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Health, health production and input financing: A theoretical note

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Abstract. *We develop a health production model with input financing in the spirit of standard health capital model. Health production depends not only on tangible inputs required to produce health services, but also depends on institutional set up or governance, and general awareness about health and related issues. In our model, part or all of inputs required to produce health is financed through tax revenues. Using Cobb-Douglas utility and production function, we explore the optimum tax rate under various scenarios of health care financing through tax revenues. The model is further extended to account for increasing returns to scale where input elasticity parameters in health production are not same. We find that increasing returns to scale in health production calls for higher tax rate to finance health productions.*

Keywords: health demand, Grossman model, behavioral factors, government policy.

JEL Classification: I12, I18, D11.

I. Introduction

Grossman’s (1972) health capital model is probably the most influential set up in theoretical health economics literature. Following his pioneering paper, later Grossman developed another structure to introduce human capital formation and demand for health (Grossman, 1999). In a sense Grossman’s work is critically based on Becker (1964). In what follows Wagstaff (1986a) also proposed a static version of health capital model. Grossman’s original (1972) model was a dynamic one which is relatively complicated for analytical policy implications purpose whereas Wagstaff’s (1986a) version is relatively simple and apt for policy oriented extension.

In the same line several interesting papers have been written later on. This includes Wagstaff (1986b), McGuire et al. (1988), Lukas (2013) Tavares (2007) etc. The issues of uncertainty and health care productivity in health production function were brought into health capital model by Koc (2004a, 2004b). On the other hand, the issues of poverty, growth and financing of health inputs in developing economy are elegantly addressed in Kida (2009), Coppola (2012), Morand (2005), Gottret et al. (2006), Evans (2002), Kumar (2011), etc.

Here in this paper we formulate a health demand model closely following Grossman (1972) and Wagstaff (1986a). Unlike the standard literature we assume that health (H) cannot be produced only by technical health input (T). It requires some other inputs like governance or administrative system, awareness of the person or the society (s) he belongs to. People’s awareness, essentially, determines the demand for health and as there is no room for excess supply, this helps conceiving the amount of supply required. Such idea captures the essence that a society with little awareness demands less, and hence production is lower as well. On the other hand, consumer optimizes utility that depends on the consumption of H and a composite consumption good, C.

The consumption behavior is constrained by consumer’s total income, Y and the health production function discussed above. In contrast with the conventional wisdom we try to focus on the framework where all health inputs and C are either sold in the market or provided by the state. State’s provision of such inputs are financed by tax collected from individuals (i.e., income tax) ensures supply of health inputs. In such a structure we derive the optimum amount of all health inputs and composite commodity. We also calculate the optimum tax rate in any economy under different production techniques. We further extend the model to look at the desired tax rate when different combinations of health inputs are financed through tax revenues.

The basic results that we derive in this essay are as follows:

a) Consumer’s utility maximization requires marginal rate of substitution (MRSS) between H and C to be equal to the ratio of shadow prices of inputs. Shadow price indicates the ratio of nominal price of input and its marginal productivity (MP) in health production function.

b) Optimum tax rate to finance health inputs depend on the nature of utility function and the nature of financing health inputs.
c) More health consumption calls for higher tax rate.
d) Economy should go for higher rate of tax if health production exhibits increasing returns to scale (IRS).

Remaining paper is structured as follows. The next section outlines the environment of the basic model and individual behavior in a health capital model. Then we extend it for a specified utility and health production function. This is followed by an analysis for different alternatives where inputs are either sold in the market or financed directly by government through tax revenues. The last section provides policy implications along with concluding remarks.

II. Environment and the consumer behavior

We specify a model of individual behavior with health demand in a standard utility maximization problem and health production function. We develop a static model following Wagstaff (1986a). Unlike the conventional literature we bring in a health production function that not only depend on technical health inputs but also on inputs like governance, consumer's awareness etc. which are qualitative, per se. Despite the qualitative nature of the later inputs we consider them as "simple" inputs and focus on their financing options.

The representative individual's utility is a function of two variables: H – health, and C – composite consumption good. In this model, H is a product or service which has to be either bought from the market or supplied by the government in exchange of certain tax paid, a-priori. Though, implications are not identical in these two alternatives as tax financing is mandatory even if the individual does not need medical care whereas in case of market determined price the individual only pays when he needs it. Despite differences in implications we should not forget that good health has positive externalities which depends on general environment or hygiene of the neighborhood generally provided by the government. This partially justifies the necessity of tax-financing. In particular developing countries also face the problem of less importance of H for relatively poor which subsequently handicaps the economy's prospect to do good later. Financing of H though can also take care of such long run problems. So, the utility function that an individual faces is

$$U = U(H, C) \qquad (1)$$

H is produced by factors T, G and A, where T indicates tangible technical health inputs such as infrastructure, number of medical personnel and equipment. G stands for institutional set up or governance – poor institution means poor governance, whereas good governance ensures proper and timely delivery of services as and when required.

A implies awareness which may define the level of education, role of media, role of non-governmental organization (NGO), access to social and cultural gathering etc.[1] Therefore health production function takes the following form

$$H = H(T, G, A) \tag{2}$$

The representative individual has to maximize utility subject to health production function given in (2) and the income of the consumer, Y. If all inputs, except G, are procured from the market the budget constraint yields

$$P_t T + P_a A + P_c C = Y \tag{3}$$

$P_i =$ price of the inputs and the composite commodity ($i = C, T,$ and A)

Note that institution, G, has no price per unit. It is, however, reasonable to introduce a flat tax on income that is used to finance institution or governance G. As long as tax is fixed (share of Y) and is deducted from total income, Y, it does not invoke any qualitative change in the optimization solution. Say the tax rate is τ; $0 < \tau < 1$. Note that an increase in τ may not guarantee good quality H production as this may not directly influence G due to some socio-economic-political, bureaucratic, corruption, pressure of some lobby etc. Nonetheless, we ignore such concern for the time being. So τ has a direct relation with G, and G positively influences H.

The modified objective function of the individual becomes

$$\max_{T,G,A,C} U = U\{H(T, G, A), C\}$$ (4)[2]

Subject to $P_t T + P_a A + P_c C = Y - \tau Y$ (5)[3]

Therefore, the Lagrangian is $\mathcal{L} = U\{H(T, G, A), C\} + \lambda[Y - \tau Y - P_t T - P_a A - P_c C]$

Where λ stands for standard Lagrange multiplier.

For the time being we replace τY by $P_g G$ in order to develop the basic foundation for further analysis.

The standard optimization principle yields

$$\lambda = \frac{\frac{\delta U \delta H}{\delta H \delta T}}{P_t} = \frac{\frac{\delta U \delta H}{\delta H \delta A}}{P_a} = \frac{\frac{\delta U \delta H}{\delta H \delta G}}{P_g} = \frac{\frac{\delta U}{\delta C}}{P_c},$$

where $MU_k = \frac{\partial U}{\partial i} (k = H \text{ and } C)$; $MP_j = \frac{\partial H}{\partial j}$ $(j = T, A \text{ and } G)$.

Simple manipulation of the optimization principle delineates the following conditions to guarantee both production equilibrium for health production and consumption equilibrium for utility maximization comprising H as a consumption good as well. Conditions are:

$$MRSS_{h,c} = \frac{P_t / MP_t}{P_c} = \frac{P_a / MP_a}{P_c} = \frac{P_g / MP_g}{P_c} \tag{6}$$

It is also important to note that ${P_t}/{MP_t}$, ${P_a}/{MP_a}$, ${P_g}/{MP_g}$ are essentially shadow prices of health in terms of T, A and G respectively (see Wagstaff, 1986a; Koc, 2004a). The production equilibrium is shown as

$$\frac{MP_t}{MP_a} = \frac{P_t}{P_a};\ \frac{MP_t}{MP_g} = \frac{P_t}{P_g};\ and\ \frac{MP_a}{MP_g} = \frac{P_a}{P_g} \qquad (7)$$

These conditions resemble tangency condition (marginal rate of technical substitution between two inputs) between production possibility curve and factor price ratio(s).

Now, if we replace $P_g G$ by τY, the equilibrium conditions will be slightly modified keeping the essence intact. In the latter case we won't have substitution of any input with G as there is no scope for the producers or for the consumers to adjust the production and/or consumption of G. We will, however, use the combination of the structures that we already developed in the subsequent analysis as we strive to determine the optimum level of tax to finance either G or other health inputs.

III. Cobb-Douglas functions and input financing

We use Cobb-Douglas (CD) utility and production functions. The utility function takes the following form:

$$U = H^{\alpha} C^{\beta} \qquad (8)$$

Where α and β have their usual interpretations – responsiveness of utility when quantity of commodity changes.

We further presume that health production function is not additive; rather it is a multiplicative one. Reason is that production of H must need all the factors in tandem. H becomes zero even when one of the factors is non-functioning. So, factors are absolutely complementary with each other in true sense. Therefore,

$$H = T.G.A \qquad (9)$$ [4]

This modifies the utility function as

$$U = (T.G.A)^{\alpha} C^{\beta} = T^{\alpha} G^{\alpha} A^{\alpha} C^{\beta}$$

So, the Lagrangian becomes $\mathcal{L} = T^{\alpha} G^{\alpha} A^{\alpha} C^{\beta} + \lambda[Y - P_t T - P_a A - P_c C]$; traditional optimization technique gives

$$\left.\begin{array}{c} P_t T = P_g G = P_a A \\ \frac{\alpha}{P_t T} = \frac{\alpha}{P_g G} = \frac{\alpha}{P_a A} = \frac{\beta}{P_c C} \end{array}\right\} \qquad (10)$$

Therefore, $P_c C = \frac{\beta}{\alpha} P_t T = \frac{\beta}{\alpha} P_g G = \frac{\beta}{\alpha} P_a A$

In what follows we get the equilibrium quantities of health inputs and C as follows

$$\left.\begin{aligned} T &= \frac{Y}{P_t}\frac{\alpha}{3\alpha+\beta} \\ G &= \frac{Y}{P_g}\frac{\alpha}{3\alpha+\beta} \\ A &= \frac{Y}{P_a}\frac{\alpha}{3\alpha+\beta} \\ C &= \frac{Y}{P_c}\frac{\beta}{3\alpha+\beta} \end{aligned}\right] \quad (11)$$

Equation (11) denotes Marshallian demand functions for T, G, A, and C. Once we know the values of T, G and A, the value of H can easily be solved for any given, income, tax rate and price.

Note that if we assign relatively more weights for H in the utility function, the values of T, G and A increases whereas that of C will fall. It is quite obvious that an increase in α leads to an increase in demand for H and decrease in C.

III.A. G is financed by Tax, $\boldsymbol{\tau}$

We have mentioned before that $\tau Y = P_g G \Rightarrow G = \frac{\tau Y}{P_g} \Rightarrow P_g = \frac{\tau Y}{G}$. Plugging this into the Marshallian demand function of (11) $G = \frac{Y}{\tau Y/_G}\frac{\alpha}{3\alpha+\beta} = \frac{GY}{\tau Y}\frac{\alpha}{3\alpha+\beta}$

$$\Rightarrow \tau^* = \frac{\alpha}{3\alpha+\beta} \quad (12)$$

τ^* signifies the optimum tax rate when only G is financed through tax revenue. So, in a system where only governance is managed by tax revenue, optimum tax rate should not be an arbitrary one. It has to be in tune with how much weight we put for H or for other inputs used in producing H and C. From (12) it is also obvious that $\tau^* = \frac{\alpha}{3\alpha+\beta} = \frac{1}{3+\beta/_\alpha}$, where an increase (decrease) in α (β) increases the value of τ^*. Taking clue from the arguments of previous sub-section we understand that increase in α leads to higher demand for H. So, supply of H needs to be increased to match with higher demand. This requires some more health inputs – T, G and A. This can only be procured or financed by higher tax revenue which is also guaranteed in equation (12). Therefore, the following proposition holds

Proposition 1: *Optimum tax rate depends on the nature of utility function.*

III.B. All inputs are financed by Tax, $\boldsymbol{\tau}$

Now let us extend our analysis for a system where all health inputs including G are financed by government's tax collection. This phenomenon is generally observed in most of the developing economies where all T, G and A are the responsibility of the government. So, once the tax rate, τ is determined, given the total income of an individual and/or the economy, we get to know the amount of revenue to be collected. The collected revenue would be shared among all the health inputs. Say, the share of revenue allotted for T, G and A are γ_t, γ_g and γ_a respectively. $0 < \gamma_t, \gamma_g, \gamma_a < 1$ and $\gamma_t + \gamma_g + \gamma_a = 1$.

Therefore broadly speaking $\gamma_t \tau Y = P_t T$; $\gamma_g \tau Y = P_g G$; and $\gamma_a \tau Y = P_a A$.

This implies $T' = \gamma_t \frac{\tau Y}{P_t};\ G' = \gamma_g \frac{\tau Y}{P_g};\ and\ A' = \gamma_t \frac{\tau Y}{P_a}$.

Comparing this with the value of G in the preceding section

$$G' = \gamma_g \frac{\tau Y}{P_g} < G = \frac{\tau Y}{P_g} \quad (13)$$

Given the values of P_g, Y and τ, amount of H produced in the latter case would be lower and so will be the amount of other health inputs. This is easily understandable as same amount of revenue is used to finance three inputs in the latter case whereas it was used to finance only G in the first case.

Now let us move further to determine the optimum tax rate when the amount of G and all other health inputs remain same as in the previous case. Taking clue from (10)

$$\tau Y = (\gamma_t + \gamma_g + \gamma_a)\tau Y = P_t T + P_g G + P_a A = 3P_g G$$

$$\Rightarrow P_g = \frac{(\gamma_t+\gamma_g+\gamma_a)\tau Y}{3G} \quad (14)$$

Using (11) and (14)

$$G = \frac{Y.3G}{(\gamma_t + \gamma_g + \gamma_a)\tau Y}\frac{\alpha}{3\alpha + \beta}$$

$$\Rightarrow \tau^{**} = \frac{3}{(\gamma_t+\gamma_g+\gamma_a)}\frac{\alpha}{3\alpha+\beta} = \frac{3\alpha}{3\alpha+\beta} \text{ (as } (\gamma_t + \gamma_g + \gamma_a) = 1) \quad (15)$$

Comparing (12) and (15) $\tau^{**} = \frac{3\alpha}{3\alpha+\beta} > \tau^* = \frac{\alpha}{3\alpha+\beta}$. Optimum tax in the latter is thrice of that of in the initial case as in the latter case three inputs need to be financed. The result also points to an interesting possibility that all inputs are financed in same proportion. It can be reassured as well from the arguments we developed before. Recalling optimization in the basic model

$P_t T = P_g G = P_a A$ and $\gamma_t \tau Y = P_t T;\ \gamma_g \tau Y = P_g G;\ \gamma_a \tau Y = P_a A.$

Hence, $\gamma_t = \gamma_g = \gamma_a$.

Again since$(\gamma_t + \gamma_g + \gamma_a) = 1 \Rightarrow 3\gamma_g = 1 \Rightarrow \gamma_g = 1/3 = \gamma_t = \gamma_a$.

So equation (15) can be modified as $\tau^{**} = \frac{1}{\gamma_g}\frac{\alpha}{3\alpha+\beta}$ (16)

Equation (15) and (16) are essentially identical as $\gamma_g = 1/3$.

Proposition 2: *Rate of increase in optimum tax rate will depend on how many health inputs are financed.*

Proof: See discussion above.

IV. Unequal responsiveness of factors in H

Unlike the previous section here we assume that the health production uses inputs where output elasticities of inputs are not same. One special case of such form could well be defined as equal output responsiveness of input case. Say the health production function assumes the following form

$$H = T^{\theta_1} G^{\theta_2} A^{\theta_3} \quad (17)$$

Note that θ_1, θ_2 *and* θ_3 are the input elasticities of output for T, G and A respectively. Utility function of (8) and health production function of (17) help us formulating the Lagrangian denoted below

$\mathcal{L} = T^{\theta_1 \alpha} G^{\theta_2 \alpha} A^{\theta_3 \alpha} C^{\beta} + \lambda\left[Y - P_t T - P_g G - P_a A - P_c C\right]$; First order condition for optimization provides

$$P_t T/\theta_1 = P_g G/\theta_2 = P_a A/\theta_3 \text{ and } P_c C = \frac{\beta}{\theta_1 \alpha} P_t T = \frac{\beta}{\theta_2 \alpha} P_g G = \frac{\beta}{\theta_3 \alpha} P_a A \quad (18)$$

Equilibrium usage and consumption of various health inputs and composite commodity are calculated and we get the equilibrium quantities of health inputs and C as follows

$$\left.\begin{aligned} T &= \frac{Y}{P_t} \frac{\theta_1 \alpha}{(\theta_1 + \theta_2 + \theta_3)\alpha + \beta} \\ G &= \frac{Y}{P_g} \frac{\theta_2 \alpha}{(\theta_1 + \theta_2 + \theta_3)\alpha + \beta} \\ A &= \frac{Y}{P_a} \frac{\theta_3 \alpha}{(\theta_1 + \theta_2 + \theta_3)\alpha + \beta} \\ C &= \frac{Y}{P_c} \frac{\beta}{(\theta_1 + \theta_2 + \theta_3)\alpha + \beta} \end{aligned}\right] \quad (19)$$

IV.A. G is financed by Tax, τ

When only G is financed by tax $\tau Y = P_g G \Rightarrow G = \frac{\tau Y}{P_g} \Rightarrow P_g = \frac{\tau Y}{G}$. Substituting this into the Marshallian demand functions described in (19)

$$G = \frac{Y}{\tau Y/_G} \frac{\theta_2 \alpha}{(\theta_1 + \theta_2 + \theta_3)\alpha + \beta} = \frac{GY}{\tau Y} \frac{\theta_2 \alpha}{(\theta_1 + \theta_2 + \theta_3)\alpha + \beta} \Rightarrow$$

$$\tau^{***} = \frac{\theta_2 \alpha}{(\theta_1 + \theta_2 + \theta_3)\alpha + \beta} \quad (20)$$

If the production function exhibits CRS, $(\theta_1 + \theta_2 + \theta_3) = 1$. In that case optimum tax rate derived in (20) reduces to $\tau^{***} = \frac{\theta_2 \alpha}{\alpha + \beta}$ (21)

If one compares (20) with (12) it would be apparent in a moment that $\tau^* > \tau^{***}$.[(5)] This is because optimum tax depends on the output elasticity of the factor which is financed by tax. In the basic model it was 1 and in the modified set up it is $\theta_2 < 1$. This calls for imposition of lower tax rate to finance such an input that in turn produces relatively lower output. The inference that we draw is that if the degree of responsiveness is low, government should not emphasize on such input as the desired change in H would not be that much. Note that in the basic model $\theta_1 = \theta_2 = \theta_3 = 1$ and $(\theta_1 + \theta_2 + \theta_3) = 3$. Even in the modified structure if we use these values we get

$$\tau^{***} = \frac{\theta_2\alpha}{(\theta_1+\theta_2+\theta_3)\alpha+\beta} = \frac{\alpha}{3\alpha+\beta}\ (= \tau^*) \quad (22)$$

Proposition 3: *The optimum tax rate depends on θ_2, the output elasticity of G.*

Proof: See discussion above.

IV.B. All inputs are financed by Tax, τ

In this subsection we extend the modified structure to explore the tax rate when all health inputs are financed through government tax. Following the assumption of III.B and the arguments developed in (18)

$$\tau Y = (\gamma_t + \gamma_g + \gamma_a)\tau Y = \frac{\theta_1}{\theta_2}P_g G + P_g G + \frac{\theta_3}{\theta_2}P_g G = P_g G\left(\frac{(\theta_1 + \theta_2 + \theta_3)}{\theta_2}\right)$$

$$\Rightarrow P_g = \frac{\tau Y}{G}\frac{(\gamma_t+\gamma_g+\gamma_a)}{(\theta_1+\theta_2+\theta_3)}\theta_2 \quad (23)$$

Using (19) and (23) $G = \frac{Y}{\tau Y}\frac{G(\theta_1+\theta_2+\theta_3)}{(\gamma_t+\gamma_g+\gamma_a)\theta_2}\frac{\theta_2\alpha}{(\theta_1+\theta_2+\theta_3)\alpha+\beta} \Rightarrow$

$$\tau = \frac{(\theta_1+\theta_2+\theta_3)\alpha}{(\gamma_t+\gamma_g+\gamma_a)\{(\theta_1+\theta_2+\theta_3)\alpha+\beta\}}.$$

Since $(\gamma_t + \gamma_g + \gamma_a) = 1$

$$\tau^{****} = \frac{(\theta_1+\theta_2+\theta_3)\alpha}{(\theta_1+\theta_2+\theta_3)\alpha+\beta} \quad (24)$$

When $(\theta_1 + \theta_2 + \theta_3) = 3$ like the basic model, equation (24) boils down to (15). However, if health production function H exhibits CRS, $(\theta_1 + \theta_2 + \theta_3) = 1$ then equation (24) becomes

$$\tau^{****} = \frac{\theta_2\alpha}{\alpha+\beta} \quad (25)$$

Comparing (24) and (21) $\tau^{****} = \frac{(\theta_1+\theta_2+\theta_3)\alpha}{(\theta_1+\theta_2+\theta_3)\alpha+\beta} > \frac{\theta_2\alpha}{(\theta_1+\theta_2+\theta_3)\alpha+\beta} = \tau^{***}$. For that in the last case all health inputs need to be financed without changing the equilibrium input and / or output combination.(6)

A careful investigation of (12), (15), (20) and (24) dictates that variations of model described in section III are the special cases of models of section IV. We could arrive at the results of (12) and (15) from (20) and (24) if$\theta_1 = \theta_2 = \theta_3$ and $(\theta_1 + \theta_2 + \theta_3) = 3 > 1$ pointing at health production function displaying IRS. Therefore, we propose that

Proposition 4: *The optimum tax rate is determined simultaneously by α, β, θ_1, θ_2 and θ_3.*

Therefore, in all the four cases demand elasticities of products (i.e., α and β) and output elasticities of inputs in health production function (i.e., θ_1, $\theta_2$and θ_3) determine the optimum tax rate. Desired rate of tax must not be set on an adhoc basis. Depending on the preference pattern of the representative consumer and the nature of input combinations required for H, government should design the tax rate and tax policy.

V. Concluding remarks

In this paper our endeavor was to develop a simple model of utility maximization where representative individual's utility depends on a composite commodity, C and health simultaneously.

We have not considered the issue of C production; C can be procured directly from the market. Production of H, however, is taken into account that needs three factors, T, G and A. In such a set-up we tried to explore the determination of optimum tax rate in different circumstances such as C-D production function with CRS, IRS, financing of G only, financing of all health inputs etc. It has been found in the analysis that in any of the above mentioned circumstances tax rate can never be an arbitrary one. It depends on how inputs and outputs are used in production and utility function, and how many inputs the government intends to finance by tax.(7)

The message we derive from the analysis: IRS in the production of H is an indication of economy's comparative advantage in H. Therefore, the country should emphasize on the production of H. Relatively more T, G and A have to be used in this direction. And when financing of such inputs in greater amount comes in, it can only be managed through higher tax rate.

It is also to be noted that when H increases, utility of the representative consumer goes up in particular and the economy reaches higher social indifference curve in general.

Notes

(1) This variable may also measure the degree of access to health care service that directly or indirectly depends on knowledge, distance, empowerment, nature of employment if any, control over family decision etc.

(2) Both H and C are "good" in economic sense indicating positive marginal utilities to the individual. However, preference for H may vary among different groups of people with varying levels of income and status concern. We guess that this phenomenon can also be analyzed using the structure that has been developed here. In that case the concern regarding status has to be modelled as a function of relative income. We apprehend that in such a situation marginal utility of H may vary significantly and at one extreme H may turn out to be a neutral good.

(3) For brevity, financing of G can be expressed as $\tau Y = P_g G$. Where P_g could be the salary of administrators and G may stand for the number of health administrators or supervisors. Therefore, for any given P_g and Y, any change in τ must be matched by equi-proportionate change in G, i.e. $\hat{\tau} = \hat{G}$.

(4) We will later modify the H production function using different weights for T, G and A. Even one can further extend it with weightage or importance in consistence with human development index. If we look at equation (9), it would be apparent in a moment that here all T, G and A have identical weights equal to unity. So this can be regarded as a special case of weights for various inputs.

(5) $\tau^* = \frac{\alpha}{3\alpha+\beta} = \frac{1}{3+\beta/\alpha}$ and $\tau^{***} = \frac{\theta_2\alpha}{(\theta_1+\theta_2+\theta_3)\alpha+\beta} = \frac{1}{\frac{(\theta_1+\theta_2+\theta_3)}{\theta_2}+\frac{\beta}{\theta_2\alpha}}$. When we consider CRS and weights are equal for all inputs, i.e. $\frac{1}{3}$, $\tau^{***} = \frac{1}{3+\frac{3\beta}{\alpha}}$. Therefore, $\tau^* > \tau^{***}$. Tax under IRS is greater than tax under CRS.

(6) In line with footnote 7 if we compare $\tau^{****} = \frac{(\theta_1+\theta_2+\theta_3)\alpha}{(\theta_1+\theta_2+\theta_3)\alpha+\beta}$, with $\tau^{**} = \frac{3\alpha}{3\alpha+\beta}$, we find $\tau^{**} > \tau^{****}$. Therefore irrespective of financing options tax under IRS is greater than tax under CRS. Underlying arguments run as before.

(7) We believe that similar analysis can also be used to determine tax for any commodity or services that could be provided by the state.

References

Becker, Gary S., 1964. Human Capital. New York: Columbia Univ. Press (for Nat. Bur. Econ. Res.).

Evans, R.G., 2002. Financing health care: taxation and the alternatives. *Funding health care: options for Europe*, pp. 31-58.

Gottret, P.E. and Schieber, G., 2006. *Health financing revisited: a practitioner's guide*. World Bank Publications.

Grossman, M., 1972. On the concept of health capital and the demand for health. *Journal of Political Economy*, 80, pp. 223-255.

Grossman, M., 1999. The human capital model of the demand for health. *NBER*, Working Paper 7078.

Kida, T.M., 2009. *The Systematic Integration of Health Care Market and Urban Poverty in Tanzania*. International Institute of Social Studies of Erasmus University (ISS).

Koc, Cagatay, 2004a. A theoretical rationale for an inelastic demand for health care. *Economics Letters*, 82, pp. 9-14.

Koç, Ç., 2004b. The productivity of health care and health production functions. *Health Economics*, *13*(8), 739-747.

Kumar, A.K., Chen, L.C., Choudhury, M., Ganju, S., Mahajan, V., Sinha, A. and Sen, A., 2011. Financing health care for all: challenges and opportunities. *The Lancet*, 377(9766), pp. 668-679.

Lukas, D., 2013. *Individual decisions and efficiency in health care demand* (Doctoral dissertation, Technische Universität Dresden).

McGuire, A., Henderson, J., Mooney, G., 1988. *The economics of health care: An introductory text*. Routledge & Kegan Paul.

Morand, O.F., 2005. Economic growth, health, and longevity in the very long term: Facts and mechanisms. *Health and economic growth: findings and policy implications*, *74*(2).

Tavares, A.I., 2007. A behavioral note on the demand for health.

Wagstaff, A., 1986a. The demand for health: a simplified Grossman model. *Bulletin of Economic Research*, 38(1), pp. 93-95.

Wagstaff A., 1986b. The demand for health: Theory and applications. *Journal of Epidemiology & Community Health*, 40, pp. 1-11.

Wagstaff, A. 2002. *Inequalities in health in developing countries: swimming against the tide?* Vol. 2795.World Bank Publications.