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The Economic Impact of Health Care Provision: A General Equilibrium Assessment of Some Policy Options in the UK's NHS

by

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Abstract

This paper focuses on the macro-economic impacts of changes in health provision via its effects on the labour market. The resource allocation issues have been explored in theory, by further developing the Rybczynski theorem and empirically, using a Computable General Equilibrium model for the UK. From the theory, changes in non-health outputs are shown to depend on so-called factor-bias and scale effects. Using the CGE model with added real-life complexities, a rise in the NHS budget is shown to yield overall welfare gains, which fall by two-third assuming health-specific factors. A nominally equivalent migration policy yields even higher welfare gains.

JEL classification: D58, F22, H51, I18, I38, J21

Keywords: CGE modelling, international trade theory, international migration, health care, labour markets

Outline

1. *Introduction*
2. *Effective labour endowments and the health sector: some low-dimension analytics*
3. *The UK CGE model and SAM*
4. *Policies aimed at alleviating rationing in UK health care*
5. *Conclusions*

Non-Technical Summary

The central idea of the paper is that an increase in the size of the health sector reduces the supply of workers available to other sectors, but simultaneously increases that supply by treating those unable to work due to ill health. This resource allocation issue has been investigated in theory, by developing an extension of the Rybczynski theorem, and empirically, using a computable general equilibrium (CGE) model for the UK. These represent the main contributions of this paper.

Using the theory, the impact of an expanding health sector on non-health outputs is shown to depend on a scale effect of increased effective labour supplies and a factor-bias effect of changes in the ratio of skilled to unskilled labour. Given that effective labour supplies are relatively inelastic with respect to health provision, factor-bias effects dominate so that an increase in health provision, which is relatively skill-intensive, is "on average" expected to yield a contraction of the relatively skill-intensive sectors and an expansion of the relatively unskilled-intensive sectors. The theoretical predictions are not generally validated by the CGE model due to added real-life complexities, providing a strong argument for its use.

The CGE model has been employed in two types of policy simulations which have identical nominal budget implications but differ in their real impact. These are an 11.64% rise in the NHS budget (equivalent to £6.267 billion) assuming, respectively, mobile and health-specific factors (i.e. highly skilled labour, high-tech capital) and a policy of employing highly skilled foreign doctors and nurses at 10% of domestic endowments and at the current wage, under alternative assumptions regarding remittances. The main findings are that the increase in the NHS budget leads to an overall welfare gain of £2.808 billion through increased worker incomes and direct increases in population well-being. The presence of health-specific factors reduces the overall welfare gain to £1.038 billion, as over half of the specified budget rise is absorbed by higher wages and rents, suggesting the importance of tackling rigidities in the health sector. The shortage of highly skilled workers may in the short-term be addressed via overseas recruitment. This policy yields the highest overall welfare gains (exceeding £3.2 billion), even if all foreign worker income is remitted abroad, since state benefits need to fall by less to finance the health budget increase due to a rise in government tax revenues. This is not to say that this is a desirable policy since many migrant workers come from developing countries which need their own educated staff. Consequently, in the long-term increasing the number of medical school places may be a more suitable policy. In addition, non-working households and pensioners may require some compensation since the government finances the NHS budget increase from a reduction in state benefits, on which these households rely relatively heavily. Alternatively, the government may consider raising direct taxes. The sensitivity of the results to the elasticity of the waiting lists with respect to health care indicates the importance of ensuring "value for money" in the UK health sector.

1. Introduction

The interactions between health care, health and the remainder of the economy are multiple and complex. On the one hand, changes in income impact upon the consumption and/or provision of health care and other goods, which affects the health of populations in terms of mortality and morbidity (illness). On the other hand, changes in health impact upon the well-being of populations, with associated consequences for labour market participation, productivity and income.

Developed countries have high living standards and levels of health, and so are thought to be in a state where the marginal contribution of health care to health is minimal and other factors, like changes in diet, lifestyle (drinking and smoking), environment and education, are more important in explaining variations in health.[1] This being said, many former sceptics of the contribution of health care to health are now willing to accept that, even after allowing for diet and lifestyle, health care does make a difference for specific conditions, such as cardiovascular disease. Apart from gains in longevity, medical care also enhances the quality of life through pain relief and increased mobility. The rise in medical costs partially reflects improvements in treatment quality enabling less drastic treatments and a more rapid recovery.[2] Nevertheless, the majority of developed country health care systems arguably fail to deliver specific medical services to a "satisfactory" standard, which is commonly attributed to limited financial means and inefficient use of resources. In the UK, pressures are visible, among others in terms of poor health outcomes for some diseases (such as cancer), poor quality of services, including long waiting lists and waiting times for certain treatments, and inequities in access and health outcomes. These pose significant costs on society, in addition to the cost of health provision. In future, health care costs are bound to rise with the prospect of an ageing population and advances in medical technology.

While the interdependencies between health care, health and the rest of the economy are now widely acknowledged, economic models which are used to assess these fail to incorporate the main channels through which interactions take place. The majority of empirical studies employ econometric analysis and usually conceal or ignore general equilibrium effects of changes in health and health care across sectors, factors, households and their implications for the government budget.[3] The small range of

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1 See Folland et al. (2001, Chapter 5) on the production function of health.

2 Wallace (2004).

3 Econometric models focusing on multiple linkages between health, health expenditures and economic growth include Bhargava et al. (2001), Bloom and Canning (2000), Bloom, Canning and Jamison (2004), Bloom et al. (2001, 2004), Crémieux et al. (1999), Ettner (1996), Hamoudi and Sachs (1999), Hitiris and Posnett (1992), Jamison et al. (2003), Knowles and Owen (1997), Mayer (2001a,b), Pritchett and Summers (1996), Strauss and Thomas (1998), Stronks et al. (1997) and Thomas (2001).

computable general equilibrium (CGE) models that does exist is diverse in application area, the majority having a developing country context (commonly Basic Needs, Externality and HIV/AIDS models)[4], an exception being Lee and McKibbin (2003), which is a global model. While each of these strands of CGE literature has its own merits, most do not assess the endogenous impact of changes in health care provision on population health, the labour force and its impact on production, income and welfare over time in a (developed country) CGE setting.[5]

Empirical studies typically fail to account for the main feature of rich and poor nations' health care systems, namely that they treat and (partially) cure people, i.e. improve their health, which not only makes them "feel better" but also enlarges the effective size of the working and non-working populations through increased working time and reduced deaths. The latter group of "young" and "retired" people are an additional source of demand for health services (and other goods), 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. At the same time health care systems use factors of production including labour, which have to be paid for and reduce the effective supply of workers available to the rest of the economy. It is in addressing this caveat that this paper seeks to make a contribution. By doing so, it is hoped to aid policy makers in their pursuance of improving health provision, population health, welfare and economic growth.

The analysis is novel in mainly two respects. The first contribution is in terms of international trade theory, by developing an extension of the standard Rybczynski Theorem from a low-dimension Heckscher-Ohlin model which casts light on some of the resource allocation issues related to the provision of health care. While there is a strong literature on endogenous labour supply models[6], these have in the main been based on direct labour supply responses to higher wages. In this model, changes in effective labour supplies come from changes in the size of the health sector.

The second contribution is in terms of empirics, by developing a CGE model for the UK with an extended health care component. 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

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4 Kouwenaar (1986), van der Hoeven (1987, 1988), Vianen and Waardenburg (1975), Savard and Adjovi (1997), Arndt (2003), Arndt and Lewis (2000, 2001), Arndt and Wobst (2002), Dixon et al. (2004), Kambou, et al. (1992).

5 An exception is the Dixon et al. (2004) model of the impact of the HIV/AIDS pandemic and health interventions on the Botswana economy.

6 e.g. Martin (1976) and Martin and Neary (1980).

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. The CGE model is calibrated to a Social Accounting Matrix (SAM) for the UK for the year 2000 with considerable refinement in terms of sectors (distinguishing health care and its main input suppliers), factors (capital, skilled and unskilled labour) and household types (based on age and labour market participation of household members). Taking the UK, an archetype of a developed country health care system in which government provision via the National Health Service (NHS) and funding dominates, as a case study allows the modelling of current “rationed” health care policies. Specifically, the policies of increasing the health care budget under mobile factors and health care-specific factors and the immigration of foreign skilled workers at the current wage are contrasted with each other.

The rest of the paper is organised as follows. Section 2 presents an extension of the Rybczynski theorem where endowment changes are modelled via changes in health provision. Section 3 discusses the UK CGE model and SAM. Section 4 presents the results of the policies aimed at alleviating rationing. The final section concludes.

2. 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): Goods 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 and so 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:

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

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

where S_i and U_i, $(i = 1, 2, H)$ are the numbers working, and S_W and U_W are the numbers of potential workers that remain unable to work.[7]

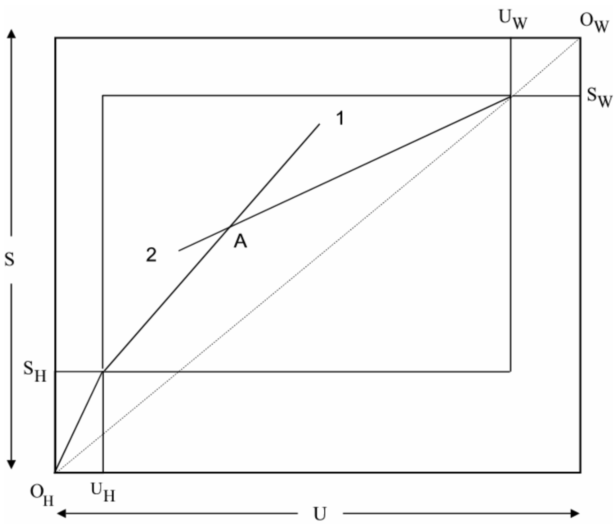
We are interested in the *effective* labour forces, S_E and U_E, where

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

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

Figure 1 shows a 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[8], that the health sector allocates its output of health treatment in proportion to the numbers falling ill, and that treatment is equally effective across labour types.

Figure 1: An initial equilibrium



The maximum possible endowments of skilled and unskilled labour are S and U respectively.[9] 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 (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 2 from the north-east corner of this box and inputs into sector 1 from the south-west corner allows us to determine the equilibrium at point A (where the production

7 We could equally well work in terms of the numbers of worker-hours lost.

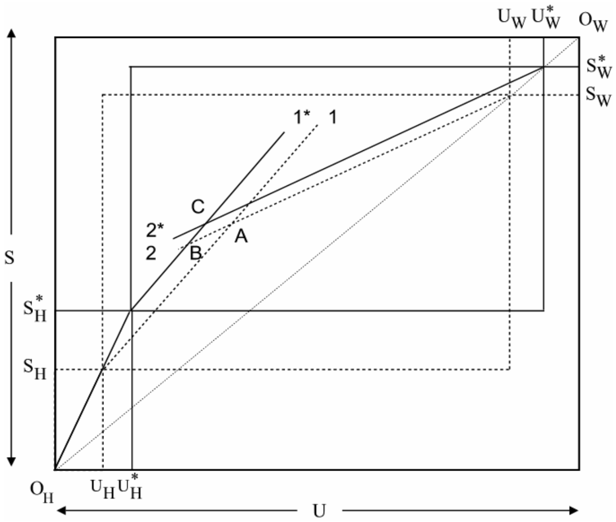
8 There is evidence that the incidence of illness is higher in the low-income groups, but we ignore this for simplicity of exposition.

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

isoquants of sector 1 and 2, not drawn for simplicity, are tangential, with a slope equal to the absolute value of the relative wage of unskilled to skilled labour).

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.

Figure 2: An example of an expanding health sector with unchanged endowments



The expansion of the health sector and the contraction of the waiting list change both the total and relative amounts of factors available to the two tradables sectors. 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.[10] 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.

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

In the example of Figure 2 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 on the provision and effectiveness of treatments for the two types of labour. For developed countries the available evidence suggests that the elasticity of effective labour supplies with respect to health care is small (and less than one) so that scale effects are small, as in Figure 2.[11] Hence, using the theory, and assuming that health care is relatively skill-intensive, we expect an exogenous increase in health expenditures to benefit the unskilled-intensive sector and harm the skilled-intensive sector.

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, possibly health care-specific, and other real-life complexities the foregoing predictions are most unlikely to be wholly true. Nevertheless, these effects will still operate in the background and thus give a useful guide to the interpretation of the outcomes of such a model.[12]

3. The UK CGE model and SAM

The analysis is based on a comparative static CGE model of the UK. The SAM underlying the model has been constructed by augmenting the UK Input-Output Supply and Use Tables for 2000, using data from the General Household Survey (GHS) for 2000-01.[13] The latter purpose-built GHS database is a valuable source of information for a range of socio-economic characteristics of private households living in Great Britain, notably health and health care use data. A short outline of the model is given below, with special detail on health and welfare effects.

The CGE model has in most respects a standard structure, the novelty coming from the explicit modelling of the health sector, comprising public (NHS) and private health care, and its interaction with the rest of the economy through its differential impact across sectors, factors and household types (see Table 1).

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11 See also Folland et al. (2001, Chapter 5).

12 Rutten (2004, Chapter 2) contains the theoretical Heckscher-Ohlin model with health effects, a Specific-Factors version, and the algebraic development of the impact of an increase in health expenditures, the immigration of foreign health care-specific skilled labour and skill-neutral and skill-biased technical change.

13 Associated publications are Office for National Statistics (2002, 2001) respectively. The responsibility for the analysis or interpretation of the data as laid out in this paper remains with the authors. The model files, programmed in the MPSGE software, and GHS database, constructed in MS Access, are available in electronic form from the authors upon request.

Table 1: The CGE model classifications

FACTORS OF PRODUCTION (f)	HOUSEHOLDS (h)
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	

All sectors are perfectly competitive and multi-product industries. The production technologies are Constant Returns to Scale (CRTS), with production a Leontief function of intermediates and value-added, itself a Cobb Douglas (CD) function of homogeneous factors of production. Household preferences are homothetic, with utility a CD function of consumption and savings. Cross-border trade is treated using the assumption that the UK is a small open economy facing exogenous world prices for imports and exports and accommodates ‘entrepôt’ trade, i.e. the re-exporting (re-importing) of imported (exported) goods and transport and trade margins. In addition, the Armington assumption (Armington, 1969) is imposed on both production and consumption: goods produced domestically are destined for either the domestic market or for the export market, while consumers differentiate between domestic and imported varieties of the “same” good. Substitution and transformation elasticities are assumed to equal two in this model.[14] The government uses its revenue from employment, production and consumption taxes to finance a fixed expenditure on goods (health care, public administration and defence, and other services) and a fixed amount of foreign exchange at the exchange rate to accommodate the trade surplus. The remainder of its budget is spent on income transfers to households which adjust so as to maintain the government account balance. Households allocate the latter income and earnings from the supply of capital, skilled and unskilled labour to savings and consumption, assuming that only working households save. All factor and product markets clear through price adjustments. Equilibrium in the capital goods market requires that the value of total savings equals the value of total investments. With the exchange rate as numéraire and the trade balance fixed in terms of foreign exchange, investments are savings-driven so that the model closure is neoclassical.

[14] 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.

Health provision effects: We model the interaction between health care and effective labour supplies 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).

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

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

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 ($\bar{F}_{hf}$), and is defined positively only for labour ($f \in l$) whereas capital is always fully effective and fully employed.[15]

The fraction of people on the waiting list, the non-participation rate, is assumed to be 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 $\eta_{f \in l} < 1$.[16] $HC_{f \in l}$ 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 CD function of its public and 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 $0 \le \upsilon_l \le 1$ 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 real government

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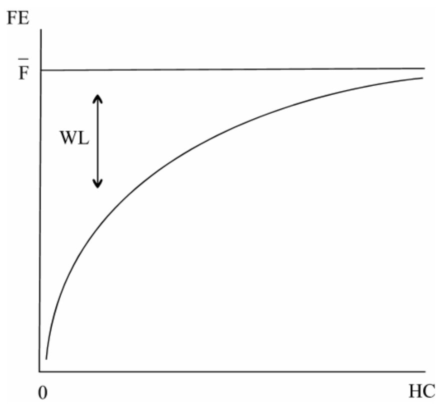
[15] This does of course ignore the loss in effective capital when, for instance, machines break down. However, the cost of repairing a machine is internal to the firm, and is assumed to be assimilated into the cost of capital services, whereas the repair (treatment) of ill workers is a cost to the state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

[16] 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.

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 health care.

Given equations (5) to (8), waiting lists (effective labour supplies) are decreasing (increasing) in the health composites, at a decreasing rate. Figure 3 illustrates (subscripts are ignored for simplicity).

Figure 3: Waiting lists and effective endowments



The contribution of public health care to the health status of skilled and unskilled labour, as measured by υ, is obtained from Emmerson et al. (2000). Using Family Resource Survey data for the period 1994/1995 to 1997/1998, they calculate the percentage of adults with private medical insurance by social class. By applying population weights corresponding to each social class from the GHS, the proportions of skilled and unskilled labour having private medical insurance are estimated at 16.6% and 4% respectively, yielding a residual of 83.4% and 96% of skilled and unskilled labour for whom health care is financed via the NHS. The latter serve as proxies for υ.

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, the authors find a fairly stable long-run average for the (yearly) sickness absence rate in the UK of around 3.20%. These and other studies[17] 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 non-participation rate of 3.20% yields η_0 = 2.89% for skilled and η_0 = 4.34% for unskilled workers.

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

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, 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.[18] These numbers are consistent with health care elasticity estimates of around 0.1 based on US data (Folland et al., 2001, pp.108-109). 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. The results are tested for sensitivity to alternative values of the waiting list elasticities.

Welfare effects: The effects on welfare of higher health provision are two-fold: it directly increases the "well-being" of the population and indirectly improves welfare by increasing the size of the *effective* (i.e. "able to work") endowments of skilled and unskilled labour for use in non-health activities. Accordingly, changes in household welfare are calculated from private household utility using the Hicksian equivalent variation, to which the benefits from changes in public good provisioning (including NHS care) are added. For linear homogeneous preferences, the equivalent variation for household h can be written as:

$$EV_h = \frac{U_h^1 - U_h^0}{U_h^0} Y_h^0 \qquad (9)$$

where U_h and Y_h denote household utility and income respectively, and superscript 0 and 1 respectively refer to the equilibria before and after a particular shock occurs.

Assuming that each household receives a share $\alpha_{G_{jh}}$ of the change in the real government consumption of good j (where $0 \le \alpha_{G_{jh}} \le 1, \sum_h \alpha_{G_{jh}} = 1$), the overall change in household welfare becomes:

$$EV_{T_h} = EV_h + \sum_j \alpha_{G_{jh}} \cdot \left(\frac{G_j^1 - G_j^0}{G_j^0} \right) \cdot GEXP_j^0 \qquad (10)$$

where $GEXP_j^0$ denotes benchmark government expenditure on good j.[19]

Consequently, overall welfare changes are equal to:

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[18] 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 $\left(\partial FE_{hf} / \partial HC_f\right)\left(HC_f / FE_{hf}\right) = \varepsilon_f \, WL_{hf} / FE_{hf} = \varepsilon_f \, \eta_f \Big/ \left(1 - \eta_f\right)$.

[19] Note that private health care is already included in the utility function and thus in welfare. The current and, for the purpose of this analysis, more appropriate welfare specification postulates that an increase in the provision of public health care (and other goods) constitutes a direct welfare gain. Also, the resulting overall welfare measure, displayed in equation (11), is equivalent to a social welfare function with equal weights, i.e. a common utilitarian social welfare function (Johansson, 1991, p.32).

$$EV_T = \sum_h EV_{T_h} \quad (11)$$

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 general practitioner 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 household shares in government transfers, α_{TRh}, are shown in Table 2.

Table 2: household shares in government transfers and public goods

Parameter	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	0.234	0.370	0.306	0.370
Working, no children	0.035	0.336	0.280	0.336

4. Policies aimed at alleviating rationing in UK health care

We examine the effects of two types of policies which have identical implications for the nominal government budget on health care (the NHS budget), but differ in terms of their real budgetary impact due to differential price effects. Experiments 1 and 2 simulate the impact of an increase in government health expenditures assuming mobile and health care-specific factors respectively. The introduction of health care-specific skilled labour and capital in the second experiment provides an alternative specification more suited to the short run. The former type consists of mainly doctors and nurses (approximately 85% of skilled labour employed in health care) and the latter consists of buildings and land (approximately 90% of capital employed in health care), and both earn a health care-specific remuneration. Using the same model specification as in Experiment 2, Experiment 3 considers the alternative policy of importing foreign health care-specific skilled workers in order to mitigate the shortage of highly skilled workers in UK health care. Health care-specific skilled wages are maintained at pre-immigration levels so that domestic workers are not worse off as a consequence of the policy. The experiment is carried out using three alternative assumptions regarding the share of foreign worker income remitted abroad, adopting illustrative values of 0%, 50% and 100% respectively, which have differential welfare effects since remittances have to be compensated for by a rise in exports and/or a fall in imports so as to maintain the balance of payments. It is assumed that an equivalent of 10% of domestic endowments of health care-specific skilled labour takes up the offer to migrate to the UK, so that the government budget on health care has to rise by 11.64% (£6.267 billion) to maintain their wages to pre-immigration levels. This budget increase is taken as point of departure for Experiment 1 and 2. Table 3 and Figures 4, 5, 6 and 7 summarise the key results.[20]

Table 3: Welfare changes measured in Equivalent Variations (including public goods)

Experiment		EV_T	HSE1	HSE2	HSE3	HSE4	HSE5	Overall
1		Millions £	-1230	-44	-97	1340	2841	2808
		%	-0.58	-0.17	-0.21	0.46	0.77	0.30
2		Millions £	-1710	-291	-316	755	2603	1038
		%	-0.81	-1.09	-0.69	0.26	0.71	0.11
3	0%	Millions £	-533	3	19	1984	3651	5124
		%	-0.25	0.01	0.04	0.68	0.99	0.54
	50%	Millions £	-656	-13	0	1678	3166	4174
		%	-0.31	-0.05	0	0.57	0.86	0.44
	100%	Millions £	-778	-29	-20	1371	2679	3223
		%	-0.37	-0.11	-0.04	0.47	0.73	0.34

Figure 4: Change in health status

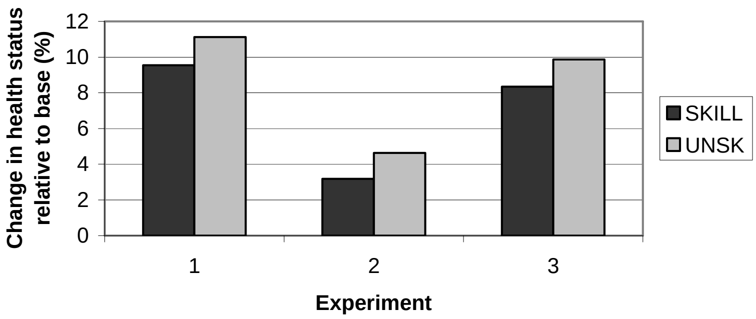
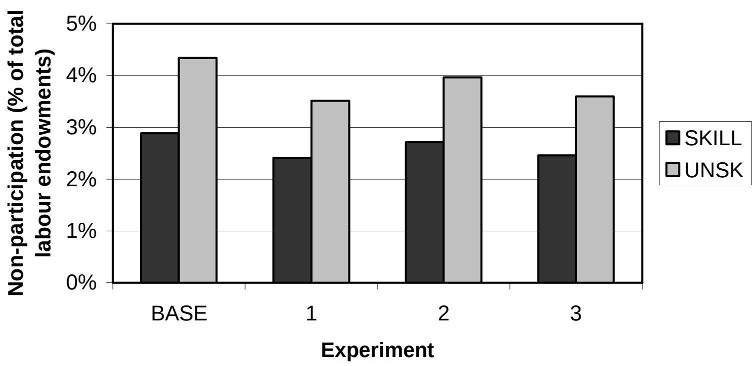


Figure 5: Non-participation rate of labour



[20] Figures 4, 5 and 6 report values for Experiment 3 in the absence of remittances as the effect on health-related variables is negligible. Household equivalent variations in Table 3 may not add up to overall welfare changes due to small measurement errors.

Figure 6: Change in waiting list

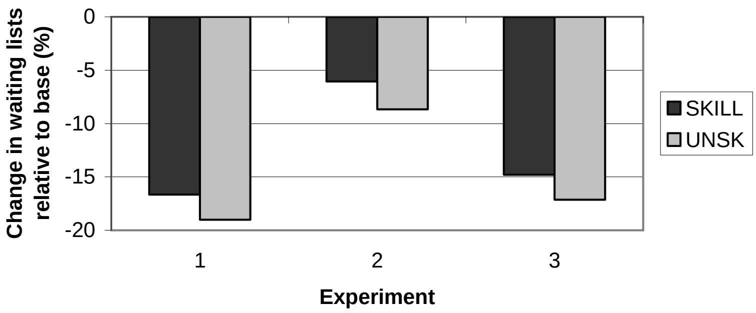
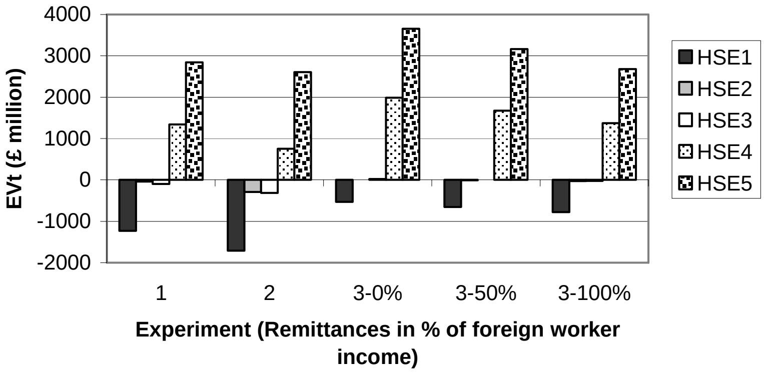


Figure 7: Changes in household welfare (incl. public goods)



Experiment 1 - a rise in NHS expenditures: The additional NHS resources result in an increase in NHS provision by 11.64% and, via input-output linkages, increase the demand for and domestic production of pharmaceutical products and medical, precision and optical instruments. 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 0.4%).

Are these sectoral effects in line with the predictions from the theoretical model of Section 2? From the theory we expect that "on average" the relatively skill-intensive sectors (2, 5, 8 and 9 in Table 1) contract and the relatively unskilled-intensive sectors (1, 3, 4, 6, 7 and 11 in Table 1) and the health sector expand.[21] Unreported results reveal that most skill-intensive sectors do contract, albeit mildly, but the pharmaceuticals sector (2) expands. This suggests that, following a rise in the health care budget and the consequent expansion of the health sector, the increased demand for intermediate inputs from this sector outweighs the reduced availability of skilled labour relative to unskilled labour.

[21] When there are many sectors in a Heckscher-Ohlin model, the Rybczynski Theorem becomes a "correlation". As Falvey (1994) states, "There is a tendency for an increase in those outputs using intensively those factors whose endowments have risen and a decline for others." Further uncertainty about outcomes in induced by the existence of intermediate inputs. The UK health sector is relatively skill-intensive, though its skill-intensity is only just above the endowment ratio, so we would expect the "correlation" to be low.

Also, most of the unskilled-intensive sectors contract, apart from construction (6) and the medical instruments sector (3). The latter's expansion is much more pronounced and, as before, is due to the intermediate demand effect from the health sector, rather than the increased availability of unskilled relative to skilled labour. The predictions of the theoretical HO model thus do not seem to carry over to the applied CGE model, providing a strong argument for the use of the latter.

The increase in public health care boosts the health of unskilled labour, its participation in the labour market, and reduces its waiting list by more relative to 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 which is more costly and less available. The changes in (effective) factor supplies and sectoral factor demands result in a (minor) fall in unskilled wages, whereas skilled wages and capital rents rise slightly. Despite the fall in unskilled wages, the increase in labour market participation ensures that all households' income from unskilled labour rises. The fall in income from state benefits, which follows from the balanced government budget, leads to reductions in income for working households with children, but relatively more so for pensioners and non-working households. Only childless working households, who own most of skilled labour endowments and rely least on government transfers, gain slightly. Adjusting private welfare losses for changes in public good provisioning (including gains from increased NHS provision) reduces welfare losses so that pensioners and non-working households lose, whereas working households gain. Nevertheless, in total welfare increases by £2.808 billion (a gain of 0.3% relative to the original level of welfare).

Experiment 2 - a rise in NHS expenditures in the presence of health care-specific factors: This simulation implements the same policy as in Experiment 1, but accounts for the fact that a large part of the labour and capital employed in health sector are, respectively, highly trained or highly specialised and therefore arguably specific to health care and immobile. Key findings are that, unsurprisingly, the presence of health care-specific skilled labour and capital constrains the production expansion of health care and related sectors. An 11.64% increase in the NHS budget leads to a rise in real levels of NHS provisioning of only 5.1%, the remainder of the budget being spent on higher wages of highly skilled doctors and nurses and capital rents, showing increases of 13.6% and 13.8% respectively, and resulting in higher unit costs (and a contraction in private care) of 6.2%. As a consequence, direct and indirect welfare gains are lower compared to the previous experiment. Non-working households and pensioners lose by more and working households gain by less, cutting the total welfare gain by 63%.

Experiment 3 - importing health care-specific skilled workers at the current wage: In the absence of remittances abroad, the specified rise in the NHS budget which is targeted towards the immigration foreign health care-specific skilled workers, yields a rise in real levels of NHS provisioning of 10.3%. This is less than in the first experiment since the wages of the domestic *and* foreign workers of aforementioned type are sustained at benchmark levels, thereby increasing the unit costs of the provisioning (and reducing private sector production) by 1.2%. The direction of effects across sectors, factors and households are nevertheless similar to those in Experiment 1. Whereas direct and indirect welfare gains from the rise in NHS provision levels and health improvements are lower, state benefits need to fall by less to finance the expansion of the NHS budget due to higher government tax revenues. Thus, in the absence of remittances, working households and to a lesser extent non-working households gain and only pensioners lose. Remittances abroad reduce welfare gains for some groups and increase welfare losses for the others so that, as in the previous experiments, pensioners and non-working households lose and working households gain. The total welfare gains however still exceed those of the generic rise in the government budget, certainly if one compares experiments with the same model specification (i.e. Experiments 2 and 3).

Sensitivity analyses: Sensitivity analyses for the elasticities of substitution and transformation show that the results of the counterfactual simulations are relatively robust: although sign changes do occur for some variables, the impact of changing the respective elasticities upon overall welfare is negligible. The same cannot be said for the waiting list elasticities for skilled and unskilled labour, for which no reliable estimates exist. In the presence of increasingly strong skill-neutral health effects, the expansion of NHS care, although representing an immediate cost to society, yields substantial welfare gains in the long-run through increases in effective labour supply and production, and by enhancing the tax revenue of the government which benefits both working households (in terms of wage income) and non-working households (in terms of income from state benefits). Nevertheless, in Experiments 1 and 2 total welfare rises for relatively low values of the waiting list elasticity (boundary values of 0.379 and 0.493 respectively) and in Experiment 3 welfare gains are guaranteed, even in the absence of health effects, so that the main results continue to hold.

5. Conclusions

This paper seeks to determine the macro-economic impacts of changes in health care provision, whilst recognising the simultaneous effects of consequent changes in health on effective labour supplies and the resource claims made by the health care sector. The resource allocation issues have been explored in theory, by developing an extension of the standard Rybczynski theorem from a low-dimension Heckscher-Ohlin framework, and empirically, by developing a Computable General Equilibrium (CGE) model, calibrated to a purpose-built dataset for the UK.

Using the theory, the impact of an expanding health sector on the outputs of non-health sectors was shown to depend on the sign and magnitude of a scale effect of increased effective labour supplies and a factor-bias effect of changes in the ratio of skilled to unskilled labour. Given that effective labour supplies are relatively inelastic with respect to health care provision, factor-bias effects dominate so that an increase in health care provision, which is relatively skill-intensive, is "on average" expected to result in an expansion of the relatively unskilled-intensive sectors and a contraction of the relatively skill-intensive sectors. These predictions were generally not found to hold in the CGE model due to added-real life complexities, most notably the presence of intermediate inputs. This is a strong argument for the use of an applied model in addition to a theoretical model.

The CGE model was used to examine two types of policies aimed at reducing rationing in UK health care which have identical nominal NHS budget implications, but differ in terms of their real budgetary impact due to differential price effects. These are: an 11.64% rise in the NHS budget under mobile and health care-specific factors, and a policy of importing health care-specific skilled workers at 10% of domestic endowments and at the current wage, under alternative assumptions regarding remittances.

The main findings are that the increase in the NHS budget, while drawing away resources from other non-health related sectors and its private counterpart, leads to an overall welfare gain through increased worker incomes and direct increases in population well-being. The presence of health care-specific skilled labour and capital reduces the overall welfare gain by 63%, as over half of the specified budget rise is absorbed by higher wages and rents. This suggests the importance of tackling rigidities in the health sector. The shortage of highly skilled workers may in the short-term be addressed via the recruitment of highly skilled foreign doctors and nurses. This policy was found to yield the highest overall welfare gains, even if all foreign worker income is remitted abroad, since government transfers need to fall by less to finance the health care budget increase due to a rise in government tax revenues. This is not to say that this is also a desirable policy given that many migrant workers come from developing countries which need their own educated staff. Consequently, in the long-term increasing the number of medical school places may be a more suitable policy response. Although we have assumed a balanced government budget in which state benefits adjust, equity considerations would favour financing the increase in NHS provision by raising direct taxes. The sensitivity of the results to the elasticity of the waiting lists with respect to health care indicates the importance of ensuring that additional resources in health care are effectively employed, which is attainable by technical and administrative improvements in health care.

Directions for future research are mainly fourfold. Firstly, we would like to model long-term population processes (births, deaths, transitions from "young" to "working" to "retired") in a dynamic (overlapping generations) model so as to link our analysis with the issue of ageing. Secondly, we aim to improve the modelling of health-related gains in "well-being" using for example the literature on happiness (Clark and Oswald, 2002). Thirdly, we seek to increase the level of disaggregation in health care in terms of, for example, types of treatments and care so as to assess the allocative efficiency of current spending, and types of health care staff and equipment to allow for differential substitution between them. Finally, we intend to model the impact of an epidemic, such as influenza, in order to test the ability of the UK health care system to cope with a disease outbreak.

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