On the Efficiency of Public and Private Health Care Systems: An Application to Alternative Health Policies in the United Kingdom

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Abstract

Health policy will be a major issue in Britain's next general election. The Labour government is committed to a substantial increase in funds for the National Health Service (NHS) and has eliminated tax relief for private health insurance. The Conservative Opposition party favors subsidizing private health insurance, though it has pledged to match the government's funding increases for the NHS.

This paper develops and implements a methodology for estimating the welfare effects of increasing public and private health care in the United Kingdom, when these policies are financed either by distortionary taxes or by user fees for the NHS. User fees are currently minimal, and the national health market "clears" by creating waiting costs. In the private sector we assume that prices approximately reflect marginal supply costs, and there are no waiting lists.

We find that the welfare change from increasing NHS output could easily be negative, particularly when extra spending is financed by distortionary taxes. In contrast, expanding private health care is always efficiency-improving in our simulations. In our central estimates, increasing private health care by a pound's worth of output produces an efficiency gain of 55 pence, but increasing national health output produces a net efficiency *loss* of 32 pence per pound! One reason for these results is that increasing the output of rationed health care has ambiguous effects on the total deadweight losses from waiting costs, but these costs unambiguously fall when the private health sector expands.

Financing policies by user fees avoids the efficiency costs of raising distortionary taxes, and it also produces efficiency gains by reducing waiting lists. In fact, increasing national health care output produces an overall efficiency gain in most of our simulations, rather than an efficiency loss, when the policy is financed by higher user fees rather than by distortionary taxes. Still, the policy is generally less efficient than a user fee–financed increase in private health care.

Key Words: National Health Service, private health care, rationing, subsidies, welfare effects

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1. Introduction

Recently, there has been much debate in the United Kingdom about how to increase the level of health care spending to levels in comparable countries. Currently, the United Kingdom spends about 6.8% of its gross domestic product (GDP) on health care. Germany spends 10.7% of its GDP on health, and the United States 13.9% (see Figure 1).[1] In part, the relatively small size of the U.K. health sector is due to the tiny role played by the private sector. Private health care spending accounts for just 1% of GDP in the United Kingdom, in Italy it is 2.3%, in France 2.5%, and in the United States 7.4% (Figure 1).

Health policy will be an issue in the next general election in Britain. Tony Blair's Labour government is committed to a substantial increase in spending on the National Health Service (NHS), which provides health care for free at the point of consumption. Annual government spending is set to increase from £45 billion in 2000–01 to £59 billion in 2003–04.[2] At the same time the government has penalized the private health care sector. In 1997 Chancellor of the Exchequer Gordon Brown scrapped tax relief for private insurance for pensioners, and in 2000 he scrapped relief against national insurance contributions for employers who provide private medical insurance schemes for employees (combined, these tax expenditures amounted to about

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[1] This is despite the fact that public spending on health care in the United Kingdom has increased by more than 3% per annum in real terms over the last twenty years (Emmerson et al. 2000).

[2] See www.hm-treasury.gov.uk/sr2000/report/index.html. For more details on the government's health policies, see the Health Policy Document, available at www.labour.org.uk.

£100 million per annum). In contrast, William Hague's Conservative Opposition party favors encouraging the private sector through tax subsidies.[3] However, the Conservatives have also pledged to match Labour's spending increases on the NHS.

The main argument for the government's providing free health care is that it allows people to receive treatment based on clinical need rather than on ability to pay.[4] In addition, subsidies for health care—either subsidies for private insurance or direct provision of public health care—have been defended on efficiency grounds. In particular, health subsidies may be a second-best response to private market failures that are due to adverse selection and moral hazard. High-risk people may crowd out low-risk people from private insurance markets by driving up average premiums. Moreover, when treatment costs are borne by the insurance company, people may go to the doctor more often than needed or demand higher-quality care than needed, again driving up premiums.[5]

But a central motivation for the recent boost in NHS funding was to increase output and thereby reduce the average wait time for NHS treatment. Since the monetary price to households of using the NHS is essentially zero, and the government cannot supply all the treatment that is demanded at a zero price, health care is rationed by creating waiting lists. In February 2000, 1.1 million people in England (2% of the population) were waiting for a hospital appointment for a clinical intervention, and the average waiting time for such appointments was more than four

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[3] It would reintroduce the tax reliefs abolished by Labour and would allow employees (as well as employers) some deduction against payroll taxes for private health insurance. In the United States, employer-provided health insurance is exempt from all payroll and income taxes, implying a substantial subsidy of about 40%.

[4] A central principle of the NHS set out in the 1944 White Paper, *A National Health Service*, was the aim that everyone "irrespective of means, age, sex, or occupation shall have equal opportunity to benefit from the best and most up to date medical and allied services available." Besley et al. (1999) find evidence that the NHS does indeed ensure provision for the poor. In contrast, about 43 million nonelderly Americans do not have any medical insurance (EBRI 1999).

[5] For more discussion of these issues, see, for example, Arrow (1963), Pauly (1974), Zeckhauser (1970), and Gaynor et al. (2000).

months (Emmerson et al. 2000). This time delay for receiving public health care is a source of deadweight loss.[6]

Increased spending on the NHS may therefore produce efficiency gains by reducing the average wait time for treatment.[7] It also produces efficiency effects because the marginal benefit from additional NHS output may be below the marginal supply cost (see below). In addition, efficiency losses arise because distortionary taxes have to be higher to finance the additional public spending.[8]

Tax subsidies for private health care can reduce NHS waiting times if they induce some people to leave the queue and go private. But they also imply higher taxes elsewhere in the economy, and the subsidy itself creates a price distortion in the private health care market, giving rise to efficiency effects.

This paper analyzes the welfare effects of policies to (marginally) increase public and private health care output. These effects stem from three sources: first, changes in the total waiting costs in the rationed health care sector; second, distortions between the marginal social benefit and the marginal social cost in the public and private health care markets, created by policy intervention; and third, general equilibrium welfare effects that arise from interactions with the tax system. We use an analytical model that provides simple formulas for each of these components of the welfare change. These formulas are estimated using wide ranges of plausible

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[6] This is similar to the deadweight loss caused by traffic congestion. In this case, roads are unpriced but are in limited supply at peak periods. The "market" for peak-period driving clears by increasing the time costs to motorists from using the road. Note that in the case of traffic congestion, people actually lose time queueing, but in the case of NHS waiting lists, people suffer a delay in receiving service rather than physically standing in a queue. For a good discussion distinguishing these different types of rationing, see Lindsay and Feigenbaum (1984). Other notable contributions to the literature on rationing by waiting include Nicholls et al. (1971), Barzel (1974), and Deacon and Sonsteile (1989).

[7] In practice, some of the increased public spending announced by Gordon Brown is likely to finance pay rises for NHS workers, rather than providing a real increase in output, and in this respect we may overstate the efficiency gains from higher NHS spending. On the other hand, higher wages may motivate workers to be more productive. These issues are beyond the scope of our analysis.

[8] Alternatively, higher spending may be financed out of the current government budget surplus. But this implies that future taxes will be higher than they would otherwise have been, in order to finance the larger carryover of national debt. Hence it is standard to assume that the opportunity cost of increased public spending is foregone tax cuts.

parameter values for the United Kingdom. Our analysis assumes that a pound of spending on the NHS produces the same quality of care as a pound of extra private health spending, aside from the wait costs.

Previous discussions of health policies have focused mainly on equity issues and the implications of market failures in private insurance markets (see, e.g., Barr 1998 and Donaldson 1998 in the U.K. context). Waiting times have been analyzed in the literature on market rationing (e.g., Lindsay and Feigenbaum 1984), but the focus has been mainly on the determinants of equilibrium waiting times. To our knowledge, ours is the first attempt to quantify the welfare effects of policy-induced changes in wait times. There is a small literature on the efficiency costs of financing health policies by distortionary taxation. For the United States this efficiency cost has been estimated at 20 to 40 cents per dollar of spending (Browning and Johnson 1980; Ballard and Goddeeris 1999). Our paper also adds to this literature by developing cost estimates for the United Kingdom. More importantly, it explores some additional interactions between health policies and the tax systems that have not been previously recognized (see below), and it compares tax financing with financing from user fees.

Our focus is on three main policy issues. First, do the efficiency effects from reducing NHS waiting times outweigh efficiency losses from other sources, when spending on either public or private health care is increased? In other words, can additional health care spending, either private or public, be justified on the grounds of reducing waiting lists, or are other justifications, such as information asymmetries, required? Second, are the net efficiency gains or losses larger per pound of additional spending on public or private health care? That is, given that the government has decided to expand the overall health care sector, is it better on efficiency grounds to expand the public sector or the private sector? Third, if additional revenues for these policies were financed by user fees for the NHS—for example, expanding prescription charges, introducing fees for general practitioner visits—rather than by higher taxes, how would this change the overall efficiency impact of the policies?

We find that increasing national health care output could actually reduce social welfare. The average wait time per operation falls, but the total number of operations rises, implying an ambiguous effect on the total deadweight losses from waiting. Moreover, the efficiency costs of financing additional national health care output through distortionary taxes further reduce the welfare performance of this policy. Only when the demand for national health care is very inelastic—such that more output has a relatively large impact on reducing equilibrium waiting times—does this policy produce an overall welfare gain in our simulations.

In contrast, increasing private health output always increases welfare in our analysis. Because of the substitution between public and private health care, this policy unambiguously reduces the total deadweight losses from waiting lists.[9] Also, its impact on exacerbating preexisting tax distortions is much less significant. Under almost all parameter scenarios, expanding private health care is more efficient than expanding public health care, and by a potentially large amount. For example, under our central parameter values, increasing private health by a pound's worth of output produces a net efficiency gain of 55 pence; increasing national health care by a pound's worth of output produces an efficiency *loss* of 32 pence.

Financing policies by user fees rather than by taxes significantly increases efficiency. This avoids the efficiency losses caused by raising distortionary taxes, and it produces an efficiency benefit by reducing wait times for rationed health care. In fact, increasing national health care output produces an overall efficiency gain in most of our simulations, rather than an efficiency loss, when the policy is financed by higher user fees rather than by distortionary taxes. Still, the policy is generally less efficient than a user fee–financed increase in private health care.

We emphasize a number of caveats to the analysis. First, because of parameter uncertainty, it is not possible to accurately pin down the absolute welfare effects of alternative health policies. Nonetheless, we are still able to draw broad conclusions about the relative welfare effects of different policies and determine whether different policies are likely to increase or decrease economic efficiency. Second, our analysis ignores some considerations that would be important in a more comprehensive policy evaluation, including equity issues, political feasibility, and informational problems in private insurance markets. For example, user fees appear attractive on efficiency grounds, but they obviously hurt the poor disproportionately and therefore would be politically difficult to implement.[10]

The rest of the paper is organized as follows. Section 2 describes the model assumptions. Section 3 derives formulas that decompose the general equilibrium welfare effects of additional

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[9] Other papers that have studied the substitution between public and private provision of private goods include Stiglitz (1974), Sonsteile (1982), Ireland (1990), and Besley and Coate (1991).

[10] Moreover, user fees could lead to worse public health for the poor, and this could have serious spillover effects if the incidence of infectious diseases increases. But these problems could be mitigated in part by means-testing user fees.

spending on public and private health care, under alternative financing options. Section 4 discusses plausible parameter values for these formulas. Section 5 presents the empirical results. Section 6 concludes.

2. Model Assumptions

Consider a static, representative agent model where the household utility function is:

$$(2.1) \quad U = U\{H(H^N, H^P), Y, l\} - k_a H^N$$

H^N and H^P are the consumption of national health care output and private health care output respectively, Y is the consumption of all other market goods, and l is leisure or nonmarket time. $U(.)$ and $H(.)$ (subutility from health care) are continuous, quasi-concave functions.

$k_a H^N$ represents the (total) cost of waiting for national health care rather than receiving instant treatment, that is, the cost of continued suffering and reduced quality of life while on the NHS waiting list. $k_a = k_a(k_m)$ where k_a and k_m are the average wait cost and the marginal wait cost, respectively, and $k'_a(k_m) > 0$. We assume that $k_m > k_a$, and therefore $k'_a(k_m) < 1$, because we need to represent the situation in practice where some people are willing to pay more than others to avoid waiting for treatment. For example, the value of k is relatively high for high-income people and those not opposed to using private health care on ideological grounds. Hence the marginal person using the NHS has a higher opportunity cost of waiting than the infra-marginal person. $\overline{H}^N$ is the current amount of health care provided by the government, and therefore in equilibrium $H^N = \overline{H}^N$.

H^P and Y are produced by competitive industries, and H^N is provided publicly. We assume that the public sector minimizes production costs, as in the private industry.[11] In each industry we assume perfectly elastic supply curves, which seem a plausible long-run assumption. Labor is the only input in production, and labor earnings are taxed at rate t. We normalize units to imply that supply prices, and the gross wage, are unity.

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[11] If the incentive to minimize production costs is weaker in the public sector than in the private sector, our analysis will understate the efficiency costs of producing more public health care.

Households pay the market price for private health care, although a small portion of these costs are tax deductible (see below).[12] We define $0 \leq s < t$ as the effective rate of subsidy for private health care. In our analysis—which abstracts from equity issues and information asymmetries in insurance markets—the private benefits from public and private health spending are equal to the social benefits. Therefore, the tax-subsidy simply creates a (small) "wedge" of s between the marginal cost of supplying private health care and the marginal benefits to households, implying a deadweight loss equal to the shaded triangle in Figure 2(a).

There is a small user fee of c for public health care, which may represent prescription charges. Households would like to consume public health care up to the point where the marginal private benefit equals c, that is, H_1^N in Figure 2(b). However, the government provides only $\overline{H}^N$ in output because of budgetary constraints. Since the demand for public health care exceeds $\overline{H}^N$ when the price is c, health care must be rationed, and this occurs through the expected wait time for receiving treatment.[13] Thus, the full price of national health care at the margin is $c + k_m / \lambda$, where λ is the marginal utility of income. The wait time is exogenous to individual households but adjusts at the market level to equate demand and supply. The total delay cost, the shaded trapezoid in Figure 2(b) equal to $\lambda k_a \overline{H}^N$, is pure deadweight loss to the economy: it represents the cost of having to wait several months to get treatment.[14]

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[12] Typically, in the private sector people purchase insurance to cover the costs of treatment in the event of illness or injury. The "price" of private health care is, roughly speaking, the average premium per household, where the total premiums paid by households cover the expected costs of treatment born by private suppliers.

[13] For a nonemergency condition people are first referred to a specialist by their general practitioner. The patient is then put on a waiting list for NHS hospital treatment. The number of individuals on in-patient waiting lists has increased from 400,000 to more than 1,200,000 in England over the last 40 years, and the average wait time was about four months in 1999 (Emmerson et al. 2000). For emergency conditions the wait times are minimal, and hence there is little incentive to pay for private treatment.

[14] Besley and Coate (1991) develop a model of public and private health care in which the quality of NHS care, which takes account of wait times, is fixed by the government and is inferior to that in the private sector, where there are no wait times. The structure of our model differs by allowing the wait time to be endogenous rather than exogenous. Other health care models with endogenous waiting times include Lindsay and Feigenbaum (1984), Gravelle (1990), and Goddard et al. (1995).

We assume that the benefit to households from additional treatment (gross of the money and time cost) is the same for both the public and the private sector (for a given quality of hospital staff and equipment). In equilibrium:

$$(2.2)\, c + k_m / \lambda = 1 - s$$

That is, the full price per unit of public health care must equal the money price of private health care.[15] Note that this implies that the wedge between the marginal supply cost and the marginal benefit to consumers is s, the same as in the private health market (see Figure 2). Also note that since k_m always adjusts to maintain condition (2.2), increases in the user fee are exactly offset by a fall in k_m, when $\overline{H}^N$ and s are constant.

The government budget constraint is:

$$(2.3)\, G + (1-c)\overline{H}^N + sH^P = tL$$

where G is an exogenous spending requirement and L is labor supply. For simplicity, we treat G as a lump-sum transfer to households. Equation (2.3) equates expenditure on the transfer payment, national health care (net of user fee revenues), and the tax expenditure for private health care, with revenues from the labor tax.

The household budget constraint is:

$$(2.4)\, cH^N + (1-s)H^P + Y = (1-t)L + G$$

The left side of (2.4) is monetary spending on consumption goods, where the monetary price of national and private health care is c and $1-s$ respectively. The right side is net of tax labor income plus the government transfer. Households also face the time constraint $\overline{L} = L + l$ where $\overline{L}$ is the time endowment.

Using duality, the household optimization problem can be expressed:

$$(2.5)\, e(\overline{U}, s, c + k_m, t) = Min \quad cH^N + (1-s)H^P + Y - (1-t)L$$

$$- \lambda^{-1}\left\{ U\left\{ H\left(H^N + H^P\right), Y, \overline{L} - l\right\} - k_a(k_m)H^N - \overline{U}\right\}$$

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[15] If, for example, $c + k_m / \lambda > 1 - s$, then people at the margin would quit waiting for the NHS and move to the private sector until k_m falls enough to restore equilibrium.

where $e(.)$ is the expenditure function and $\overline{U}$ is the maximized value of utility. The solution to this problem yields the compensated demand and labor supply functions:

$$(2.6)\ H^N = H^N(s, c + k_m, t)\ ; \qquad H^P = H^P(s, c + k_m, t)\ ; \qquad Y = Y(s, c + k_m, t)\ ;$$
$$L = L(s, c + k_m, t)$$

where we have normalized the marginal utility of income to unity (this is reasonable when we are dealing with incremental policy changes). Differentiating the expenditure function in (2.5), and noting that in equilibrium $H^N = \overline{H}^N$, we can obtain:

$$(2.7)\ \frac{\partial e}{\partial s} = -H^P\ ; \frac{\partial e}{\partial k_m} = \overline{H}^N k_a'\ ; \frac{\partial e}{\partial c} = \overline{H}^N\ ; \frac{\partial e}{\partial t} = L$$

3. Deriving Formulas for the Welfare Effect of Additional Health Spending

We now derive formulas for the efficiency effect of policies to increase public and private health care output by the same incremental amount, financed both by higher taxes and by higher user fees.[16]

A. Policies Financed by Higher Taxes

(i) Increasing the private health subsidy. Consider an incremental increase in the private health subsidy financed by raising the labor tax. The welfare gain from this policy is defined by:

$$(3.1)\ dW_t^P = \frac{-de/ds}{dH^P/ds}$$

The numerator in (3.1) is the lump-sum transfer that would have to be taken away from the household to keep utility constant following an incremental increase in s (taking into account induced changes in t and k_m). The denominator is the increase in private health consumption

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[16] An alternative approach would be to compare the efficiency of increasing government spending on the NHS with that of increasing the subsidy outlay for private health care, each by a pound. In this case the increase in output would be different in the public and private health markets. In fact, the change in output would also differ according to whether polices are financed by higher taxes or higher user fees. This would make the cost comparisons across policies more difficult to interpret.

from an incremental increase in s. Hence dW_t^P is the welfare gain per unit of additional private health output.[17]

Some manipulation gives (see Appendix A):

$$(3.2)\ dW_t^P = -s + \overline{H}^N\left(-k_a'\frac{dk_m}{dH^N}\frac{dH^N}{dH^P}\right) + t\frac{dL}{ds}\frac{ds}{dH^P}$$

Equation (3.2) decomposes the welfare effect into three components. The first term, s, is the welfare loss from the increase in the shaded triangle in Figure 2(a) due to the private health output effect. For the low levels of subsidy assumed below, however, this effect is empirically small. The second term is the efficiency benefit from reducing delay costs (the trapezoid in Figure 2(b)) in the national health care market. It equals the reduction in average delay cost (the term in brackets) times the quantity of public health care. The delay cost falls because the increase in private health consumption shifts in the demand curve for public health care. The third term is the welfare gain or loss in the labor market. This equals the change in labor supply times the labor tax, where the labor tax equals the difference between the value marginal product of labor (equal to the gross wage) and the marginal opportunity cost of leisure time (the net wage).

We can decompose the welfare effect in the labor market into the following two expressions (see Appendix):

$$(3.3)\ t\frac{dL}{ds}\frac{ds}{dH^P} = -\left\{H^P\frac{ds}{dH^P} + s\right\}M + t(1+M)\frac{\partial L}{\partial s}\frac{ds}{dH^P}$$

where

$$(3.4)\ M = \frac{-t\dfrac{\partial L}{\partial t}}{L + t\dfrac{\partial L}{\partial t}} = \frac{\dfrac{t}{1-t}\varepsilon_L}{1 - \dfrac{t}{1-t}\varepsilon_L}$$

and $\varepsilon_L = (\partial L/\partial(1-t))(1-t)/L$ is the (compensated) labor supply elasticity.

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[17] Under this definition of the welfare change, quantity changes depend on compensated price effects (i.e., pure substitution effects). This approach has been defended by Browning et al. (1997) and Fane and Jones (1997).

The first expression on the right in (3.3) is the welfare cost of financing the additional subsidy payment through distortionary labor taxation, or the *revenue-financing effect*.[18] This is the product of two terms. The term in parentheses, which equals $d(sH^P)/dH^P$, is the increase in subsidy outlays required to increase H^P by one unit. M denotes the *marginal excess burden* (MEB) of labor taxation, that is, the welfare loss from raising one extra pound of revenue by increasing the labor tax.[19] The second term in (3.3) is the efficiency gain from the positive impact on labor supply as the subsidy lowers the money price of goods and hence increases the real wage. This has been termed the *tax-interaction effect* in other policy contexts (e.g., Goulder 1995). The increase in labor supply produces a welfare gain of $(1+M)t$ per unit, when we take into account the gap (t) between the gross and net wage, and the efficiency value of the increase in labor tax revenues per unit increase in labor supply (Mt).

Imposing weak separability between goods and leisure in the utility function, we can obtain (see Appendix):

$$(3.5)\, dW_t^P = -s + \left(-\frac{dH^N}{dH^P}\right)\frac{1-s}{\eta^N}k_a' - M\left\{s - \frac{1-s}{\eta^P}\right\} + \frac{(1-s)}{(-\eta^P)}M\zeta^P$$

where

$$(3.6)\, \eta^P = \frac{dH^P}{d(1-s)}\frac{1-s}{H^P} < 0\,;\, \eta^N = \frac{dH^N}{dk_m}\frac{c+k_m}{\overline{H}^N} < 0\,;\, \zeta^P = \frac{\partial H^P}{\partial I}\frac{I}{H^P} > 0$$

η^P and η^N are the own price elasticities of demand for private and public health care respectively, and ζ^P is the expenditure elasticity for private health care (I denotes disposable income). The last three terms on the right in (3.5) correspond to the change in wait costs, the revenue-financing effect, and the tax-interaction effect. As discussed below, private health care is probably a luxury good ($\zeta^P > 1$) and is therefore a relatively strong substitute for leisure (see, e.g., Deaton 1981). Suppose that $s = 0$; then in this case there would be a net welfare gain from

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[18] This terminology is from Parry (1998).

[19] Note that the numerator of the first expression for M in (3.4) is the welfare loss from an incremental increase in t and the denominator is the increase in revenue from an incremental increase in t. Hence M is the welfare loss per pound of extra revenue. See Browning (1987) for a thorough discussion of the marginal excess burden of taxation.

the revenue-financing effect and the tax-interaction effect in (3.5). In other words, up to a point, subsidizing private health care could be justified on the grounds of tax-efficiency.[20]

(ii) Increasing public health care. Consider a unit increase in public health output, financed by increasing the labor tax. The welfare change from this policy is:

$$(3.7)\ dW_t^N = \frac{-de}{d\overline{\overline{H}}^N}$$

Some manipulations yield (see Appendix):

$$(3.8)\ dW_t^N = -\{1 - (c + k_m)\} + \left\{ \overline{H}^N k_a' \left(-\frac{dk_m}{d\overline{\overline{H}}^N} \right) - k_m \right\} - s\frac{dH^P}{d\overline{\overline{H}}^N} + t\frac{dL}{d\overline{\overline{H}}^N}$$

There are four sources of welfare change from increasing public health output by one unit. First is a welfare loss of $1 - (c + k_m) = s$, the gap between the marginal supply cost and the marginal benefit to households (i.e., the addition to the shaded triangle in Figure 2(b)). Second is the welfare effect from the change in delay costs (the term in parentheses). Again, there is an efficiency benefit equal to the fall in average delay costs $(-k_a' dk_m / d\overline{H}^N)$ times the quantity of public health care. And the fall in delay costs will be larger than before, since the price effect is direct rather than indirect (compare the relevant terms in (3.2) and (3.8) and note that $|dH^N / dH^P| < 1$). But since public health output is marginally higher, delay costs also increase by k_m. Hence, on balance, the deadweight losses from wait costs could actually *increase*. Third, there is a welfare loss in the private health market (a slight reduction in the shaded triangle in Figure 2(a)), since demand falls in response to the lower price of public health. Again, since *s* is small for the United Kingdom, the first and third terms in (3.8) are empirically unimportant (see below).

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[20] Conversely, if $\zeta^P < 1$, private health would be a relatively weak leisure substitute, and the subsidy causes a net efficiency loss from interactions with preexisting taxes. These results are consistent with the theory of optimal commodity taxes, which implies that relatively strong (weak) leisure substitutes should be subsidized (taxed) relative to other goods.

Our analysis simplifies by ignoring possible feedback effects of improved health on labor productivity. This turns out to be a complicated theoretical issue, and the overall impacts on labor supply are ambiguous (Williams 1998). Moreover, the relative empirical magnitude of these feedback effects may not be that large because a disproportionate amount of health spending is on the elderly, nonworking population.

The fourth source of welfare change is in the labor market, and this can also be expressed (see Appendix):

$$(3.9)\, t\frac{dL}{d\overline{H}^N} = -M\left\{1 - c + s\frac{dH^P}{d\overline{H}^N}\right\}$$

Comparing (3.9) and (3.3), we see two crucial differences. First, the revenue-financing effect is larger. In this case, the revenue-financing effect is the MEB multiplied by the revenue cost of the extra unit of national health output, $1-c$, net of the induced change in subsidy outlays in the private health market. But since c and s are small, the revenue-financing effect is close to M (see below). In contrast, the revenue-financing effect is well below M for the private health subsidy, since the demand for private health care is elastic (plug s small and $\left|\eta^P\right| >> 1$ in the revenue-financing effect in (3.5)). The second difference is that there is no offsetting tax-interaction effect in (3.9). Increasing (free) national health care does not affect the monetary price of consumption goods and therefore does not affect the real household wage, and hence it does not change the return-to-work effort.

In short, increasing public health care increases efficiency only if it reduces the total deadweight losses from waiting times, *and* if it does so by more than enough to offset the efficiency cost of the revenue-financing effect. In contrast, subsidizing private health care always increases efficiency in our simulations. This is because it unambiguously reduces the deadweight losses from waiting, and the efficiency effects from interactions with the tax system are much smaller, if not positive.

Using (2.2), (3.6), (3.8), and (3.9), we can obtain:

$$(3.10)\, dW_t^N = -s + \left\{\frac{1-s}{-\eta^N}k_a' - (1-s-c)\right\} - s\frac{dH^P}{d\overline{H}^N} - M\left\{1 - c + s\frac{dH^P}{d\overline{H}^N}\right\}$$

These four terms correspond to the public health output effect, the change in wait costs, the private health output effect, and the revenue-financing effect.

B. Policies Financed by Higher User Fees

(i) Increasing the private health subsidy. The welfare gain from this policy, when financed by higher user fees rather than by higher taxes, is (see Appendix):

$$(3.11)\, dW_c^P = -s + \overline{H}^N k_a'\left\{\left(-\frac{\partial k_m}{\partial H^N}\frac{dH^N}{dH^P}\right) + \frac{dc}{dH^P}\right\} + t\frac{dL}{ds}\frac{ds}{dH^P}$$

Comparing (3.2) and (3.11), we see that wait costs are reduced by an additional effect. Given the demand for national health care, and because output is fixed, the increase in user fees is fully offset by a fall in the (marginal) wait cost.

Some manipulation gives (see Appendix):

$$(3.12)\; dW_c^P \approx -s + \left(-\frac{dH^N}{dH^P}\right)\frac{1-s}{\eta^N}k_a' + k_a'\left\{s - \frac{1-s}{\eta^P}\right\} + \frac{1-s}{\eta^P}\frac{M}{1+M}\zeta^P$$

Comparing (3.5) and (3.12), we find no revenue-financing effect. Instead, the third term in (3.12) is the efficiency gain from the impact of higher user fees on reducing waiting costs. This term equals the marginal subsidy payment times $k_a'(k_m)$. Therefore, financing this policy by user fees rather than by taxes not only avoids the costly revenue-financing effect, but it also produces a direct efficiency gain by reducing the excess demand for rationed health care and hence the deadweight losses from waiting.

(ii) Increasing public health care. Finally, the welfare change from increasing public health output financed by user fees is (see Appendix):

$$(3.13)\; dW_c^N \approx -s + \left\{\frac{1-s}{-\eta^N}k_a' - (1-s-c)\right\} + k_a'\left\{1 - c + s\frac{dH^P}{d\overline{H}^N}\right\} - s\frac{dH^P}{d\overline{H}^N}$$

Again, comparing with (3.10), we see that the welfare performance of this policy improves because there is no revenue-financing effect, and because higher user fees reduce waiting costs.

Table 1 summarizes the components of the welfare changes under all the policies discussed in this section.

4. Parameter Values

This section describes the ranges of parameter values we use to estimate the welfare change formulas. These values are summarized in Table 1. Our objective in the subsequent simulations is not to attempt really accurate estimates of the welfare changes, but rather to illustrate the sign of the welfare changes, and the relative ranking of policies, over wide ranges of plausible parameter scenarios.

Tax subsidy for private health care. Private health insurance in the United Kingdom is no longer eligible for any relief from payroll or income taxation. Purchased inputs into private health care production are subject to the value-added tax of 17.5%, but the final output is not. In

other words, there is a small tax subsidy for medical services, relative to other final goods, because the value added at the final stage of production of medical services is not covered by the value-added tax. We adopt a benchmark value of $s = 0.05$, but as noted below the results are only moderately sensitive to alternative values.

Health demand and expenditure elasticities. Besley et al. (1999) estimate that the expenditure elasticity of demand for private health care is around 2.2% in the United Kingdom, which is broadly consistent with results from Propper (1993). We consider a range of 1.0 to 3.0 for ζ^P with a starting value of 2.0. We would expect the demand for NHS care to be inelastic with respect to its full price, because substitution possibilities are limited by the small size of the private sector, and many households are ideologically opposed to using the private sector (Propper 1993). Lindsay and Feigenbaum (1984) estimated an elasticity of –0.55 to –0.70, but Martin and Smith (1999) report elasticities about half this magnitude. We adopt a range of –0.3 to –0.7 for η^N, with a starting value of –0.5.

We are not aware of any studies that directly estimate the own price demand elasticity for private health care in the United Kingdom, but other evidence suggests this elasticity might be fairly high. Besley et al. (1999) estimated that a 1% increase in waiting costs for the NHS might increase private insurance by 12%. For the United States, estimates of the own price elasticity for private medical insurance range between about –0.5 and –1.5 (e.g., Pauly 1986; Phelps 1992). We would expect the U.K. elasticity to be a lot larger because the quantity of private health care is much smaller in the United Kingdom (Figure 1).[21] We illustrate cases where η^P varies between –2 and –10. Note that η^P only appears in the revenue-financing and tax-interaction effect terms in the above welfare change formulas, and is therefore less important than η^N.

In practice, in response to an increase in *s,* the demand for private health insurance will increase because (a) people substitute private health care for public health care, (b) people increase their overall demand for health care relative to other (nonhealth) goods, and (c) people who are already in the private sector increase the amount of their insurance. If (b) and (c) were

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[21] The effective price is also much lower in the United States because of the exemption of private health insurance from personal and payroll taxes. Note that demand elasticities are larger the higher the price and the smaller the quantity.

zero, then $dH^N/dH^P = -1$, but if (a) were zero, $dH^N/dH^P = 0$. However, (a) is likely to be sizable relative to both (b) and (c),[22] and we consider a range of –0.4 to –0.8 for dH^N/dH^P.[23]

Relation between marginal and average waiting costs. There is not really any evidence that can be used to pin down $k_a'(k_m)$. But it must be less than unity; it would equal one only if everyone had the same willingness to pay to avoid waiting for treatment, which is clearly not the case. In addition, it must be positive, since the average person suffers a positive cost from having to wait longer for treatment. We illustrate a wide range of possibilities from $k_a'(k_m) = 0.25$ to 0.75 with a central value of 0.5. The low value represents a relatively wide dispersion in the opportunity costs of waiting among people using rationed care, and the high value represents a relatively narrow dispersion in the opportunity costs of waiting.

User fees. We assume that user fees amount to 2% of the supply price of national health care. This figure is obtained by multiplying the resource cost of prescriptions (£4.7 billion) by the fraction of prescriptions that households (as opposed to the government) pay for (0.15), and dividing by national health spending (£37 billion).[24]

Labor supply elasticity. In our highly aggregated model, the labor supply elasticity represents the combined responsiveness of the participation rate and average hours worked per employee, to changes in net wages, averaged across all members (male and female) of the labor force. A plethora of studies have been done for the United States (e.g., Killingsworth 1983), and aggregating estimates for male and female elasticities, a plausible central value for the

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[22] The degree of substitution between public and private health goods is much larger than that between health as a whole and other (nonhealth) goods. In addition, the range of private polices offered is relatively narrow in the United Kingdom, limiting the ability of people with existing policies to increase spending on insurance (Propper 1993).

[23] Conversely, if national health care output were incrementally increased, the induced increase in demand would come mainly from people who exclusively use the NHS rather than from people moving from the private sector to the NHS. Since, according to Figure 1, the private sector is 17.5% the size of the public sector, we take $dH^P/d\overline{H}^N$ to be 0.175. Our results are not sensitive to alternative values, because this term is multiplied by s, a very small number, in the welfare change formulas.

[24] See *www.doh.gov.uk/public/sb9917.htm* and *www.hm-treasury.gov.uk/budget2000/fsbr/chapc.htm* (Table C19). These figures are for 1998.

(economywide) compensated elasticity is about 0.35.[25] About two-thirds of the responsiveness is due to the participation decision and one-third to the hours-worked decision. The few studies that have been done for the United Kingdom yield broadly similar values for male and female elasticities (e.g., Blundell 1997). Given the variance of estimates across studies, we consider a range of values from 0.2 and 0.5.

      Labor tax rate. We consider a range of 0.36 to 0.42 for the U.K. labor tax rate, with a starting value of 0.39. These figures are from Parry (2000) and represent the combined burden on gross labor income of income taxes, payroll taxes, and taxes on goods (excluding externality taxes, such as gasoline taxes).[26] Using (3.4), these figures imply a central value of 0.29 for the marginal excess burden of taxation, with low and high values of 0.13 and 0.57.

5. Empirical Results

      This section provides empirical estimates of the welfare effects of the health policies. We start by focusing only on welfare effects in the health sector. Subsections B and C estimate the welfare effects from financing the policies by taxes and by user fees.

A. Welfare Effects in the Health Sector

(i) Public health subsidy. Figure 3 illustrates the marginal welfare effect of increased spending on public health care, according to the formula in equation (3.10), but ignoring the revenue-financing term. The vertical axis indicates the marginal welfare gain or loss in pounds per pound of increased output, and on the horizontal axis we vary $k_a'(k_m)$ across its range from 0.25 to 0.75. The dashed curves indicate the welfare effect from the change in wait times only; the solid curves also include the output effects in the public and private health markets. The upper, middle, and lower sets of curves correspond to cases in which the demand elasticity for national health care is –0.3, –0.5 and –0.7, respectively. There are several noteworthy points.

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[25] This is based on a recent survey of opinion among labor economists reported in Fuchs et al. (1998), Table 2. It assumes weights of .6 and .4 for the male and female elasticities, respectively.

[26] This is an average rate of tax and is relevant for the labor force participation decision, the major determinant of the labor supply elasticity. In principle we should use a weighted average of the average and (higher) marginal tax rate, as the latter is relevant for the hours-worked decision. This would increase the central value to about 42% (Parry 2000). But on the other hand, this figure may overstate the true tax burden a little, since a portion of the payroll tax may effectively be offset by higher expected retirement income (Feldstein and Samwick 1992).

First, the welfare effects from the changes in output in the national and private health markets are very small, as indicated by the very narrow gaps between the solid and dashed curves. This is because the wedge between the marginal supply cost and the marginal benefit to households in each market, *s*, is very small.

Second, the welfare effects from changes in wait times are potentially very large—but both the magnitude and the sign of these effects are highly uncertain. The welfare effect is very sensitive to $k_a'(k_m)$. When the dispersion in wait costs is relatively narrow ($k_a'(k_m)$=0.75), there is a net welfare gain of about 50 pence per pound of extra national health output, when the demand elasticity is –0.5. Here, the reduction in wait costs to inframarginal users of the NHS exceeds the addition to wait costs from the extra unit of output. The converse applies when the dispersion in wait costs is relatively wide ($k_a'(k_m)$=0.25); then there is a net welfare loss of about 50 pence.

Third, the welfare effect is very sensitive to the demand elasticity for national health care. When $k_a'(k_m)$=0.5, there is a welfare gain of 60 pence per pound when η^N = –0.3 and a welfare loss of 30 pence per pound when η^N = –0.7. Clearly, the more inelastic the demand for national health care, the larger the fall in the equilibrium wait time following an increase in output, and hence the greater the likelihood of an overall reduction in the deadweight losses from waiting.

In short, without more information on underlying parameter values ($k_a'(k_m)$ and η^N), it is very difficult to pin down the sign—let alone the magnitude—of welfare effects in the health sector from additional national health care output. The results are still useful, however, because they show that there is not *necessarily* an efficiency gain in the health sector. A gain occurs only when the dispersion in wait costs is relatively narrow and/or the demand for national health care is very inelastic. Moreover, we can draw more concrete policy lessons when we compare increasing public health care with increasing private health care (see below).

(ii) Private health subsidy. Figure 4 shows the welfare effect in the health sector from increasing private health output by one unit using (3.5) but ignoring the revenue-financing and tax-interaction effects. The upper, middle, and lower sets of curves correspond to cases in which we assume the demand elasticity for public health care, η^N, is –0.3, –0.5, and –0.7, respectively. In addition, these curves correspond to cases in which a unit increase in private health output reduces the demand for national health output by 0.8, 0.6, and 0.4 units of output, respectively ($=-dH^N/dH^P$). The upper and lower curves bound the range of possible outcomes, given our parameter scenarios. Again, the dashed curves indicate the welfare effect from the change in wait

times only; the solid curves also include the output effect in the private health market. We note the following points.

First, the policy always increases welfare. This is because it unambiguously reduces the deadweight losses from wait costs: there is a fall in average waiting costs, but no increase in the amount of waiting (i.e., no increase in the right side of the shaded trapezoid in Figure 2(b)).

Second, the welfare gains are obviously larger the greater the reduction in public health care demand per unit of increased private health care ($-dH^N/dH^P$), and the narrower the dispersion in wait costs ($k_a'(k_m)$). They are also larger the more inelastic the demand for public health care, since this implies a larger fall in waiting costs per unit reduction in public health care demand. The welfare gain in Figure 4 varies substantially, from a low of 9 pence per pound of extra output to 185 pence per pound.

Finally, the gap between the solid and dashed curves is very small, indicating that the welfare loss from added output in the private health market is very small.

 (iii) Policy comparison. Table 3 shows the difference in welfare from increasing private versus public health care, each by one unit ($dW^P - dW^H$), still focusing only on welfare effects within the health sector, for a variety of parameter combinations. When a cell entry is positive, the welfare gain is larger from increasing private health output, and when a cell entry is negative, the welfare gain from increasing public health output is larger.

As the table indicates, 24 of the 27 cell entries are positive. Indeed, the conditions under which the welfare gain from increasing public health output would significantly exceed the gain from increasing private health output are very stringent. The demand for national health care would have to be very inelastic ($\eta^N = -0.3$); the substitution in demand between public and private health care, modest ($dH^N/dH^P = -0.4$); *and* the dispersion in wait times, very narrow ($k_a'(k_m) = 0.75$). These conditions are met only in the third row of the first column. Moreover, the efficiency gains from increasing private as opposed to public output are typically large: more than 30 pence per pound of extra output in 23 of 27 cases, and more than 50 pence per pound in 18 cases.

For further policy comparisons we focus on just three cases in Table 3, indicated by asterisks (*). These correspond to the most favorable scenario for additional public health output, the most favorable for additional private health output, and the outcome under our central parameter values.

B. Tax-Financed Policies

Figure 5 illustrates the overall change in welfare from increasing public health output by a unit when we include the revenue-financing effect (the last term in (3.10)), and for now we use our central value for the marginal excess burden *M* of 0.29. Note that *M* in (3.10) is multiplied by the term in parentheses, and this term just varies between 0.94 and 0.96 under our parameter ranges. Thus, the revenue-financing effect is 0.27 to 0.28 pence per pound of extra output.

Comparing Figure 5 with Figure 3, we see that all the curves are shifted down by about 0.275. This significantly raises the hurdle for an overall welfare improvement. As we can see, when the demand elasticity for public health care is –0.5, the policy now reduces welfare unless the dispersion of waiting costs is very narrow ($k_a'(k_m) > 0.67$). Even when demand is very inelastic ($\eta^N = -0.3$), the policy reduces welfare if $k_a'(k_m)$ is below 0.41.

As discussed above, in the case of the subsidy for private health care, the cost of the revenue-financing effect is smaller, and there is an offsetting tax-interaction effect. Thus, accounting for interactions with the tax system further reduces the efficiency of the policy to increase rationed health output relative to that from increasing private health output.

Table 4 summarizes the empirical implications in our three summary parameter scenarios from Table 3. Cell entries show calculations of $dW_t^P - dW_t^N$ from equations (3.5) and (3.10). In the central parameter value case, the efficiency gain from increasing private health output rather than public health output increases from 56 pence per pound to 87 pence per pound, when we allow for interactions with the tax system and assume the marginal excess burden of taxation is 0.29. In this case increasing private health output produces an efficiency gain of 55 pence per pound of extra output, but increasing public health output produces an efficiency loss of 32 pence. In the scenario most favorable to public health, the efficiency gain from increasing public health output rather than private health output is reduced from 49 pence per pound to 22 pence. Indeed, in all the other parameter scenarios in Table 3, increasing public health output rather than private health output produces an efficiency loss between 25 pence and 119 pence per pound.[27]

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[27] These results are moderately sensitive to the level of preexisting subsidy in the private health care market. For example, if the tax subsidy were 30% rather than 5%, the welfare difference between the policies would be 67 pence per pound rather than 87 pence, under central values for other parameters.

C. Policies Financed by User Fees

Figure 6 illustrates the marginal welfare change from additional public health output when the policy is financed by higher user fees rather than by distortionary taxes. Now the policy produces a welfare *gain* rather than a loss in most of the scenarios. The policy is always efficiency-improving when the demand elasticity for national health care is –0.3. Even when the demand is relatively elastic ($\eta^N = -0.7$), the policy still improves welfare when $k'_a(k_m) > 0.43$. In fact, in the central case ($\eta^N = -0.5$, $k'_a(k_m) = 0.5$), there is an efficiency gain of 46 pence per pound, compared with an efficiency loss of 32 pence when the policy is financed by higher distortionary taxes.

As discussed above, there are two reasons for the improvement in efficiency. First, the policy avoids the cost of the revenue-financing effect, and this raises efficiency by about 27 pence per pound. Second, higher user fees reduce equilibrium wait costs to maintain the equilibrium condition in equation (2.2). The size of this effect can be inferred by comparing the curves in Figure 6 with those in Figure 3. When $\eta^N = -0.5$, efficiency improves, by about 25 to 60 pence per pound. For example, in the central case ($\eta^N = -0.5$, $k'_a(k_m) = 0.5$), when the overall efficiency gain is 46 pence per pound (Figure 6), we would estimate an efficiency loss of 2 pence when financing effects are ignored (Figure 3).

Finally, Table 5 shows the efficiency gain or loss from increasing private health output rather than public health output by a unit when both policies are financed by user fees, for the cases marked with asterisks (*) in Table 3. The cell entries show calculations of $dW_c^P - dW_c^N$ from equations (3.11) and (3.13). In this case, taking financing effects into account substantially narrows rather than substantially increases the efficiency differential between the policies. For example, in the central case the efficiency gain from expanding private rather than public health output by a unit falls from 56 pence per pound (excluding financing effects) to just 15 pence per pound (with financing effects).

The reason is that the extra revenue needed to increase public health output by a unit is larger than that needed to induce private health output to increase by a unit (see above), and raising revenue produces an efficiency benefit rather than an efficiency loss, since higher user fees lead to lower equilibrium wait times.[28]

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[28] Subsidizing private health care still leads to the beneficial tax-interaction effect. But this efficiency gain is smaller than the difference in the efficiency benefit from raising revenues under the two policies.

6. Conclusion

This paper develops and implements a framework for estimating the welfare effects of policies to incrementally increase free but rationed public health care and private health care in the United Kingdom, when these policies are financed either by distortionary taxes or by user fees for the National Health Service (NHS). A central feature of the analysis is the deadweight loss from waiting costs in the rationed public health market, where the monetary price at the point of consumption is (essentially) zero.

Increasing NHS output may either increase or decrease the deadweight losses associated with waiting lists, depending on the demand elasticity for national health care. Moreover, when the opportunity costs of financing the policy by higher distortionary taxes are taken into account, the policy reduces social welfare unless the demand for national health care is very inelastic. But if the policy is instead financed by introducing user fees for the NHS, the net impact of the policy is generally to increase rather than decrease social welfare. This is because higher user fees induce a reduction in waiting times and avoid the efficiency costs of higher taxes.

Subsidizing private health care always increases social welfare in our analysis, whether the policy is financed by distortionary taxes or by user fees. This policy produces significant welfare gains by indirectly reducing waiting costs in the rationed public health care market, and the distortionary costs in the private health care market are small. For a given method of financing, the welfare performance of this policy is superior to that of increasing national health care in most of the scenarios considered. For example, under tax finance and using our central parameter values, increasing private health by a pound's worth of output produces an efficiency gain of 55 pence, but increasing national health output produces an efficiency loss of 32 pence.

The bottom line is that expanding supply in a rationed health care market may be an inefficient way to address the deadweight losses caused by rationing through waiting times. Other policies that directly or indirectly reduce demand—including user fees and subsidizing private health care—appear to be superior on the grounds of pure economic efficiency.

It is important to bear in mind, however, some qualifications to these policy conclusions. In particular, the burden of user fees is likely to fall disproportionately on low-income families who rely on the NHS; conversely, high-income households will be the beneficiaries of subsidies for private health insurance. This is contrary to the original goal of the NHS, which was to provide the best health care possible to everyone, regardless of ability to pay.

Appendix

Deriving Equation (3.2)

From (2.5):

$$(A1)\frac{de}{ds} = \frac{\partial e}{\partial s} + \frac{\partial e}{\partial k_m}\frac{dk_m}{ds} + \frac{\partial e}{\partial t}\frac{dt}{ds}$$

Substituting (2.7) in (A1):

$$(A2)\frac{de}{ds} = -H^P + \bar{H}^N k_a' \frac{dk_m}{ds} + L\frac{dt}{ds}$$

Substituting (2.6) into the government budget constraint (2.3) and totally differentiating with respect to *s*, *t,* and k_m , we can obtain:

$$(A3) \ \frac{dt}{ds} = \frac{H^P + s\dfrac{dH^P}{ds} - t\dfrac{dL}{ds}}{L}$$

Substituting (A2) and (A3) in (3.1) gives (3.2).

Deriving Equation (3.3)

Using (2.6):

$$(B1)t\frac{dL}{ds} = t\frac{\partial L}{\partial s} + t\frac{\partial L}{\partial t}\frac{dt}{ds}$$

Separating out the labor supply terms, we can derive an alternative expression to (A3) using (2.3) and (2.6):

$$(B2)\frac{dt}{ds} = \frac{H^P + s\dfrac{dH^P}{ds} - t\dfrac{\partial L}{\partial s}}{L + t\dfrac{\partial L}{\partial t}}$$

Substituting (B2) in (B1), and using the definition of *M* in (3.4), we can easily obtain (3.3).

Deriving Equation (3.5)

Using (3.6) we can obtain:

$$(C1)\, \bar{H}^N \frac{dk_m}{dH^P} = \bar{H}^N \frac{dk_m}{dH^N} \frac{dH^N}{dH^P} = \frac{c + k_m}{\eta^N} \frac{dH^N}{dH^P}$$

Using (C1) and (2.2), it is easy to obtain the second term in (3.5) from the corresponding term in (3.2). From (3.3) and (3.6) it is straightforward to obtain the third term in (3.5).

Using Slutsky symmetry property:

$$(C2)\, \frac{\partial L}{\partial s} = \frac{\partial H^P}{\partial t}$$

When goods and leisure are weakly separable in the utility function:

$$(C3)\, \frac{\partial H^P}{\partial t} = \frac{\partial H^P}{\partial I} \frac{dI}{dt}$$

That is, the demand for H^P changes only to the extent that disposable income, denoted *I*, changes (see, e.g., Layard and Walters 1978, 165). The change in disposable income, which is equivalent to gross labor earnings, is equal to the change in labor supply, $\partial L / \partial t$. Making these substitutions in the last term of (3.3), and using (3.4), we can obtain:

$$(C4)\, t(1 + M) \frac{\partial L}{\partial s} \frac{ds}{dH^P} = ML \frac{\partial H^P}{\partial I} \frac{ds}{dH^P}$$

Making appropriate substitutions from (3.6) in (C4), we obtain the last term in (3.5).

Deriving Equation (3.8)

From (2.5):

$$(D1)\, \frac{de}{d\bar{H}^N} = \frac{\partial e}{\partial k_m} \frac{dk_m}{d\bar{H}^N} + \frac{\partial e}{\partial t} \frac{dt}{d\bar{H}^N}$$

Substituting (2.7) in (D1):

(D2) $\dfrac{de}{d\overline{\overline{H}}^N} = \dfrac{\overline{\overline{H}}^N}{\lambda} k'_a \dfrac{dk_m}{d\overline{\overline{H}}^N} + L \dfrac{dt}{d\overline{\overline{H}}^N}$

Substituting (2.6) into the government budget constraint (2.3) and differentiating, we obtain:

(D3) $\dfrac{dt}{d\overline{\overline{H}}^N} = \dfrac{1 - c + s \dfrac{dH^P}{d\overline{\overline{H}}^N} - t \dfrac{dL}{d\overline{\overline{H}}^N}}{L}$

Substituting (D3) in (D2), we can obtain (3.8).

Deriving Equation (3.9)

Using (2.6):

(E1) $t \dfrac{dL}{d\overline{\overline{H}}^N} = t \dfrac{\partial L}{\partial t} \dfrac{dt}{d\overline{\overline{H}}^N}$

Using (2.3), (D3) can also be expressed:

(E2) $\dfrac{dt}{d\overline{\overline{H}}^N} = \dfrac{(1 - c)\overline{H}^N + s \dfrac{dH^P}{d\overline{\overline{H}}^N}}{L + t \dfrac{\partial L}{\partial t}}$

Substituting (E2) in (E1), and using (3.4), we obtain (3.9).

Deriving Equation (3.11)

From (2.5):

(F1) $\dfrac{de}{ds} = \dfrac{\partial e}{\partial s} + \dfrac{\partial e}{\partial k_m} \dfrac{dk_m}{ds} + \dfrac{\partial e}{\partial c} \dfrac{dc}{ds}$

Substituting (2.7) in (F1) gives:

(F2) $\dfrac{de}{ds} = -H^P + \overline{H}^N k'_a \dfrac{dk_m}{ds} + \overline{H}^N \dfrac{dc}{ds}$

From differentiating the government budget constraint:

$$(F3)\ \frac{dc}{ds} = \frac{H^P + s\dfrac{dH^P}{ds} - t\dfrac{dL}{ds}}{\overline{H}^N}$$

From (F2) and (F3):

$$(F4)\ dW_c^P = \frac{-de/ds}{dH^P/ds} = -s - \overline{H}^N k_a' \frac{dk_m}{dH^P} + t\frac{dL}{ds}\frac{ds}{dH^P}$$

In this case:

$$(F5)\ \frac{dk_m}{dH^P} = \frac{\partial k_m}{\partial H^P} + \frac{\partial k_m}{\partial c}\frac{dc}{dH^P}$$

Differentiating (2.2) when s is constant gives $\partial k_m / \partial c = -1$. Making these substitutions in (F4) gives (3.11).

Deriving Equation (3.12)

Using (2.6):

$$(G1)\ t\frac{dL}{ds} = t\frac{\partial L}{\partial s} + t\frac{\partial L}{\partial c}\frac{dc}{ds}$$

From differentiating the government budget constraint, we can obtain:

$$(G2)\ \frac{dc}{ds} = \frac{H^P + s\dfrac{dH^P}{ds} - t\dfrac{\partial L}{\partial s}}{\overline{H}^N + t\dfrac{\partial L}{\partial c}}$$

Define the term:

$$(G3)\ M' = \frac{-t\dfrac{\partial L}{\partial c}}{\overline{H}^N + t\dfrac{\partial L}{\partial c}}$$

Using analogous expressions to (C2) and (C3) above, $\partial L / \partial c = (\partial H^N / \partial I)(\partial L / \partial t)$. Substituting in (G3) gives:

$$(G4)\ M' = \frac{\dfrac{t}{1-t}\zeta^N \varepsilon_L}{1 - \dfrac{t}{1-t}\zeta^N \varepsilon_L}$$

where $\zeta^N = (\partial H^N / \partial I)(L / \overline{H}^N)$.

From (G1)-(G3):

$$(G5)\ t\frac{dL}{ds}\frac{ds}{dH^P} = -\left\{ H^P \frac{ds}{dH^P} + s \right\} M' + t(1+M')\frac{\partial L}{\partial s}\frac{ds}{dH^P}$$

This expression is analogous to that in (3.3) except that the marginal excess burden is defined by M' rather than M. Note that $M' = M$ if $\zeta^N = 1$. In this case national health care is an average substitute for leisure, and raising an extra pound of revenue by raising the price of national health care has the same efficiency impact in the labor market as raising an extra pound of revenue by increasing the labor tax (see Parry 2000). But we make the assumption that $\zeta^N = 0$ because user fees for the NHS are trivial; that is, the demand for national health care is not constrained by income. In this case, $M' = 0$. Using (G5), (3.4), $\partial L / \partial s = (\partial H^I / \partial I)(\partial L / \partial t)$, and using the elasticity definitions, we can obtain the last expression in (3.12).

The second term in (3.12) is easily obtained using (C1). The third term can be obtained by substituting (F3) and using the elasticity definitions.

Deriving Equation (3.13)

From (2.5):

$$(H1)\ \frac{de}{d\overline{H}^N} = \frac{\partial e}{\partial k_m}\frac{dk_m}{d\overline{H}^N} + \frac{\partial e}{\partial c}\frac{dc}{d\overline{H}^N}$$

Substituting (2.7) in (H1):

$$(H2)\ \frac{de}{d\overline{H}^N} = \frac{\overline{H}^N}{\lambda}k_a'\frac{dk_m}{d\overline{H}^N} + \overline{H}_N\frac{dc}{d\overline{H}^N}$$

Substituting (2.6) into the government budget constraint (2.3) and differentiating, we obtain:

$$\text{(H3)} \quad \frac{dc}{d\overline{H}^N} = \frac{1 - c + s\dfrac{dH^P}{d\overline{H}^N} - t\dfrac{dL}{d\overline{H}^N}}{\overline{H}_N}$$
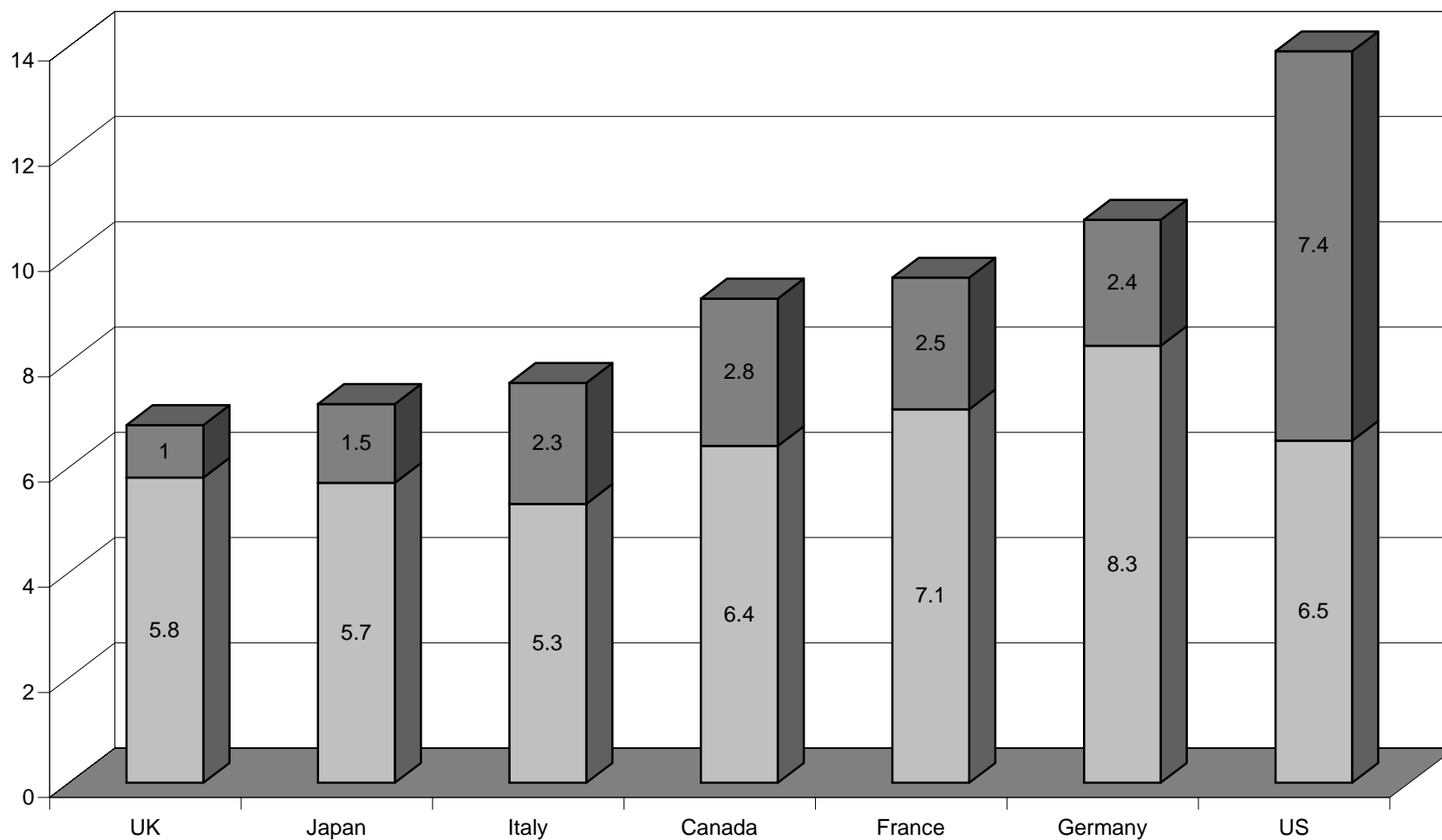
Using (2.6):

$$\text{(H4)} \quad \frac{dL}{d\overline{H}^N} = \frac{\partial L}{\partial c}\frac{dc}{d\overline{H}^N}$$

But we can infer from above that $\partial L / \partial c = 0$ because we assume $\zeta^N = 0$. Analogous to (F5):

$$\text{(H5)} \quad \frac{dk_m}{d\overline{H}^N} = \frac{\partial k_m}{\partial \overline{H}^N} + \frac{\partial k_m}{\partial c}\frac{dc}{d\overline{H}^N}$$

Substituting (H3)-(H5) in (H1), we can obtain (3.13) with some manipulation.

Figure 1. Public and Total Health Expenditure as a Percentage of GDP in the G7 Countries, 1997

Country	Public	Additional
UK	5.8	1
Japan	5.7	1.5
Italy	5.3	2.3
Canada	6.4	2.8
France	7.1	2.5
Germany	8.3	2.4
US	6.5	7.4

Source: Emmerson et al. (2000).

Figure 2. Equilibrium in the Private and Public Health Care Markets

(a) Private health care

Demand

Marginal cost

H_0^P

Quantity

(b) Public health care

Demand

Marginal cost

c

$\overline{H}^N$

H_1^N

Quantity
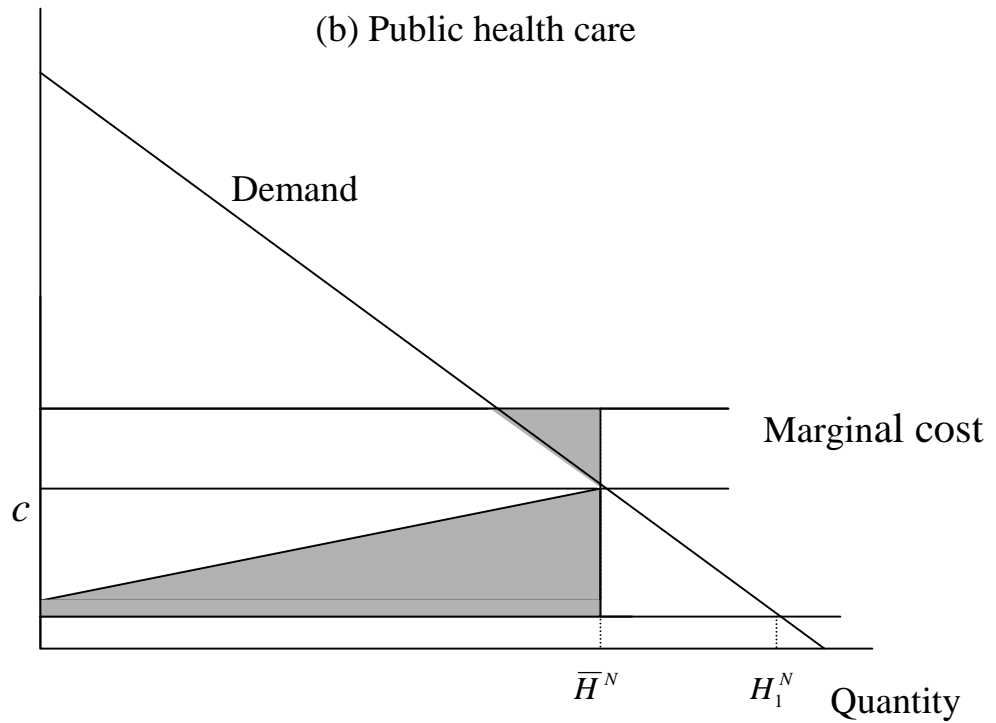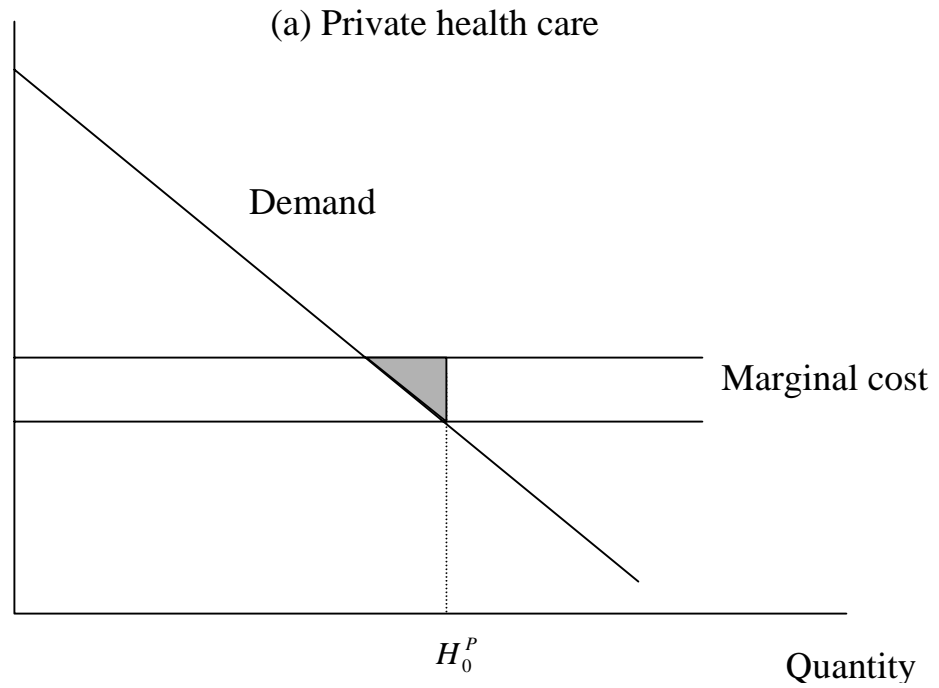
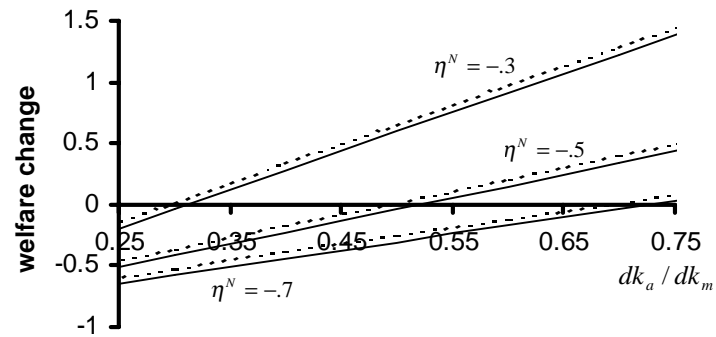**Figure 3. Welfare Change in the Health Sector from Increasing Public Health Output**

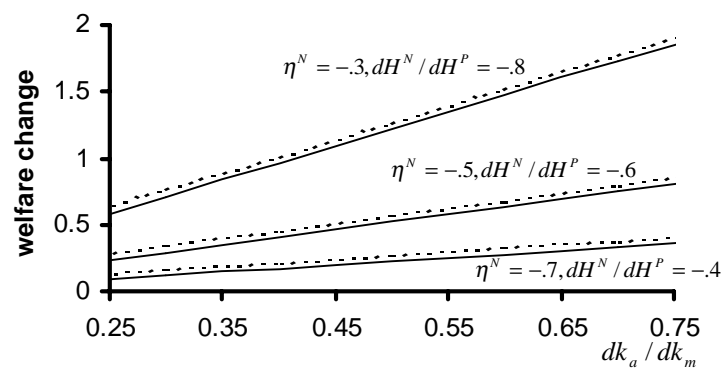**Figure 4. Welfare Change in the Health Sector from Increasing Private Health Output**

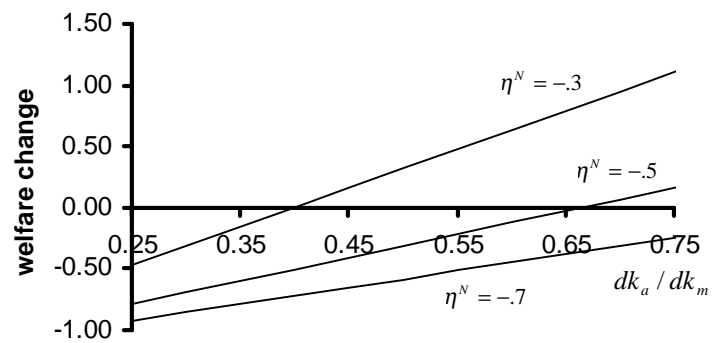**Figure 5. Welfare Change from Increasing Public Health Output with Tax Financing**

Figure 6. Welfare Change from Increasing Public Health Output
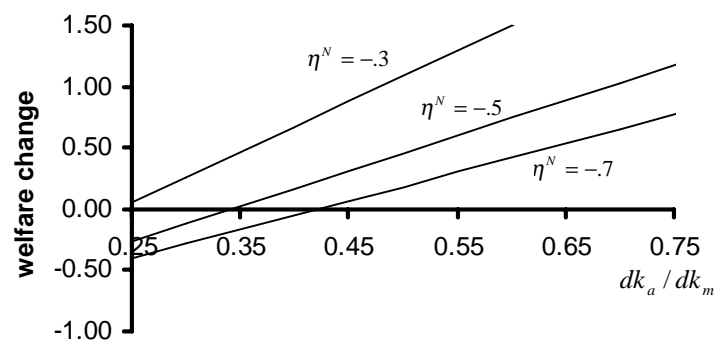**with User Fee Financing**

Table 1. Welfare Changes under Alternative Policies

Policy	Welfare change from				
	Output effect in private health market	Output effect in public health market	Change in wait time	Revenue-financing effect	Tax-interaction effect
Tax-financed increase in private health	−	0	+	−	+
Tax-financed increase in national health	−	−	+ or −	−	0
User fee–financed increase in private health	−	0	+	0	+
User fee–financed increase in national health	−	−	+ or −	0	0

Note: '+' indicates a welfare gain and '−' a welfare loss.

Table 2. Summary of Assumed Parameter Values

Parameter	Starting value	Range considered
Tax subsidy for private health care: s	0.05	0.05
Private health expenditure elasticity: ζ^P	2.0	1.0 to 3.0
National health demand elasticity: η^N	-0.5	-0.3 to -0.7
Private health demand elasticity: η^P	-6.0	-2.0 to -10.0
Subs. between H^P and H^N: dH^N/dH^P	-0.60	-0.40 to -0.80
Subs. between H^P and H^N: $dH^P/d\overline{H}^N$	0.175	0.175
NHS user fees relative to production costs, c	0.02	0.02
Relation of average to marginal delay cost: k_a'	0.5	0.25 to 0.75
Labor supply elasticity: ε_L	0.35	0.2 to 0.5
Labor tax rate: t_L	0.39	0.36 to 0.42
MEB of labor taxation: M	0.29	0.13 to 0.57

Table 3. Welfare Difference in the Health Sector between Increasing Private and Public Health Output

k'_a	η^N	dH^N / dH^P		
		-0.4	-0.6	-0.8
0.25		0.47	0.63	0.78
0.50	-0.3	-0.01	0.31	0.63
0.75		-0.49*	-0.01	0.46
0.25		0.65	0.75	0.84
0.50	-0.5	0.37	0.56*	0.75
0.75		0.08	0.37	0.65
0.25		0.74	0.80	0.87*
0.50	-0.7	0.53	0.67	0.80
0.75		0.67	0.53	0.79

**Table 4. Welfare Difference Between Increasing Private and Public
Health Output with Tax Financing**

	Case 1: Highly favorable to national health	Case 2: Central	Case 3: Favorable to private
Excluding revenue-financing and tax-interaction effects	-0.49	0.56	0.87
$M = 0.13$	-0.38	0.69	1.01
$M = 0.29$	-0.22	0.87	1.19
$M = 0.57$	-0.03	1.16	1.49

Cases 1, 2 and 3 correspond to those marked by asterisks (*) in Table 3.

**Table 5. Welfare Difference between Increasing Private and Public
Health Output with User Fee Financing**

	Case 1: Highly favorable to national health	Case 2: Central	Case 3: Favorable to private
Excluding financing effects	-0.49	0.56	0.87
With financing effects	-1.22	0.15	0.70

References

Arrow, K. 1963. "Uncertainty and Medical Care." *American Economic Review* 53: 941–73.

Ballard, C.L., and J.H. Goddeeris. 1999. "Financing Universal Health Care in the United States: A General Equilibrium Analysis of Efficiency and Distributional Effects." *National Tax Journal* LII: 31–51.

Barr, N. 1998. *The Economics of the Welfare State*. Third edition. Oxford University Press, Oxford, UK.

Barzel, Y. 1974. "A Theory of Rationing by Waiting." *Journal of Law and Economics* 17: 73–95.

Besley, T., J. Hall, and I. Preston. 1999. "The Demand for Private Health Insurance: Do Waiting Lists Matter?" *Journal of Public Economics* 72: 155–181.

Besley, T., and S. Coate. 1991. "Public Provision of Private Goods and the Redistribution of Income." *American Economic Review* 81: 979–984.

Blundell, R. 1997. "Labour Supply and Taxation: A Survey." Institute for Fiscal Studies, London, U.K.

Browning, E.K. 1987. "On the Marginal Welfare Cost of Taxation." *American Economic Review* 77: 11–23.

Browning, E.K. and W.R. Johnson. 1980. "Taxation and the Cost of National Health Insurance." In *National Health Care Insurance: What Now, What Later, What Never*? by M.V. Pauly (ed.). Washington DC: American Enterprise Institute.

Browning, E.K., T. Gronberg, and L. Liu. 1997. "Alternative Measures of the Marginal Cost of Funds." Texas A&M University, College Station, Texas.

Deacon, R., and J. Sonstelie. 1989. "The Welfare Costs of Rationing by Waiting." *Economic Inquiry* 27: 179–196.

Deaton, A. 1981. "Optimal Taxes and the Structure of Preferences." *Econometrica* 49: 1245–1259.

Donaldson, C. 1998. *Why a National Health Service*. London: Institute for Public Policy Research.

EBRI. 1999. *Sources of Health Insurance and Characteristics of the Uninsured: Analysis of the March 1998 Current Population Survey*. Employee Benefits Research Institute, Washington, DC.

Emmerson, C., C. Frayne, and A. Goodman. 2000. *Pressures in UK Health Care: Challenges for the NHS*. Institute for Fiscal Studies, London, UK.

Fane, G., and C. Jones/ 1997. "The Marginal Cost of Funds: The Tradtional Lump-Sum Methodology is Appropriate After All." Discussion paper, Australian National University, Canberra, Australia.

Feldstein, M., and A. Samwick. 1992. "Social Security Rules and Marginal Tax Rates." *National Tax Journal* XLV: 1–22.

Fuchs, V.R., A.B. Krueger, and J.M. Poterba. 1998. "Economists' Views about Parameters, Values and Policies: Survey Results in Labor and Public Economics." *Journal of Economic Literature* 36: 1387−1425.

Gaynor, M., D. Haas-Wilson, and W.B. Vogt. 2000. "Are Invisible Hands Good Hands? Moral Hazard, Competition, and Second-Best in Health Care Markets." *Journal of Political Economy* 108: 992–1005.

Goddard, J.A., M. Malek, and M. Tavakol. 1995. "An Economic Model of the Market for Hospital Treatment for Non-Urgent Conditions." *Health Economics* 4: 41–55.

Goulder, L.H. 1995. "Environmental Taxation and the 'Double Dividend': A Reader's Guide." *International Tax and Public Finance* 2:157–183.

Gravelle, H.S.E. 1990. "Rationing Trials by Waiting: Welfare Implications." *International Review of Law and Economics* 10: 255–270.

Ireland, N. 1990. "The Mix of Social and Private Provision of Goods and Services." *Journal of Public Economics* 43: 201–219.

Killingsworth, M.R. 1983. *Labor Supply*. Cambridge University Press: Cambridge, MA.

Layard, P.R.G., and A.A. Walters. 1978. *Microeconomic Theory*. McGraw-Hill, New York.

Lindsay, C.M., and B. Feigenbaum. 1984. "Rationing by Waiting Lists." *American Economic Review* 74: 404–417.

Martin, S., and P.C. Smith. 1999. "Rationing by Waiting Lists: An Empirical Investigation." *Journal of Public Economics* 71: 141–164.

Nicholls, D., E. Smolensky, and E. Tideman. 1971. "Discrimination by Waiting Time in Merit Goods." *American Economic Review* 61: 312–323.

Parry, I.W.H. 2000. "Comparing the Marginal Excess Burden of Labour, Petrol, Cigarette and Alcohol Taxes: An Application to the United Kingdom." Discussion paper, Resources for the Future, Washington, DC.

Parry, I.W.H. 1998. "A Second Best Analysis of Environmental Subsidies." *International Tax and Public Finance* 5: 157–74.

Pauly, M.V. 1986. "Taxation, Health Insurance, and Market Failure in the Medical Economy." *Journal of Economic Literature* 24: 629–675.

Pauly, M.V. 1974. "Over Insurance and Public Provision of Insurance: The Roles of Moral Hazard and Adverse Selection." *Quarterly Journal of Economics* 88:44–62.

Phelps, C.E. 1992. *Health Economics*. Harper Collins, New York.

Propper, C. 1993. "Constrained Choice Sets in the UK Demand for Private Medical Insurance." *Journal of Public Economics* 51: 287–308.

Sonsteile, J. 1982. "The Welfare Cost of Free Public Schools." *Journal of Political Economy* 90: 794–808.

Stiglitz, J.E. 1974. "The Demand for Education in Public and Private School Systems." *Journal of Public Economics* 3: 349–385.

Williams, R.C. 1998. "The Effect of Pre-Existing Taxes on the Benefits of Regulations Affecting
      Health or Productivity" Working paper, University of Texas, Austin.

Zeckhauser, R. 1970. "Medical Insurance: A Case Study of the Tradeoff Between Risk
      Spreading and Appropriate Incentives." *Journal of Economic Theory* 2: 10–26.