## A Short Note on the UK CGE model and SAM

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*This note describes the model and data used in my Review of International Economics Paper (Rutten, 2009). However, the note is also valid for earlier versions of this paper as appeared in the IIDE discussion paper series (Rutten, 2007) and World Bank Policy Research Working Paper Series (Rutten, 2008), and my Ph.D. thesis, which I completed at the University of Nottingham (Rutten, 2004).*[1]

The UK CGE model is a comparative static Computable General Equilibrium model of the UK economy. The Social Accounting Matrix 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 (GHS) for 2000-01.[2] The latter purpose-built 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 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 (see Table 1).

| **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 1. The CGE Model Classifications*

All sectors are perfectly competitive and multi-product industries. The production technologies are Constant Returns to Scale, with production a Leontief function of intermediates and value-added, itself a Cobb Douglas (CD) function of homogeneous

[1] Model specifications may however differ somewhat.

[2] Associated publications are Office for National Statistics (2002, 2001) respectively.

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.[3]

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 in nature.

**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 (1), and the waiting list for factor $f$ by household $h$, $WL_{hf}$, is displayed in equation (2).

[3] 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.

$$FE_{hf} = \bar{F}_{hf} - WL_{hf} \qquad (1)$$

$$WL_{hf} = \eta_f \bar{F}_{hf} \qquad (2)$$

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.[4]

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:

$$\eta_{f \in l} = \eta_{0f} HC_f^{-\varepsilon_f} \qquad (3)$$

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 $\eta_{f \in l} < 1$.[5] $HC_{f \in l}$ 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, $\varepsilon_{f \in l} = -\left(\partial WL_{hf} / \partial HC_f\right) \cdot \left(HC_f / WL_f\right) > 0$.

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:

$$HC_{f \in l} = G_{"10"}{}^{\upsilon_f} \left(\sum_h C_{"10"h}\right)^{(1-\upsilon_f)} \qquad (4)$$

where $0 \le \upsilon_l \le 1$ denotes the share of public health care in the health status of labor type $l$. $G_{"10"}$ denotes health care (commodity "10" in Table 1) 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.

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[4] 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.

[5] Note that $\lim_{HC_f \to \infty} \left(\eta_f\right) = 0$, but that the upper constraint for $\eta_f$ 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.

Given equations (1) to (4), waiting lists (effective labor supplies) are decreasing (increasing) in the health composites, at a decreasing rate. Figure 1 illustrates (subscripts are ignored for simplicity).

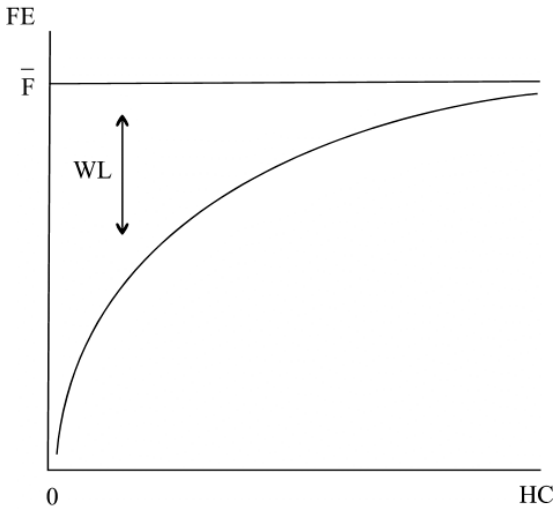


*Figure 1. Waiting Lists and Effective Endowments*

The contribution of public health care to the health status of skilled and unskilled labor, as measured by $\upsilon$, 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 $\upsilon$.

The scale parameter $\eta_0$ 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[6] 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

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

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, $\varepsilon$, is set to 2 for both labor 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 (labor) endowments with respect to the health composite in the benchmark are 0.06 and 0.09 approximately for skilled and unskilled labor respectively.[7] These numbers are consistent with health care elasticity estimates of around 0.1 based on US data (Folland et al., 2001, p.108-109). The elasticity of effective labor supply with respect to the health composite 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. The results of the simulations 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 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:

$$EV_h = \frac{U_h^1 - U_h^0}{U_h^0} Y_h^0 \qquad (5)$$

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:

$$EV_{T_h} = EV_h + \sum_j \alpha_{G_{jh}} \cdot \left( \frac{G_j^1 - G_j^0}{G_j^0} \right) \cdot GEXP_j^0 \qquad (6)$$

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

where $GEXP_j^0$ denotes benchmark government expenditure on good $j$.[8]

Consequently, overall welfare changes are equal to:

$$EV_T = \sum_h EV_{T_h} \qquad (7)$$

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, $\alpha_{TRh}$, are shown in Table 2.

| **Parameter** | $\alpha_{TRh}$ | $\alpha_{G_{jh}}$ | | |
|---|---|---|---|---|
| **Household type** | | 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 2. Household Shares in Government Transfers and Public Goods*

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[8] 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 (7), is equivalent to a social welfare function with equal weights, i.e. a common utilitarian social welfare function (Johansson, 1991, p.32).

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