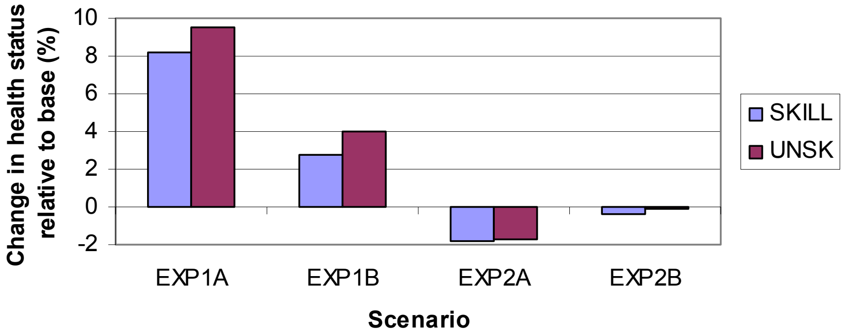


Figure 11: Change in Waiting List

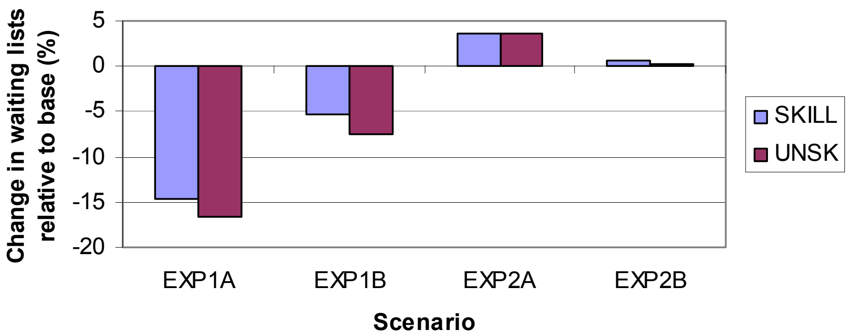
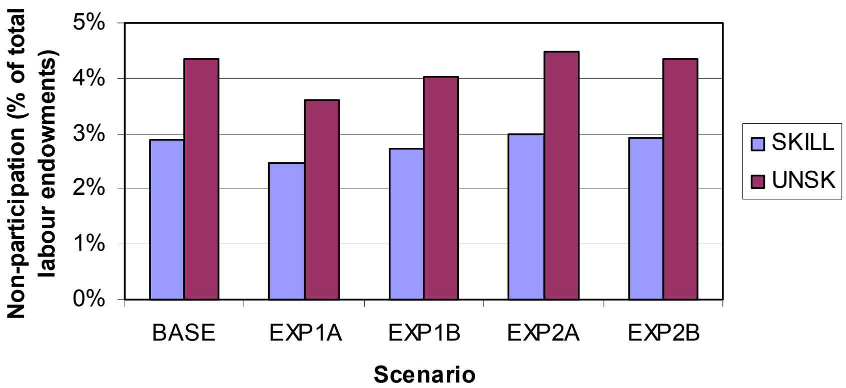


Figure 12: Non-participation Rate of Labour



[41] The change in household welfare and overall welfare both include changes in the public provision of goods

7. Sensitivity analysis

This section reports on the sensitivity of the results to changes in the waiting list elasticity for skilled and unskilled labour (ε). Firstly, values for this parameter are varied while adhering to the assumption of equal elasticities across labour types. Secondly, this section considers unilateral changes in the waiting elasticity for skilled labour, whilst keeping the waiting list elasticity for unskilled labour at the benchmark level of 2. The former procedure tests the sensitivity of model results to the effectiveness of a change in health care provisioning in treating and/or curing people across all labour types, whereas the latter procedure shows how model outcomes are altered by allowing for skill-biased health effects - implying that a given increase in health care provisioning treats and/or cures more skilled workers relative to unskilled workers.[42] As altering the level of the waiting list elasticity impinges upon the effectiveness of a change in health care provisioning, the sensitivity analysis is carried out for experiment (1a), which simulates an increase in public health care expenditures. The observed patterns carry over to the other experiments.

The results of (1a) are relatively robust to skill-biased and skill-neutral changes in the waiting list elasticity - differences are generally within the margin of 1-2 percentage points - though the direction of effects and outcomes for health (care) and labour market related variables are affected. When simulating a 10% increase in levels of NHS care (experiment 1a), the following patterns can be observed from uniform increases in the waiting list elasticities:

The higher the waiting list elasticity, the more the non-participation rate and the size of the waiting lists is reduced for a 10% increase in public health care expenditures. Eventually, the more pronounced expansion in effective labour endowments ensures that the production and supply of all goods rises. This includes public *and* private health care provisioning, which magnifies the positive health effects. Skilled and unskilled labourers are relatively less scarce in supply, so that wages for both labour types fall whereas rents on capital rise. As more people return to the labour force and so more is produced in the economy for a given increase in NHS expenditures, the government sees its tax revenue rise so that it needs to reduce transfer payments to households by less in order to finance the increase in the health care budget. Consequently, more and more households gain; at first only working households, but for higher levels of the waiting list elasticity also pensioners and non-

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and are reported in absolute terms (£ million) and relative to original income, i.e. as a % of original expenditures on goods (including government consumption) and savings.

42 In other words, health care expenditures are either targeted more towards skilled workers *or* skilled workers are more effective ‘producers’ of health.

working households. Overall welfare (including government consumption of goods) rises for relatively low values of the waiting list elasticities (of 1 and higher) and increases by more for higher values.

Skill-biased increases in the waiting list elasticities reveal much the same tendencies, except when it comes to labour market variables; a given 10% increase in public health care expenditures reduces the non-participation rate and the size of the waiting list for skilled labour by more, the higher the waiting list elasticity for skilled labour. Given that the waiting list elasticity for unskilled labour remains at the benchmark level of 2, the changes in the non-participation rate and the waiting list for this type of labour in (1a) are not affected by the increase in the waiting list elasticity. For higher levels of the waiting list elasticity of skilled labour relative to unskilled labour, only skilled labour becomes relatively less scarce in supply, so that wages for skilled labour fall, whereas rents on capital and unskilled wages rise. Comparison of the sensitivity of overall welfare changes in (1a) to uniform and skill-biased changes in the waiting list elasticity reveals that welfare gains are lower if the waiting list elasticity for unskilled labour lags behind that of skilled labour, i.e. if the change in NHS treatment levels treats and/or cures relatively more skilled workers.

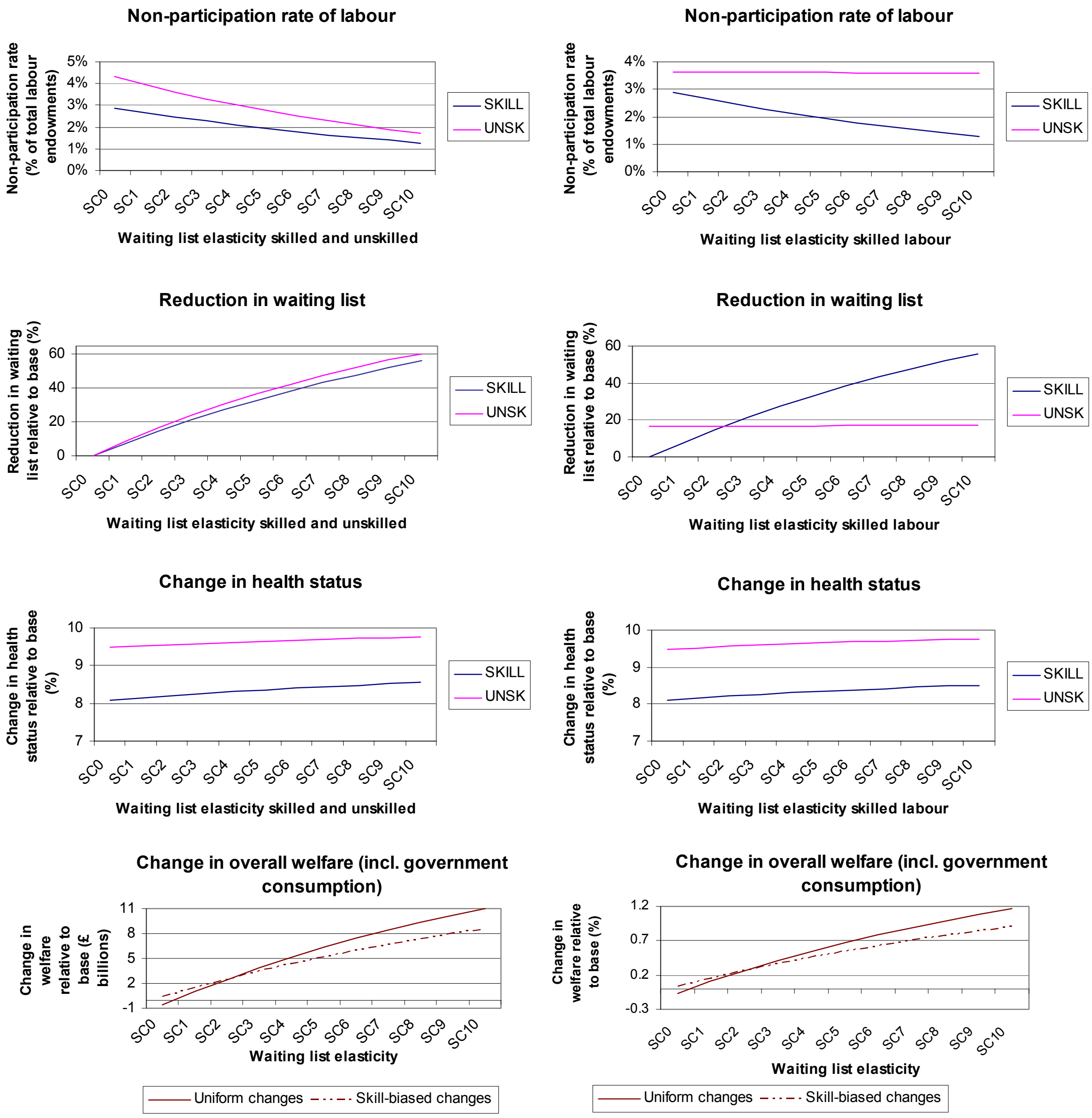
The effect of changing the waiting list elasticity is illustrated in Panel 1 for a selection of variables. Results are reported for uniform and skill-biased changes in the waiting list elasticities, where the relevant elasticities are set to values of 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 (in scenario sc0, sc1,.., sc10 respectively).[43] A waiting list elasticity of zero illustrates the direct impact of additional health care expenditures on the economy (and welfare), and suppresses the indirect effects of improving (household) income through increased labour market participation. This could be interpreted as the *short run* economic impact of expanding health care, as opposed to the *long run*, in which consequent health improvements materialise.

8. Conclusions and comments

This paper has outlined the results from a static CGE model of health care applied to the United Kingdom. It models health provision and its simultaneous effects on effective labour supply and resource claims made by the health sector, and shows the magnitude of changes to sectoral production, factor rewards, health and labour market participation, household income and welfare that could be expected from scenarios of increased public health expenditure and increased pharmaceutical prices under alternative closure rules.

[43] For skill-biased changes, the waiting list elasticity for unskilled labour remains at a level of 2, whereas the skilled waiting list elasticity adopts aforementioned values.

Panel 1: Sensitivity of results in experiment (1a) to the waiting list elasticity



The main findings of the paper are that a 10% increase in expenditures on the NHS, while drawing away resources from other non-health related sectors and its private counterpart, leads to an overall welfare gain of £2.474 billion (a relative gain of 0.26%) through increased worker incomes and direct increases in the well-being of the population. The overall welfare gain is reduced to £920 million (a relative gain of 0.1%) if the presence of health-care specific skilled labour and capital in the short run is accounted for.

Furthermore, a 20% rise in the domestic consumption price of pharmaceuticals, the main intermediate input into health care, has adverse overall welfare effects of £2.64 billion (0.28% in relative terms), through falling household incomes and direct decreases in the well-being of the population. These welfare losses are mitigated by \$508 million if the government allows the health budget to grow by 1.8% so as to cover additional costs of health care provision and maintain previous treatment levels under the NHS.

Distributional effects of the counterfactual simulations are unequal across labour categories and household types. Skilled workers at all times are worse off in terms of health status and employment relative to unskilled workers as the latter largely benefit from public health care, whereas some of the former consume private health care (and insurance) which becomes more costly. Depending on changes in relative factor demands and (effective) supply of endowments, factor remunerations rise or fall. Households with working members gain from health improvements through increased participation in the labour market and direct improvements in well-being, whereas pensioners and non-working households are worse off; the direct improvements in well-being are insufficient to compensate for the loss in income from state benefits, from which the NHS budget expansion is financed.

These results depend on the effectiveness of health care, as represented in the model by the waiting list elasticity, governing how labour participation rates respond to changes in health provision. A sensitivity analysis of the elasticity of the waiting list with respect to health status suggests that our results are relatively robust. More importantly, in the presence of increasingly strong skill-neutral health effects, an expansion of NHS care, although representing an immediate cost to society, leads to substantial welfare gains in the long-run through increases in effective labour supply and production, and by enhancing the tax earning ability of the government which benefits both working households (in terms of wage income) and non-working households (in terms of transfer income). Skill-biased increases in the waiting list elasticity are also considered so as to test the assumption of skilled workers receiving more of extra health expenditures or being relatively more effective in 'producing' health. Welfare gains rise but are found to be lower relative to skill-neutral increases in the waiting list elasticity.

We modelled the positive gains from health provision that occur through increased effective labour supply and direct increases in 'well-being'. The model currently does not distinguish between part-time and fulltime work and does not include effects that health care may have through increasing leisure (non-working) time. Future research might include the modelling of such benefits, and might also improve on the manner in which health is incorporated into the model by incorporating explicit dynamics, including the modelling of generational changes (this also touches upon the issue of ageing and sustainability of pension schemes), the manner in which ill individuals move to good health, and the intra-household distribution of health benefits to individuals and workers. In order to model how individuals move through the health system and how this affects participation in the labour market, economic growth and welfare, it is essential to get the numbers of persons and their demographic, socio-economic and employment characteristics correct.

The model distinguishes between rationed public health care and private care, each with a different clientele. Another avenue of research would be to incorporate different types of care; primary and secondary (medical and surgical) care typically have differential impact upon illness rates, health and effective labour supply, and the inclusion of such variety in treatments may allow us to infer conclusions about cost effectiveness.

Possibly the greatest obstacle to modelling the economic impact of changes in health and health provisioning is the availability of data. Refining the empirical basis of the model will be a crucial element of any progress made in the area of health modelling in a macroeconomic context.

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