POLICY RESEARCH WORKING PAPER 4593

Medical Migration:

What Can We Learn from the UK's Perspective?

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April 2008

Abstract

This paper seeks to determine the macro-economic impacts of migration of skilled medical personnel from a receiving country's perspective. The resource allocation issues are explored in theory, by developing an extension of the Rybczynski theorem in a low-dimension Heckscher-Ohlin framework, and empirically, by developing a static computable general equilibrium model for the United Kingdom with an extended health sector component. Using simple diagrams, an expansion of the health sector by recruiting immigrant skilled workers in certain cases is shown to compare favorably to the (short-term) long-term alternative of using domestic (unskilled) workers. From a formal analysis, changes in non-health outputs are shown to depend on factor-bias and scale effects. The net effects generally are indeterminate. The main finding from the applied model is that importing foreign doctors and nurses into the United Kingdom yields higher overall welfare gains than a generic increase in the National Health Service budget. Welfare gains rise in case of wage protection.

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1. Introduction

Health workers migrate from developing to developed countries to better their economic or social situation immediately or for the purpose of career development. The incentives to migrate typically involve a combination of "push factors" (unsatisfactory working or living conditions in the country of origin) and "pull factors" (attractive working or living conditions, availability of positions and active recruitment in the country of destination). While individual motives underlie the observed migration flows – and in this sense are neither new nor unique to the health sector as such – the so-called medical "brain drain" causes the unique problem of severe workforce shortages in developing country health systems that are already under stress (Chen et al., 2004; Dovlo, 2005).[i] A notable difference with the past is that medical migration and the accompanying shortage of health personnel for developing countries are now usually permanent.[ii] Faced with a dwindling work force, the task facing developing countries in building up their health care systems is particularly daunting. This is the more so for countries in Sub-Saharan Africa (SSA) suffering the HIV/AIDS pandemic, which uses up much of health and medical service capacity <u>and</u> claims the lives of many health workers.[iii]

Eastwood et al. (2005) and Buchan and Dovlo (2004) suggest that the UK plays a major role in the medical brain drain from (especially English-speaking) countries in SSA. Obvious pull factors are that (1) English is an increasingly international language and (2) the shortage of UK-trained doctors and nurses makes immediately available and qualified substitutes an attractive alternative. While the UK's Code of Practice for International Recruitment may have had a dampening effect on the recruitment of foreign doctors and nurses,[iv] it can be expected that the UK will continue to recruit medical migrants given its continued strong demand for

health care, its ageing health work force and increasingly globalized labor markets, especially once progress is made in the negotiations on Mode 4 of the General Agreement on Trade in Services (GATS) of the WTO.[v]

This paper analyzes the economic consequences of migration of skilled medical personnel from a receiving country's perspective, taking the UK as an archetypal OECD economy that imports medical services.[vi] The focus on medical migration allows us to analyze the associated positive health consequences for developed countries, such as the UK, whose health care systems are rationed by limited public funding, an aspect which has not been explicitly modeled before. The analyses developed in this paper can nonetheless also be extended to the sending country perspective and clearly have a mirror image in terms of the associated adverse health consequences for many developing countries, particularly in SSA, that already suffer from severe medical workforce shortages.

The paper adds to the existing literature on the economic impacts of increased worldwide migration[vii] by its focus on the international movement of skilled health personnel. The existing applied literature unequivocally finds considerable global welfare gains, as workers flow from low productivity areas (developing countries) to high productivity areas (developed countries), yielding a rise in world output (Bhatnagar, 2004). In addition, poorer developing regions stand to gain especially from increased temporary unskilled labor emigration due to their relative abundance in this factor, the relatively large size of the productivity gap between home and host countries for this type of labor, the benefits from acquired skills and experience available for use upon return and the remittances sent home. Temporary migration has the additional benefit to the (developed) receiving regions of avoiding the political costs associated with permanent migration. However, as previously noted for the

health sector, the migration of skilled workers usually entails a permanent loss of already scarce human capital in the developing country of origin, i.e. a brain drain, with adverse consequences for service delivery and outcomes, and for welfare.[viii] So, while economic models suggest that the migration of unskilled workers leads to welfare gains across the globe, the impact of the migration of skilled workers on global welfare is a lot less clear.[ix]

The analysis is novel in two main respects. The first contribution is an extension of the standard Rybczynski (R) Theorem (Rybczynski, 1955). While there is a strong literature on endogenous labor supply models (e.g. Martin, 1976; Martin and Neary, 1980), these have in the main been based on direct labor supply responses to higher wages. Here, changes in effective labor supplies come from changes in the size of the health sector. The paper presents the effects of a health sector expansion on sectoral outputs in the long-term, where the health sector expansion is driven by an increase in the use of domestic skilled and unskilled labor, and in the short-term, where skilled workers in the health sector have health-specific skills so that an increase in health output is driven by either an increase in the use of unskilled labor only or also the importing of foreign skilled medical workers.

The second contribution is in terms of empirics, by developing a static Computable General Equilibrium (CGE) model for the UK with a detailed health component. The CGE model is calibrated to a purpose-built Social Accounting Matrix (SAM) for the year 2000 with considerable refinement in terms of sectors (distinguishing health care and its main input suppliers), factors (capital, skilled and unskilled labor) and household types (based on age and labor market participation of household members). It is the first of its kind in that it has been designed to analyze the macro-economic impacts of changes in health care provision, whilst recognizing

the simultaneous effects of changes in health on effective labor supplies and the resource claims made by the health sector. 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 labor for use in non-health activities. The model is employed in two "rationed" health care policy simulations. Specifically, the policies of a generic increase in the National Health Service (NHS) budget and the recruitment of foreign doctors and nurses at the current wage are contrasted with one another. We assume that doctors and nurses are immobile across sectors and, for the purpose of comparability, that the policies have identical nominal NHS budget implications. In order to illustrate the social welfare effects of medical wage protection following immigration we also report the results of the immigration policy when wages of doctors and nurses are allowed to fall.

2. Medical Migration into the UK: Some Low-Dimension Analytics

To provide some intuition in support of the subsequent formal analysis we start with a simplified diagrammatic representation of the interrelationships between the level of health provision, the number of workers treated successfully and so returning to work, and the outputs of two an export and an import good. The approach is based on that commonly used in the explanation of 'R effects' in the Heckscher-Ohlin-Samuelson (HOS) model[x] following exogenous changes in factor endowments.

The R theorem predicts that at constant product prices, and hence constant factor prices, and with factors of production that are perfectly mobile between domestic sectors, an exogenous increase in the endowment of only one factor leads to an increase in output in the sector that is intensive in the increased factor and a

decrease in the output of the other sector.[xi] Here, however, we are concerned with changes in factor endowments that are endogenously determined in that the government decides on, and finances, the size of the non-tradable health sector. An increase in the size of that sector reduces the factor endowments available to the tradables production sectors directly. However, it also increases those endowments indirectly by treating people who were previously on the 'waiting list' for health care, i.e. people currently unable to work due to ill health, leading to a range of possible outcomes.

A further complication is that most (for simplicity we assume all) of the skilled workers in the health sector have health-specific skills that take time to acquire and are not readily transferable to other domestic sectors. This implies that in the short-term the health sector can only expand by using more unskilled labor or by recruiting skilled workers with health-specific skills from other countries. In this case the standard 'R effects' in the HOS model must be modified, and the analysis becomes closer to that of the Specific Factors model (Jones, 1971).

A Possible Initial Equilibrium

Figure 1 shows a 'factor endowment box', defined by the south-west and north-east corners, O_H and O_W respectively. The vertical and horizontal dimensions measure the total endowments of skilled labor (S) and unskilled labor (U) respectively. Inputs of skilled and unskilled labor to the health sector are measured from O_H, and the numbers of skilled and unskilled workers unable to work (on the 'waiting list' for health care) are measured from O_W. The skilled and unskilled workers available to work in the tradables sectors 1 and 2 are thus shown by the dimensions of the inner factor box, identified by the south-west and north-east corners, O_1 and O_2

respectively. Labor inputs to tradables sector 1 are measured from O_1 and those to

tradables sector 2 from O_2. For simplicity it is assumed that, at the given factor

prices, the health sector has the same skill intensity as the economy, and that the

incidence of illness, the provision of treatment and the responsiveness to that

treatment are identical for all workers. Thus the north-east corner of the 'health box'

and the south-west corner of the 'waiting list box' lie on the diagonal of the total

endowment box, $O_H O_W$.

INSERT Figure 1 Here

In the initial equilibrium the health sector employs S_H and U_H of skilled and

unskilled labor respectively. These provide a health output that treats ill workers to

the extent that numbers S_W and U_W of skilled and unskilled labor remain on the

waiting list and hence are unable to work. Thus the numbers of skilled and unskilled

labor available to work in the tradables sectors are $S_T = S - S_H - S_W$ and

$U_T = U - U_H - U_W$ respectively, these being the dimensions of the factor box defined

by O_1 and O_2. The given relative factor prices determine the skill intensities in the

two tradables sectors (sector 1 being the more skill-intensive), and the intersection of

the rays $O_1 X_1$ and $O_2 X_2$ at point a determines the full employment outputs of

sectors 1 and 2.

Expanding the Health Sector Using Only Unskilled Domestic Workers

Figure 2 illustrates the effects of an expansion of the health sector using only

domestic unskilled workers (the endowment of health-specific skilled workers

remaining at $\overline{S}_H$). The changes (indicated by a #) result in a new tradables

equilibrium at point b. The supply of skilled workers to the tradables sectors

necessarily increases, but the supply of unskilled workers rises if the fall in the waiting list exceeds the increased use of unskilled labor in the health sector and falls otherwise.

INSERT Figure 2 Here

Given the assumption that the incidence of illness, the provision of treatment and the responsiveness to that treatment are identical for all workers, the output of sector 1 necessarily increases. The output of sector 2 will decrease, unless the growth in the supply of unskilled workers to the tradables sectors is large enough to overcome the reduction effect of the expansion of the supply of skilled workers. These results depend on, inter alia, the 'efficiency' of the health sector in treating and curing workers who are on the health care waiting list. For example, a neutral improvement in health sector technology will further increase the output of sector 1 and reduce the likelihood of a decrease in sector 2 output. The increase in the ratio of unskilled to skilled workers in the health sector implies that the marginal product and hence the real wage of the skilled workers increases.

Expanding the Health Sector by Importing Workers with Health-Specific Skills
The alternative short-term method of expanding the health sector is to recruit workers with equivalent health-specific skills from other countries. This increases the vertical dimension of the economy's factor box, which is shown in Figure 3 by extending its vertical dimension downwards. The changes (indicated by a +) result in a new tradables equilibrium at point c. Figure 3 has been drawn on the assumption that the immigrant skilled workers are paid the same wage as their domestic counterparts and that the wage does not change, so that the skill intensity in the health sector will be unchanged. This implies that the government increases the health budget to the extent

needed to maintain the initial skilled wage. Moreover, it is assumed that the recruitment of skilled workers is that which will result in the same increase in the employment of unskilled workers in the health sector as in the previous case.

INSERT Figure 3 Here

The increase in the employment of skilled workers in the health sector, with the same increase in unskilled labor, expands its output compared to the previous case, and so results in greater reductions in the waiting lists. As a consequence, there is a greater increase in the supply of skilled labor to the tradables sectors, and a smaller fall (greater rise) in that of unskilled labor. Thus the output of sector 1 will increase by more than previously, while that of sector 2 will fall by less (or increase by more). Hence, in the current setup, the expansion of the health sector by recruiting immigrant skilled workers has favorable implications for the outputs of the two tradables sectors compared to an expansion using only the additional unskilled workers.[xii]

Expanding the Health Sector by Using More Skilled and Unskilled Domestic Workers
Figure 4 shows the consequences of an expansion of the health sector using both domestic skilled and unskilled workers but no immigrant labor with health-specific skills, a situation representative of the long-term. To facilitate comparison with the health sector expansion using immigrant skilled labor, the expansion of the health service is assumed to involve the same increase in skilled labor as the importation of immigrant skilled labor, and the same increase in the use of unskilled labor. This implies that the reductions in the waiting lists are the same. The changes (indicated by a *) result in a new tradables equilibrium at point d.

INSERT Figure 4 Here

Compared to the previous scenario, the supply of skilled labor to the tradables sectors increases by less and that of unskilled labor remains the same. As a consequence, the output of sector 1 will increase by less than previously, while that of sector 2 will fall by more (or increase by less). Hence, in the current setup the expansion of the health sector in the short-term by recruiting immigrant skilled workers also has favorable implications for the outputs of the two tradables sectors compared to an expansion in the long-term using domestic workers only.

Abandoning the simplifying assumption that the skill-intensity of the health sector is identical to the skilled-unskilled national endowment ratio complicates the analysis, but reference to the standard R results gives us some insight. For example, if the health sector is more skill-intensive than that assumed, then an expansion of that sector will reduce the skilled-unskilled ratio of the workers available to the tradables sectors. This will reduce the size of the skill-intensive sector 1 and increase the size of the other sector relative to that shown in Figure 4.

The diagrammatic analysis is useful in identifying the varied effects of different ways of expanding of the health sector on the effective endowments of labor and the outputs of the other production sectors. However, it is limited in that there are a number of possible cases, the consideration of which would require multiple diagrams. To remedy this, we use the standard proportional change analysis to derive the changes in sectoral outputs in a more general setting.

The Heckscher-Ohlin-Samuelson Model

The full employment conditions for the two factors are

$$S_H + S_1 + S_2 = S_E = S - S_W \tag{1}$$

$$U_H + U_1 + U_2 = U_E = U - U_W \tag{2}$$

where S_E and U_E are the effective endowments of skilled and unskilled labor. The amount of factor k used in producing one unit of output in sector i, a_{ki}, is determined by the ratio of the given wages, w_S for skilled labor, w_U for unskilled labor. If the outputs of the three sectors are X_i, $i = H, 1, 2$, then we may write (1) and (2) as

$$a_{SH} \cdot X_H + a_{S1} \cdot X_1 + a_{S2} \cdot X_2 = S_E = S - S_W \tag{3}$$

$$a_{UH} \cdot X_H + a_{U1} \cdot X_1 + a_{U2} \cdot X_2 = U_E = U - U_W \tag{4}$$

Total differentiation of (3) and (4), and adopting the small country assumption so that w_S and w_U, and thus factor intensities, are exogenously determined, yields

$$\lambda_{SH} \cdot \hat{X}_H + \lambda_{S1} \cdot \hat{X}_1 + \lambda_{S2} \cdot \hat{X}_2 = \hat{S}_E \tag{5}$$

$$\lambda_{UH} \cdot \hat{X}_H + \lambda_{U1} \cdot \hat{X}_1 + \lambda_{U2} \cdot \hat{X}_2 = \hat{U}_E \tag{6}$$

where $\lambda_{Si} = a_{Si} \cdot X_i / S_E$, $\lambda_{Ui} = a_{Ui} \cdot X_i / U_E$, $\sum_i \lambda_{Si} = \sum_i \lambda_{Ui} = 1$ and $\hat{X}_i = dX_i / X_i$.

Suppose that the government finances the provision of health care via a lump-sum transfer, T, from the representative household. The cost of health care provision is given by the product of the number of units of health delivered and the cost per unit:

$$T = p_H \cdot X_H \tag{7}$$

where p_H is determined by the unit cost of provision:

$$p_H = w_S \cdot a_{SH} + w_U \cdot a_{UH} \tag{8}$$

A change in health care expenditure implies that $\hat{T} = \hat{p}_H + \hat{X}_H$, but with exogenously determined wages $\hat{p}_H = 0$, so that $\hat{X}_H = \hat{T}$. We can now solve (5) and (6) as

$$\hat{X}_1 = \frac{1}{|\lambda|}\left(\lambda_{U2} \cdot \hat{S}_E - \lambda_{S2} \cdot \hat{U}_E\right) + \left(\lambda_{UH} \cdot \lambda_{S2} - \lambda_{SH} \cdot \lambda_{U2}\right) \cdot \frac{\hat{T}}{|\lambda|} \qquad (9)$$

$$\hat{X}_2 = \frac{1}{|\lambda|}\left(\lambda_{S1} \cdot \hat{U}_E - \lambda_{U1} \cdot \hat{S}_E\right) - \left(\lambda_{S1} \cdot \lambda_{UH} - \lambda_{SH} \cdot \lambda_{U1}\right) \cdot \frac{\hat{T}}{|\lambda|} \qquad (10)$$

where $|\lambda| = \lambda_{S1} \cdot \lambda_{U2} - \lambda_{S2} \cdot \lambda_{U1} > 0$ under the assumption that sector 1 is skill-intensive relative to sector 2.

Changes in the health budget will lead to changes in the waiting list for skilled labor and thus in its effective (able to work) endowment. Since $S_E = S - S_W$ and the overall skill endowment is fixed ($dS = 0$), we have $dS_E = -dS_W$ as a consequence of a change in health output of dX_H, i.e.

$$dS_E = -\frac{\partial S_W}{\partial X_H} \cdot dX_H = \left(-\frac{\partial S_W}{\partial X_H} \cdot \frac{X_H}{S_W}\right) \cdot \frac{dX_H}{X_H} \cdot S_W$$

where the term in parentheses is the elasticity of the skilled labor waiting list with respect to health output, ε_H^S. Dividing though by S_E allows us to write the proportionate change $\hat{S}_E$ as

$$\hat{S}_E = \varepsilon_H^S \cdot \delta_{SW} \cdot \hat{X}_H \qquad (11)$$

where $\delta_{SW} = S_W / S_E > 0$ is the ratio of skilled labor on the waiting list to the effective skilled labor endowment, which may be interpreted as the 'dependency ratio' for skilled labor. Similarly we may write the proportionate change in the effective endowment of unskilled labor following a change in health output as

$$\hat{U}_E = \varepsilon_H^U \cdot \delta_{UW} \cdot \hat{X}_H \qquad (12)$$

where ε_H^S is the elasticity of the unskilled labor waiting list with respect to health output and $\delta_{UW} = U_W / U_E > 0$ is the 'dependency ratio' for unskilled labor.

Remembering that $\hat{X}_H = \hat{T}$ we may rewrite (9) and (10) as

$$\hat{X}_1 = \left(\lambda_{U2} \cdot \varepsilon_H^S \cdot \delta_{SW} - \lambda_{S2} \cdot \varepsilon_H^U \cdot \delta_{UW} + \lambda_{UH} \cdot \lambda_{S2} - \lambda_{SH} \cdot \lambda_{U2}\right) \cdot \frac{\hat{T}}{|\lambda|} \quad (13)$$

$$\hat{X}_2 = \left(\lambda_{S1} \cdot \varepsilon_H^U \cdot \delta_{UW} - \lambda_{U1} \cdot \varepsilon_H^S \cdot \delta_{SW} - \lambda_{S1} \cdot \lambda_{UH} + \lambda_{SH} \cdot \lambda_{U1}\right) \cdot \frac{\hat{T}}{|\lambda|} \quad (14)$$

For simplicity we focus on the outcome when skilled and unskilled labor are homogenous in health status in that $\varepsilon_H^S = \varepsilon_H^U = \varepsilon$ and $\delta_{SW} = \delta_{UW} = \delta$, so that after further manipulation of terms, (13) and (14) become

$$\ddot{X}_1 = \ddot{X}_1^S + \ddot{X}_1^F = \left(\lambda_{U2} - \lambda_{S2}\right) \cdot \delta \cdot \varepsilon \frac{\ddot{P}}{|\lambda|} + \lambda_{U2} \cdot \lambda_{UH} \cdot \left(\frac{\lambda_{S2}}{\lambda_{U2}} - \frac{\lambda_{SH}}{\lambda_{UH}}\right) \cdot \frac{\ddot{P}}{|\lambda|} \quad (15)$$

$$\hat{X}_2 = \hat{X}_2^S + \hat{X}_2^F = \left(\lambda_{S1} - \lambda_{U1}\right) \cdot \varepsilon \cdot \delta \cdot \frac{\hat{T}}{|\lambda|} + \lambda_{UH} \cdot \lambda_{U1} \cdot \left(\frac{\lambda_{SH}}{\lambda_{UH}} - \frac{\lambda_{S1}}{\lambda_{U1}}\right) \cdot \frac{\hat{T}}{|\lambda|} \quad (16)$$

The first terms in these expressions represent the scale effects, $\hat{X}_i^S$, of the expansion of the health sector, which depend directly on factor intensities in the tradables sectors. Specifically, if sector 1 has a skilled/unskilled ratio that is higher than the skilled/unskilled effective endowment ratio then $\lambda_{S1} > \lambda_{U1}$, while if sector 2 has a skilled/unskilled ratio that is lower than the skilled/unskilled effective endowment ratio then $\lambda_{S2} < \lambda_{U2}$. In that case $\hat{X}_1^S > 0$ and $\hat{X}_2^S > 0$.[xiii]

The second terms represent the factor bias effects, $\hat{X}_i^F$, where the differences in factor intensities between the health sector and the identified tradables sectors play a part. Specifically, if $\lambda_{SH}/\lambda_{UH} > \lambda_{S2}/\lambda_{U2}$, i.e. the health sector is more skill-intensive than tradables sector 2, then the factor bias effect will decrease the output of tradables sector 1, and conversely, while if $\lambda_{SH}/\lambda_{UH} > \lambda_{S1}/\lambda_{U1}$, i.e. the health sector

is more skill-intensive than tradables sector 1, then the factor bias effect will increase the output of tradables sector 2.[xiv]

The net effect of the factor bias and scale effects in the HOS model with a non-tradable health sector in which endowments are endogenous depends on the sign and relative size of the factor bias and scale effects. Table 1 shows that the net effects are in general indeterminate, depending on the factor intensity rankings and the 'efficiency' of the health sector in treating and curing sick workers.

INSERT Table 1 Here

All cases shown in Table 1 are representative of the long-term, since skilled and unskilled workers are fully mobile. Introducing health-specific skilled workers complicates the analysis by introducing separate effective endowments, waiting lists and wages for health-specific and other skilled workers respectively. The added complexities obscure the derivation of the R theorem (where the health sector expansion would be driven by an increase in the use of domestic unskilled workers) and the derivation of the impacts of the importation of health-specific skilled workers on the proportionate changes in outputs of tradables.[xv] Combined with the absence of real-life complexities, such as more sectors, factors of production and households, a tax-charging and transfer- and public good-providing government, intermediate inputs, remittances of migrant workers and welfare gains from health sector provisioning, this provides a strong argument for the use of an applied model.

3. Model Simulations and Results: Reducing Rationing in UK Health Care

The model used in this study is a comparative static CGE model of the UK economy. The SAM underlying the model has been constructed by augmenting the UK Input-Output Supply and Use Tables for 2000 with data from the General Household

Survey for 2000-01.[xvi] The CGE model has in most respects a standard structure, the novelty coming from the explicit modeling 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 (specified in Table 2).[xvii]

INSERT Table 2

Setting Up the Model Experiments

We employ the model in two types of experiments, both targeted at alleviating rationing in UK health care, and both observed in reality. Firstly we examine the impact of importing medical services, i.e. skilled health personnel, consisting of doctors and nurses (experiment 1). On entering the UK, foreign doctors and nurses are assumed to become part of the existing domestic household structure, i.e. they are perfect substitutes for their domestic equivalents. This assumption takes into account that many of them plan to stay and will thus become permanent UK households in the long-term. Furthermore, their wages are maintained at pre-immigration levels so that domestic workers are not worse off as a consequence of the policy. This assumption is representative of the UK situation, given that wages of health workers in the UK are essentially fixed in bilateral bargaining rounds between the Department of Health (constrained by the Treasury) and the medical profession (represented by, among others, the British Medical Association). However, in order to illustrate the welfare implications of wage protection of the medical profession, we subsequently consider the impact of allowing the wage of skilled health workers to fall. The experiment uses three alternative assumptions regarding the share of foreign worker income remitted abroad, adopting illustrative values of 0%, 50% and 100% respectively.[xviii] Varying the share of migrant income remitted will have differential welfare implications 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.[xix]

Secondly, we consider the alternative policy of increasing government health expenditures, so that not only more doctors and nurses, but also more of other skilled workers (technicians, managers), unskilled workers (hospital ward assistants, ambulance staff, ancillary workers), capital (electronic machinery, land, buildings) and intermediate inputs (pharmaceuticals and medical instruments) can be bought (experiment 2).

For the purpose of comparability, we carry out the two experiments so that they will have identical implications for the nominal government budget on health care (i.e. the NHS budget). In experiment 1, it is assumed that an equivalent of 10% of the current domestic endowments of doctors and nurses takes up the chance to migrate to the UK, so that the NHS budget has to rise by 12.8% (approximately £6.9 billion) to maintain their wages at the pre-immigration levels in the UK health sector. This budget increase is taken as the point of departure for experiment 2.[xx]

Since we expect that alleviating the shortage of health personnel and medical services in general – as evident from, for example, long waiting lists and, relative to other OECD countries, poor health outcomes in some areas – will entail significant health benefits to the population of the UK, we run the experiments in the presence of (positive) health effects. 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 labor for use in non-health activities. With respect to the direct gains in well-being, changes in household welfare are calculated from private household utility using the Hicksian equivalent variation,

to which the changes in public good provisioning are added. With respect to the indirect gains in endowments (and so income), separate waiting lists for skilled and unskilled labor are introduced, these being a function of a health status variable, itself a Cobb Douglas function of NHS and private health consumption. The equations are calibrated such that the effective supplies (waiting lists) of skilled and unskilled labor are increasing (decreasing) in the health composites, at a decreasing rate. As best and rather conservative estimates of the indirect health effects, we use elasticity values of 0.06 and 0.09 for skilled and unskilled labor respectively, so that a doubling of their health status (following from a rise in NHS and/or private health care provisioning) will lead to a rise in the effective endowments of skilled and unskilled labor of 6% and 9% respectively.[xxi]

Finally, we adjust the model specification to account for the fact that doctors and nurses are highly-skilled and specific to the health sector, and therefore immobile in the short-run. Doctors and nurses account for approximately 85% of skilled labor employed in health care and earn a fixed wage, whereas the remaining 15% of skilled labor in the health sector remains mobile and thus earns the market-clearing wage.

Table 3 and Figure 5 display the changes in household and overall welfare resulting from experiment 1, for each of the remittance and wage scenarios, and experiment 2.

INSERT Table 3 and Figure 5 Here

Experiment 1: Importing Doctors and Nurses at the Current Wage

In the absence of remittances abroad the specified rise in the NHS budget (of 12.8%), which is targeted towards the immigration of foreign health care-specific skilled workers, yields a rise in real levels of NHS provisioning of approximately the same proportion. The demands for and the domestic production of pharmaceutical products

and medical instruments increase by 6.4% and 2.7% respectively. While the wages of the domestic *and* foreign workers of the aforementioned types are sustained at benchmark levels, the costs of intermediate inputs of pharmaceuticals, rents on capital, and so unit costs of health care rise slightly so that private health care contracts (by 0.3%).

The increase in public health care boosts both the health and the participation in the labor market of unskilled labor relative to skilled labor (12.2% relative to 10.5% and 0.9% relative to 0.5% respectively), as unskilled labor is affected primarily by changes in public health care provision, whereas the skilled labor is also affected by changes in private health care provision, which is now more costly and less available.

The changes in (effective) factor supplies and sectoral factor demands result in a (minor) fall in wages of mobile skilled and unskilled labor, whereas capital rents rise slightly. Despite the fall in wages, the higher labor market participation ensures that all household incomes from labor rise. Although government income from taxation rises, the NHS budget expands by more, so that the government has to reduce state benefits to households (by 4.8%). Taking into account that the increase in NHS provisioning (and other public goods) in itself constitutes a welfare gain, the expansion yields welfare gains for all households except pensioners, who lose by 0.3% (Table 3). Non-working households, with or without children, gain by 0.2% and 0.1% respectively, whereas working households, with or without children, gain by 0.8% and 1.1% respectively. In total, welfare rises by £5.678 billion (a gain of 0.6% relative to the original level).

Accounting for remittances abroad reduces (increases) the previously observed income and welfare gains (losses) for households so that overall welfare

gains fall to a level of £4.733 billion (0.5% in relative terms) and £3.787 (0.4% in relative terms) respectively when 50% or 100% of migrant income is remitted.

If the government does not maintain the wages of doctors and nurses at pre-immigration levels, NHS (and private health care) provision levels increase by approximately 4.4% at the given NHS budget and in the absence of remittances. This is made possible by a fall in wages of doctors and nurses of 12.8%, yielding a fall in unit costs of health provisioning by approximately 4.2%. Despite the fall in wages, the increase in labor market participation ensures that, with the exception of the original domestic doctors and nurses in the UK, the income of all households from labor rises. Government transfers to households in the form of state benefits now also increase given the rise in government tax revenues, since NHS provision levels expand by less. Consequently, all households experience welfare gains, with pensioners and non-working households now benefiting relatively more compared to the working households (gains in the range of 0.5%-1% for the former compared to 0.3%-0.4% for the latter). In total, welfare rises by £3.892 billion in the absence of remittances (a gain of 0.4% in relative terms), which is less than if the government protected the wages of doctors and nurses. This apparently counterintuitive result can be explained by the fact that NHS provision levels expand by less if wages of doctors and nurses are not sustained, yielding lower indirect welfare gains from increased effective, i.e. "able to work", labor endowments.[xxii] Hence, in a second best environment in which health care provision is rationed at too low a level from a social welfare point of view, wage protection following the immigration of foreign health workers is welfare-improving.

Experiment 2: A Generic Increase in the NHS Budget

A 12.8% increase in the NHS budget leads to a rise in the real level of NHS provisioning of only 8% and, via input-output linkages, increases the demand for and domestic production of pharmaceutical products and medical instruments by 3.8% and 1.6% respectively. The remainder of the NHS budget is spent on higher wages of doctors and nurses, showing increases of 13.3%, which results in higher unit costs and hence a contraction in private care of 4.5%.[xxiii]

As before, the increase in public health care improves the health and participation in the labor market of unskilled labor relative to skilled labor (7.4% relative to 5.8% and 0.6% relative to 0.3% respectively), 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.

Again, the changes in (effective) factor supplies and sectoral factor demands result in a (minor) fall in wages of mobile skilled and unskilled labor, whereas capital rents rise slightly. Despite this fall in wages, the increase in labor market participation ensures that the income from labor rises for all households.

While experiments 1 and 2 have equal nominal NHS budget implications (assuming that in the former the wages of doctors and nurses are maintained at pre-immigration levels), the income from state benefits falls by relatively more (5.3%) compared to experiment 1 since government tax revenue is lower. Consequently, household welfare falls for pensioners and non-working households (in the range of 0.6% to 0.9%) and rises for working households (in the range of 0.4% to 0.8%). In total, welfare increases by £1.770 billion (a gain of 0.2% relative to the original level of welfare).

The total welfare gains are lower than those observed in experiment 1, even when migrant workers remit all income. This result can be explained as a consequence of the immigration of doctors and nurses in the first experiment addressing the bottleneck of the scarcity of this type of labor in the UK, while increasing the NHS budget in the second experiment aggravates it (by putting upward pressure on the wages of doctors and nurses).

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.

Varying the health elasticities for skilled and unskilled labor, which govern the indirect health effects of improved health on effective labor supplies, does however affect the results considerably: generally, in the presence of increasingly strong health effects for both skilled and unskilled labor, the expansion of NHS care, while drawing away resources from other sectors, yields substantial welfare gains in the long-run through increases in effective labor supply and production, and by enhancing the tax revenue of the government, which in turn benefits both working households (in terms of their wage income) and non-working households (in terms of their receipt of state benefits).

INSERT Table 4 and Figure 6 Here

Table 4 and Figure 6 report the results of our experiments when we double the health elasticities for skilled and unskilled labor. Comparison with Table 3 and Figure 5 reveals that, given the incidence of illness, if the health sector is twice as efficient in

'producing' healthy workers, overall welfare gains increase in the range of 60% to 90% for immigration at the current wage, in the range of 40% to 70% for immigration at the current NHS budget, and by 110% for a generic increase of the NHS budget. Further, apart from the latter policy experiment, all households now benefit from the policies implemented.

These results suggest that if we were to employ the model for a different country then we could get quite different results, depending on, inter alia, the incidence of illness (which determines the number of people treated by the health sector and so the number of healthy workers that could be 'produced') and the 'efficiency' of the health sector in producing healthy workers.

At the lower end, welfare gains are guaranteed in experiment 1, even in the absence of health effects,[xxiv] whereas in experiment 2 welfare rises for relatively low values of the health elasticities (of around 0.01 to 0.02 for skilled and unskilled labor respectively), so that the main results continue to hold.

4. Conclusions

This paper seeks to determine the macro-economic impacts of migration of skilled medical personnel from a receiving country's perspective, taking the UK as an archetypal OECD economy that imports medical services.

Using a low dimension diagrammatic analysis of the HOS model, we show that under simplifying assumptions (i.e. in certain cases) an expansion of the health sector by recruiting immigrant skilled workers in the short-term has favorable implications for the outputs of the two tradables sectors compared to an expansion in the short-term using only additional domestic unskilled workers *and* an expansion in the long-term using domestic skilled and unskilled workers only.

From a formal derivation of the changes in sectoral outputs using the standard proportional changes analysis, we show that the impact of an expanding health sector on the outputs of non-health sectors in general depends on the sign and magnitude of the scale effects of increased effective labor supplies and factor-bias effects of changes in the ratio of skilled to unskilled labor. The net effects are generally indeterminate in that they depend on the factor intensity rankings and the 'efficiency' of the health sector in treating and curing sick workers.

Using an applied CGE model for the UK, importing medical services of foreign doctors and nurses yields higher overall welfare gains than does a generic increase in the NHS budget, even if all foreign worker income is remitted abroad. The immigration of doctors and nurses addresses the bottleneck of the scarcity of this type of labor in the UK, while increasing the NHS budget generally aggravates it by putting upward pressure on the wages of doctors and nurses. Surprisingly, the protection of wages of doctors and nurses in the UK following an influx of foreign workers yields higher welfare gains compared to a situation where wages would be allowed to fall. This is a consequence of a second best environment created by a rationed health care system such as that of the UK, in which the size of the health sector is too small from a social welfare point of view due to the presence of positive health externalities.

The foregoing results do not imply that migration is also a desirable policy given that many migrant workers come from developing countries, which often need their own educated staff.[xxv] Indeed, an important direction for future research is to apply the framework of this paper to a sending country's perspective. For notable shortage countries that suffer from a high burden of disease (i.e. countries in SSA), the gains from remittances may well be insufficient to compensate for losses in terms

of the health and the well-being of their populations (i.e. we expect scale effects to be large). Further research is necessary to test this proposition.

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Appendix – The UK CGE model: health and welfare effects

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.[xxvi]

The government uses its revenue from employment, production and consumption taxes to finance a fixed expenditure on goods (health care, public administration and defense, 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 labor 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.

Health Provision Effects

We model the interaction between health care and effective labor supplies by the use of a non-participation rate for each type of labor. 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 (A1), and the waiting list for factor f by household h, WL_{hf}, is displayed in equation (A2).

$$FE_{hf} = \bar{F}_{hf} - WL_{hf} \tag{A1}$$

$$WL_{hf} = \eta_f \bar{F}_{hf} \tag{A2}$$

where $0 < \eta_f < 1$ for labor 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 labor ($f \in l$) whereas capital is always fully effective and fully employed.[xxvii]

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:

$$\eta_{f \in l} = \eta_{0f} HC_f^{-\varepsilon_f} \tag{A3}$$

where $\eta_{0f \in l} > 0$ 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

$\eta_{f\in l} < 1$.[xxviii] $HC_{f\in l}$ 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 labor type l's waiting list for household h following a change in the health composite,

$$\varepsilon_{f\in l} = -\left(\partial WL_{hf}/\partial HC_f\right)\left(HC_f/WL_f\right) > 0.$$

The health care composite for labor type l is a measure of the 'healthiness' or health status of this labor type and is a CD function of its public and private health care consumption:

$$HC_{f\in l} = G_{"10"}{}^{\upsilon_f}\left(\sum_h C_{"10"h}\right)^{(1-\upsilon_f)} \qquad (A4)$$

where $0 \leq \upsilon_l \leq 1$ denotes the share of public health care in the health status of labor type l. $G_{"10"}$ denotes health care (commodity "10" in Table 2) provided via the NHS - as given by real 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 health care.

Given equations (A1) to (A4), waiting lists (effective labor supplies) are decreasing (increasing) in the health composites, at a decreasing rate. Figure A1 illustrates (subscripts are ignored for simplicity).

INSERT Figure A1 Here

The contribution of public health care to the health status of skilled and unskilled labor, 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 labor having private medical insurance are estimated at 16.6% and 4% respectively, yielding a residual of 83.4% and 96% of skilled and unskilled labor 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, 2004) 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[xxix] find that sickness absence varies by socio-economic characteristics. 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 $\eta_0 = 2.89\%$ for skilled and $\eta_0 = 4.34\%$ for unskilled workers.

The waiting list elasticity parameter, ε, is set to 2 for both labor types, so that a 10% increase in health status leads to a 20% decrease in waiting lists. A value of 2 seems reasonable since it gives health elasticities for skilled and unskilled labor of around 0.1 (0.06 and 0.09 for skilled and unskilled labor respectively), consistent with the scant empirical evidence that exists in this area.[xxx]

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 labor 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:

$$EV_h = \frac{U_h^1 - U_h^0}{U_h^0} Y_h^0 \tag{A5}$$

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 $0 \leq \alpha_{G_{jh}} \leq 1, \sum_h \alpha_{G_{jh}} = 1$), the overall change in household welfare becomes:

$$EV_{T_h} = EV_h + \sum_j \alpha_{G_{jh}} \cdot \left(\frac{G_j^1 - G_j^0}{G_j^0} \right) \cdot GEXP_j^0 \tag{A6}$$

where $GEXP_j^0$ denotes benchmark government expenditure on good j.[xxxi] Consequently, overall welfare changes are equal to:

$$EV_T = \sum_h EV_{T_h} \tag{A7}$$

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 defense, 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 A1.
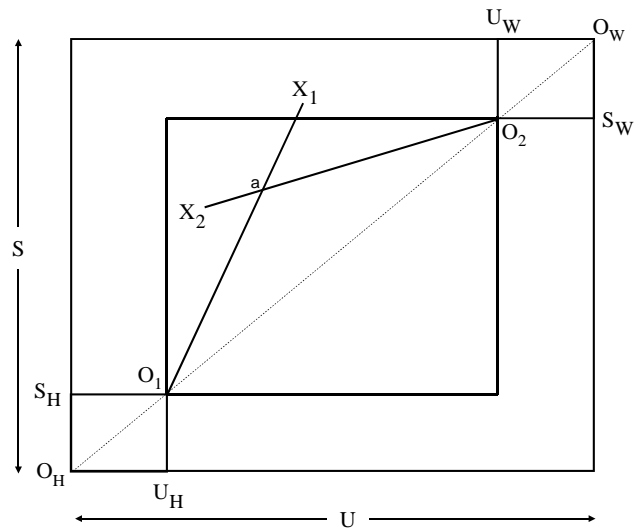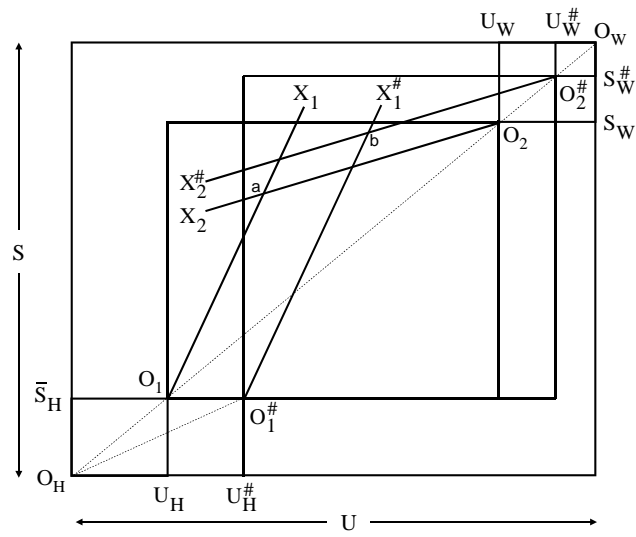
Figure 1. An Initial Equilibrium

Figure 2. An Expansion of the Health Sector Using Domestic Unskilled Workers
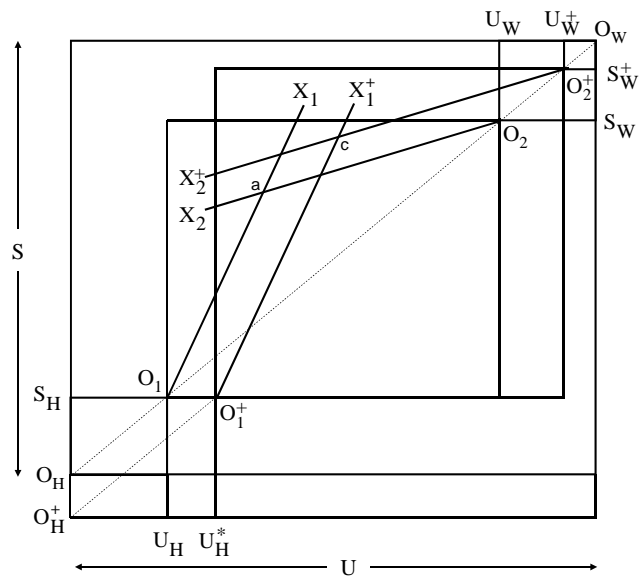
Figure 3. An Expansion of the Health Sector Using Immigrant Skilled Workers
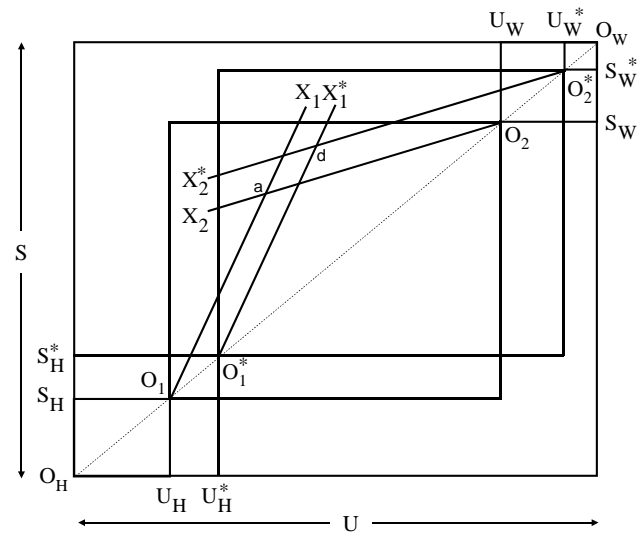

Figure 4. An Expansion of the Health sector Using Domestic Workers
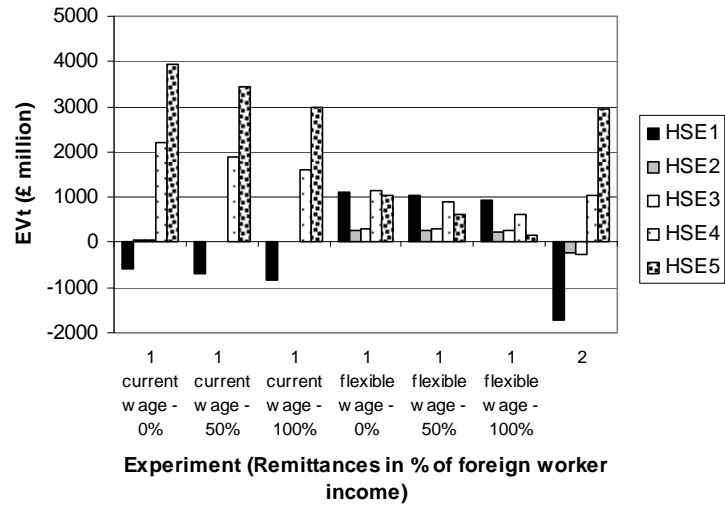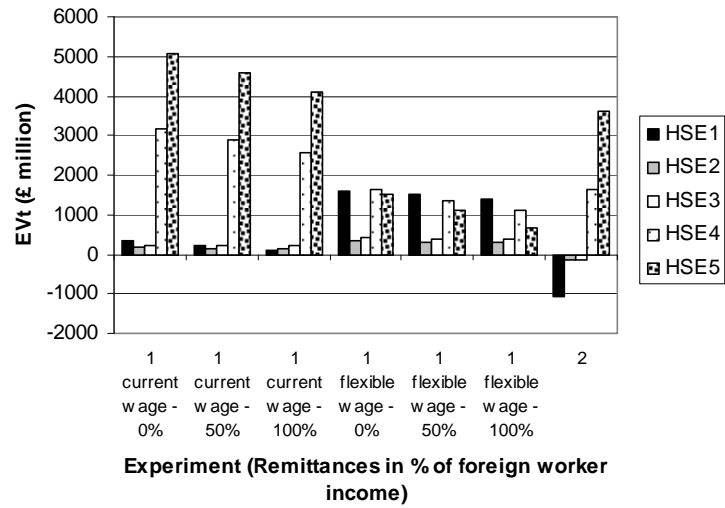
Figure 5. Changes in Household Welfare

Figure 6. Changes in Household Welfare if the Health Sector is Twice as Efficient
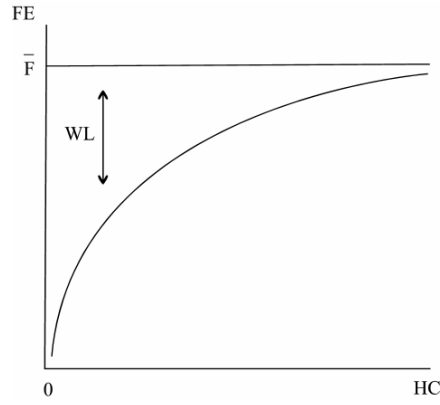
Figure A1. Waiting Lists and Effective Endowments

Skill Intensity	Sector 1			Sector 2		
	Scale Effect	Factor Bias Effect	Net Effect	Scale Effect	Factor Bias Effect	Net Effect
$s_H > s_E > s_1 > s_2$ [*]	$\hat{X}_1^S > 0$	$\hat{X}_1^F < 0$	+/-	$\hat{X}_2^S < 0$	$\hat{X}_2^F > 0$	-/+
$s_H > s_1 > s_E > s_2$	$\hat{X}_1^S > 0$	$\hat{X}_1^F < 0$	+/-	$\hat{X}_2^S > 0$	$\hat{X}_2^F > 0$	$\hat{X}_2 > 0$
$s_1 > s_E > s_H > s_2$	$\hat{X}_1^S > 0$	$\hat{X}_1^F < 0$	+/-	$\hat{X}_2^S > 0$	$\hat{X}_2^F < 0$	-/+
$s_1 > s_H > s_E > s_2$	$\hat{X}_1^S > 0$	$\hat{X}_1^F < 0$	+/-	$\hat{X}_2^S > 0$	$\hat{X}_2^F < 0$	-/+
$s_1 > s_E > s_2 > s_H$	$\hat{X}_1^S > 0$	$\hat{X}_1^F > 0$	$\hat{X}_1 > 0$	$\hat{X}_2^S > 0$	$\hat{X}_2^F < 0$	-/+
$s_1 > s_2 > s_E > s_H$	$\hat{X}_1^S < 0$	$\hat{X}_1^F > 0$	-/+	$\hat{X}_2^S > 0$	$\hat{X}_2^F < 0$	+/-

[*] where $s_j = S_j / U_j$ for $j = 1, 2, H, E$

Table 1. Scale and Factor Bias Effects in the Tradables Sectors

Factors of Production (f)	Sectors (i) / Commodities (j)
Skill Skilled	1. Primary
Unsk Unskilled	2. Pharmaceuticals
Cap Capital	3. Medical instruments
	4. Other manufacturing
Households (h)	5. Energy
Hse1 Pensioners	6. Construction
Hse2 Non-working, children	7. Distribution & transport
Hse3 Non-working, no children	8. Finance
Hse4 Working, children	9. Public administration & defense
Hse5 Working, no children	10. Health care
	11. Other services

Table 2. The CGE Model Classifications

Experiment	Remittances	HSE1[*]	HSE2[*]	HSE3[*]	HSE4[*]	HSE5[*]	Overall
1 10% immigration of doctors and nurses at current wage (12.8% increase in NHS budget)	0%	-572 (-0.27)	47 (0.18)	50 (0.11)	2211 (0.75)	3942 (1.07)	5678 (0.60)
	50%	-695 (-0.33)	32 (0.12)	31 (0.07)	1906 (0.65)	3459 (0.94)	4733 (0.50)
	100%	-818 (-0.38)	16 (0.06)	12 (0.03)	1602 (0.55)	2975 (0.81)	3787 (0.40)
1 10% immigration of doctors and nurses at current NHS budget (wages fall by 12.8%)	0%	1127 (0.53)	262 (0.98)	309 (0.68)	1164 (0.40)	1030 (0.28)	3892 (0.41)
	50%	1023 (0.48)	249 (0.93)	293 (0.64)	896 (0.31)	602 (0.16)	3064 (0.32)
	100%	920 (0.43)	237 (0.88)	278 (0.61)	629 (0.21)	174 (0.05)	2236 (0.24)
2 Generic rise in NHS budget (12.8%)		-1710 (-0.80)	-228 (-0.85)	-266 (-0.58)	1042 (0.36)	2932 (0.79)	1770 (0.19)

[*]{HSE1,2,3,4,5} = {Pensioner, Non-Working With Children, Non-Working Without Children, Working With Children, Working Without Children} Households

Table 3. Welfare Changes in £ mln. (%) Measured by Equivalent Variation

Experiment	Remittances	HSE1[*]	HSE2[*]	HSE3[*]	HSE4[*]	HSE5[*]	Overall
1 10% immigration of doctors and nurses at current wage (12.8% increase in NHS budget)	0%	330 (0.15)	162 (0.61)	239 (0.52)	3180 (1.09)	5086 (1.38)	8997 (0.95)
	50%	209 (0.10)	147 (0.55)	221 (0.48)	2877 (0.98)	4604 (1.25)	8058 (0.85)
	100%	88 (0.04)	132 (0.49)	202 (0.44)	2574 (0.88)	4121 (1.12)	7117 (0.75)
1 10% immigration of doctors and nurses at current NHS budget (wages fall by 12.8%)	0%	1611 (0.76)	324 (1.21)	409 (0.89)	1622 (0.55)	1534 (0.42)	5499 (0.58)
	50%	1511 (0.71)	311 (1.16)	394 (0.86)	1358 (0.46)	1110 (0.30)	4685 (0.49)
	100%	1412 (0.66)	299 (1.12)	378 (0.83)	1094 (0.37)	686 (0.19)	3870 (0.41)
2 Generic rise in NHS budget (12.8%)		-1060 (-0.50)	-146 (-0.55)	-133 (-0.29)	1652 (0.56)	3604 (0.98)	3917 (0.41)

[*]{HSE1,2,3,4,5} = {Pensioner, Non-Working With Children, Non-Working Without Children, Working With Children, Working Without Children} Households

Table 4. Welfare Changes in £ mln. (%) if the Health Sector is Twice as Efficient

Household type	α_{TRh}	$\alpha_{G_{jh}}$		
		Public administration and defense	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

Table A1. Household Shares in Government Transfers and Public Goods

Endnotes

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i   Exceptions are countries such as India and the Philippines, which have collaborative health-worker migration schemes and are reported to over-produce physicians and nurses intended for an international market. According to Bhatnagar (2004) and Lorenzo et al. (2007), these countries are nonetheless also reported to suffer from shortages locally.

ii   This is especially true for countries with wider policy failures, e.g. in SSA. According to Eastwood et al. (2005) in countries with better opportunities, such as India, some health workers do return.

iii   Dixon et al. (2002) for example reports a HIV/AIDS prevalence rate of 20% for South African nurses. Moreover, Dovlo (2007) notes that worries of contracting HIV in the workplace is likely to further induce increased migration of nurses from SSA.

iv   According to the Code of Practice, the UK limits recruitment to countries with which it has signed a health worker migration agreement, most notably India and the Philippines. See Buchan (2007) for its impact on international nurse recruitment.

v   GATS Mode 4, by which services can be traded via the movement of natural persons, governs the provision of health services by individuals in another country on a temporary basis.

vi   The paper is part of a broader research project examining the effects of the medical brain drain on both receiving countries and sending countries, which is a follow-up of the author's Ph.D. thesis (Rutten, 2004). A shortened version of the paper has been published in the Review of International Economics (Rutten, 2008). See Rutten (2007) for an overview of the literature.

vii   Iregui (2003), Walmsley and Winters (2003), Winters (2003), Winters et al. (2003) and World Bank (2005), all use CGE modeling to quantify the impact of increased

international migration. The first study in this field, by Hamilton and Whalley (1984), is based on a partial equilibrium analysis and is updated by Moses and Letnes (2003, 2004). There are, as far as we know, no applied CGE models on the economic impacts of medical migration.

viii   Here there may also benefits such as remittances and 'brain gain' generated by a rise in the expected return on education for those staying behind, resulting in additional investment in education. Schiff (2006), however, shows that claims about the size and impact of the brain gain on welfare and growth are greatly exaggerated and that brain drain is likely to just entail a welfare loss for developing source countries. Kangasniemi et al. (2007) arrives at the same conclusion based on evidence from the UK. The evidence on whether remittances outweigh the welfare losses of human capital in source countries is also mixed, though generally in shortage countries the health sector is considered to be at a loss since remittances benefit the economy as a whole and are unlikely to flow back into the health sector, especially when it is poorly functioning.

ix   A point also made by Bhatnagar (2004). Taking the example of the health sector, one may well expect the health and welfare gains of an influx of skilled health workers into developed countries with relatively well-functioning health care systems to be insufficient to compensate for the adverse health and welfare consequences of the (permanent) loss of already scarce skilled health workers for developing countries where (well-) functioning health care systems are lacking and where the burden of disease is relatively high.

x   Characterized by the assumptions of two goods, two factors that are perfectly mobile within each country but immobile between countries, perfect competition and constant returns to scale.

xi   An important corollary is that an exogenous equiproportionate increase in the endowments of both factors will lead to the same proportionate increase in the output of both sectors.

Since any increase in both factor endowments can be decomposed into an equiproportionate increase in both endowments and an increase in the endowment of one of the factors, we have the more general result that the output of one sector must increase while the change in the output of the other is in general indeterminate.

xii   In this setting the migration option is more expensive than the option of using domestic unskilled workers only. If wages of domestic health-specific workers were not maintained, the numbers of unskilled workers employed in the health sector vs. the tradables sectors, and hence sectoral outputs, would depend on, among others, the elasticity of substitution between health-specific skilled and unskilled labor in the health sector. So, if both options involved an identical health care budget increase, it would be unclear which option would perform better in terms of tradables outputs.

xiii   Note that at least one of the three sectors must have a skilled/unskilled ratio that is higher (lower) than the skilled/unskilled effective endowment ratio.

xiv   By assumption sector 1 is more skill-intensive than sector 2.

xv   Specifically, prices of health care and health-specific skilled workers become endogenous and the cost share of health-specific skilled workers, the substitution elasticity between this type and unskilled workers in the health sector, and the ratio of unskilled workers employed in the health and tradables sectors become additional unknowns.

xvi   Associated publications are Office for National Statistics (2002, 2001) respectively.

xvii   An outline of the model is given in the appendix. All MPSGE model files are available from http://www.i4ide.org/people/~rutten/.

xviii   A reliable estimate of the share of foreign worker income remitted abroad cannot be obtained since the evidence on remittances by migrant workers itself is mixed and difficult to establish for three main reasons: (1) a large proportion of remittances is transferred informally and is therefore not recorded in official statistics; (2) remittance behavior will

depend on the characteristics of the migrants in question, for example, the skill type, income level, length of stay and the country of origin and (3) it is unclear how much of the remittance flows can actually be attributed to health workers.

xix In contrast with the standard neoclassical CGE model closure, in which the current account balance is fixed and assumed equal to the capital balance, the modeling of migration and associated remittances implies that the trade balance has to adjust so as to maintain the balance of payments. Note that our model does not explicitly account for other components of the capital account, since it is focused on the consequences of international trade (in services) on the domestic economy.

xx Note that the two policy experiments will differ in terms of their real budgetary impact due to differential price effects. In addition, in a setup where, given the NHS budget, wages of doctors and nurses are allowed to fall following immigration, the comparability with a generic NHS budget increase logically breaks down, immigration being essentially costless since the NHS budget does not have to increase to accommodate an increase in NHS provision levels.

xxi See also the appendix.

xxii If indirect welfare effects are absent, overall welfare gains would actually be higher (by £333 million, or 0.04%, in the absence of remittances).

xxiii Note that if all skilled labor were perfectly mobile, NHS production would increase by 12.8% and private health care would contract only slightly, by 0.4%. Total welfare would increase by £3.033 billion, a relative gain of 0.3%. The presence of health care-specific skilled labor thus constrains the production expansion of health care and related sectors, the health of the population, and effective labor supplies, and so yields lower overall welfare gains, cutting total welfare gains by 42%.

xxiv If wages of doctors and nurses are sustained and all migrant income is remitted abroad, a slight (0.003%) decrease in overall welfare is observed.

xxv Moreover, one may argue that in the long-term the only sustainable policy which addresses the root cause of the shortage of medical personnel is to increase the number of medical school places in the UK

xxvi 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.

xxvii 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.

xxviii Note that $\eta_f \to 0$ as $HC_f \to \infty$, but that the upper constraint for η_f is not automatically satisfied. $\eta_{0f \in l}$ 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.

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

xxx Folland et al. (2001, p.108-109). These elasticities measure the proportionate change in the size of effective endowments of skilled and unskilled labor following a change in the health composite, and are calculated as

$$\left(\partial FE_{hf} \big/ \partial HC_f \right)\left(HC_f \big/ FE_{hf} \right) = \varepsilon_f \, WL_{hf} \big/ FE_{hf} = \varepsilon_f \, \eta_f \big/ \left(1 - \eta_f \right).$$ The elasticity is

higher for unskilled labor due to the fact that a relatively higher proportion of the unskilled suffer illness, so that health expenditure's "leverage" is greater for this labor type.

xxxi 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 (A7), is equivalent to a social welfare function with equal weights, i.e. a common utilitarian social welfare function (Johansson, 1991, p.32).