Sickness absence and health care in an economic federation

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Abstract

This paper addresses vertical fiscal externalities in a model where the state governments provide health care and the federal government provides a sickness benefit. Both levels of government tax labor income and policy decisions affect labor income as well as participation in the labor market. The results show that the vertical externality affecting the state governments' policy decisions can be either positive or negative depending on, among other things, the wage elasticity of labor supply and the marginal product of expenditure on health care. Moreover, it is proved that the vertical fiscal externality will not vanish by assigning all powers of taxation to the states.

Key words: economic federation; moral hazard; vertical fiscal externalities; sickness absence; sickness benefits

JEL classification: H2; H4; H7

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1 Introduction

In Sweden, there is an ongoing debate concerning the high rates of absence from work for health related reasons. The rates have risen significantly over the last decade and, in 2004, 5.2 percent of employee working hours were lost due to sickness absence. At the same time 8.1 percent of the population between the age of 16 and 64 years were on disability pension. One explanation for these high rates is the high benefit levels and the relatively loose regulations regarding sick leave and disability pensions in Sweden. A complementary explanation is the long waiting time for many surgical operations. For example, the waiting time for a primary hip joint operation exceeds one and a half years in some parts of the country.[1]

In Sweden, the levels of the publicly provided sickness benefit and disability pension are decided by central government. However, the county councils are responsible for providing health care. The question that arises, on the basis of this division of power between the two levels of government, is whether it leads to a suboptimal allocation of resources. In this paper an economic federation model is presented, where the state governments provide health care, the federal government provides a sickness benefit and both levels tax labor income.[2] The model resembles the situation in countries such as Finland and Sweden. The purpose of this paper is twofold. First, to analyze the fiscal externalities facing the state governments and to characterize the differences in health care expenditure and level of the sickness benefit between the centralized and the decentralized solutions. Second, to analyze the different ways in which the second best solution can be obtained by changing the governments' responsibilities or policy instruments. In order to focus on vertical externalities, this paper ignores the horizontal ones.

The paper primary relates to the literature concerning vertical fiscal externalities but also to the literature relating to absence from work. Brown and Sessions (1996) provide a survey of the literature in the latter field. Most of

[1] The data are obtained from Statistics Sweden (www.scb.se), The Swedish Social Insurance Agency (www.forsakringskassan.se) and The Swedish Association of Local Authorities and Regions (sas.lf.se).

[2] In this paper "federal government" is used to denote the central government and "state government" is used to denote the lower level of government, like state, regional or local level government.

the literature in this area is empirical and includes estimations of the effects of working conditions, stipulated work time, job satisfaction and overtime, on work absence. Also, the literature provides strong support for the idea that economic incentives impact upon absence behavior.

Vertical fiscal externalities when federal and state governments impose taxes on the same tax base were first considered by Hansson and Stuart (1987), Flowers (1988) and Johnson (1988). Flowers showed that a federation of Leviathan revenue maximizing governments will end up on the downward sloping section of the Laffer curve. Johnson showed that residents of a state prefer to redistribute using state taxes as opposed to federal taxes since this, by reducing the money income in the state, reduces the state's federal tax bill, meaning that some of the cost of the redistribution will be born by residents of other states. To deal with the vertical fiscal externality Hansson and Stuart (1987), Boadway and Keen (1996) and Boadway et al. (1998) proposed that the power of taxation be assigned to only one level of government. Aronsson and Wikström (2001, 2003) showed that intergovernmental transfer schemes can, in certain situations, induce the correct incentives, making it unnecessary to restrict the taxation power to one level of government.[3]

The majority of the literature in this field focuses on the externality that arises from the co-occupancy of a common tax base, as opposed to expenditure externalities, and has come to the conclusion that the vertical externality is negative.[4] An interesting exception is Dahlby and Wilson (2003). In their model a state government provides a productivity-enhancing public input and both levels of government tax wages and corporate profits. They show that the vertical externality can be either positive or negative depending on the wage elasticity of the labor demand. In this paper, a different kind of expenditure externality is examined. Instead of providing a productivity-enhancing public input, the states in this paper provide a private good, health care, which affects the fraction of the population that is able to work. The state's decisions not only affect the federal government's tax revenues but also affect its sickness benefit expenditure. The results show that the states will have an incentive to either under-provide or over-provide health care depending on, among other things,

[3] Keen (1998) reviewed the literature on vertical fiscal externalities.

[4] Tax and expenditure externalities are here defined as the effects of a government tax and the effects of expenditure decisions, respectively, on other governments' budget constraints.

the wage elasticity of the labor supply and the marginal product of expenditure on health care at the equilibrium. The federal government can induce the states to increase (reduce) their expenditure on health care, by reducing (increasing) the sickness benefit and the federal tax rate. Whether health care will be under- or over-provided in the decentralized solution depends on the sign of the fiscal externality facing the states, the social costs of financing the sickness benefit and on the slope of the states' reaction functions. The federal government is able to achieve the second best solution if it is given the possibility of deciding an intergovernmental transfer.

In comparison to earlier studies, this paper contributes to the literature by letting the state governments provide a good that affects the share of the population that works and hence the federal government's transfers to those not working. The results can be generalized to state financed programs which reduce the number of recipients of federal transfers, for example labor market programs, economic development ventures aimed at reducing poverty and programs aimed at reducing the abuse of federal transfers. Another contribution is that this paper shows that vertical externalities will not vanish by assigning all powers of taxation to the state governments if federal expenditure depends directly on the decisions taken by the states.

The rest of the paper is organized as follows: In section 2 the model is set up and the decision rules for a unitary central government, which will serve as a benchmark in the following, are derived. Section 3 presents the decentralized solution. First, in subsection 3.1 the policy decisions that the state governments will take if they act as Nash competitors to one another and towards the federal government are examined and compared with the policy decisions of the unitary central government. Here the states' reactions to changes in the federal governments' policy variables are also derived. The following subsection describes the policy decisions taken by the federal government, when it acts as a first mover. Different ways of implementing the second best solution are discussed in subsection 3.3. Finally, in section 4 the paper's conclusions are presented.

2 The model

The federation consists of N identical states, which are small relative to the federation. Each state is populated by a continuum of residents normalized to unity. The federal government pays a sickness benefit to individuals on sick leave and the state governments are responsible for providing health care. Following Boadway and Keen (1996), both levels of government are assumed to finance their expenditure via a proportional labor income tax and to balance their budgets. Residents are assumed to be immobile between states and benefit spillovers from health care are assumed not to exist. These assumptions allow us to focus on the vertical fiscal externalities and ignore possible horizontal externalities. Since the states are identical, no index for states is used and the analysis is focused on a representative state, and due to the lack of horizontal externalities N is normalized to one.

The utility function of an individual is written, $U_i = u(c,l,h) - g(m_i)$, where $i \in [0,1]$, c is private consumption, l labor supply and h health state. Preferences are identical and the utility is increasing in c, decreasing in l and strictly concave in c and l. Individuals have no access to capital markets, so they consume all of their income. There are two health states; healthy, h^h, and sick, h^s, where the first yields higher utility for given levels of c and l. $m_i \in [\underline{m}, \overline{m}]$ is a moral parameter that varies continuously among individuals and has a rectangular distribution. $-g(m)$ shows the non-pecuniary disutility from pretending to be sick, when healthy. A high value of m depicts a high moral and g is assumed to be increasing and concave in m.

By letting individuals differ in respect to a moral parameter, I allow for the possibility of a positive fraction of mimickers in the respective solutions. The motive for doing so is primarily to add realism to the model. In reality individuals are heterogeneous and it is, therefore, sub-optimal for a government with limited instruments to form policies so that no one mimics another. Second, letting the individuals be heterogeneous in this respect makes it possible to demonstrate how the presence of mimickers affects the vertical externalities. An alternative to including moral in this form is to allow for heterogeneity with respect to the value of consumption or leisure, or to allow for a continuum of health states. Additive separability in g is assumed for simplicity.

The health function, equation (1) below, which is the steady state solution to the dynamic equation,[5] describes the relationship between the sickness rate

[5] The dynamic equation is written

$$\dot{a} = d(1-a) - ra - f(e).$$

(a) and the public health care expenditure per capita (e).

$$a(e) = \frac{d - f(e)}{r + d}. \tag{1}$$

Healthy individuals turn sick at the exogenous rate d and sick individuals recover by themselves at the exogenous rate r. Both d and r take values between zero and one. $f(e)$ denotes the rate at which the population recovers as a result of medical treatment.[6] Health care is assumed to be exclusively financed by the governments and patients are assumed to experience no disutility by treatment. $f' > 0$ and $f'' < 0$ are assumed, stating that health care expenditure have a positive effect on the number of recoveries but that the effect of expenditure is decreasing.[7]

The justification for the assumption that health care is exclusively financed by the governments is two-fold. First, the purpose of this paper is to study the interactions between different levels of government when health care and sickness benefits are publicly provided. Second, incorporating motives for the public provision, instead of just assuming it, would complicate the model without contributing to the understanding of the problem. Among the possible motives for the public provision of health care and sickness benefit, distributional objectives and adverse selection can be mentioned.

In the model presented here, all sick individuals will be on sick leave. Healthy individuals can either work (workers) or be on sick leave (mimickers). Let $s(e) = a(e) + \hat{a}(1 - a(e))$, where $s(e)$ is the absence rate[8] and $\hat{a}$ is the fraction of healthy individuals who are mimickers. Both levels of government are assumed to know the size of $f(e)$ for all possible levels of e as well as the value of the parameters r and d; $a(e)$, $s(e)$ and $\hat{a}$ are also assumed to be observable by them. However, the governments can not observe an individual's morals or whether the individual is sick or a mimicker. In reality, governments that provide sickness

[6] Since the population is constant, this is a way of modeling the number of treated individuals as a monotone function of health care expenditure, but does not imply that that medical treatment is applied to the whole population. An alternative would be to let $f(e)$ denote the rate at which the sick fraction of the population recovers as a result of medical treatment. However, this would imply that the cost of treating a given share of the sick is independent of the number of sick individuals, which is clearly unrealistic.

[7] Expenditure on health care might affect the sickness rate by, for example, leading to a reduction in waiting times or improved procedures.

[8] In this paper, the absence rate can be interpreted to include not only the sickness absence rate among employees, but also the rate of individuals on disability pension.

benefits often attempt to distinguish mimickers from the sick by requiring a doctor's certificate as a prerequisite for receiving a sickness benefit, at least for long-term sick leave. However, physicians cannot distinguish perfectly between a sick individual and a mimicker, and even if they can, the incentives to reveal a mimicker is often limited (see e.g. Shortell (1998) for a discussion of physician's multiple accountabilities). The governments are, therefore, unlikely to be able to identify all mimickers. One could model this by introducing some probability for a mimicker to be detected and perhaps a penalty if detected. This would reduce the problem with mimickers, but would not change the general results. Further as introducing this factor would complicate the model, the extreme case where governments have no possibility of detecting a mimicker is chosen.

The private agents are assumed to make their choices concerning labor supply and sick leave after the governments' policies have been proclaimed. The workers choose consumption and labor supply to maximize their utility, subject to their budget constraints

$$c = w(1-t-T)l,$$

where t and T are tax rates imposed by the state and federal governments, respectively, and w is the exogenously given real wage rate. The outcome of a worker's optimization problems will be $c = c(w(1-t-T))$ and $l = l(w(1-t-T))$. For individuals on sick leave $c = B$, where B is the sickness benefit. The indirect utility function for workers, and the conditional indirect utility functions for mimickers and sick individuals, respectively, are written

$$V^h = v(w(1-t-T), h^h),$$

$$\widehat{V_i^h} = \widetilde{v}(B, h^h) - g(m_i),$$

$$V^s = \widetilde{v}(B, h^s),$$

where tilde indicates that the indirect utilities for mimickers and sick individuals are conditioned on the labor supply being fixed at zero. Healthy individuals will be on sick leave if

$$\widetilde{v}(B, h^h) - g(m_i) \geq v(w(1-t-T), h^h), \tag{2}$$

therefore $\hat{a} = \hat{a}(t, T, B)$. Equation (2) tells us that for the last individual who chooses to be a mimicker $m_i = g^{-1}(x)$, where $x = \widetilde{v}(B, h^h) - v(w(1-t-$

$T), h^h)$. The rectangular distribution of m, together with the concavity of $g(m)$, is sufficient to prove the following results:

$$\begin{aligned}
\frac{\partial \hat{a}}{\partial t} &= \frac{\partial \hat{a}}{\partial T} = g^{-1\prime}(x) v'(w(1-t-T), h^h) w > 0 \\
\frac{\partial \hat{a}}{\partial B} &= g^{-1\prime}(x) \widetilde{v}'(B, h^h) > 0 \\
\frac{\partial^2 \hat{a}}{\partial t \partial T} &= \frac{\partial^2 \hat{a}}{\partial t^2} = \frac{\partial^2 \hat{a}}{\partial T^2} = -g^{-1\prime}(x) v''(w(1-t-T), h^h) w^2 \\
&\quad + g^{-1\prime\prime}(x)[v'(w(1-t-T), h^h) w]^2 > 0 \\
\frac{\partial^2 \hat{a}}{\partial t \partial B} &= v'(w(1-t-T), h^h) w g^{-1\prime\prime}(x) \widetilde{v}'(B, h^h) \geq 0 \\
\frac{\partial^2 \hat{a}}{\partial B^2} &= g^{-1\prime}(x) \widetilde{v}''(B, h^h) + g^{-1\prime\prime}(x)[\widetilde{v}'(B, h^h)]^2 \gtreqless 0.
\end{aligned}$$

Ranking individuals by increasing morals and assuming the welfare objective to be utilitarian[9], permits the governments' objective function to be written

$$\begin{aligned}
&(1-a(e))(1-\hat{a})\ v(w(1-t-T), h^h) + a(e)\widetilde{v}(B, h^s) \\
&+(1-a(e)) \int_{i=0}^{\hat{a}} [\widetilde{v}(B, h^h) - g(m_i)] di. \qquad (3)
\end{aligned}$$

2.1 Centralized policy decisions

In this section the policy decisions that a central government in a unitary nation would take, in the absence of any fiscal responsibility of any lower level of government, are derived. These policy decisions will later be used as a benchmark against which the decentralized policy decisions will be compared. When all policy decisions are made by the central government there is no need to distinguish between the federal and state tax rates. It is therefore assumed that the

[9] One could allow the governments to differently weight the utility of workers, sick individuals and mimickers. Perhaps the most reasonable alteration would be to assign a lower weight to mimickers, since they abuse the system (see e.g. Sandmo (1981) for a discussion about this). This would affect the decisions taken both in the centralized and decentralized setting, but would not contribute to the understanding of the vertical fiscal externalities analyzed in this paper. Since this also would expand the notation and require more extensive explanations of the equations to follow, this is not done. However, the main effects of assigning a lower weight to mimickers will be mentioned in the paper.

government chooses a single rate $\tau = T + t$. The decision variables are τ, B and e. The second order conditions for maximums are assumed to be fulfilled and the solution is assumed to imply positive levels for all variables. The optimization problem of the central government in a unitary nation coincides with the social optimization problem and can be written

$$\begin{aligned}&\operatorname*{Max}_{\tau,B,e}\,(1-a(e))(1-\hat{a})\; v(w(1-\tau),h^h) + a(e)\widetilde{v}(B,h^s)\\ &+(1-a(e))\int_{i=0}^{\hat{a}}[\widetilde{v}(B,h^h)-g(m_i)]di\end{aligned}$$

subject to the budget constraint

$$(1-a(e))(1-\hat{a})\tau wl - (a(e)+\hat{a}(1-a(e)))B - e = 0,$$

where $a(e)$, $\hat{a}$ and l are defined as before. The Lagrangian becomes

$$\begin{aligned}L = {} & (1-a(e))(1-\hat{a})\; v(w(1-\tau),h^h) + a(e)\widetilde{v}(B,h^s)\\ &+(1-a(e))\int_{i=0}^{\hat{a}}[\widetilde{v}(B,h^h)-g(m_i)]di\\ &+\gamma\{(1-a(e))(1-\hat{a})\tau wl - (a(e)+\hat{a}(1-a(e)))B - e\},\end{aligned}$$

where γ is the Lagrangian multiplier, which at the optimum can be interpreted as the marginal cost of public funds. Given that the condition in equation (2) results in equally high utilities for a worker and for the last individual who chooses to be a mimicker, the first order conditions can be written

$$\tau \quad : \quad -(1-\hat{a})v'(w(1-\tau),h^h)w$$
$$+\gamma\{(1-\hat{a})(wl-\tau w^2 l') - (\tau wl + B)\frac{\partial \hat{a}}{\partial \tau}\} = 0 \tag{4}$$

$$B \quad : \quad a(e)\tilde{v}'(B,h^s) + (1-a(e))\hat{a}\tilde{v}'(B,h^h)$$
$$-\gamma\{a(e) + \hat{a}(1-a(e)) + (1-a(e))(\tau wl + B)\frac{\partial \hat{a}}{\partial B}\} = 0 \tag{5}$$

$$e \quad : \quad -\left[(1-\hat{a})V^h - V^s + \int_{i=0}^{\hat{a}} \widehat{V_i^h} di\right] a'(e)$$
$$-\gamma\{(1-\hat{a})(\tau wl + B)a'(e) + 1\} = 0. \tag{6}$$

Note that the expression in curly brackets in equation (4), except $B\frac{\partial \hat{a}}{\partial \tau}$, multiplied with $(1-a(e))$ represents the slope of the so called 'Laffer curve'.[10] Since $v'(w(1-\tau),h^h) > 0$, $(1-a(e)) > 0$ and $B\frac{\partial \hat{a}}{\partial \tau} > 0$, equation (4) implies that the tax revenue is a non-decreasing function of the tax rate in the unitary solution. Throughout this paper, l' is assumed to be strictly positive, stating that the substitution effect always dominates the income effect.

Equation (5) shows that the marginal benefit of consumption, for the average person on sick leave, will be higher than the marginal cost of public funds. The reason for this is that the government holds back the level of the sickness benefit, since it will affect the fraction that works.

The first row of equation (6) shows the marginal benefit of expenditure on health care. Since a fraction of those who will be treated will become mimickers, the expression consists of a weighted sum of workers' utility and mimickers' utility, minus the utility of sick individuals. Throughout this paper, the utility of the average healthy individual is assumed always to exceed the utility of a sick individual. $-(1-\hat{a})(\tau wl + B)a'(e)$ is a 'health budget feedback effect' that shows the extra tax revenues and public savings that expenditure on health care will cause. Let τ^*, B^*, e^*, denote the second best tax and expenditure policies.[11]

[10] In addition to the standard terms in the Laffer curve, which describes the relationship between tax revenues and the tax rate through the workers labor supply decision, the expression includes the term $\tau wl\frac{\partial \hat{a}}{\partial \tau}$, which multiplied with $(1-a(e))$ describes how the tax revenues are affected by the tax rate through its effect on the number of workers.

[11] If mimickers were assigned the weight ζ, $0 \leq \zeta < 1$, in the social welfare function, this would result in lower levels of τ^*, B^*, e^* compared to the case above, when the weight is unity.

3 Decentralized policy decisions

This section begins with a description of the optimization problems facing the state and federal governments, and then different methods of implementing the second best resource allocation are discussed. The decisions of the federal government are important for all states and therefore the federal government is assumed to act as a first mover, committing to its policies before the states and anticipating their effects on the states' decisions. The consequences for the federal government of the actions taken by a single small state are minor and the states are therefore assumed to act as Nash competitors towards it. As mentioned, no interactions between the states are assumed to exist and hence the states take the decisions by the other states as given.

3.1 The state governments

Since all states are identical, we can focus on a representative state. The state government chooses t and e to maximize its objective function subject to its budget constraint. The optimization problem can be written

$$\underset{t,e}{\mathrm{Max}}\ (1-a(e))(1-\hat{a})\ v(w(1-t-T),h^h)+a(e)\widetilde{v}(B,h^s)$$

$$+(1-a(e))\int_{i=0}^{\hat{a}}[\widetilde{v}(B,h^h)-g(m_i)]di$$

s.t.

$$(1-a(e))(1-\hat{a})twl-e=0,$$

This can be seen by inserting ζ before the mimickers' utilities and marginal utilities in the first order conditions and adding the terms $[\zeta\widehat{V_{\hat{a}}^h}-V^h]\frac{\partial\hat{a}}{\partial\tau}$ and $[\zeta\widehat{V_{\hat{a}}^h}-V^h]\frac{\partial\hat{a}}{\partial B}$ to equations (4) and (5), respectively. Here $\widehat{V_{\hat{a}}^h}$ denotes the utility of the marginal mimicker. Since equation (2) gives that $\widehat{V_{\hat{a}}^h}=V^h$, these new terms will be negative and therefore work for a lower tax rate and a lower sickness benefit. The latter would also be reduced compared to the case when $\zeta=1$, since part of the utility of the benefit goes to mimickers. Further, the government's incentive to cure individuals would be reduced, since some of the cured ones would become mimickers.

The decentralized solution is affected correspondingly.

where $a(e)$, $\hat{a}$ and l are defined above. The first order conditions can be written

$$\begin{aligned} t \quad &: \quad -(1-\hat{a})v'(w(1-t-T), h^h)w \\ &\qquad +\gamma^s\{(1-\hat{a})(wl - tw^2 l') - twl\frac{\partial \hat{a}}{\partial t}\} = 0 \\ e \quad &: \quad -\left[(1-\hat{a})V^h - V^s + \int_{i=0}^{\hat{a}} \widehat{V_i^h} di\right] a'(e) \\ &\qquad -\gamma^s\{(1-\hat{a})twla'(e) + 1\} = 0, \end{aligned}$$

where γ^s denotes the Lagrangian multiplier, which at the optimum can be interpreted as the state's perceived marginal cost of public funds.

Comparing these conditions with those for the unitary nation, we see that they neglect the effect that the policy decisions will have on the federal budget. The tax externality works for a too high t and e if $T > 0$ or $B > 0$, but the opposite is true for expenditure externality. Which effect that dominates is inconclusive, given the assumptions made. Even if the federal tax rate is zero, the states may have suboptimal incentives since they neglect the effect that their decisions will have on the federal government's expenditure for sickness benefit.

To determine under which conditions the state will have an incentive to under- and over-provide health care, an expression for the vertical fiscal externality has to be derived. Given that the federal government's budget constraint, R_f, can be written

$$R_f = (1-a(e))(1-\hat{a})Twl - (a(e) + \hat{a}(1-a(e)))B, \tag{7}$$

the effect of a state's expenditure on health care on R_f can be written

$$\frac{dR_f}{de} = -(1-a(e))\left[(1-\hat{a})Tw^2 l' + (Twl + B)\frac{\partial \hat{a}}{\partial t}\right]\frac{dt}{de} - (1-\hat{a})(Twl+B)a'(e) \tag{8}$$

$$\frac{dt}{de} = \frac{1 + (1-\hat{a})twla'(e)}{(1-a(e))\left[(1-\hat{a})(wl - tw^2 l') - twl\frac{\partial \hat{a}}{\partial t}\right]}, \tag{9}$$

where $\frac{dt}{de}$ originates from the state's budget constraint. The first part of the equation describes the indirect effect that the state's health care expenditure have on the federal budget constraint, through its relationship with the state's tax rate given by the state's budget constraint. This indirect effect works through the effect of the tax rate on the workers' labor supply and the rate of mimickers. The last term shows how the state's health care expenditure influence the federal budget constraint by changing the share of the population that works and therefore not only altering the federal tax income but also the federal government expenditure on sickness benefit. A positive vertical fiscal externality, $\frac{dR_f}{de} > 0$, means that the state will have an incentive to under-provide health care.

Given that the federal budget constraint can be written

$$(1 - s(e))Twl = s(e)B. \tag{10}$$

and multiplying by $\frac{de}{dt}$ gives us Proposition 1 below, where $\eta = (\partial l/\partial w)(w/l)$ is the wage elasticity of the labor supply among workers and the term $\frac{de}{dt}$ is the inverse of equation (9). Given the states' first order conditions, $\frac{de}{dt}$ is positive.

Proposition 1 *In a decentralized setting where the state governments act as Nash competitors and given any level of the federal government's tax rate and the sickness benefit, the states will under-provide (over-provide) health care if*

$$s(e)\eta + \frac{1}{1-\hat{a}}\frac{\partial \hat{a}}{\partial t} < (>) \frac{-1}{1-a(e)} a'(e) \frac{de}{dt}. \tag{11}$$

The proposition shows that health care will be under-provided by the states for any given level of B and T if the tax externality (the left hand side of equation (11)) is dominated by the expenditure externality (the right hand side). That is, health care will be under-provided if an increase in the states' tax rates will have a smaller impact on the federal government's budget constraint than the expenditure on health care that the tax increase can finance.

Proposition 1 shows that the less sensitive healthy individuals' total labor supply is to taxes, the more likely health care is to be under-provided by the state government. The workers' labor supply elasticity will be more important the higher the fraction of individuals on sick leave. This may seem counterintuitive at first, but is explained by the form of the federal governments' budget constraint. Equation (10) shows that a high value of $s(e)$ implies that federal tax revenues from a worker have to be large in comparison to the level of the sickness benefit. Therefore, changes in the labor supply will cause relatively large effects on the federal tax revenues. Other things being equal, health care is less likely to be under-provided the higher the share of mimickers. The intuition is that if a large share of the healthy individuals is represented by mimickers, the fiscal reason for treating the sick becomes less important, reducing the expenditure externality.[12]

Equation (11) can be rewritten using the state government's decision rule. Maximizing the state's objective function with respect to e, and letting t be defined subsequently by the state's budget constraint, gives the first order condition

$$-\left[(1-\hat{a})V^h - V^s + \int_{i=0}^{\hat{a}} \widehat{V_i^h} di\right] a'(e) - (1-a(e))(1-\hat{a})v'(w(1-t-T), h^h)w\frac{dt}{de} = 0. \tag{12}$$

This allows equation (11) to be written as

$$s(e)\eta + \frac{1}{(1-\hat{a})}\frac{\partial \hat{a}}{\partial t} < (>)(1-\hat{a})\frac{v'(w(1-t-T), h^h)w}{(1-\hat{a})V^h - V^s + \int_{i=0}^{\hat{a}} \widehat{V_i^h} di}. \tag{13}$$

The denominator of the right hand side of equation (13) shows the indirect utilities for individuals in different states. If the redistribution in the society is extensive, the utility of sick individuals will approach the utility of the average healthy individual. In this case, health care will be under-provided, since the expression on the right hand side of equation (13) will approach infinity. The intuition is straight forward. If the average individual only experiences a very little increase in utility by getting treated, there is little incentive for the state to provide health care.

Before we continue to the federal level, it is helpful to analyze how the state government will react to the federal government's decisions. Below, I describe how the state will alter its expenditure on health care in response to changes of T and B, respectively, and letting the state's tax rate be defined subsequently by its budget constraint. In order to do so, equation (12) is differentiated with respect to e and T or B, holding the other federal governments' policy instruments fixed. This gives the following expressions

$$\frac{de}{dT} = -\frac{\begin{array}{c} a'(e)(1-\hat{a})v'w + (1-a(e))(1-\hat{a})v''w^2\frac{dt}{de} \\ +(1-a(e))v'w\frac{dt}{de}\frac{\partial \hat{a}}{\partial T} - (1-a(e))(1-\hat{a})v'w\frac{\partial(dt/de)}{\partial T} \end{array}}{\delta} \tag{14}$$

[12]Proposition 1 holds even if the social weights assigned to the utilities of mimickers and other groups are changed, since these not directly affect the governments' budget constraints.

$$\frac{de}{dB} = -\frac{\begin{array}{c} a'(e)\left[\frac{\partial\widetilde{v}(B,h^s)}{\partial B} - \hat{a}\frac{\partial\widetilde{v}(B,h^h)}{\partial B}\right] \\ +(1-a(e))v'w\frac{dt}{de}\frac{\partial\hat{a}}{\partial B} - (1-a(e))(1-\hat{a})v'w\frac{\partial(dt/de)}{\partial B}\end{array}}{\delta}, \tag{15}$$

where δ is the second derivative of the state's optimization problem with respect to e.

As will be demonstrated, both the numerators and the denominators of equations (14) and (15) are negative, meaning that the state will react to an increased federal tax rate or sickness benefit by reducing its expenditure on health care.

The denominators, δ, are negative given that the state's objective function is concave in e.

The first term in the numerator of equation (14) shows that an increased federal tax rate will reduce the workers' utility, reducing the state's incentive to cure sick individuals. The other terms demonstrate how the state's perception of the marginal costs of public funds is affected by the federal tax rate. An increased federal tax rate increases the workers' marginal benefit of income and reduces the amount of health care that can be financed by a given tax rate, since it reduces the total number of hours worked. Both these effects tend to increase the state's perception of the marginal costs of public funds when the federal tax rate is increased. However, a higher federal tax rate also reduces the number of workers that are affected by the tax rate, by increasing the share of mimickers. This effect goes in the opposite direction to the other two. In the appendix it is demonstrated that this effect is dominated by the effect that works through changing the relation between t and e.

The first term in the numerator of equation (15) shows that an increased sickness benefit will increase the utility of people on sick leave. This will reduce the state's incentive to cure sick individuals, if $\frac{\partial\widetilde{v}(B,h^s)}{\partial B} > \hat{a}\frac{\partial\widetilde{v}(B,h^h)}{\partial B}$. This will be the case unless consumption and health are sufficiently strong complements, and the number of mimickers is sufficiently large. This is extremely unlikely and the first term will therefore be assumed to be negative.[13] The other two

[13] Empirical estimates reported in the literature indicate that consumption and health are complements, but not strong enough to make the first term in equation (15) positive. Viscusi and Evans (1990) estimate the marginal utility of consumption when ill to be 77.3 per cent of that when well. The corresponding estimates reported in Gilleskie (1998) for acute illness are 58.2 and 15.6, depending on the type of illness. Since the rate of mimickers is indeed below these figures, these estimates support the assumption that the first term in equation (15) is

terms illustrate how the state's perception of the marginal costs of public funds is affected by the sickness benefit. As demonstrated in the appendix these terms will be jointly negative.

To conclude, given the assumptions made, an increase in the federal tax rate or the sickness benefit reduces the state's incentive to cure sick individuals and increases its perception of the marginal costs of public funds, causing it to reduce its expenditure on health care. Due to the balanced budget constraint, this might imply a reduction of the state's tax rate. However, a reduction of the expenditure on health care does not by itself guarantee that the state's tax rate will also be reduced, since a change in anyone of the federal government's policy variables alters the relationship between the state's policy variables. How the state will adjust its tax rate, when the federal government changes its policy choices, can be derived and interpreted in the same manner as for the state's adjustment of its expenditure on health care. In the appendix it is demonstrated that $\frac{dt}{dT} < 0$ and $\frac{dt}{dB} < 0$.

3.2 The federal government

The federal government acts as a first mover and chooses T and B to maximize its objective function subject to its budget constraint, the private agents' responses and the states' reaction functions just described. The problem can be written

$$\underset{T,B}{\text{Max}}\ (1-a(e))(1-\hat{a})\ v(w(1-t-T),h^h) + a(e)\widetilde{v}(B,h^s)$$

$$+(1-a(e))\int\limits_{i=0}^{\hat{a}}[\widetilde{v}(B,h^h)-g(m_i)]di$$

s.t.

$$(1-a(e))(1-\hat{a})Twl - (a(e)+\hat{a}(1-a(e)))B = 0,$$

where $e = e(B,T)$, $t = t(e(B,T),B,T)$ and where $a(e)$, $\hat{a}$ and l are defined as before. Letting γ^f denote the Lagrangian multiplier, which at the optimum can be interpreted as the federal government's perceived marginal cost of public

negative.

funds, the federal government's first order conditions can be written

$$\begin{aligned} T &: -(1-a(e))(1-\hat{a})v'(w(1-t-T),h^h)w \\ &+\gamma^f(1-a(e))\left[(1-\hat{a})(wl-Tw^2l')-(Twl+\ B)\frac{\partial\hat{a}}{\partial T}\right]+\delta_T=0 \\ B &: a(e)\widetilde{v}'(B,h^s)+(1-a(e))\hat{a}\widetilde{v}'(B,h^h) \\ &-\gamma^f\left\{a(e)+\hat{a}(1-a(e))+(1-a(e))(Twl+\ B)\frac{\partial\hat{a}}{\partial B}\right\}+\delta_B=0, \end{aligned}$$

where

$$\begin{aligned} \delta_T &= [-(1-a(e))(1-\hat{a})v'w \\ &+\gamma^f(1-a(e))\left[(1-\hat{a})(-Tw^2l')-(Twl+\ B)\frac{\partial\hat{a}}{\partial t}\right]]\frac{dt}{dT}|_{de=0} \\ &+\gamma^f Z\frac{de}{dT}, \\ \delta_B &= [-(1-a(e))(1-\hat{a})v'w \\ &+\gamma^f(1-a(e))\left[(1-\hat{a})(-Tw^2l')-(Twl+\ B)\frac{\partial\hat{a}}{\partial t}\right]]\frac{dt}{dB}|_{de=0} \\ &+\gamma^f Z\frac{de}{dB}, \end{aligned}$$

$$\frac{dt}{dT}|_{de=0}=-\frac{(1-\hat{a})(-tw^2l')-twl\frac{\partial\hat{a}}{\partial T}}{(1-\hat{a})(wl-tw^2l')-twl\frac{\partial\hat{a}}{\partial t}}>0,$$

$$\frac{dt}{dB}|_{de=0}=\frac{twl\frac{\partial\hat{a}}{\partial B}}{(1-\hat{a})(wl-tw^2l')-twl\frac{\partial\hat{a}}{\partial t}}>0,$$

$$\begin{aligned} Z &= -(1-a(e))\left[(1-\hat{a})Tw^2l'+(Twl+B)\frac{\partial\hat{a}}{\partial t}\right]\frac{dt}{de} \\ &-(1-\hat{a})(Twl+\ B)a'(e). \end{aligned}$$

Here, δ_T and δ_B represent the indirect effects of the federal government's decision variables on the Lagrangian, via the reaction function for the states' expenditure on health care and their budget constraints. The first two rows in the expressions for δ_T and δ_B, respectively, describe the effect that the federal government's decision variables have on the Lagrangian through their effects on the state's tax bases. These terms work in favor of lower T and B, respectively, since this will reduce the states' tax rates for any given level of e. Z relates to the vertical externality facing the state governments, described in equation (8). If the states have an incentive to under-provide health care, Z will be positive, working in favor of lower T and B, and vice versa.

A special case appears when the tax and expenditure externalities described in equation (8) compensate each other exactly. Z will then equal zero and the first order conditions will be identical to the first order conditions for the unitary nation.[14] In this case the federal government has enough instruments at its disposal to obtain the unitary nation optimum. By setting $B = B^*$ the federal government will induce the state governments to set $e = e^*$ and the budget constraints gives $(t + T) = \tau^*$.

In general, the externalities facing the state governments will not cancel out and the federal government will not be able to simultaneously achieve both B^* and e^*, given that B and T are its only two policy variables. Instead, the federal government is left to choose a point on the state governments' reaction functions. The different situations are illustrated in Figure 1, where the problem is reduced to the state governments choosing e and the federal government choosing B, letting t and T be defined subsequently by the respective budget constraints. $Z < 0$ and $Z > 0$ illustrate what the states' reaction functions can look like if the states have an incentive to over-provide and under-provide health care, respectively. $Z = 0$ is an illustration of the case where the tax- and expenditure externalities cancel out exactly. U_1 and U_2 ($U_1 < U_2$) illustrate what the federal government's indifference curves in the $B - e$ plane might look like given the relationship between these variables and the tax rates.

Figure 1 illustrates a setting where the federal government will choose a point in the North East quadrant if the states have incentives to over-provide health care. By setting B above B^* the federal government has induced the states to reduce their expenditure on health care compared to point 1. However, e is still above e^* and the total tax rate exceeds that of the unitary solution.

[14] To see this, use that $\frac{\partial \hat{a}}{\partial t} = \frac{\partial \hat{a}}{\partial T}$, insert the expressions for $\frac{dt}{dT}|_{de=0}$ and $\frac{dt}{dB}|_{de=0}$, respectively, in the first order conditions and rearrange.

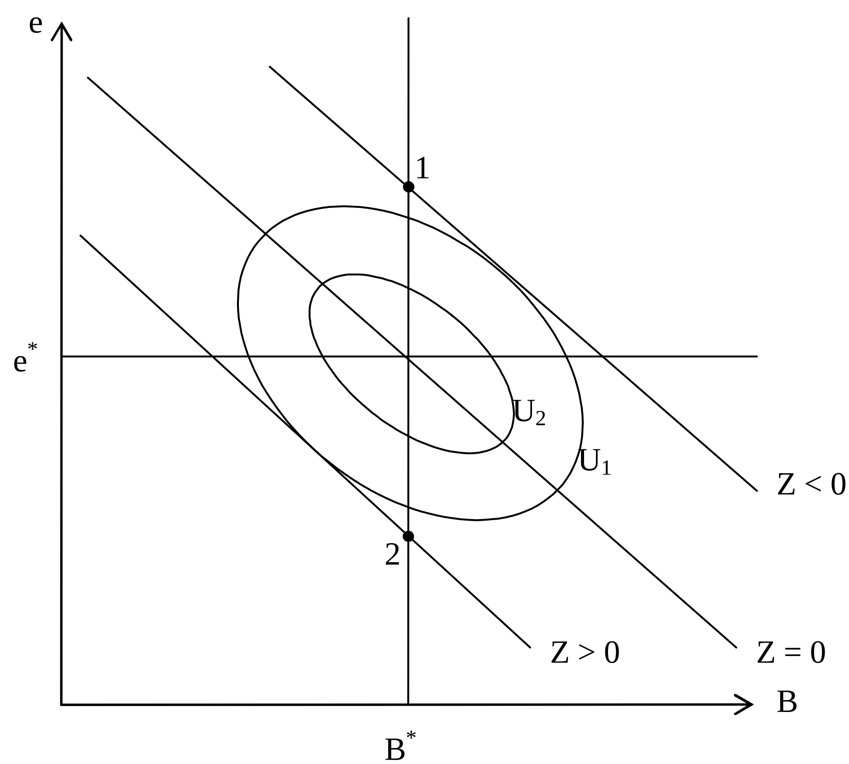

Figure 1. Illustration of possible solutions in the decentralized setting

Given the general form of the model, we can not conclude that the solution will be in this quadrant. If the high state tax rates, associated with high expenditure on health care, result in sufficiently high social cost for financing the sickness benefit and if the slope of the states' reaction functions is sufficiently flat, the federal government will choose a point in the North West quadrant. In the opposite case the federal government will choose a point in the South East quadrant, which means that, by selecting a high enough sickness benefit, it will induce the states to choose e below e^*, despite their incentives to choose a too high level of e for any given level of B.

If the states have incentives to under-provide health care, the federal government might choose a point in the South West quadrant, as illustrated in Figure 1. This case illustrates a situation where the federal government has induced the states to increase their expenditure on health care, compared to point 2, by reducing the sickness benefit. If the low state tax rates, associated with low expenditure on health care, result in sufficiently low social cost for financing the sickness benefit and the slope of the states' reaction functions is sufficiently flat, the federal government will choose a point in the South East quadrant. Low state tax rates could reduce the social cost of financing the sickness benefit by reducing the share of mimickers and the workers' marginal benefit of income, and by increasing the number of hours each worker supplies. However, low expenditure on health care implies a high share of the population being absent from work due to illness, which increases the social cost of financing the sickness benefit. If this effect is strong enough and the slope of the states' reaction functions is steep enough, the federal government might end up choosing a point in the North West quadrant, which means that e will be above e^*, despite the states having incentives to under-provide health care for any given level of B.

To conclude, given the general form of the model we can not determine how the level of health care provided in the decentralized setting will be in relation to the second best level, except when the externalities facing the state governments cancel out exactly. Whether health care will be under- or over-provided in the other situations depends not only on the sign of the fiscal externality facing the states, but also on the social costs of financing the sickness benefit, which affects the form of the federal government's indifference curves, and on the slope of the states' reaction functions.

3.3 Implementing the second best solution

This section examines different ways that the unitary nation optimum can be achieved by changing the governments' responsibilities or policy instruments. A self-evident solution is to abolish the federal structure, either by transferring the responsibility of providing health care to the federal level or by transferring the responsibility of providing the sickness benefit to the state level. In this model these two solutions will be equally effective, but in reality both solutions might be unfeasible for constitutional, political or other reasons not accounted for in the model.

It is also possible to implement the second best solution while retaining the federal structure. If the federal government is given the possibility of deciding a positive or negative intergovernmental transfer, R, the state and the federal governments' budget constraints become

$$(1-a(e))(1-\hat{a})twl - e + R = 0 \tag{16}$$

and

$$(1-a(e))(1-\hat{a})Twl - (a(e) + \hat{a}(1-a(e)))B - R = 0,$$

respectively. The federal government now has three policy instruments at its disposal, T, B and R. It can observe the true marginal cost of public funds and the preference of the individuals and is therefore able to set $B = B^*$. The federal government is also able to observe the optimal value of τ and to design the intergovernmental transfer so that the state governments will internalize the effects that their decisions have on the federal government. This is described in Proposition 2.

Proposition 2 *If the federal government remits all its tax revenues back to the states, but makes each state transfer back an amount equal to the expenditure on the optimal sickness benefit in that state, then $t = \tau^* - T$ and $e = e^*$ will solve the state governments' optimization problem. The intergovernmental transfer can be written as*

$$R = (1-a(e))(1-\hat{a})(Twl + B^*) - B^*, \tag{17}$$

where $(1-a(e))(1-\hat{a})$ is the share of workers, Twl is the federal tax income per worker and B^* is the optimal sickness benefit.[15]

Proof. By substituting equation (17) into equation (16) the states optimization problem becomes

$$\operatorname*{Max}_{t,e}\ (1-a(e))(1-\hat{a})\ v(w(1-t-T), h^h) + a(e)\widetilde{v}(B, h^s) + (1-a(e)) \int_{i=0}^{\hat{a}} [\widetilde{v}(B, h^h) - g(m_i)]di$$

s.t.

$$(1-a(e))(1-\hat{a})twl - e + (1-a(e))(1-\hat{a})(Twl + B^*) - B^* = 0,$$

[15] Aronsson and Wikström (2003) derived a similar result, in the context of risk-sharing in an economic federation.

where $a(e)$, $\hat{a}$ and l are defined as before. The Lagrangian is written

$$\begin{aligned} L &= (1-a(e))(1-\hat{a})\ v(w(1-t-T),h^h)+a(e)\widetilde{v}(B,h^s) \\ &+(1-a(e))\int_{i=0}^{\hat{a}}[\widetilde{v}(B,h^h)-g(m_i)]di \\ &+\gamma^s\{(1-a(e))(1-\hat{a})(t+T)wl-(a(e)+\hat{a}(1-a(e)))B^*-e\}. \end{aligned}$$

Since $\tau = t + T$ by definition, this Lagrangian is identical with that for the social optimization problem in subsection 2.1.

The fact that T can be set at any level is a result of t and T entering additively in the individuals' utility functions. The choice of T will not affect the policy rule, as such, but the size of the intergovernmental transfer. That is, T is a superfluous policy instrument. However, if the tax rates are constrained to be non-negative, T must be $0 \leq T \leq \tau^*$. To understand why the transfer will make the externalities facing the states vanish, notice that equation (17) is identical with the federal government's budget constraint without an intergovernmental transfer, equation (7), when $B = B^*$. Therefore, the states will take the same decisions as they would have taken if they directly took the effect of their decisions on the federal government's budget constraint into account.

A special case is when $T = 0$, which allows the transfer to be written

$$R = -(a(e) + \hat{a}(1-a(e)))B^*. \tag{18}$$

The transfer will in this case be negative and equal to the expenditure on the optimal sickness benefit in each state. The size of the negative transfer depends on each state's decisions regarding e and t and not only has the objective to finance the federal government's expenditure on the sickness benefit, but also to correct the states' incentives. This result differs from that presented by for example Boadway and Keen (1996). They claim that if all rents and tax powers are allocated to the states, the vertical externality will vanish and the sole objective of the transfer will be to finance the federal expenditure. The different result is caused here by the fact that the federal government has at its disposal a redistributive policy instrument, B, which was not present in Boadway and Keen (1996), and the fact that the need for redistribution is directly affected by the decisions taken by the states.

Moral hazard among individuals (captured by the parameter $\hat{a}$) does not affect the different ways the second best solution can be implemented, but does affect the size of the optimal transfers. This can be seen in equations (17) and (18).[16]

4 Discussion

This paper addresses provision of health care and redistribution, in terms of a sickness benefit, in an economic federation. The analysis is based on a model where the state governments provide health care and the federal government provides a sickness benefit and both levels of government tax labor income.

The results show that the states can either have an incentive to under- or over-provide health care. The federal government can induce the states to increase (reduce) their expenditure on health care, by reducing (increasing) the sickness benefit and the federal tax rate. The results also demonstrate that the federal government can induce the state governments to internalize the effects that their decisions will have on the federal government's budget constraint. This can be done by introducing an intergovernmental transfer, where the federal government remits all its tax revenues to the states, but makes each state transfer back an amount equal to the expenditure for the optimal sickness benefit in that state. In this model, the vertical fiscal externality will not vanish even if all powers of taxation are assigned to the states. This result differs from previous ones presented in the literature and is caused by the fact that the states' decisions in this model directly affect the federal government's expenditure.

The results from this paper can be generalized to other state financed programs that reduce the number who receive federal transfers, for example labor market programs, and may inform policy makers on how to reduce the misallocation of resources associated with such programs.

One important assumption in the paper is that no horizontal externalities exist. In reality, labor mobility will give rise to horizontal externalities. If labor is mobile, expenditure on health care in a state may attract sick individuals

[16] Similarly, Proposition 2 holds even if mimickers' utilities are assigned a lower social weight, but the size of the optimal transfers would be affected since this would affect the values of the parameters.

to that state and discourage workers, due to the higher tax rate necessary for financing the increased expenditure. Other states will therefore benefit from a state's increased expenditure, which implies that labor mobility gives rise to a positive horizontal externality.[17] Including these positive horizontal externalities in the analysis would therefore increase the probability of health care being under-provided in the decentralized setting, but it will not change the way the federal government can influence the states' decisions and the general result that the unitary nation optimum can be implemented through an intergovernmental transfer.

[17] The possibility of patients seeking treatment in another state than that of resident, will also cause a horizontal externality, if the state of resident does not have to fully reimburse the state which treated the patient.

Appendix

Define

$$F = [1 + (1 - \hat{a})twla'(e)],$$

$$G = (1 - a(e))\left[(1 - \hat{a})(wl - tw^2 l') - twl\frac{\partial \hat{a}}{\partial t}\right]$$

and note, by comparing with equation (9), that $\frac{F}{G} = \frac{dt}{de}$. Using these definitions, the derivative of equation (9) with respect to T can be written

$$\begin{aligned}\frac{\partial(dt/de)}{\partial T} \quad = \quad & G\left[-\frac{\partial \hat{a}}{\partial T}twla'(e) - (1 - \hat{a})a'(e)tw^2 l'\right] \\ & -F\{(1 - a(e))[(1 - \hat{a})(-w^2 l' + tw^3 l'') \\ & -\frac{\partial \hat{a}}{\partial T}(wl - tw^2 l') - twl\frac{\partial^2 \hat{a}}{\partial t \partial T} + tw^2 l'\frac{\partial \hat{a}}{\partial t}]\}/G^2. \qquad (19)\end{aligned}$$

By substituting equation (19) into equation (14) and rearranging, the latter equation can be written

$$\frac{de}{dT} = -\frac{\begin{array}{c} a'(e)(1-\hat{a})v'w + (1-a(e))(1-\hat{a})v''w^2\frac{dt}{de} \\ +(1-a(e))v'w/G\frac{\partial \hat{a}}{\partial T}[F + (1-\hat{a})twla'(e) \\ -F\frac{(1-\hat{a})(1-a(e))(wl - tw^2 l')}{G}] \\ +(1-a(e))(1-\hat{a})v'w\{(1-\hat{a})a'(e)tw^2 l'/G \\ +F(1-a(e))\left[(1-\hat{a})(-w^2 l' + tw^3 l'') - twl\frac{\partial^2 \hat{a}}{\partial t \partial T} + tw^2 l'\frac{\partial \hat{a}}{\partial t}\right]/G^2\} \end{array}}{\delta}. \qquad (20)$$

The terms in the four last rows in the numerator of equation (20) describe how the state's perception of the marginal cost of public funds is affected by the federal tax rate, through its effect on the share of workers in the population and its effect on the relationship between t and e. As will be demonstrated, these four rows are jointly negative given the assumptions made. G and F are positive according to the state's first order condition. The quotient in the third row is larger than one, which guarantees that the second and third rows are jointly negative. In the fifth row, the term $tw^2 l'\frac{\partial \hat{a}}{\partial t}$ is dominated by the term $-(1-\hat{a})w^2 l'$, since the assumption that the state's tax revenue is strictly increasing in its tax rate, requires that $t\frac{\partial \hat{a}}{\partial t} < (1-\hat{a})$. This guarantees also that the fourth and fifth rows are jointly negative.

The derivative of equation (9) with respect to B is written

$$\begin{aligned}\frac{\partial(dt/de)}{\partial B} &= \{-G\frac{\partial\hat{a}}{\partial B}twla'(e)\\ &\quad +F(1-a(e))\left[\frac{\partial\hat{a}}{\partial B}(wl-tw^2l')+twl\frac{\partial^2\hat{a}}{\partial t\partial B}\right]\}/G^2. \qquad (21)\end{aligned}$$

By substituting equation (21) into equation (15) and rearranging, the latter equation can be written

$$\frac{de}{dB} = -\frac{\begin{array}{c} a'(e)\left[\frac{\partial\widetilde{v}(B,h^s)}{\partial B}-\hat{a}\frac{\partial\widetilde{v}(B,h^h)}{\partial B}\right] \\ +(1-a(e))v'w/G\frac{\partial\hat{a}}{\partial B}[F+(1-\hat{a})twla'(e) \\ -F\frac{(1-a(e))(1-\hat{a})(wl-tw^2l')}{G}] \\ -(1-a(e))(1-\hat{a})v'wF(1-a(e))twl\frac{\partial^2\hat{a}}{\partial t\partial B}/G^2 \end{array}}{\delta}. \qquad (22)$$

The terms in the last three rows in the numerator of equation (22) describe how the state's perception of the marginal costs of public funds is affected by the sickness benefit. Given the assumptions made, these terms are jointly negative for the same reason as described above.

$\frac{dt}{dT}$ and $\frac{dt}{dB}$ can be derived in a similar manner. Maximizing the states' objective functions with respect to t, letting the state's expenditure on health care be defined subsequently by its budget constraint, gives the first order condition

$$-\left[(1-\hat{a})V^h-V^s+\int_{i=0}^{\hat{a}}\widehat{V_i^h}di\right]a'(e)\frac{de}{dt}-(1-a(e))(1-\hat{a})v'(w(1-t-T),h^h)w=0. \qquad (23)$$

Differentiating equation (23) with respect to T and t, holding B fixed gives

$$\frac{dt}{dT} = -\frac{\begin{array}{c} a'(e)(1-\hat{a})v'w\frac{de}{dt}-\left[(1-\hat{a})V^h-V^s+\int_{i=0}^{\hat{a}}\widehat{V_i^h}di\right]a'(e)\frac{\partial(de/dt)}{\partial T} \\ +(1-a(e))(1-\hat{a})v''w^2+(1-a(e))v'w\frac{\partial\hat{a}}{\partial T} \end{array}}{\zeta}. \qquad (24)$$

ζ is the differential of equation (23) with respect to t and is therefore negative, given that the state's objective function is concave in t. The first term in the numerator of equation (24) shows that an increased federal tax rate will reduce the workers utility, reducing the state's incentive to raise taxes to finance the treatment of sick individuals. The second term demonstrates that this incentive is further reduced by the fact that an increased federal tax rate reduces the total number of hours worked, reducing the amount of health care that can be financed by a given state tax. Further more, an increased federal tax rate will increase the workers marginal benefit of income, increasing the social cost of raising the taxes. The fourth term shows that the social cost of raising taxes is reduced by the fact that an increased federal tax rate reduces the number of workers that are affected by the tax rate. By substituting equation (25)

$$\begin{aligned}\frac{\partial(de/dt)}{\partial T} &= \{F(1-a(e))[(1-\hat{a})(-w^2l'+tw^3l'') \\ &\quad -\frac{\partial\hat{a}}{\partial T}(wl-tw^2l')-twl\frac{\partial^2\hat{a}}{\partial t\partial T}+tw^2l'\frac{\partial\hat{a}}{\partial t}] \\ &\quad +G\frac{\partial\hat{a}}{\partial T}twla'(e)+G(1-\hat{a})tw^2l'a'(e)\}/F^2 \end{aligned} \tag{25}$$

into equation (24) and rearranging using equation (23), it can be seen below that the fourth term in equation is dominated by the second one.

$$\frac{dt}{dT} = -\frac{\begin{array}{c} a'(e)(1-\hat{a})v'w\frac{de}{dt}+(1-a(e))(1-\hat{a})v''w^2 \\ -a'(e)\left[(1-\hat{a})V^h-V^s+\int\limits_{i=0}^{\hat{a}}\widehat{V_i^h}di\right] \\ \{F(1-a(e))\left[(1-\hat{a})(-w^2l'+tw^3l'')-twl\frac{\partial^2\hat{a}}{\partial t\partial T}+tw^2l'\frac{\partial\hat{a}}{\partial t}\right] \\ +G(1-\hat{a})tw^2l'a'(e)\}/F^2 \\ +(1-a(e))v'w\frac{\partial\hat{a}}{\partial T}/F\left[F+(1-\hat{a})twla'(e)-F\frac{(1-a(e))(1-\hat{a})(wl-tw^2l')}{G}\right] \end{array}}{\zeta}$$

Differentiating equation (23) with respect to B and t, holding T fixed gives

$$\frac{dt}{dB} = -\frac{\begin{array}{c} a'(e)\left[\frac{\partial\tilde{v}(B,h^s)}{\partial B}-\hat{a}\frac{\partial\tilde{v}(B,h^h)}{\partial B}\right]\frac{de}{dt} \\ -a'(e)\left[(1-\hat{a})V^h-V^s+\int\limits_{i=0}^{\hat{a}}\widehat{V_i^h}di\right]\frac{\partial(de/dt)}{\partial B} \\ +(1-a(e))v'w\frac{\partial\hat{a}}{\partial B} \end{array}}{\zeta} \tag{26}$$

The first term in the numerator of equation (26) shows that an increased sickness benefit will increase the utility of people on sick leave. Given the assumption stated in Section 3.1, this will reduce the state's incentive to raise taxes to finance health care. The second term demonstrates that this incentive is further reduced by the fact that a higher sickness benefit reduces the total number of hours worked, reducing the amount of health care that can be financed by a given state tax rate. The last term shows that the social cost of raising taxes is reduced by the fact that an increased sickness benefit reduces the number of workers that are affected by the tax rate. By substituting equation (27)

$$\begin{aligned}\frac{\partial(de/dt)}{\partial B} &= \{-F(1-a(e))\left[\frac{\partial\hat{a}}{\partial B}(wl-tw^2l')+twl\frac{\partial^2\hat{a}}{\partial t\partial B}\right] \\ &\quad +G\frac{\partial\hat{a}}{\partial B}twla'(e)\}/F^2 \qquad (27)\end{aligned}$$

into equation (26) and rearranging using equation (23), it can be seen below that the last term in equation (26) is dominated by the second one.

$$\frac{dt}{dB} = -\frac{\begin{array}{c} a'(e)\left[\frac{\partial\widetilde{v}(B,h^s)}{\partial B}-\hat{a}\frac{\partial\widetilde{v}(B,h^h)}{\partial B}\right]\frac{de}{dt} \\ +a'(e)\left[(1-\hat{a})V^h-V^s+\int\limits_{i=0}^{\hat{a}}\widehat{V_i^h}di\right] \\ (1-a(e))twl\frac{\partial^2\hat{a}}{\partial t\partial B}/F \\ +(1-a(e))v'w/F\frac{\partial\hat{a}}{\partial B}\left[F+(1-\hat{a})twla'(e)-F\frac{(1-a(e))(1-\hat{a})(wl-tw^2l')}{G}\right]\end{array}}{\zeta}$$

References

Aronsson, T. and Wikström, M. (2001). Optimal taxes and transfers in a multilevel public sector. *FinanzArchiv*, 58, 158-166.

Aronsson, T. and Wikström, M. (2003). Optimal taxation and risk-sharing in an economic federation. *Oxford Economic Papers*, 55, 104-120.

Boadway, R. and Keen, M. (1996). Efficiency and the optimal direction of federal-state transfers. *International Tax and Public Finance*, 3, 137-155.

Boadway, R., Marchand, M. and Vigneault, M. (1998). The consequences of overlapping tax bases for redistribution and public spending in a federation. *Journal of Public Economics*, 68, 453-478.

Brown, S. and Sessions, J.G. (1996). The economics of absence: Theory and evidence. *Journal of Economic Surveys*, 10, 23-53.

Dahlby, B. and Wilson, L.S. (2003). Vertical fiscal externalities in a federation. *Journal of Public Economics*, 87, 917-930.

Flowers, M.R. (1988). Shared tax sources in a leviathan model of federalism. *Public Finance Quarterly*, 16, 67-77.

Gilleskie, D.B. (1998). A dynamic stochastic model of medical care use and work absence. *Econometrica*, 66, 1-45.

Hansson, I. and Stuart, C. (1987). The suboptimality of local taxation under two-tier fiscal federalism. *European Journal of Public Economy*, 3, 407-411.

Johnson, W.R. (1988). Income redistribution in a federal system. *The American Economic Review*, 78, 570-573.

Keen, M. (1998). Vertical tax externalities in the theory of fiscal federalism. *IMF Staff Papers*, 45, 454-485.

Sandmo, A. (1981). Income tax evasion, labor supply, and the equity-efficiency tradeoff. *Journal of Public Economics*, 16, 265-288.

Shortell, S.M. (1998). Physicians as Double Agents - Maintaining Trust in an Era of Multiple Accountabilities. *The Journal of the American Medical Association*, 280, 1102-1108.

Viscusi, W.K. and Evans, W.N. (1990). Utility functions that depend on health status: Estimates and economic implications. *The American Economic Review*, 80, 353-374.