From micro to macro linkages of health, healthcare and poverty

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Abstract

This note addresses the research question of how to integrate the demographic dividend of healthcare in a dynamic recursive Computable General Equilibrium (CGE) while taking into account potential impoverishing effects of health expenditures that may lower the spillover effect on productive sectors. Indeed, household investments in health enhance the productivity, which enables individuals to accumulate income or wealth. However, catastrophic out-of-pocket health payments that might occur are barriers to achieve maximal productivity gains. This paper develops an innovative framework by taking into account these two side effects of household out-of-pocket expenditures on health. It provides guidance to researchers interested in a more thorough understanding of the economy wide effects of health expenditures.

Keywords: Poverty, agricultural productivity, health, out-of-pocket health expenditure

JEL classifications: Q12, I130, I320
1. Introduction

As earlier underlined in the Grossman’s theory of demand for healthcare (Grossman, 1972a, 1972b) and other microeconomics theories and studies (Becker 1965; Pitt and Rosenzweig 1986; Abul Naga and Lamiraud, 2011; Allen 2014), out-of-pocket health payments affect health and have implications for productivity and welfare. Investments in health may foster economic growth as developing a healthy labor force to create new opportunities from the demographic dividend.

Several studies have established the link between health and productivity at the micro level (Croppenstedt and Muller, 2000; Badiane and Ulimwengu, 2009; Allen and al., 2014) and it was widely recognized that health can enhance productivity. Poor health will lead to a loss of days worked or in reduced worker capacity, which, when family and hired labor are not perfect substitutes or when there are liquidity constraints, is likely to reduce the output (Antle and Pingali, 1994). It has been shown that there is a close nexus between health and poverty, suggesting that better health enhances the capability to work, which in turn enhances productivity and income (Kumar and Mitra 2009).

This paper develops a macroeconomic framework that allows the assessment of the evolution of household health consumption on labor productivity and on the overall economy. Indeed, we propose how we can integrate the indirect link between household out-of-pocket health expenditures and labor productivity in a macroeconomic perspective without omitting the fact that at a certain threshold these expenditures can become a burden and impoverish household because accounting for a large share of budget. Such payments can push households to reduce their expenditures for basic needs such as for food and to sell productive assets they used in their activities, what may lower the extent to which healthcare boost productivity.

A Computable General Equilibrium Model (CGE) is used as the basis of our framework. A CGE model is more suitable for estimating the externality effects between sectors and therefore determines the economic wide impacts of the structure and the changes in household out-of-pocket health payments. Another strength of the proposed approach is that it does not require necessary a health-focused Social Accounting Matrix (SAM) to address the interaction between healthcare provision and the economy.
The rest of this note is structured as follows. The first part presents the feature of the incorporation of the relationship between healthcare, health and productivity in CGE models and the second part attempts to take into account the existence of impoverishing effects.

2. Health, welfare and growth

2.1. Healthcare and growth: a macroeconomic perspective

In the CGE models production is carried out by activities which are assumed to maximize profits subject to their technology and taking prices of inputs and factors as given. Each producer maximizes its profits by choosing quantities corresponding to the equality between marginal revenue product of the different factors and rents. For details on CGE modelling interested readers can see Lofgren (2002) and Thurlow (2004).

At the top level of the production technology, we find in general a Constant Elasticity of Substitution (CES) function (it can also be a Leontief function) of the quantities of value-added and aggregate intermediate inputs. The former itself is a CES function of factors, whereas the latter is a Leontief of disaggregated inputs as specified in what follows:

$$QA_a = \alpha^a \cdot \left( \sum_{j \in F} \delta^a_j \cdot (QVA_a)^{-\rho^a_j} + (1 - \delta^a) \cdot (QINTA_a)^{-\rho^a} \right)^{-\frac{1}{\rho^a}}$$  \hspace{1cm} (1)

Where $a$ is a set of activities having a CES function at the top of the technology nest, $QA_a$ is the activity level, $QVA_a$ the quantity of aggregate value added and $QINTA_a$ the quantity of aggregate intermediate input, $\rho^a$ the CES activity function exponent, $\alpha^a$ the efficiency parameter in the CES activity function and $\delta^a$ the CES activity function share parameter.

Below in equation (2) the optimal mix of intermediate inputs and value-added is a function of the relative prices of value-added and the aggregate intermediate input ($PVA_a$ and $PINTA_a$).

$$\frac{QVA_a}{QINTA_a} = \left( \frac{PINTA_a}{PVA_a} \cdot \frac{\delta^a}{1 - \delta^a} \right)^{\frac{1}{\rho^a + 1}}$$  \hspace{1cm} (2)

Equation (3) states that for each activity the quantity of value-added is a CES function of the disaggregated factor quantities.
\[ QV_{a} = \alpha_{a} \cdot \left( \sum_{f \in F} \delta_{f}^{va} \cdot \xi_{f}^{va} \cdot (QF_{f})^{-\rho_{a}^{va}} \right)^{\frac{1}{\rho_{a}^{va}}} \]  

(3)

The different activities demand factors at the point where the marginal cost of each factor is equal to the marginal revenue product of factors, as presented in equation (4).

\[ W_{f} \cdot WFDIST_{fa} = PVA_{a} \cdot (1 - tv_{a}) \cdot QV_{a} \cdot \left( \sum_{f \in F} \delta_{f}^{va} \cdot \xi_{f}^{va} \cdot (QF_{f})^{-\rho_{a}^{va}} \right)^{-1} \cdot \delta_{f}^{va} \cdot \xi_{f}^{va} \cdot (QF_{f})^{-\rho_{a}^{va}} \]  

(4)

\( WFDIST_{fa} \) is the distortion factor for factor \( f \) in activity \( a \), \( W_{f} \) the average price of factor \( f \), \( \rho_{a}^{va} \), CES value-added function exponent e.g. a transformation of the elasticity of factor substitution, \( a_{a}^{va} \) the efficiency parameter in the CES value-added function, \( \delta_{f}^{va} \) the CES value-added function share parameter for factor \( f \) in activity \( a \), \( tv_{a} \) the rate of value-added tax for activity \( a \), \( QF_{fa} \) the quantity demanded of factor \( f \) from activity \( a \) and we include \( \delta_{f}^{va} \) to model productivity of factor \( f \) in act \( a \).

For each activity, the demand for disaggregated intermediate demand for commodity \( c \) \((QINT_{ca})\) is modeled with the Leontief formulation as the level of aggregate intermediate input \((QINTA_{a})\) use times a fixed intermediate input coefficient.

\[ QINT_{ca} = ic_{c} \cdot QINTA_{a} \]  

(5)

An aggregated domestic output from outputs of different activities of a given commodity is computed through a CES function to take into account imperfect substitutability between these products.

\[ QX_{c} = \alpha_{c}^{ac} \cdot \left( \sum_{a \in A} \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_{c}^{ac}} \right)^{\frac{1}{\rho_{c}^{ac}}} \]  

(6)

We assume that labor productivity, \( \xi_{L}^{va} \) in equation (3) with \( f = L \), growth is affected by external factors and depends on household health investment which corresponds to the health good they purchase from the health sector. Health is considered as an investment good meaning that its consumption is expected to provide productivity gains.
Considering this, the labor-augmenting efficiency parameter can be specified as endogenous and written in this manner:

\[
\xi_{L,a}^{va}(t + 1) = \xi_{L,a}^{va}(t) (1 + \Phi(H)) \tag{7}
\]

Where \(H\) is a health related variable in relation to household health status and \(\Phi\) translate the incidence of health status variable to productivity.

Assuming a linear decomposition of \(\Phi\) between labor categories we can write

\[
\xi_{L,a}^{va}(t + 1) = \xi_{L,a}^{va}(t) (1 + \sum_{l} s_{al} \varphi(H_l)) \tag{8}
\]

\(l\) represents the different labor categories in the model, \(H_l\) is their aggregate health status of labor category \(l\) and \(s_{al}\) the share of labor category \(l\) used in the production process of activity \(a\).

We use the mapping between labor categories and household categories to derive the potential impacts of health good consumption. This mapping can be obtained in surveys such as Household poverty monitoring survey that covers various topics such as employment and household consumption.

### Table 1: Mapping between labor types and household categories

<table>
<thead>
<tr>
<th>Labour types</th>
<th>Households</th>
<th>(h_1)</th>
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<th>…</th>
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<td>(l_1)</td>
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<td>(l_N)</td>
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<td>(\beta_{N2})</td>
<td>(\beta_{NI})</td>
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</tbody>
</table>

Source: Author

The above mapping will help to derive and incorporate the issue of health in the CGE model. \(\beta_{lh}\) represents the proportion of individuals belonging to labor category \(l\) and household \(h\).
The investment on health goods of different labor categories is computed by using the health consumption of household and by distributing accordingly. Therefore, we have the following relation.

\[ \xi_{La}(t + 1) = \xi_{La}(t) (1 + \sum_{i=1}^{L} s_{ai} \sum_{h} \beta_{lh} \left( \frac{A(P_{health}(h,t)Q_{health}(h,t-1))}{P_{health}(h,t)Q_{health}(h,t-1)} \right) ) \] (9)

With \( h \) the index for household groups within the model \( P_{health}(h,t) \) and \( Q_{health}(h,t) \) respectively the price and the quantity of health good consumed by household \( h \) at period \( t \) and the responsiveness of labor productivity to household consumption level of health inputs is captured through the elasticity parameter \( \vartheta \), regardless of the labor category and the household type. This parameter can be derived from the semi-elasticity estimated using household level data and taking into account endogeneity in health-labor productivity linkage, as did in Allen (2014).

### 2.2. Impoverishing effect of catastrophic expenditure

The growth rate of labor productivity parameter is linked to household investment in health goods as specified earlier. However, health payments when becoming catastrophic can be barriers to achieve maximal productivity gains.

For this reason, we want to capture more accurately the effect of household health payments and allow the equation (9) to depend also on the catastrophic out-of-pocket health payments through the inclusion of the household group related headcount ratio that we define as follows.

\[ H_c^h = \frac{1}{H^h} \sum_{i=1}^{H^h} \text{Ind} \left( \frac{T_i^h}{Y_i^h} > \xi_c \right) \] (10)

Where \( \text{Ind} \left( . \right) \) equals to 1 if \( \frac{T_i^h}{Y_i^h} > \xi_c \) and 0 otherwise, \( \xi_c \) represents the threshold above which the ratio \( \frac{T_i^h}{Y_i^h} \) corresponding to health expenditures are to be considered catastrophic, \( H^h \) the sample size of aggravated household group \( h \) , \( Y_i^h \) income and \( i \) subscript for household within the aggregate group \( h \).

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1 Each household maximizes a Stone Geary utility function subject to a consumption expenditure constraint.
Out-of-pocket payment is considered as catastrophic and make household impoverished if exceeding 40% of annual household non-food expenditure (Kawabata and Carrin, 2002; Xu and al., 2003; Karami et al., 2009) or 10% of the ratio between health expenditure to consumption expenditure (Pradhan and Prescott, 2002; Wagstaff and Van Doorlaer, 2003; Russel, 2004).

\( H_c^h \) gives an estimate of the proportion of households that experienced health payments above the threshold \( \xi_c \) for each household group of the model. \( H_c^h \) is likely related to the severity of morbidity level within the different household groups and translate the effectiveness of health inputs in generating technical progress. If all households within a given household group \( h \) spend on health goods without catastrophe, then there is a perfect transmission of investment in health inputs to productivity accordingly with the elasticity \( \vartheta \).

Hence, equation (9) can be rewritten in the following manner:

\[
\xi_{La}^{pa} (t + 1) = \xi_{La}^{pa} (t) \left( 1 + \sum_{i=1}^{L} \sum_{a=1}^{L} \beta_{ih} \left( \frac{A(P_{health}(h,t)Q_{health}(h,t-1))}{P_{health}(h,t)Q_{health}(h,t-1)} \right) (H_c^h)^{(1-1[A(PQ)>0]}) (1 - H_c^h)^{(1-A(PQ)>0}) \right)
\]

The model is intended to take into account potential non-automatic adjustment of productivity with respects to health investments.

We acknowledge that this effect of catastrophic out-of-pocket health spending will not only limit the extent to which health expenditure affect productivity as indicated in equation 11 but also will affect directly household poverty level.

Let consider \( g(y, Z) \) as the household poverty overshoot that equals to \( Z_{pov} - y \), with \( Z_{pov} \) the poverty line and \( y \) the income.

\( g(y, Z_{pov}) \) is monotonically decreasing with the income or any measure of living standard \( y \) for all \( y \leq Z_{pov} \) and \( g(y, Z_{pov}) \) equals to zero if \( y \geq Z_{pov} \). Giving this property \( g \) is invertible and it exists \( \Theta \) such as \( y = \Theta(g, Z_{pov}) \). We can express the above mentioned out-of-pocket health expenditures in this manner: \( \mathcal{T} = \chi (\Theta (g, Z_{pov}), H, M, X) + \mu \)

Where \( H \) represents household health status, \( X \) represent households’ socioeconomic and environmental characteristics, \( M \) the level of out-of-pocket household health expenditure and \( \mu \) the residual term.
\( \frac{\partial T}{\partial g} \) depicts the relation between catastrophic out-of-pocket household expenditures (above the catastrophic threshold) and poverty overshoot informs on the linkages between these catastrophic expenditures and aggregate poverty level. It indicates the intermediary variables through which the relation exists.

\[
\frac{\partial T}{\partial g} = x_1 \frac{\partial \Theta}{\partial g} + x_2 \frac{\partial H}{\partial g} + x_3 \frac{\partial M}{\partial g} + x_4 \frac{\partial X}{\partial g} + \frac{\partial \mu}{\partial g}
\]  
(13)

With \( x_j \) the derivate of \( X \) with regards to its j-th parameter. Many terms in the right-side equation are most plausibly positive or equals to zero, provided the variables are measured in term of non-deprivation. The term \( \frac{\partial \Theta}{\partial g} \) is negative as \( \Theta(g, Z_{pov}) \) is decreasing in \( g \).

The existence of these potential direct negative effects can be tested as commonly done in the literature of impoverishing effects of catastrophic out-of-pocket health expenditure (Hjortsberg, 2003; Xu et al., 2003; Gupta and Joe, 2013; Brinda et al., 2014; Séné and Cissé, 2015) and combined with the indirect effects that can be derived from CGE modelling applying the proposed framework.

3. Conclusion

The paper presents a framework for analyses that will shed light on the contribution of healthcare in the economy as productivity driver. The positive returns of health goods and services consumption occurs in the model through the effect on labor productivity growth. The model is easily applicable for countries using a nationally representative household survey and a dynamic CGE model calibrated to a SAM. Application of the model can be insightful regarding the coordination of policies between productive sectors and the health sector. Allocating more resource to health sector can allow achievement of higher economic growth and poverty reduction. Governments should create financial mechanisms (such as insurance coverage and Mutual Health Organizations) that offer protection against the burden of catastrophic out-of-pocket health expenditure for households to enable maximal returns of healthcare investment in terms of productivity. Given the tight budget constraints that governments are faced, this framework is informative on how it is possible to get higher
productivity returns without necessary much financial resource to directly allocate to productive economic investments.

Bibliography


