An operationalizing theoretical framework for the analysis of universal health coverage reforms: First test on an archetype developing economy

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Abstract

This paper presents an operationalizing theoretical framework to analyze the potential effects of universal health coverage (UHC) using dynamic stochastic general equilibrium (DSGE) model. The DSGE encapsulates a set of heterogeneous households that optimize their intertemporal utility of consumption, health capital, and leisure. The model is calibrated to capture the salient features of an archetype developing economy. The model is, then, used to simulate alternative UHC-financing policies. The theoretical framework we propose can be easily adapted to assess the implementation of UHC in a particular developing country setting. When applied to a hypothetical country, results show that the implementation of UHC can indeed improve access to healthcare for the population while offering households financial protection against future uncertainty. However, the degree of financial risk protection appears to vary across heterogeneous households and UHC-financing policies, depending on the associated benefits and the additional burden borne by each group.

Keywords

Universal Health Coverage; Financial Risk Protection; Dynamic Stochastic General Equilibrium Model; Developing Countries.

1. Introduction

Universal health coverage (UHC) – one of the Sustainable Development Goals 2015-2030 (Target 3.8) – has been considered as a vehicle to improve not only health-related outcomes but also other non-related health development goals (World Bank 2017; United Nations 2015; WHO 2015). However, to date, there has been no theoretical work that can enable to illustrate and assess the potential multiple effects that an implementation of the UHC may have at both micro- and macro-economic levels. In effect, akin to other public interventions, the implementation of UHC program is expected to affect households' dynamic decisions *vis-à-vis* the allocation of resources and their welfare. This effect may operate through different channels, mainly, the household's budget constraint and their health capital. At the macro-level, the effect of UHC may operate through different channels, mainly, government budget allocation and labor productivity, which in turn may affect the economic growth.

Economic implications of health insurance coverage have widely been examined in the literature. However, reported evidence on the impact of health insurance coverage on households' decisions as regards labor supply, consumption and savings appear to be rather mixed. For instance, while econometric-based studies (e.g., Baicker et al. (2014); (Bai and Wu 2014); Qin and Chernew (2014); Chou and Staiger (2001)) show that the impact of health insurance on labor supply and saving can be ambiguous (null, positive or negative), studies that employed general equilibrium models (e.g., Bairoliya et al. (2018); Imrohoroğlu and Kitao (2012)) show that both labor supply and saving may decrease due to, for instance, the increase in financial protection. Nonetheless, expanding coverage of a publicly-funded health insurance can have a staggering burden on government budget (Somanathan et al. 2014). Given the budget constraints and the limited capacity to generate additional fiscal space, many developing countries may have to consider alternative strategies to finance the additional health spending generated by the UHC (Heller 2006). These strategies can rely on general taxation or contributions or a mixed of both. These policies are expected to have different impacts on government budget and the economy (e.g., Auerbach and Gorodnichenko 2012; Arnold et al. 2011; Davig and Leeper 2011; Mertens and Ravn 2011). Overall, the net impact of UHC on the economy would be determined by its impact on households' behaviors *vis-à-vis* labor supply, saving and consumption, on the one hand, and on government budget, on the other hand. However, empirical evidence on the impact of alternative financing strategies for UHC remain to date scare.

This paper seeks, therefore, to lay out an operationalizing theoretical model that enables to assess *ex-ante* the potential impact of UHC in developing countries. Particularly, we build a dynamic stochastic general equilibrium (DSGE) model that is calibrated in a way to capture the salient features of a representative economy of a developing country. The model enables to examine the effect of an exogenous expansion of health insurance coverage at both the micro- and macro-level. To the best of our knowledge, this paper is the first in the literature on UHC that *ex-ante* assesses the impact of UHC at both the micro- and macro-level in the broader context of DSGE while allowing for endogenous labor supply, health capital and health investment decisions in addition to the consumption-savings decision.

We are particularly interested in assessing the impact of UHC on the behavior of heterogeneous households with respect to labor supply and spending-savings patterns in view of financial risk protection. The expansion of health insurance coverage is captured by increasing the share of covered population (*the breadth*) as well as the share of the covered healthcare costs (*the width*). We also assess the impact on government budget assuming a government-sponsored health insurance scheme and a fixed debt-GDP ratio. The potential impact of expanding the breadth and width of insurance coverage is assessed under different policy scenarios such as direct *vs*. indirect taxes, which may offer a different degree of financial risk protection. Lastly, given the fact that the path towards UHC is context-specific (Cotlear et al. 2015; Savedoff et al. 2012), the theoretical framework we propose can be easily adapted and contextualized to a particular developing country setting. The remaining of this paper is organized as follows. Section 2 lays out the model. In Section 3, we present the solution and the properties of the steady state, the calibration of the model parameters, and some comparative statistics of the steady state equilibrium. Section 4 shows the main simulations' results, and Section 5 concludes.

2. Theoretical framework

We build a dynamic stochastic general equilibrium model (DSGE) for a hypothetical economy that consists of heterogeneous households, a representative firm, an infinitely-lived government, and foreign sector. At each period $t = 1,2,\dots,T$, the population grows at a constant rate, κ. The share of each group of households, n_i, is also assumed to be constant. The following subsections lay out the model.

2.1 Households

The consumption side of the economy is represented by infinitely-lived heterogeneous households. We assume that households, $i = 1, \dots, \mathrm{I}$, are endowed with a maximum amount of labor, $\bar{l}$, and different levels of assets and of health capital accumulation. They obtain utility from consumption expenditure on non-health goods and services, c_{it}, as well as the level of accumulated health capital, h_{it}. We further assume that the amount of labor supplied, l_{it}, generates disutility. Households solve the following intertemporal utility-maximization problem

$$\max_{\{c_{it}, l_{it}, m_{it}, h_{it+1}, a_{it+1}\}_{t=0,\dots,T}} E_0 \sum_{t=0}^{T} \beta^t \left(\log c_{it} + \nu_i \log h_{it} + e_i \log(\bar{l} - l_{it})\right) \tag{1}$$

$$s.t \quad \left(1 - \tau_t^l - \pi_t\right) w_t l_{it} + (1 + r_t) a_{it} = (1 + \tau_t^c) c_{it} + oop_t m_{it} + a_{it+1} \tag{2}$$

$$h_{it+1} = \left(1 - \delta_i^h\right) h_{it} + f(m_{it}, l_{it}) \tag{3}$$

where E_0 is the expectation operator that entails the optimization which is conditional on the information given at time $t = 0$, with $\beta \in (0,1)$ being a time-discount rate. Health capital and leisure are assigned different weights, ν_i and e_i, respectively, relative to c_{it} in the utility function. The first constraint is the budget constraint where a_{it} is assets, m_{it} is total medical investment, oop_t is the share of out-of-pocket medical expenditures, w_t and r_t are the prices on labor and capital, respectively. Each household pays income and consumption taxes, τ_t^l and τ_t^c, and contribute to the health insurance scheme, π_t if insured. The second constraint represents the accumulation of health capital. We assume that h_{it} depreciates at a constant rate, δ_i^h, and can be produced through investment in health and leisure. Thus,

$$f(m_{it}, l_{it}) = m_{it}^{\chi_i} \left(\bar{l} - l_{it}\right)^{1-\chi_i} \tag{4}$$

where $\chi_i > 0$[1]. The solution to the household optimization problem is represented by the stochastic process $\{c_{it}, l_{it}, m_{it}, h_{it+1}, a_{it+1}\}_{t=0,\dots,T}$, where c_i, l_i, and m_i are the control variables and h_i and a_i

[1] Equation (4) assumes a constant elasticity of substitution ($CES = 1$). General formulation (with undetermined CES) was not tractable in the model. Note that Eq. (4) captures an important stylized fact in the economy: absenteeism at work (due to the necessity to contribute to health capital formation) and its effects on worker productivity. Indeed, worker-agent can (re)build their health capital using either m or $\bar{l} - l_{it}$ with possible substitutions. Then, changes in labor supply can be due either to variations in the relative price of health investment to wages (*first channel*), or to disutility from labor (*second channel* as shown in Eq. 6).

are the state variables. At each period, the solution satisfies, in addition to the two constraints, the following first-order conditions:

$$\frac{(1+\tau_{t+1}^c)u_{c_{it}}}{(1+\tau_t^c)u_{c_{it+1}}}=\beta(1+r_{t+1}) \tag{5}$$

$$\frac{f_{l_{it}}}{f_{m_{it}}}=\frac{\left(1-\tau_t^l-\pi_t\right)w_t}{oop_t}+\frac{(1+\tau_t^c)u_{l_{it}}}{oop_t u_{c_{it}}} \tag{6}$$

$$\frac{u_{h_{it+1}}}{u_{c_{it+1}}}=\frac{(1+r_{t+1})oop_t}{(1+\tau_{t+1}^c)f_{m_{it}}}-\frac{\left(1-\delta_i^h\right)oop_{t+1}}{(1+\tau_{t+1}^c)f_{m_{it+1}}} \tag{7}$$

Equation (5) is the standard Euler equation for consumption indicating that the marginal rate of substitution between current and future consumption adjusted for consumption tax is equal to the discounted rate of return on assets. Equation (6)[2] shows that the marginal rate of substitution between leisure and health investment in the production of health is lower than their prices ratio by $(1+\tau_t^c)u_{l_{it}}/oop_t u_{c_{it}}, u_{l_{it}}<0$. The last condition (Eq. 7) shows that the marginal rate of substitution between future health capital and consumption depends inversely on the current marginal production of investment in health and positively on the future marginal production of investment in health. This suggests that the smaller (larger) the current (future) marginal production of investment in health, the larger the household willingness to forgo some of future consumption for future health capital.

2.2 Other agents

We assume a representative maximizing-profit firm which has the following program

$$\max_{K_t,L_t}\ \ profit_t=Y_t-w_tL_t-\left(r_t\left(1+\tau_t^k\right)+\delta^k\right)K_t \tag{8}$$

$$s.t.\ \ Y_t=Z_tK_t^{\alpha}L_t^{1-\alpha} \tag{9}$$

$$\log Z_{t+1}=\rho^z\log Z_0+(1-\rho^z)\log Z_t+\varepsilon_t^z \tag{10}$$

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[2] Equation (6) can be written as $(1-\tau_t^l-\pi_t)w_t\left(\bar{l}-l_t\right)=((1-\chi)/\chi)oop_t m_t+e(1+\tau_t^c)c_t$. This suggests that the monetary value of leisure is a weighted average of total expenditure (i.e., health investment and consumption), where the weights, $(1-\chi)/\chi$ and e, are, respectively, the relative preference of leisure to health investment in the health production function, and the relative preference of leisure to consumption in the utility function.

where Y_t is the aggregate output, L_t and K_t are the aggregate levels of labor and capital, respectively, τ_t^k is capital tax, and δ^k is the depreciation rate of capital which is assumed to be constant. We assume a Cobb-Douglas production function with share of capital equals to α and level of technology equals to Z_t that is assumed to follow a first-order autoregressive process, where ρ^z is constant and ε_t^z is a log-normally distributed disturbance. The equilibrium values of wage and interest rate are, respectively,

$$w_t = (1-\alpha)Z_t k_t^{\alpha} l_t^{-\alpha} \tag{11}$$

$$r_t = (\alpha Z_t k_t^{\alpha-1} l_t^{1-\alpha} - \delta^k)/\left(1+\tau_t^k\right) \tag{12}$$

where k_t and l_t are capital investment and labor demand in per capita terms. The government spends on goods and services, g_t, as well as medical goods and services, m_t. Government expenditure is financed through taxation, health insurance contributions and by issuing debt, b_t. We assume that the government seeks to maintain the debt-GDP ratio at a certain level, γ_t. The government budget is given by

$$(1+\kappa)b_{t+1} - (1+r_t)b_t = g_t + (1-oop_t)m_t - \left(\tau_t^l + \pi_t\right)w_t l_t - \tau_t^c c_t - \tau_t^k r_t k_t \tag{13}$$

where all variables are in per capita terms. The accumulated debt is related to output by $b_t = \gamma_t y_t$. The international budget constraint is

$$(1+\kappa)a_{t+1}^f - (1+r_t)a_t^f = tb_t \tag{14}$$

where a_t^f is net foreign assets and tb_t is trade balance per capita.

2.5 Market clearing equations

Competitive equilibrium requires that capital, labor, and output markets all clear in each period as follows,

$$k_t = a_t + a_t^f - b_t \tag{15}$$

$$l_t = \sum_{i=1}^{J} n_{it} l_{it} \tag{16}$$

$$y_t = c_t + m_t + g_t + i_t + tb_t \tag{17}$$

where i_t is investment. Capital accumulates according to the following equation,

$$(1+\kappa)k_{t+1} = (1-\delta^k)k_t + i_t \tag{18}$$

2.6 Solution method

Following Rausch (2009), we solve the model using the "sequential recalibration method" – a method that is designed to deal with many heterogeneous households in DSGE model. The equilibrium is found in two steps. First, we find the general equilibrium solution by log-linearizing the model around its steady state assuming that we only have one representative household. In this step, we assign an initial guess of the preference's parameters, v, e, δ^h, χ, for this representative household. Secondly, given general equilibrium prices, we find the partial equilibrium solution for each household. Then, the preference parameters of the representative household are *recalibrated* iteratively based on the aggregate behavior of the multiple heterogeneous households. Iteration stops when the difference between the solution of the representative household (macro-level) and the aggregate values obtained from partial equilibriums is very small. For more details, see Rausch (2009).

3. Steady state

3.1 Solution of the steady state

A steady-state equilibrium is a state where all (per capita) variables are assumed to be time-invariant. The steady state values of wage and interest rate are, respectively,

$$w^* = (1-\alpha)\left(\frac{\left(\frac{1}{\beta}-1\right)(1+\tau^k)+\delta^k}{\alpha}\right)^{\alpha/(\alpha-1)} \tag{19}$$

$$r^* = \frac{1}{\beta} - 1 \tag{20}$$

It is worth noting that both wage and interest are not functions of the health insurance parameters. At the micro-level, the steady state value of labor supply for each household, i, is

$$l_i^* = \frac{\left(\frac{\zeta_{i1}+1}{\zeta_{i2}}\right)(1-\tau^l-\pi)w^*\bar{l} - r^* a_i}{\left(1+\frac{\zeta_{i1}+1}{\zeta_{i2}}\right)(1-\tau^l-\pi)w^*} \tag{21}$$

where $\zeta_{i1} = \left(1 - \beta\left(1 - \delta_i^h\right)\right)/\chi_i \delta_i^h \beta v_i$ and $\zeta_{i2} = ((1 - \chi_i)/\chi_i) + e_i \zeta_{i1}$. The steady state value of labor depends on input prices and household's initial endowment of assets. Out-of-pocket expenditure has no impact on the steady state value of labor supply while health insurance contribution has a negative impact if $a_i > 0$ as shown in the following equation

$$\frac{\partial l_i^*}{\partial \pi} = \frac{-\left((1 - \chi_i)\chi_i \delta_i^h \beta v_i + \left(1 - \beta\left(1 - \delta_i^h\right)\right) e_i \chi_i\right) r a_i}{\left(\chi_i \delta_i^h \beta v_i + \left(1 - \beta\left(1 - \delta_i^h\right)\right)(e_i + 1)\chi_i\right) w (1 - \tau^l - \pi)^2} \tag{22}$$

Note that if the initial value of assets is zero, then the change of labor supply will be zero. This suggests that if labor is the solely source of income, then households will not alter their labor supply as premiums change. The steady state value of investment in health is

$$m_i^* = \frac{(1 - \tau^l - \pi) w \left(\bar{l} - l_i^*\right)}{oop\zeta_{i2}} \tag{23}$$

Thus, the total change in investment in health due to a change in health insurance parameters is

$$dm_i^* = \frac{\partial m_i^*}{\partial \pi} \partial \pi + \frac{\partial m_i^*}{\partial oop} \partial oop \tag{24}$$

where

$$\frac{\partial m_i^*}{\partial \pi} = -\frac{w}{oop\zeta_{i2}} \left((1 - \tau^l - \pi)\frac{\partial l_i^*}{\partial \pi} + \left(\bar{l} - l_i^*\right)\right) \tag{25}$$

$$\frac{\partial m_i^*}{\partial oop} = -\frac{(1 - \tau^l - \pi) w \left(\bar{l} - l_i^*\right)}{\zeta_{i2}} \tag{26}$$

Since $\left(\bar{l} - l_i^*\right) < -(1 - \tau^l - \pi)\, \partial l_i^* / \partial \pi$, then the increase in premiums reduces health investment. Similarly, the increase of oop would decrease health investment. Thus, health insurance can affect health capital, $h_i^* = \left((m_i^*)^{\chi_i}\left(\bar{l} - l_i^*\right)^{1-\chi_i}\right)/\delta_i^h$, through two channels: health investment and labor supply. The steady state value of consumption expenditure on non-health goods and services is

$$c_i^* = \frac{oop\zeta_{i1}m_i^*}{(1+\tau^c)} \tag{27}$$

The provision of health insurance can affect the steady-state value of consumption expenditure through changes in health investment as follows

$$\frac{\partial c_i^*}{\partial \pi} = \frac{oop\zeta_{i1}}{(1+\tau^c)}\frac{\partial m_i^*}{\partial \pi} \tag{28}$$

$$\frac{\partial c_i^*}{\partial oop} == \frac{\zeta_{i1}m_i^*}{(1+\tau^c)}\left[\epsilon_{m_i^*,oop} + 1\right] \tag{29}$$

where $\epsilon_{m_i^*,oop} = -1$ is the elasticity of investment in health to out-of-pocket expenditure, thus, $\partial c_i^* / \partial oop = 0$. This indicates that c_i^* is only affected by health insurance contributions.

At the macro level, the steady state value of capital investment per capita is

$$k^* = (\vartheta_1)^{\frac{1}{\alpha-1}} \frac{\left((1-\tau^l-\pi)(1-\alpha)\left({\vartheta_1}^{\alpha/(\alpha-1)}\right)\bar{L}\right) + \left(\frac{\vartheta_4}{\vartheta_5}tb\right)}{(1-\tau^l-\pi)(1-\alpha)\left({\vartheta_1}^{\alpha/(\alpha-1)}\right) + \frac{\vartheta_4}{\vartheta_5}(\vartheta_2+\vartheta_3)} \tag{30}$$

where $\vartheta_1 = \left[\left((1/\beta)-1\right)(1+\tau^k)+\delta^k\right]/\alpha$, $\vartheta_2 = \left((1/\beta)-\kappa-1\right)\gamma - (\tau^l+\pi)(1-\alpha)\left({\vartheta_1}^{\alpha/(\alpha-1)}\right) - \tau^k(1/\beta)\left({\vartheta_1}^{1/(\alpha-1)}\right)$, $\vartheta_3 = \left({\vartheta_1}^{\alpha/(\alpha-1)}\right) - (\kappa+\delta^k){\vartheta_1}^{1/(\alpha-1)}$, $\vartheta_4 = \left((1-\chi)\beta v\delta^h / \left(1-\beta(1-\delta^h)\right)\right) + e$ and $\vartheta_5 = \left(\chi\beta v\delta^h / \left(1-\beta(1-\delta^h)\right)\right) + 1$. The impact of health insurance contribution on capital investment is

$$\frac{\partial k^*}{\partial \pi} = \frac{\frac{\vartheta_4}{\vartheta_5}(1-\alpha)\left({\vartheta_1}^{(\alpha+1)/(\alpha-1)}\right)\left[tb\left(\frac{\vartheta_4}{\vartheta_5}+1\right) - \left(\frac{1}{\beta}-\kappa-1\right)\left(\gamma+{\vartheta_1}^{1/(\alpha-1)}\right)\bar{l}\right]}{\left((1-\tau^l-\pi)(1-\alpha)\left({\vartheta_1}^{\alpha/(\alpha-1)}\right)+\frac{\vartheta_4}{\vartheta_5}(\vartheta_2+\vartheta_3)\right)^2} \tag{31}$$

The sign of the derivative $\partial k^*/\partial \pi$ depends on the sign of the term between the square brackets. The impact of the provision of health insurance is expected to increase capital if $tb(\vartheta_4/\vartheta_5+1) > \left((1/\beta)-\kappa-1\right)\left(\gamma+{\vartheta_1}^{1/(\alpha-1)}\right)\bar{l}$.

We are also interested in the public finance indicators. The steady state value of government expenditure (excluding health insurance reimbursement) is

$$g^* = \left(\vartheta_3 {\vartheta_1}^{-1/(\alpha-1)} k^* - tb\right) - \frac{(1-\tau^l-\pi)w^*\left(\bar{l} - {\vartheta_1}^{-1/(\alpha-1)} k^*\right)\left(oop + (\vartheta_5 - 1)(1+\tau^c)\right)}{\vartheta_4 (1+\tau^c) oop} \tag{32}$$

The impact of out-of-pocket payment share is positive while the impact of premiums is a function of $\partial k^*/\partial \pi$. The steady state value of government revenues, gr, is

$$gr^* = \left((\tau^l + \pi)(1-\alpha)\vartheta_1 + \tau^k r^*\right)k^* + \frac{\tau^c(1-\tau^l-\pi)w}{\vartheta_4(1+\tau^c)}\left(\bar{l} - {\vartheta_1}^{-1/(\alpha-1)} k^*\right) \tag{33}$$

Thus, similar to the government expenditure, the impact of increasing premiums on government revenues is a function of $\partial k^*/\partial \pi$, however, there is no impact of altering the out-of-pocket payment share.

3.2 Parametrization

For the purpose of our analysis, we create a hypothetical developing country by averaging the relevant socioeconomic and sociodemographic characteristics of a set of developing (low- and middle-income) countries (e.g., population growth rates, out-of-pocket payments, tax rates, etc.). This economy consists of sixteen heterogeneous households. Households are different in their gender, health status, socioeconomic status, and insurance status. For simplicity, we assume that all households are employed. Households have different weights of health capital and leisure in the utility function, different elasticities of health investment in the production of health, and different rates of health capital depreciation. The model parameters are summarized in Table 1. Different sources are used for this purpose. These include, amongst others, the World Development Indicators (WDI), representative surveys, and the literature. The only parameter that is arbitrary chosen is health insurance premium. In fact, in some developing countries, health insurance contributions are paid for indirectly through payroll taxes. It is, thus, difficult to find information on contribution rates for all countries.

The average population growth for low- and middle-income countries (LMICs) is about 1.6% (World Bank 2018). The population is decomposed as follows: 49.5% are female (World Bank 2018), 64.8% have good health status, 28.1% are considered poor (World Bank 2018), while 40% do not have health insurance (e.g., Alami 2017; Cotlear et al. 2015; Lagomarsino et al. 2012). Every household is assigned a value of health capital depreciation with an average value of 0.056 as in Scholz and Seshadri (2011). Health depreciation is greater for men and the unhealthy (Gerdtham and Johannesson 1999). We assume that the poor and uninsured have higher rates of health depreciation as compared to the non-poor and insured. The parameters, v_i, e_i and χ_i are calibrated using the steady-state equations of (Eq. 3, Eq. 6 and Eq. 7) and data from the World Health Surveys (WHS) for different developing countries. As Table 1 shows, the mean values of the weights of health capital and leisure are, 0.15 and 0.43, respectively. This indicates that, on average, health capital is less important in the household utility than the time devoted to leisure, whereas both health capital and leisure are less important than consumption expenditure. The average elasticity of health investment in the production of health is estimated at about 70%, which indicates that health investment is more important than leisure time in the production of health.

The value of the time discount factor is set at 0.985 as in Auerbach and Kotlikoff (1987). As regards the elasticity of capital, different values are found in the literature (e.g., 20% in Cerda and Larrain (2010) and Berg et al. (2013) and 30% in Millner and Dietz (2015)). We, therefore, set the value of elasticity of capital to 25%. As for the depreciation of capital, empirical evidence shows that the rate of capital depreciation can range from less than 2% to more than 70% (e.g., Mercado and Cicowiez 2013; Cerda and Larrain 2010; Bu 2006). In this paper, we apply a modest value of 40%. The tax rates are calculated using data from the multinational services networks[3]. The values of labor income tax, consumption tax, and capital tax are set to 5%, 13.5%, and 24%, respectively. According to the World Bank, the average debt-GDP ratio in LMICs is about 43%. As for the health insurance parameters, we choose an arbitrary value for the premium rate which equals to 5%. The share of out-of-pocket payment is set at 44%, which is the average value for LMICs calculated based on the WDI. In what follows, we show how changes in some important parameters can affect at the steady state equilibrium.

3.3 Comparative statistics

[3] These include PricewaterhouseCoopers (PwC), Klynveld Peat Marwick Goerdeler (KMPG), and "trading economics".

This sub-section summarizes the main comparative static properties of the steady state. Table 2 reports percentage changes of the model variables resulting from alerting relevant parameters, namely, health insurance premiums, share of out-of-pocket payments, labor and consumption taxes, and the proportion of the population covered. As shown in Table 2, doubling health insurance premiums (from 5 to 10%) would reduce labor supply (with a notable exception being the poorest 25% of the population). This would, in turn, reduce consumption expenditure, health investment and health capital (by an average of 2.2%, 1.9%, and 1.6% respectively). By contrast, such increase in premiums would increase both public revenues and expenditures (by 9.9% and 12.8%, respectively) as compared to the initial steady state.

A reduction in out-of-pocket payment, oop, (from 44% to 30%) would not affect the steady state values of labor supply and consumption (as shown in Eq. 21 and Eq. 29). However, health investment and health capital would increase (by 16.4% and 13.4%, respectively). The increase in health insurance reimbursement resulting from the reduction in oop would balloon public health expenditures (a 34.6% increase) while leaving public revenues unchanged. Given the assumption of fixed debt-GDP ratio (balanced budget), the increase of public health expenditure would crowd out other public expenditures (a decrease by 7.9%).

An increase in labor income tax (by 5%) would have similar impact as premiums shock. However, given that labor income tax is borne by all households, the impact of labor tax shock appears to be larger. For instance, both public revenues and expenditures rise by 24.8% and 30.9% as compared to 9.9% and 12.8% in the case of premiums shock, respectively. A similar increase in consumption tax (by 5%) would generate lower public revenues than those generated by labor tax (18.6% vs. 24.8%). Thus, the impact on public expenditure is also lower (22.7% vs. 30.9% under labor tax). At the disaggregate level, only consumption expenditures appear to fall by 4.2% for all households while no impact is observed for labor supply and health investment because both are independent of consumption tax (as shown in Eq. 21 and Eq. 23).

Turning to the health coverage, we first consider the impact of a full coverage of the population. Then, we assess the impact of an increase in the coverage of health care costs. Under full population coverage, all households incur the same premiums and out-of-pocket share. Results, which are also reported in Table 2 show that, on average, both labor supply and consumption expenditure would decrease due to premiums, while health investment would substantially increase thanks to lower oop. Nevertheless, the provision of such full coverage would increase public revenues (by about 15%) and public health expenditure (by 165%) with a crowding out effect on other public expenditures (a decrease by 19.5%).

Considering now the impact of a cut in the share of out-of-pocket payment (from 44% to 30%) coupled with a full coverage of the population. While a similar impact on public revenues as that observed under full coverage (with 44% oop share) is observed, such reduction in oop would further increase the level of public health expenditure by more than three folds as compared to the initial steady state.

The comparative statics – presented above – give an overall picture on how the expansion of health insurance coverage may affect the economy. In the next section, we study the dynamic effects of such changes.

4. Simulation Scenarios

In this section, we use the impulse response functions (IRFs) that allows to assess the dynamic reactions of the model variables to a given shock. We analyze four scenarios. The first scenario assumes an expansion of the public health insurance coverage from a current level of 40% to a full coverage of the population (i.e., the breadth of coverage). This scenario involves the same steady state premiums ($\pi = 5\%$) and out-of-pocket payments share ($oop = 44\%$). The second scenario assumes, beside the full coverage of the population, an expansion of the coverage of health care costs (i.e., the width of coverage). This is measured by a reduction in the out-of-pocket health expenditure (from 44% to 30%). The third and fourth scenarios introduce a shock to the second scenario by increasing labor and consumption taxes, respectively. Results from the simulations are displayed in Figures 1.1-4.3. The implementation of the UHC (*first scenario*) appears to exercise a positive (net) effect on the supply of labor. Given that employees are assumed to shoulder the full burden of health insurance costs, such increase in labor supply is expected as agents would substitute health investment for leisure in the formation of health capital, on the one hand, and compensate for the decrease in wages on the other hand.

A closer look at the disaggregate results shows that the increase in labor supply is more pronounced amongst the poor segment of the population – who holds very low (or negative) endowment of assets – as compared to non-poor. In addition, some variations can be observed across the health insurance and health status groups with labor supply responsiveness being slightly higher for the formerly-insured and the unhealthy as compared to the newly insured and the healthy.

This is not surprising given our parametrization attaching more (*less*) weights to leisure (*labor*) in the preferences of the formerly-insured and the healthy.

With the exception of the rich-healthy newly-insured group, the proposed UHC-oriented reform appears to reduce future savings, particularly amongst the unhealthy and the poor groups. This is in line with the previous literature suggesting that the *precautionary-saving motive* can fall with the expansion of insurance coverage (e.g., Kirdruang and Glewwe 2018; Bai and Wu 2014). Interestingly, our results show that the *UHC-driven reduction in savings* would rather enhance the initially low current health investment at the expense of current consumption. Given the parametrization that equally weighs consumption in the utility functions, the decrease in the current consumption does not vary across the heterogeneous groups of the population. As a result, health capital increases with higher improvements being always in favor of the *worst off* groups of the population (*viz*. the poor, the unhealthy, and the newly-insured). In our model, the production of health capital is a function of both health investment and leisure with higher weights being assigned to health investment. Thus, the impact of the increase of health investments overwhelms the negative impact due to the decrease in leisure. Turning to the budgetary impact of such UHC plan, the *population-wide contributory basis* coupled with a shallow coverage of health care costs (55%) appear to yield excess revenue that can be used to expand public expenditures, *proviso* a fixed debt-GDP ratio.

By considering a more generous UHC plan (*second scenario*), similar trends can generally be observed with respect to the households' behaviors *vis-à-vis* labor supply, savings, consumption expenditure, health investment, and health capital. Interestingly, the magnitude of increase in health investment appears to be higher as compared to the first scenario due to the increase in the level of financial protection offered by this UHC plan. The latter implies higher public health spending that – given the same funding resources – would *crowd out* other public expenditures. Such *crowding out effect* would last for about twenty periods following the shock. A slight positive effect on public expenditures can then be observed before returning to its initial steady state. This indicates that a parallel expansion of the coverage of both population and healthcare costs may not be self-financed and would temporarily increase the burden on the government budget. This calls for supplementary financial resources. Alternative financing strategies for UHC include, amongst others, increasing revenue from taxes such as income or consumption tax as well as health insurance contributions.

In the following two scenarios, we assess the impact of increasing labor income tax and consumption tax by 5%.

As compared to the second scenario, the 5% increase in labor tax appears to help eliminate the negative impact on the government budget resulting from the expansion of the coverage of healthcare costs. Nevertheless, the resulting decrease in wages, which is relatively higher as compared to the second scenario, would further enhance labor supply with similar discrepancies across groups as those observed in the second scenario. The decrease in future savings is lower under this scenario (as compared to the second scenario) due to the lower future certainty that is associated with the new tax burden borne by the households. Also of note that the most disadvantaged (*unhealthy and poor*) newly-insured group would opt for more saving due to the risk of higher future burden.

Alternatively, a similar increase of consumption tax would approximately generate the same revenues as labor tax. However, it is worth noting that such finding relies on the assumption that both income and consumption taxes are borne by all households – an assumption that can be relaxed. As compared to the income tax shock, some important differences due to the application of consumption tax may worth highlighting. Investment in health appears to be higher, thus, leading to higher public health spending. Unlike the labor tax, there will be no further decrease in wages, hence, no further increase in labor supply as compared to the second scenario. This is in line with the fact that indirect taxes are less likely to distort labor-leisure choice as compared to direct taxes. Furthermore, the impact on savings is lower or even positive for some disadvantaged groups than the labor tax. This indicates that higher consumption taxes would increase future uncertainty, hence, trading off consumption for savings and health investment.

5. Discussion

As mentioned at the outset, an operationalizing theoretical framework that enables to assess *ex-ante* the potential impact of the UHC-oriented reforms – one of the 2015-2030 SDGs – was in order. This paper sought to respond to this demand by developing a general theoretical framework that can be adapted and applied to assess alternative UHC-financing policies in a real world setting. The implementation of UHC may have multiple repercussions at both micro- and macro-level of the economy. A subtle treatment of these effects may thus require going beyond the descriptive anecdotal approach that has so far dominated the literature (including relevant reports of the international organizations). We, therefore, proposed to assess the potential impact of UHC within a broader context of dynamic stochastic general equilibrium (DSGE) model of heterogeneous households with endogenous labor, health capital, and savings. The proposed DSGE model has been carefully calibrated to reflect the salient features of developing economies.

Enhancing *financial risk protection* and *improving population health* are often cited as the main goals of the UHC (WHO and World Bank 2017; WHO 2015). Therefore, we were particularly interested in assessing the extent to which these goals may be achieved under alternative UHC-financing policies. This has been done by assessing the responsiveness of heterogeneous groups – defined in terms of socio-economic and health characteristics – *vis-à-vis* labor supply and savings-spending patterns.

Some results emerged from our analyses may worth discussing in light of previous findings reported in the literature and the ongoing policy debate on the UHC-oriented reforms. First, our results corroborate previous evidence suggesting that the UHC can improve the general population health – captured in our model by health capital accumulation – through shifting resources towards health investment on the part of both households and the government (e.g., Cotlear et al. 2015; Moreno-Serra and Smith 2012). Secondly, under conditions of low-coverage and limited fiscal space, a parallel expansion of both the UHC breadth (population) and width (healthcare costs) appeared to exercise a budgetary pressure on existing resources and ultimately crowd out expenditures on other public sectors. Although the crowding-out effect of UHC was shown in our model to be temporary (given the assumption of a fixed debt-GDP ratio). A policy adjustment that can mobilize additional resources for UHC and restore the budgetary position of the government may be required. Thus, as argued by Mcintyre, Meheus, and Røttingen (2017) and Meheus and McIntyre (2017), it seems more plausible to create a fiscal space for UHC through mobilizing additional resources (through for instance taxation) rather than reallocating existing resources. Raising UHC premiums is another policy option that can be used to generate additional revenues. However, given that the expansion of the population coverage can be on a voluntary-basis (at least in the early stage), raising premiums may discourage enrollment, particularly, for the less advantaged groups that constitute the bulk of the uninsured population (e.g., Barasa et al. 2018; Pettigrew and Mathauer 2016). We, therefore, limited our analyses in this paper to direct and indirect forms of taxations.

Thirdly, the overall impact of UHC-oriented reforms on households' behaviors with respect to labor supply, saving-spending (consumption and health investment) patterns, as well as health capital appeared to be relatively comparable under the four scenarios. Interestingly, however, the size of the impact of alternative UHC-financing policies emerged to be different across heterogeneous households. Such effect seems to depend mainly on the associated benefits (*viz*. the width of health insurance coverage) and the incremental tax burden that is borne by each group of the population. For instance, it was interesting to show how the behavior of the disadvantaged households towards savings can vary across the different tax policies (increasing under consumption tax while decreasing under income tax). This seems to reflect the different degrees of financial protection that can be associated with each alternative UHC-financing policy.

An important conclusion to be drawn from the analyses is that the policy choice is a key for the achievement of UHC goals mainly the *financial risk protection* goal. Achieving the latter requires increasing not only the breadth of population coverage but also the width (cost of services covered). However, given their limited fiscal space, many developing countries' government may opt for expanding the breadth of coverage (in the early stage of implementation) with a shallow coverage of healthcare costs. Under such conditions, a policy that may ensure a similar degree of financial protection (i.e., similar effect on *saving-spending patterns*) to that observed under a hypothetically more generous UHC scheme (with higher width) may, thus, be desired. Although relying on specific assumptions, results reported in this paper can be informative as they demonstrate how alternative UHC-financing policies can have varying economic implications at both micro- and macro-level.

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Tables

Table 1: Values of the Model parameters

Parameter	Values	Source
Population growth rate, κ	1.6%	World Development Indicators (WDI)
Population shares, $n_i, i = 1, \ldots, 16$		
Female	49.5%	WDI
Good health	64.8%	World Health Surveys (WHS)
Poor	28.1%	WDI
Insured	40%	Literature (e.g., Alami 2017; Cotlear et al. 2015; Lagomarsino et al. 2012)
Weight of health capital in utility, v_j	0.15	Calibrated using WHS
Weight of leisure in utility, e_j	0.43	Calibrated using WHS
Depreciation of health capital, δ_i^h	0.056	(Scholz and Seshadri 2011; Gerdtham and Johannesson 1999)
Elasticity of medical expenditure in the production of health, χ_i	0.69	Calibrated using WHS
Discount rate, β	0.985	Auerbach and Kotlikoff (1987)
Elasticity of capital, α	0.25	Literature (e.g., Cerda and Larrain 2010; Berg et al. 2013; Millner and Dietz 2015)
Depreciation of capital, δ^k	40%	Literature (e.g., Mercado and Cicowiez 2013; Cerda and Larrain 2010; Bu 2006)
Income tax, τ_t^l	5%	Multinational services networks (PricewaterhouseCoopers , Klynveld Peat Marwick Goerdeler, and trading economics)
Tax on capital, τ_t^k	24.4%	
Tax on consumption, τ_t^c	13.5%	
Debt-GDP ratio, γ	43%	WDI
Premium rate, π	5%	Arbitrary
Out-of-pocket payment share, oop	44%	WDI

$*$ These are authors calculations based on different sources. Values are averages for different developing countries (low- and middle-income countries). The values for the parameters, v_j, e_j, δ_i^h and χ_i are the averages for all households.

Table 2: Comparative statistics of the steady state for the representative household and groups of households

Variable	Initial steady state	$\pi = 0.10$	$oop = 0.30$	Full coverage 1	Full coverage 2	$\tau^l = 0.10$	$\tau^c = 0.18$
		Percentage changes					
Labor supply, l	**0.715**	**-0.009**	**0**	**-0.014**	**-0.014**	**-0.023**	**0**
Poor	0.668	0.034	0	0.047	0.047	0.081	0
Non-poor	0.734	-0.024	0	-0.036	-0.036	-0.060	0
Good health	0.708	-0.009	0	-0.015	-0.015	-0.024	0
Bad health	0.719	-0.008	0	-0.014	-0.014	-0.023	0
Uninsured	0.709	0	0	-0.024	-0.024	-0.024	0
Insured	0.724	-0.021	0	0	0	-0.021	0
Consumption expenditure, c	**0.355**	**-2.213**	**0**	**-3.079**	**-3.079**	**-5.298**	**-4.221**
Poor	0.297	-2.280	0	-3.248	-3.248	-5.535	-4.221
Non-poor	0.377	-2.192	0	-3.027	-3.027	-5.225	-4.221
Good health	0.343	-2.233	0	-3.066	-3.066	-5.305	-4.221
Bad health	0.361	-2.202	0	-3.0853	-3.085	-5.294	-4.221
Uninsured	0.352	0	0	-5.173	-5.173	-5.183	-4.221
Insured	0.359	-5.465	0	0	0	-5.465	-4.221
Health investment, m	**0.032**	**-1.963**	**16.449**	**74.723**	**156.261**	**-5.353**	**0**
Poor	0.0513	-2.442	19.944	65.847	143.242	-5.542	0
Non-poor	0.024	-1.565	13.539	82.117	167.105	-5.194	0
Good health	0.043	-2.070	17.477	72.208	152.572	-5.333	0
Bad health	0.025	-1.865	15.499	77.050	159.674	-5.370	0
Uninsured	0.034	0	0	115.400	215.921	-5.234	0
Insured	0.028	-5.570	46.668	0	46.667	-5.570	0
Health capital, h	**1.517**	**-1.656**	**13.406**	**43.587**	**89.683**	**-3.857**	**0**
Poor	1.316	-1.650	12.3647	36.556	75.136	-3.713	0
Non-poor	1.596	-1.658	13.742	45.855	94.376	-3.904	0
Good health	1.3159	-1.616	12.9352	36.763	76.043	-3.540	0
Bad health	1.626	-1.674	13.6122	46.579	95.664	-3.997	0
Uninsured	1.499	0	0	73.513	128.647	-3.712	0
Insured	1.544	-4.069	32.931	0	32.931	-4.069	0

Capital investment, k	**0.359**	**-0.009**	**0**	**-0.014**	**-0.014**	**-0.023**	**0**
Reimbursement, $(1 - oop)m$	**0.015**	**-3.053**	**34.589**	**164.988**	**336.440**	**-2.315**	**0**
Government expenditure, g	**0.066**	**12.795**	**-7.918**	**-19.494**	**-58.743**	**30.935**	**22.722**
Government revenues, gr	**0.094**	**9.881**	**0**	**14.928**	**14.928**	**24.835**	**18.560**
Output, y	**0.602**	**-0.009**	**0**	**-0.014**	**-0.014**	**-0.023**	**0**
Public debt, b	**0.261**	**-0.009**	**0**	**-0.014**	**-0.014**	**-0.023**	**0**
Total welfare, u	**-1.498**	**-1.578**	**0.842**	**-0.390**	**1.300**	**-3.952**	**-2.879**
Poor	-1.727	-1.504	0.773	2.664	5.753	-3.808	-2.500
Non-poor	-1.391	-1.626	0.339	1.072	3.057	-4.088	-3.101
Good health	-1.522	-1.569	0.605	2.315	5.120	-3.974	-2.834
Bad health	-1.466	-1.596	0.4121	1.186	3.273	-4.009	-2.943
Uninsured	-1.482	0	0	2.660	5.774	-4.025	-2.910
Insured	-1.490	-3.953	1.199	0	1.199	-3.953	-2.984

- The values in the initial steady state are calculated using the parameters reported in Table 1. The currency could be any monetary unit. Labor supply is measured in a way such that the maximum labor a household can supply is one. Health capital is a scale-variable. Welfare is measured in terms of "utile".
- Full coverage refers to full health insurance coverage with $\pi = 0.05$ and $oop = 0.44$ under Full coverage 1 and $oop = 0.30$ under Full coverage 2.
- The initial value of the welfare is negative since we are dealing with a log utility function and small input values.
- Similar to premiums, we consider an increase by 5% in income tax and consumption tax.
- The wage rate is the same for all scenarios which equals to 0.63 except for the scenario where we change the depreciation of capital; wage becomes 0.69.
- The results for some parameters do not appear in this table because either these parameters do not have an impact at the steady-state values of the disaggregate variables or they have impact on few variables only.
- Health investment and consumption are measured as shares of total expenditure.
- In this table, results are reported for three significant digits because, in some cases, the differences across categories are very small.
- The impact of change in all parameters on labor supply, capital, and output is the same because their steady-state values are proportionally related by ϑ_1.

Figures

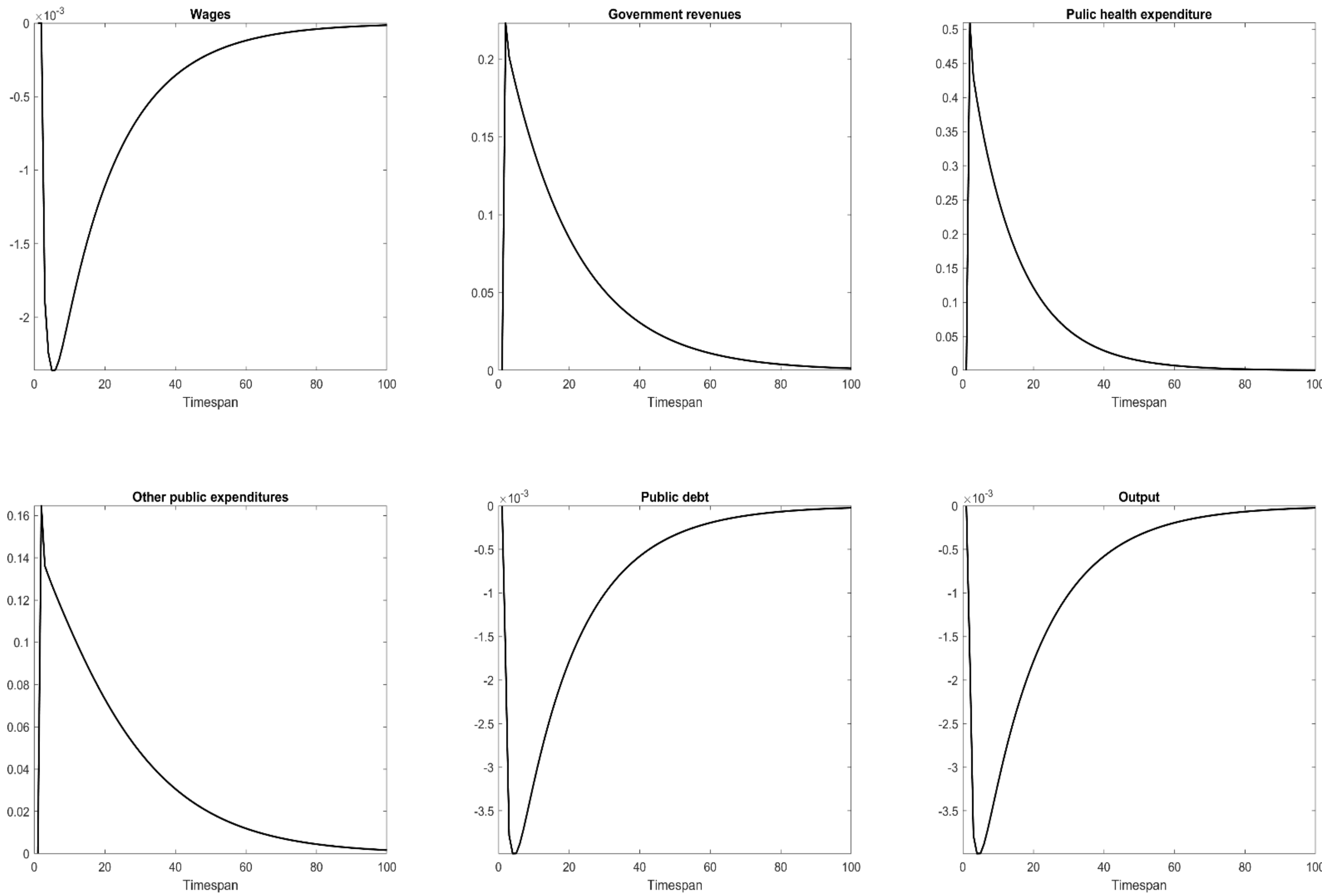

Fig. 1.1. Response of macro variables to the shock on UHC implementation

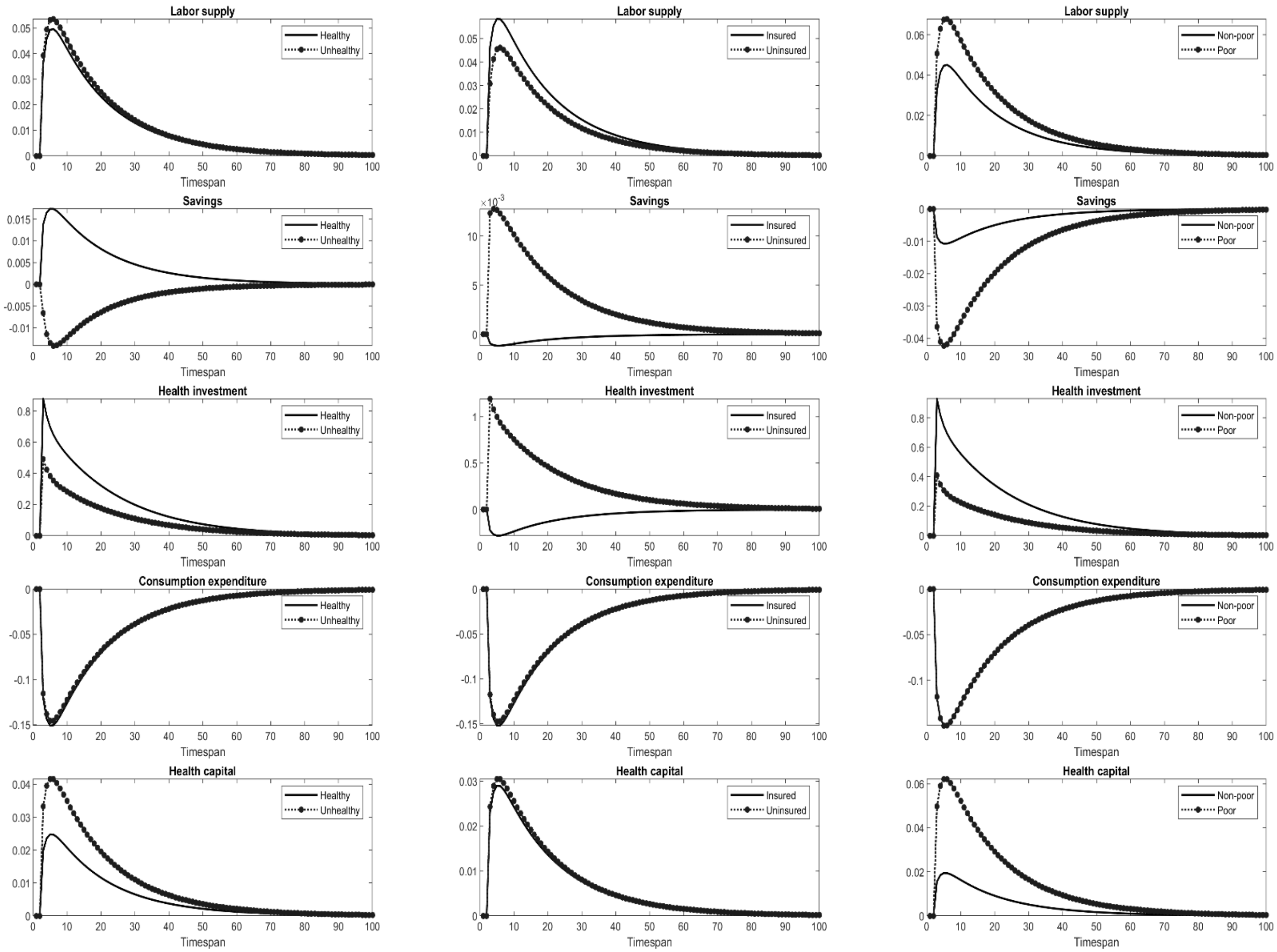

Fig. 1.2. Response of the disaggregate variables to the shock on UHC implementation

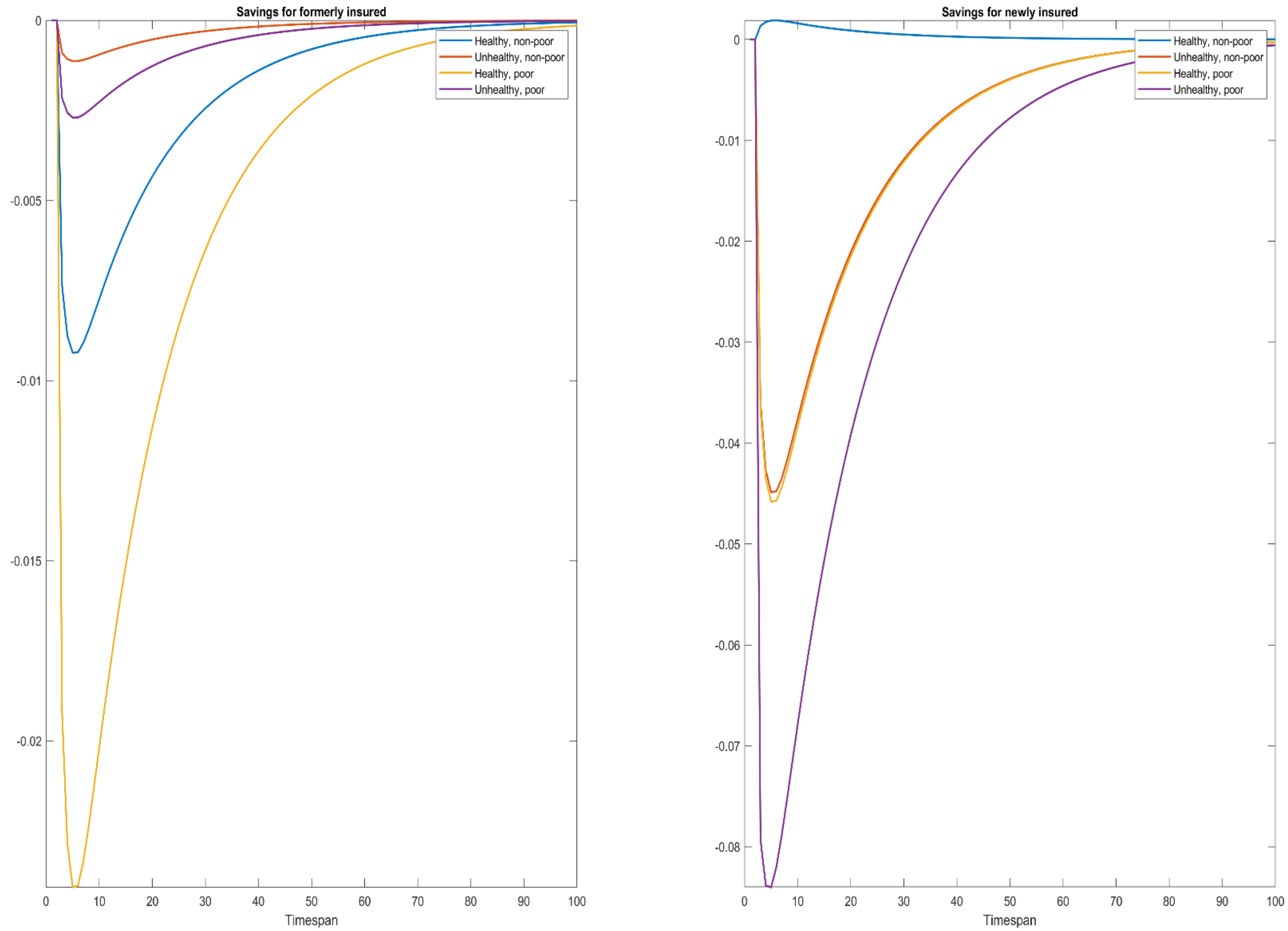

Fig. 1.3. Response of savings to the shock on UHC implementation

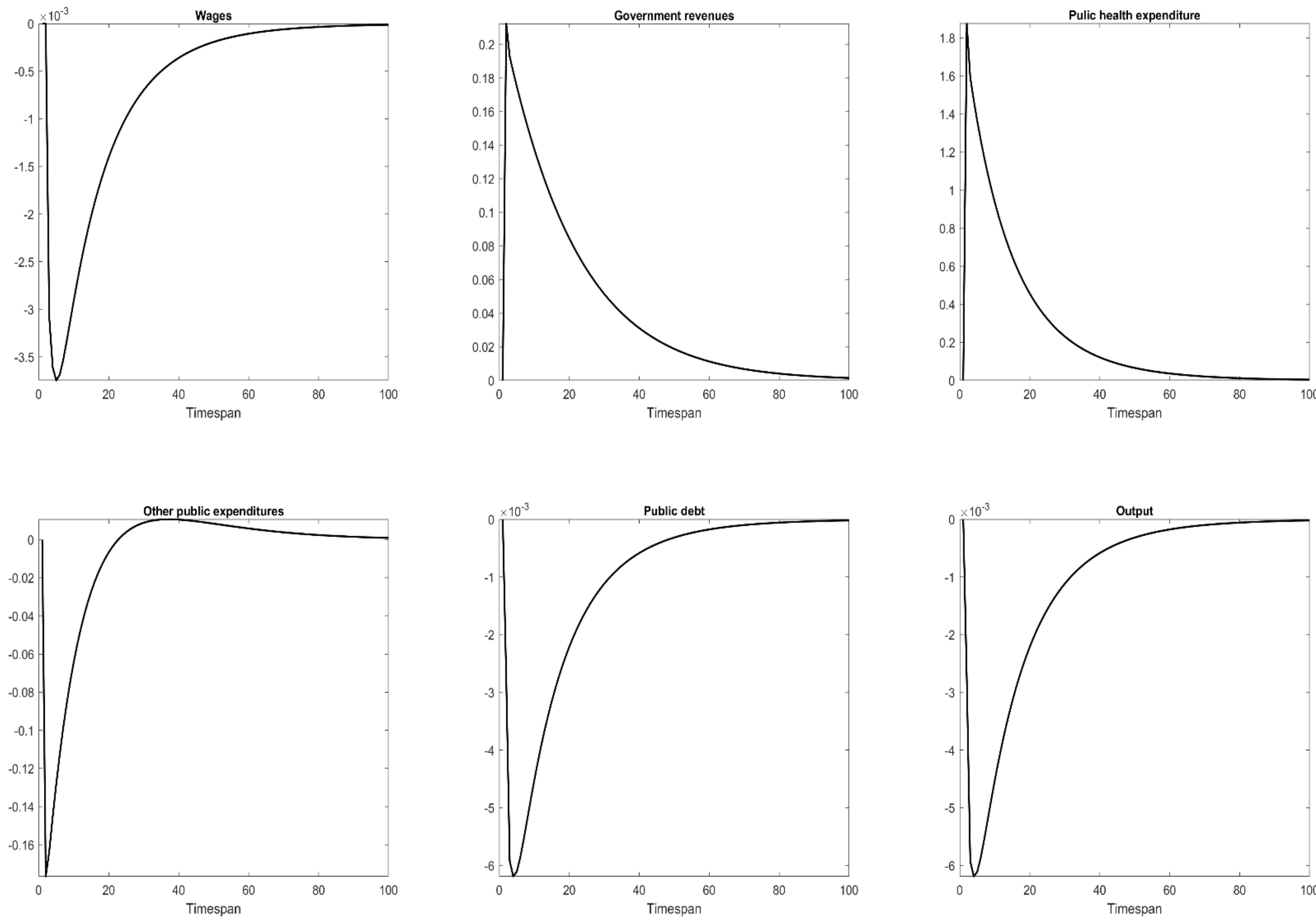

Fig. 2.1. Response of macro variables to the shock on the expansion of the coverage of healthcare costs

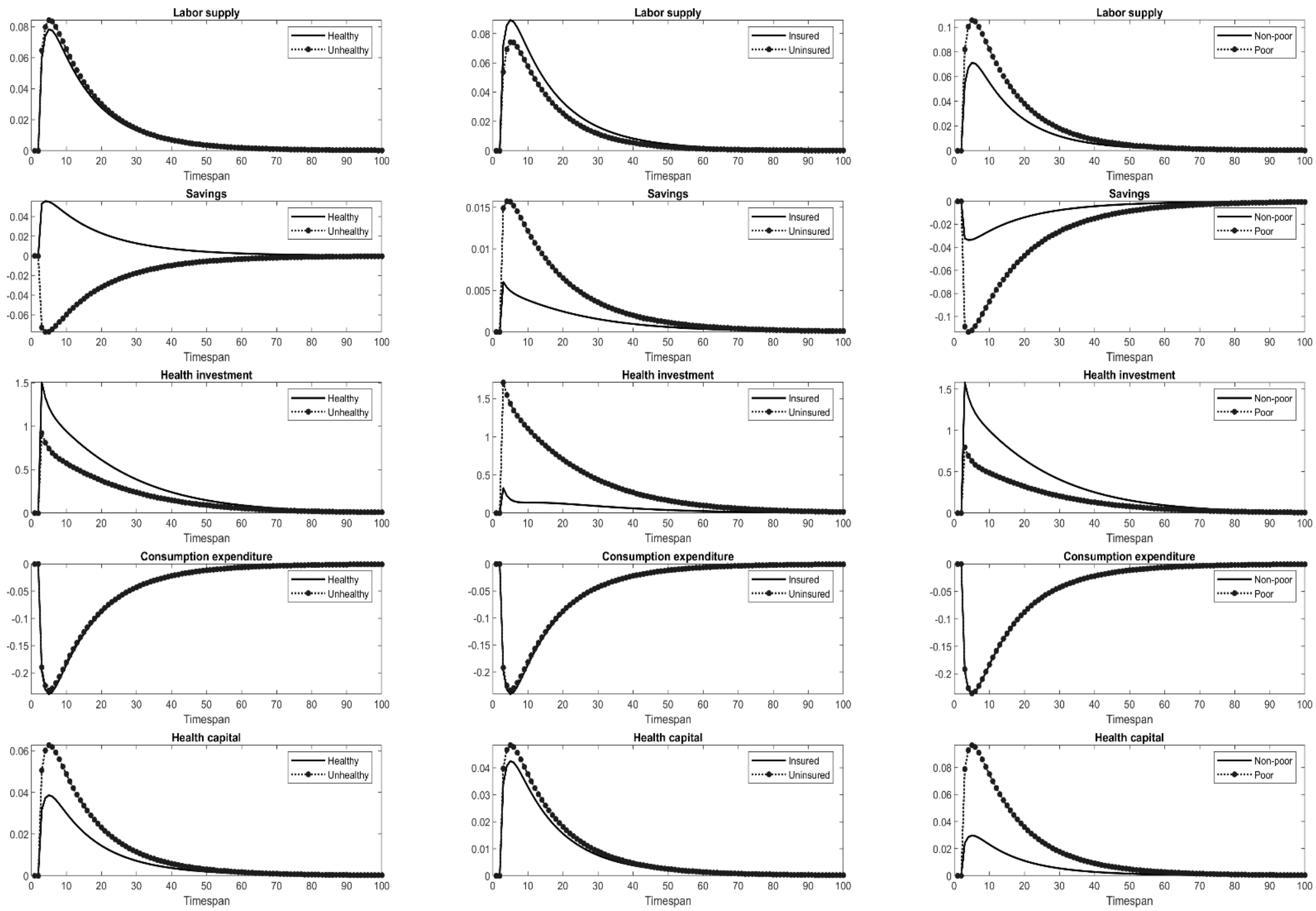

Fig. 2.2. Response of the disaggregate variables to the shock on the expansion of the coverage of healthcare costs

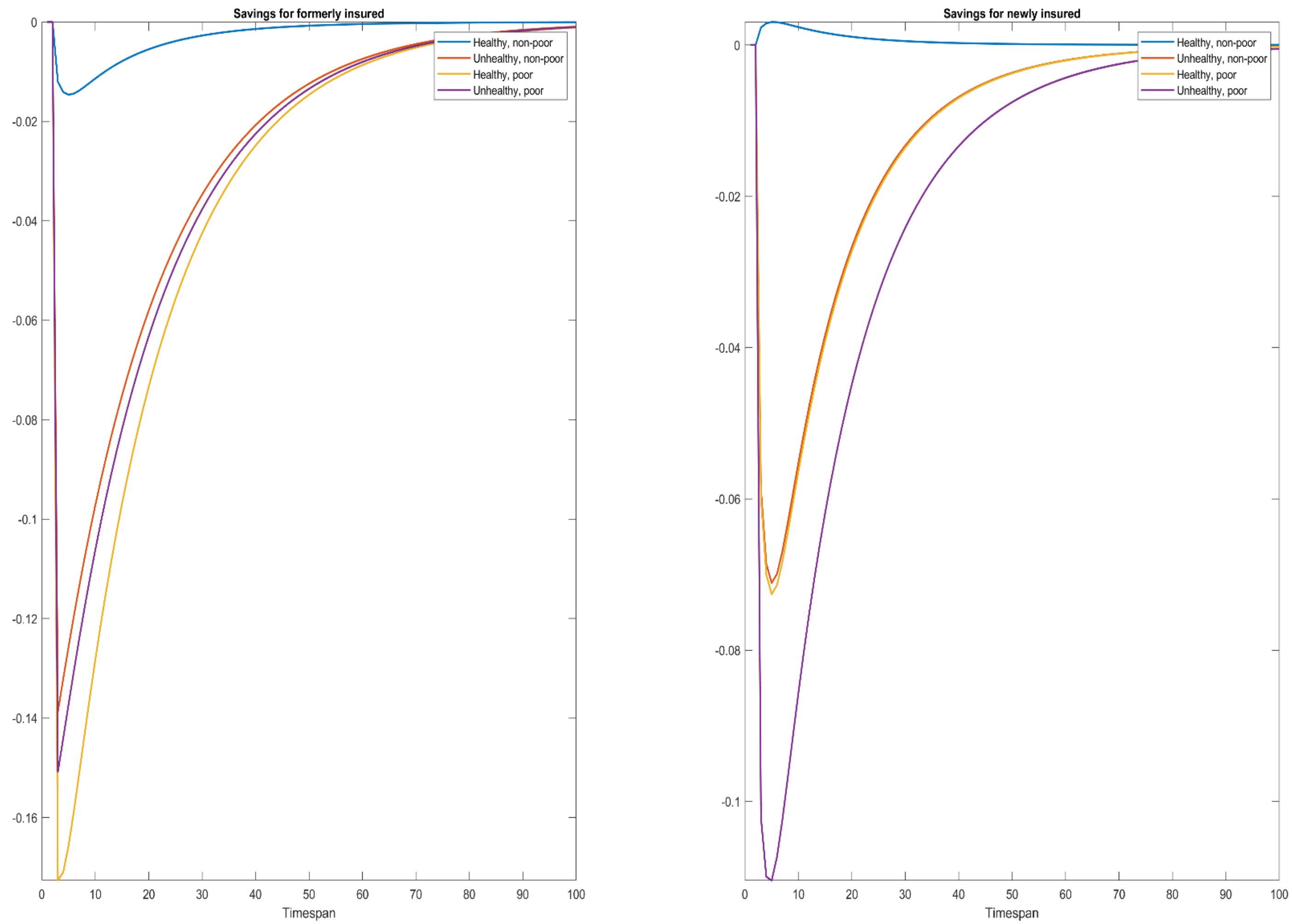

Fig. 2.3. Response of savings to the shock on the expansion of the coverage of healthcare costs

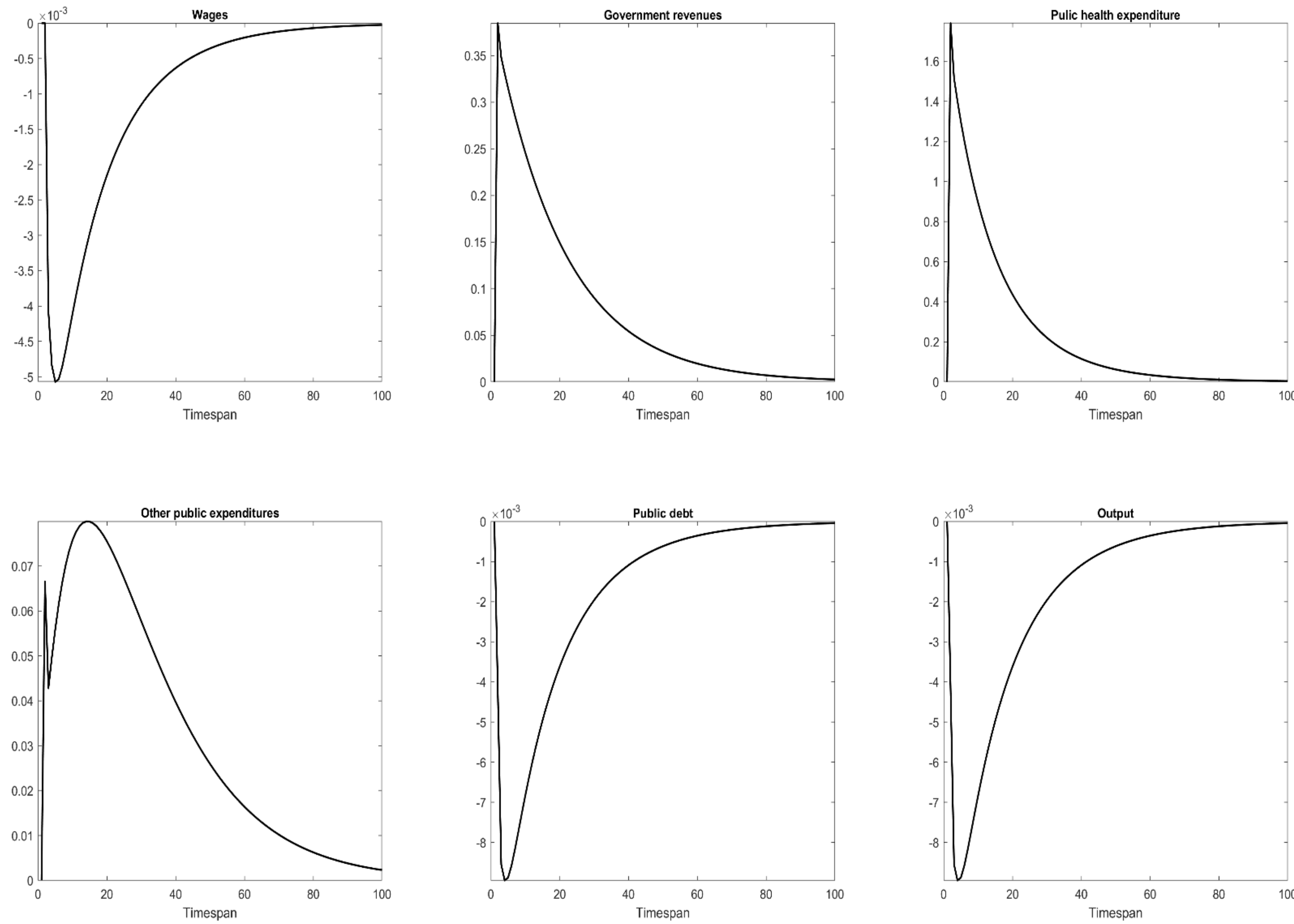

Fig. 3.1. Response of macro variables to the shock on labor income tax

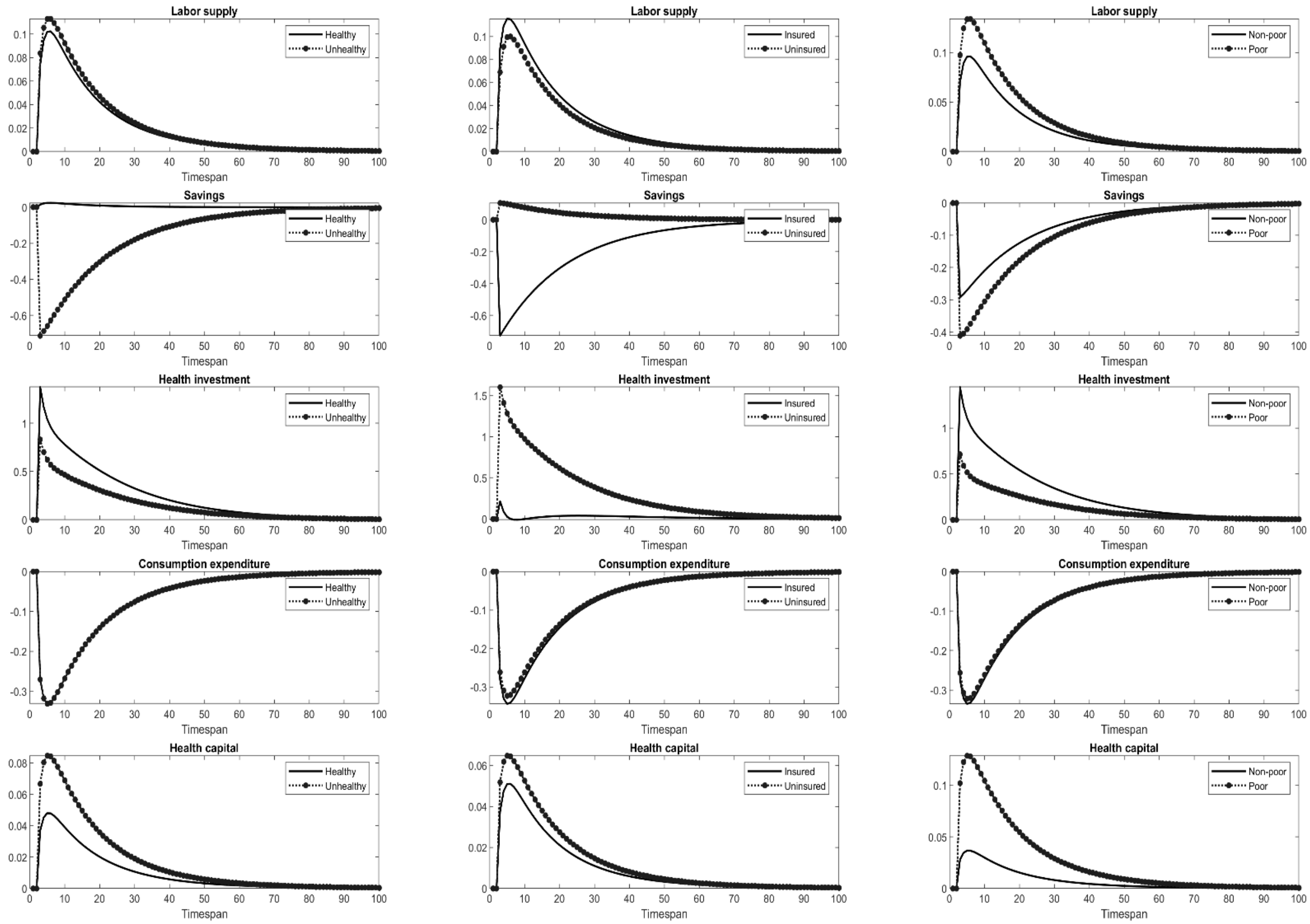

Fig. 3.2. Response of the disaggregate variables to the shock on labor income tax

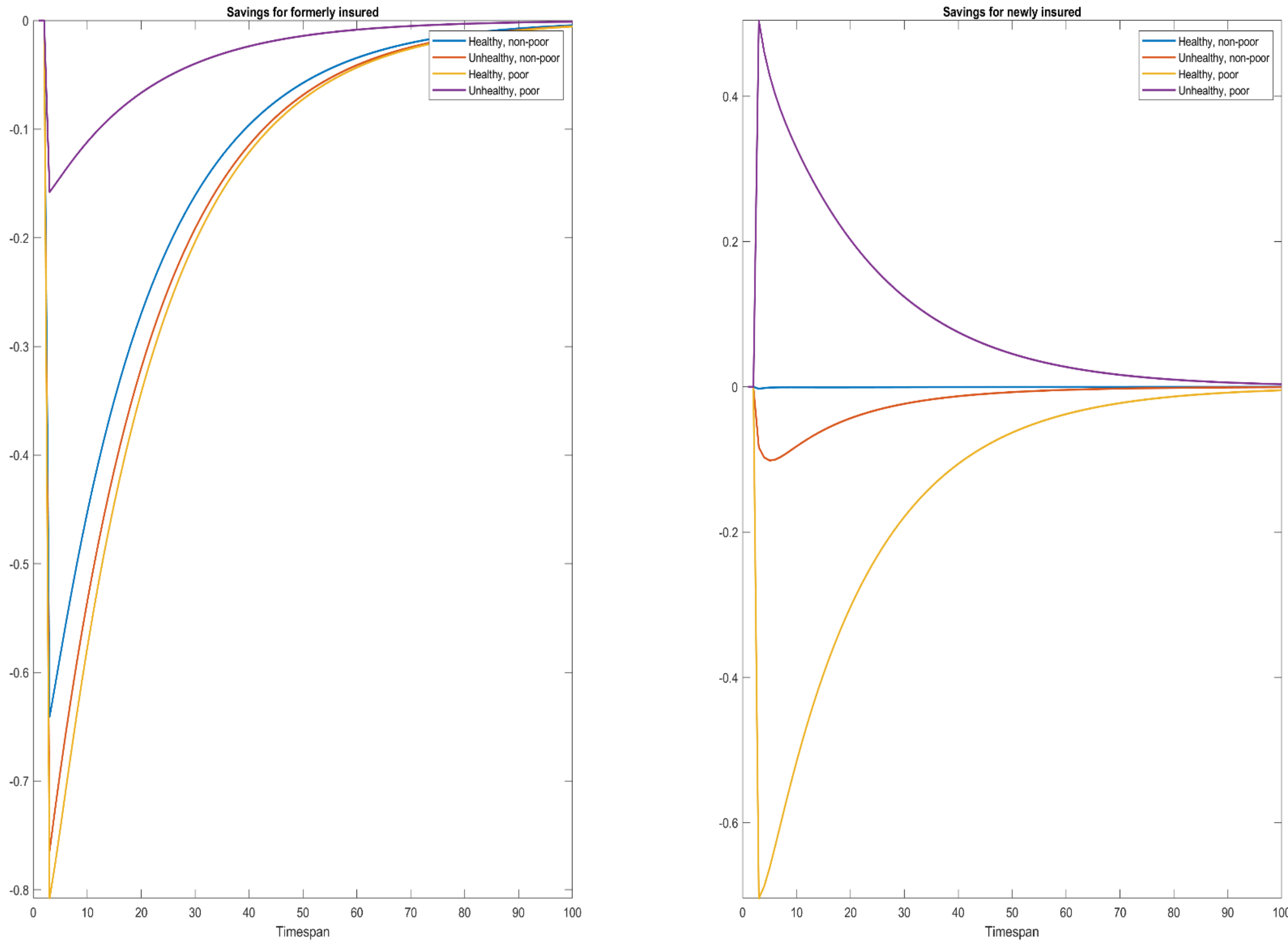

Fig. 3.3. Response of savings to the shock on labor income tax

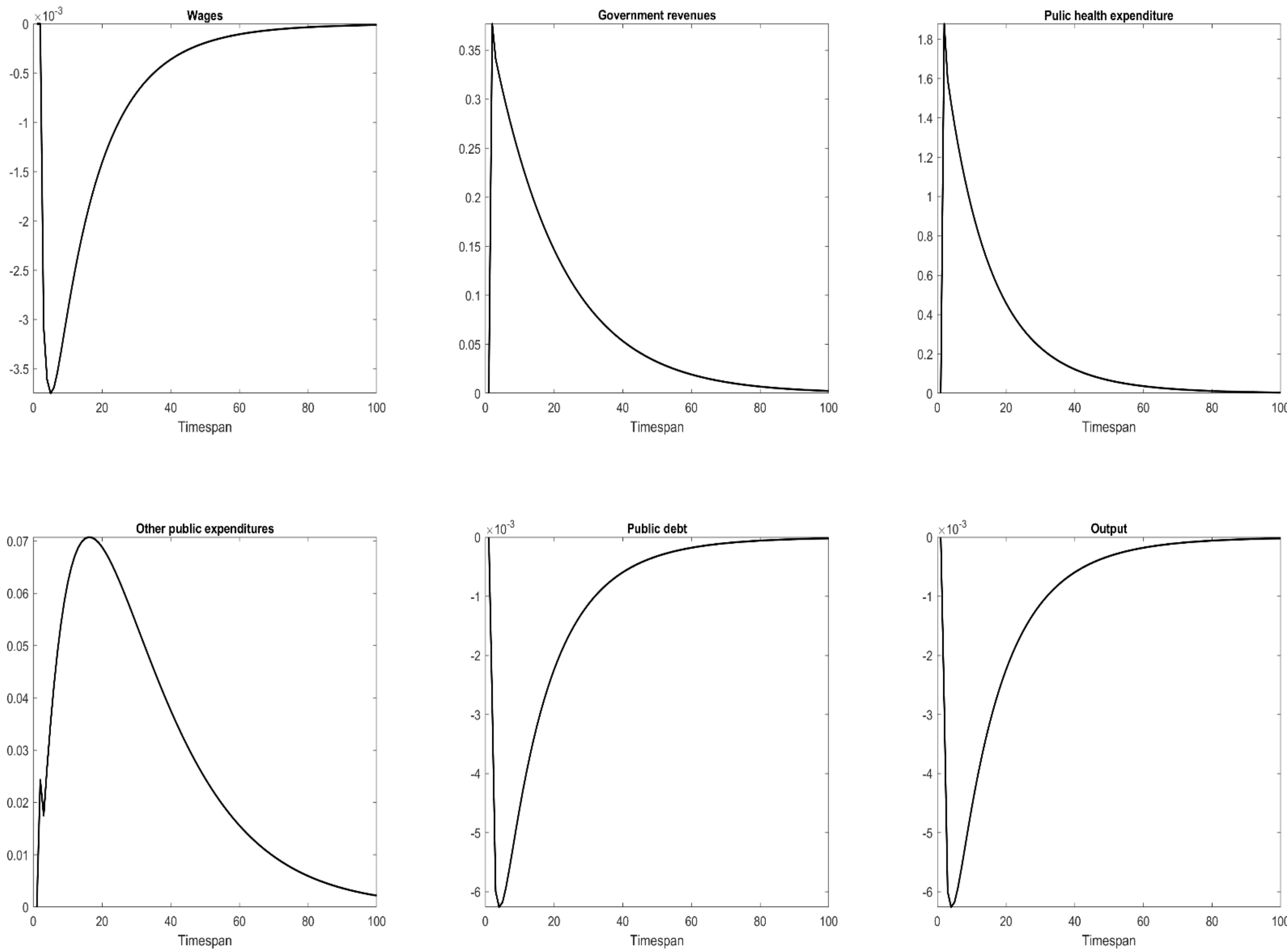

Fig. 4.1. Response of macro variables to the shock on consumption tax

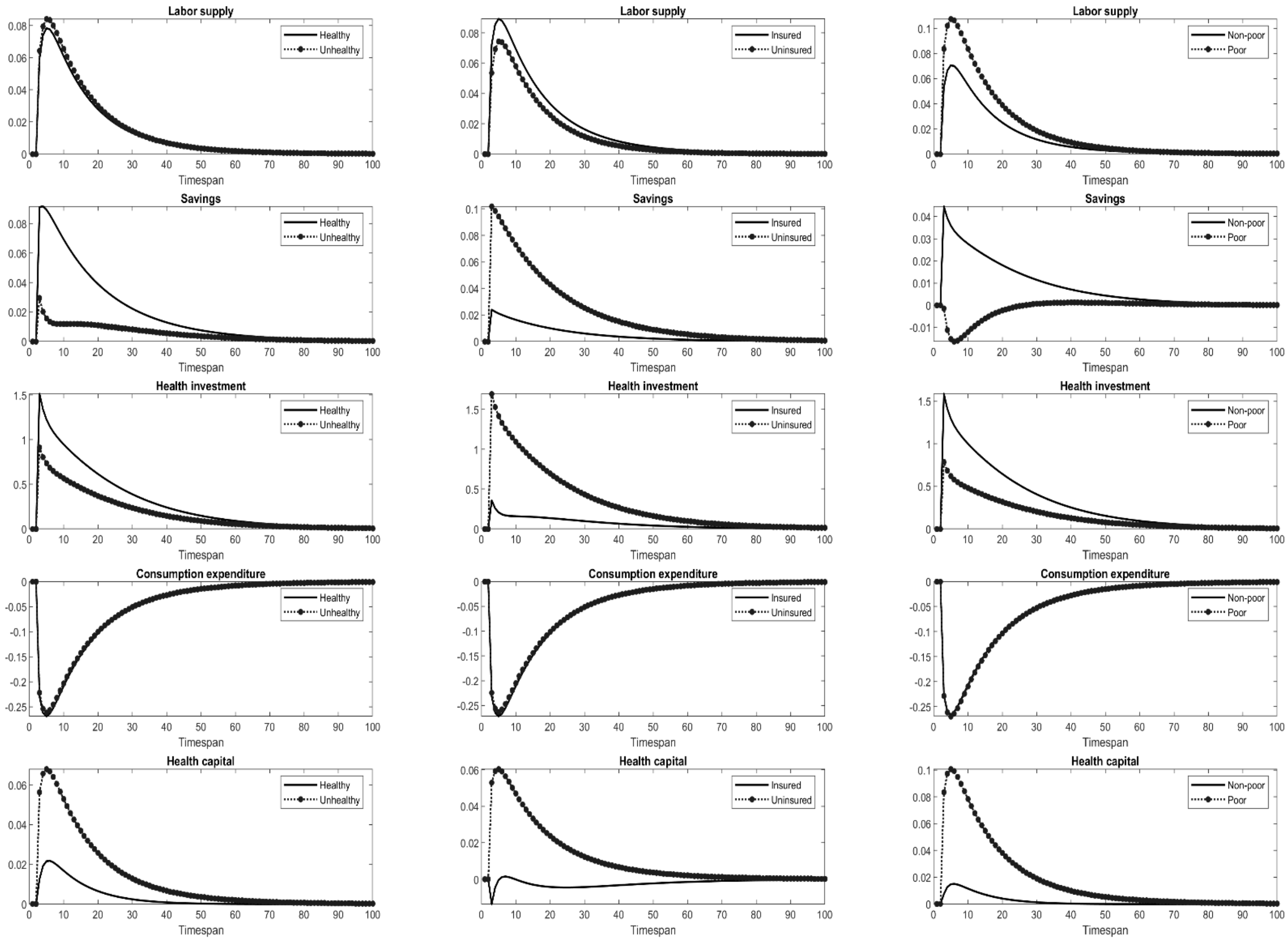

Fig. 4.2. Response of disaggregate variables to the shock on consumption tax

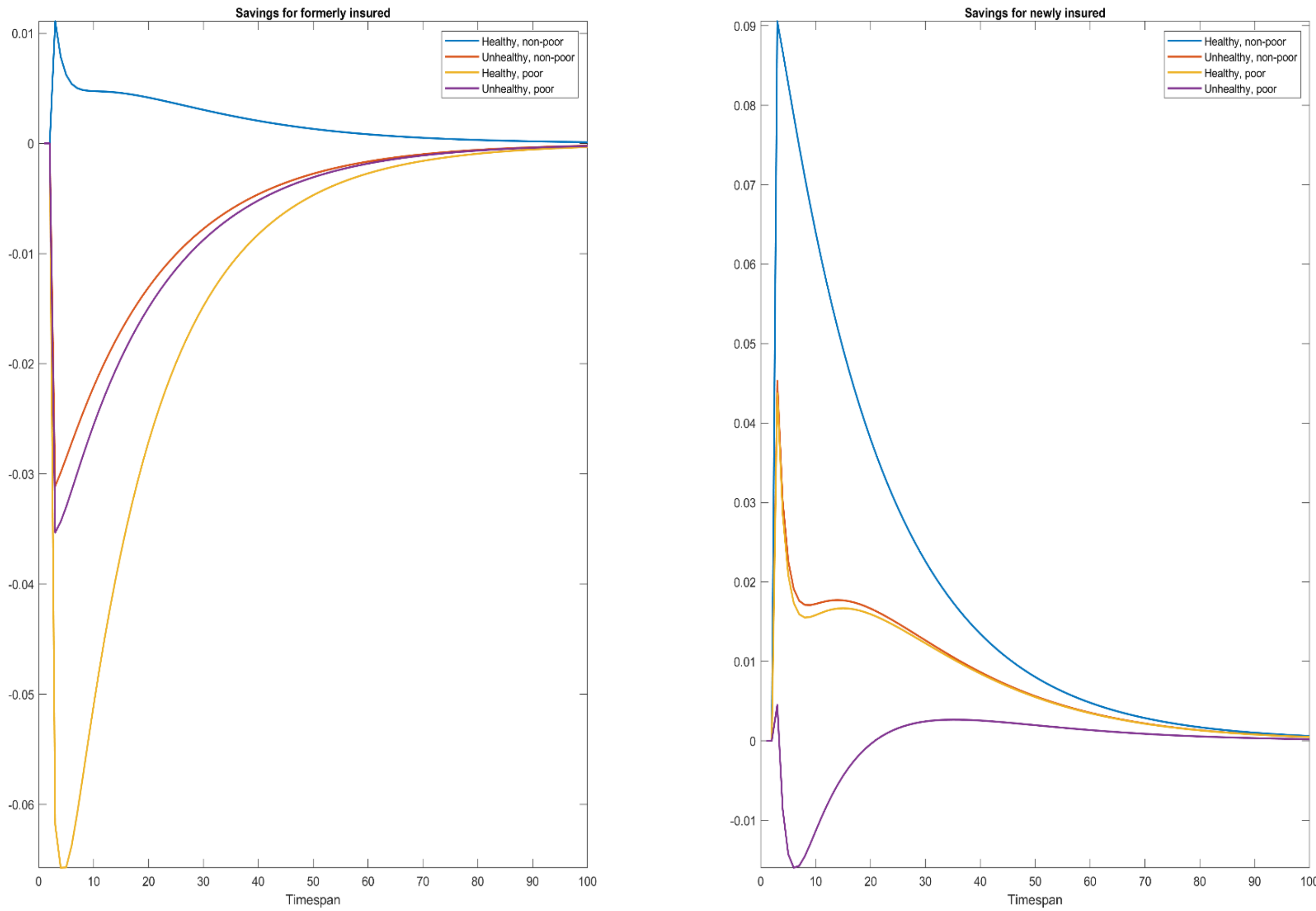

Fig. 4.3. Response of savings to the shock on consumption tax