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Colombia

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Abstract

Healthcare expenditure in Colombia is expected to increase by 35% over the next eight years, due to population aging, rising costs, and domestic policies. These trends, in a context of high levels of informality and affiliation to the subsidized regime, add significant pressure to public finances. Using a dynamic general equilibrium model with heterogeneous households, we analyze the macroeconomic impact of financing a higher public healthcare expenditure through different taxes. The funding sources play a significant role in shaping the aggregate dynamics and income inequality. While consumption taxes are the best option in terms of output, financing with taxes on high-skilled labor improves income distribution.

JEL Classification: E10, E62, E26, F41

Keywords: *General Equilibrium; Heterogeneous Agents; Taxes; Government Expenditure.*

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Efectos macroeconómicos del financiamiento del sector salud en Colombia

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Resumen

En Colombia, el gasto público en salud incrementaría alrededor de 35% en los próximos ocho años debido al envejecimiento de la población, al aumento de los costos de tratamientos y medicinas, y a las políticas propias del sector. Estas tendencias, en un contexto de alta informalidad y dependencia del régimen subsidiado al presupuesto del Gobierno, ejercen una presión significativa sobre las finanzas públicas. Utilizando un modelo de equilibrio general dinámico con hogares heterogéneos, analizamos el impacto macroeconómico de la financiación de un mayor gasto en salud a través de impuestos al consumo, al uso del capital y al trabajo. Encontramos que las fuentes de financiamiento tienen un papel significativo en la determinación de la dinámica agregada y la desigualdad del ingreso. Mientras que los impuestos al consumo son la mejor opción en términos de producto, la financiación mediante impuestos al trabajo de alta calificación mejora la distribución del ingreso.

Clasificación JEL: E10, E62, E26, F41

Palabras clave: *Equilibrio General, agentes heterogéneos, impuestos, gasto del gobierno.*

1 Introduction

Public healthcare expenditure in Colombia is expected to increase by approximately two percentage points of GDP in the next eight years. This is mainly due to increasing demand for quality services, rising costs of skilled procedures, technological advancements, and aging population, factors that also explain the trend of rising healthcare spending in OECD countries Lorenzoni et al. (2019). Besides these factors, certain characteristics of Colombia's healthcare system and the economy interact with these trends and compound to increase the pressure on public finances. In particular, the on-going process of per-capita public expenditure equalization between the subsidized and contributory systems, high levels of firm and labor informality, high degrees of access and coverage, and low out-of-pocket spending, all contribute to a challenging outlook Arango et al. (2023).

In this paper, we analyze the macroeconomic effects of funding the additional expected expenditure through various tax schemes, including taxes on consumption and production factors, such as capital and labor. Additionally, we examine the implications of changing the labor composition of the economy, while maintaining constant expenditure per individual, without changes in taxes. This latter scenario can be related to the large migration flows that Colombia has experienced in recent years, which have been characterized by workers with low levels of education that end up in the informal sector of the economy. To conduct the analysis, we propose a dynamic general equilibrium model for a small open economy with heterogeneous households, a fragmented labor market with formal and informal labor, and a variety of fiscal policy instruments, and produce alternative simulations of the response of macroeconomic variables to different ways of financing the foreseen increase in healthcare expenditure.

A key feature of the healthcare system in Colombia that is important for the results of the paper is its financing structure which is divided into two regimes: the contributory and the subsidized. In the contributory regime, formal firms and workers pay payroll taxes that directly fund the system. In the subsidized regime, the government allocates resources from the national budget to subsidize healthcare access for the rest of the population, including informal workers, migrants, and the unemployed. Approximately 50% of the population belongs to the subsidized regime. This significant proportion underscores the critical link between labor informality, healthcare, and public finances. A common theme in policy discussions in Colombia is the need to reduce labor informality to boost productivity and enhance the funding sources for the social security system. In our analysis, we examine the impact of increasing healthcare expenditure per person in both regimes (contributory and subsidized) under

a baseline specification, as well as under an extension in which healthcare expenditure is linked to productivity enhancement and higher life expectancy.

Our results suggest that all financing schemes have a negative impact on aggregate output, with differing magnitudes and effects on welfare and income distribution. Funding healthcare with consumption taxes generates fewer distortions and requires a smaller tax rate increase, resulting in less severe output reduction. In contrast, taxing low-skilled formal labor is the least desirable option, adversely affecting output, income inequality, and welfare. Notably, if there are positive spillover effects of healthcare expenditure on labor productivity or life expectancy, we observe a reduction in the adverse effects of higher taxation. With respect to the change in the composition of the population we find that increasing the high-skilled population has positive effects on the economy, particularly in terms of public finances and output per capita. Notably, in this scenario, funding the additional expenditure due to a larger population does not require a tax increase. The existing tax rates prove sufficient, as the system is over-financed in this context. In the alternative case, when the low-skilled population increases, we observe the opposite results: output per capita falls and the economy requires higher taxes to finance the additional expenditure.

Our study contributes to the economic literature on the macroeconomic effects of financing additional healthcare expenditure. We provide a quantitative tool that is flexible enough to consider different financing schemes and that can be easily adapted to any small open economy with fragmented labor markets. Our results highlight the importance of: 1) the financing scheme for different macroeconomic outcomes; 2) externalities of higher healthcare expenditure; 3) the interplay between labor market's structure and healthcare public expenditure; 4) and quantifying the impact of higher healthcare expenditure under different policies.

In general, the overall impact of increased healthcare expenditure on the economy is ambiguous. On the one hand, expenditure may improve health outcomes, reduce treatment expenditure, and increase productivity.¹ On the other hand, higher expenditure may divert resources from alternative uses. This paper shows that for the Colombian economy the positive effects of higher healthcare expenditure are outweighed by the costs of higher taxes unless labor productivity or life expectancy increase, or informality drops. In this way the paper is related to the literature that shows that understanding impact of healthcare financing on macroeconomic aggregates is crucial to designing effective policies

¹The literature has found positive effects of higher expenditure on life expectancy, birth, and mortality rates (Berger & Messer, 2002; Blazquez-Fernández et al., 2017; Christopoulos & Eleftheriou, 2020; Nixon & Ulmann, 2006).

Gechert et al. (2021). In terms of the impact of healthcare spending on economic growth, the literature has found mixed evidence. Some papers have found that tax hikes have high contractionary effects on the economy (Cloyne, 2013; Romer & Romer, 2016), whereas lower contributions stimulate economic growth through positive supply side effects. The results of our study calibrated for the Colombian economy point in this direction. However, other studies have found evidence in the opposite direction. For example, (Alper, Demiral, et al., 2016; Wang, 2015) find that increasing health spending when expenditure is below the optimal level leads to better economic performance (Alper, Demiral, et al., 2016; Raghupathi & Raghupathi, 2020; Wang, 2015) find a positive correlation between healthcare expenditure and income, GDP, and labor productivity for the United States.

This paper is structured into six sections, including this introduction. Section 2 presents the general equilibrium model to study the effects of different healthcare financing policies in a small open economy with heterogeneous households and fragmented labor markets. Section 3 describes some relevant aspects of the Colombian health system and presents a quantification of the expected increase in costs in the coming years. Section 4 describes the strategy to calibrate the model for the Colombian context. Section 5 contains the results and analysis of the effects of four alternative tax schemes to finance additional healthcare expenditure. Section 6 concludes.

2 Model

In this section, we describe the dynamic general equilibrium model used for the quantitative analysis. Our set up builds on the model developed by Arango et al. (2022) and Ávila-Montealegre et al. (2023), and inherits some characteristics of the benchmark small open economy (SOE) models, such as the debt-elastic interest rate and investment adjustment costs. In particular, we extend the basic SOE model to consider heterogeneous households, differentiated labor, and a variety of taxes that finance public expenditure.

Our model considers an economy inhabited by two types of households that differ in labor productivity, access to financial markets, and the distribution of subsidies (health expenditure). On the firms' side, we consider two production layers. In the first one, a mass of heterogeneous firms use capital and labor to produce differentiated goods. These firms operate under monopolistic competition. In the second layer, a competitive firm combines heterogeneous inputs and produces a homogeneous good that can be used for consumption, investment, and net exports. We also assume that formal low-skilled workers earn a fixed minimum wage. Finally, the government has a variety of taxes, including

consumption, capital, and labor, which are used to finance public expenditure. For simplicity, we assume a balanced budget and expenditure as a lump-sum transfer. In the following sections, we describe the optimization problem of households and firms, and the government budget constraints.

2.1 Households

A mass one of households is divided into high-skilled N^H and low-skilled N^L . On the one hand, high-skilled households offer highly productive labor, have access to foreign financial markets, own physical capital and firms, and make consumption and investment decisions. The representative high-skilled consumer maximizes the present value of her utility, choosing consumption (c_t^H), hours supplied (h_t^H), foreign assets (a_t^f), capital (k_t), and investment (i_t). They also pay taxes on consumption (τ_t^c) and labor income (τ_t^H), and obtain a personal subsidy from the government (g_t^H). Their income sources come from wages (w_t^H), rent on capital (R_t), foreign assets return ($\Phi_t R_t^f$), and any firms' profits (Π_t). Tables (2) and (3) describe the model parameters and their corresponding sources. The optimization problem of the representative high-skilled household is given by:

$$\max_{c_t^H, h_t^H, i_t, k_{t+1}, a_{t+1}^f} E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{(c_t^H)^{1-\sigma}}{1-\sigma} - \psi_H \frac{\nu_H}{1+\nu_H} (h_t^H)^{\frac{1+\nu_H}{\nu_H}} \right)$$

subject to the budget constraint, the capital's law of motion (with investment adjustment costs), and the debt-elastic interest rate (equations 1 to 3):

$$P_t c_t^H (1 + \tau_t^c) + P_t i_t + a_{t+1}^f \leq \Phi_{t-1} R_{t-1}^f a_t^f + w_t^H h_t^H (1 - \tau_t^H) + R_t k_t + \frac{\Pi_t}{N^H} + P_t g_t^H \quad (1)$$

$$k_{t+1} \leq (1 - \delta)k_t + i_t - \frac{\phi}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 \quad (2)$$

$$\Phi_t = \Phi_{ss} \exp \left(-\phi_a \left(A_t^f / Y_t - \bar{A}^f / \bar{Y} \right) \right) \quad (3)$$

From the first order conditions (F.O.Cs) we find the marginal rate of substitution between consumption and labor,

$$P_t (1 + \tau_t^c) \psi_H (h_t^H)^{1/\nu_H} = (c_t^H)^{-\sigma} w_t^H (1 - \tau_t^H) \quad (4)$$

and the Euler equations for investment, capital, and foreign bonds (equations 5 to 7):

$$\frac{(c_t^H)^{-\sigma}}{(1 + \tau_t^c)} = \mu_t \left(1 - \phi \left(\frac{i_t}{i_{t-1}} - 1 \right) \frac{1}{i_{t-1}} \right) + \beta E_t \mu_{t+1} \phi \left(\frac{i_{t+1}}{i_t} - 1 \right) \frac{i_{t+1}}{i_t^2} \quad (5)$$

$$\mu_t = \beta E_t \left(\mu_{t+1} (1 - \delta) + \frac{(c_{t+1}^H)^{-\sigma}}{P_{t+1} (1 + \tau_{t+1}^c)} R_{t+1} \right) \quad (6)$$

$$\frac{(c_t^H)^{-\sigma}}{P_t (1 + \tau_t^c)} = \beta E_t \frac{(c_{t+1}^H)^{-\sigma}}{P_{t+1} (1 + \tau_{t+1}^c)} \Phi_t R_t^f \quad (7)$$

On the other hand, low-skilled households are hand-to-mouth workers, meaning that their consumption (c_t^L) equals their income. They offer two types of low-productivity labor, formal (h_t^F) and informal (h_t^I), and receive subsidies from the government (g_t^H). Low-skilled households also pay consumption taxes and potentially on formal labor income (τ_t^L). Informal labor does not pay taxes and is less productive than formal labor. The income sources of low-skilled households include wages from formal and informal labor, w_t^F and w_t^I . The representative low-skilled consumer maximizes the value of her utility according to the following problem:

$$\max_{c_t^L, h_t^F, h_t^I} E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{(c_t^L)^{1-\sigma}}{1-\sigma} - \psi_F \frac{\nu_F}{1+\nu_F} (h_t^F)^{\frac{1+\nu_F}{\nu_F}} - \psi_I \frac{\nu_I}{1+\nu_I} (h_t^I)^{\frac{1+\nu_I}{\nu_I}} \right]$$

subject to

$$P_t c_t^L (1 + \tau_t^c) \leq w_t^F h_t^F (1 - \tau_t^L) + w_t^I h_t^I + P_t g_t^L \quad (8)$$

This group of households can not move resources across time, which implies that their optimization problem is static. From the F.O.Cs, we get the marginal rates of substitution between consumption and labor (formal and informal),

$$P_t (1 + \tau_t^c) \psi_F (h_t^F)^{1/\nu_F} = (c_t^L)^{-\sigma} w_t^F (1 - \tau_t^L) \quad (9)$$

and

$$P_t (1 + \tau_t^c) \psi_I (h_t^I)^{1/\nu_I} = (c_t^L)^{-\sigma} w_t^I \quad (10)$$

We assume that P_t is the numeraire of the economy, thus $P_t = 1$. Aggregate consumption is the sum of individual consumption times the mass of households of each type:

$$C_t = N_t^H c_t^H + N_t^L c_t^L \quad (11)$$

Similarly, aggregate investment, capital, high-skilled labor, and foreign assets are given by:

$$X_t = N_t^H x_t \quad (12)$$

where $X_t \in \{I_t, K_t, L_t^H, A_t\}$ and $x_t \in \{i_t, k_t, h_t^H, a_t\}$. And low-skilled formal and informal labor:

$$L_t^F = N_t^L h_t^F \quad (13)$$

$$L_t^I = N_t^L h_t^I \quad (14)$$

Aggregate demand is the sum of consumption, investment, and net exports, $Y_t = C_t + I_t + NX_t$. Our small open economy setup follows the emerging market business cycle literature (Garcia-Cicco et al., 2010; Schmitt-Grohé & Uribe, 2003), assuming that the domestic final good is substitutable for the good produced by the rest of the world. This property, along with the exogenous foreign interest rate, allows the model to be closed with net exports, eliminating the need for explicit modeling of exports and imports. It also implies that the real exchange rate is equal to one in the long run.

2.2 Production

We divide the production process into two stages. In the top stage, a competitive firm combines a continuum of heterogeneous domestic inputs to produce a homogeneous final good. This firm maximizes its profits according to:

$$\begin{aligned} \max_{Y_t(j)} P_t Y_t - \int_0^1 P_t(j) Y_t(j) dj \\ \text{s.t. } Y_t = \left(\int_0^1 Y_t(j)^{\frac{\xi-1}{\xi}} dj \right)^{\frac{\xi}{\xi-1}} \end{aligned} \quad (15)$$

where Y_t is domestic production and $Y_t(j)$ is the input produced by the heterogeneous firm (j). In equilibrium, domestic production is allocated to consumption among households, investment, and net exports. From the F.O.C. we find that the demand for input (j) depends on its relative price and the aggregate demand for domestic goods:

$$Y_t(j) = \left(\frac{P_t(j)}{P_t} \right)^{-\xi} Y_t \quad (16)$$

At the inner level, we have a continuum of heterogeneous firms that act under monopolistic competition and minimize production costs. Firm (j) chooses its optimal demands for capital and the three types of labor, subject to the technological constraint and the demand for its heterogeneous input. We subtract the time index to simplify the notation. Her optimization problem is:

$$\begin{aligned} \max_{P(j), K(j), L^H(j), L^F(j), L^I(j)} P(j) Y(j) - \\ \left((1 + \tau^{FH}) w^H L^H(j) + (1 + \tau^{FL}) w^F L^F(j) + w^I L^I(j) + (1 + \tau^k) R K(j) \right) \end{aligned} \quad (17)$$

subject to the technological constraint (production function) and the product demand (equation 16):

$$Y(j) = AK(j)^\alpha L(j)^{1-\alpha} \quad (18)$$

$$L(j) = \left[\theta (L^L(j))^{\frac{\eta-1}{\eta}} + (1 - \theta) (L^H(j))^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \quad (19)$$

$$L^L(j) = \left[\theta_L (L^I(j))^{\frac{\eta_L-1}{\eta_L}} + (1 - \theta_L) (L^F(j))^{\frac{\eta_L-1}{\eta_L}} \right]^{\frac{\eta_L}{\eta_L-1}} \quad (20)$$

The aggregation of production factors is highly flexible, allowing for different degrees of substitutability among the three types of labor. Taking advantage of the CES structure we construct an aggregate labor input, assuming that formal and informal low-skilled labor are more substitutes, while high-skilled and low-skilled labor are more complements. In a first step, equation (20) combines formal and informal low-skilled labor into a factor L^L . This combination is governed by the elasticity of

substitution η_L and the relative productivity θ_L . Similarly, equation (19) shows how total labor L is a combination of low- and high-skilled workers, regulated by the parameters η and θ . Finally, we aggregate the labor factor L , with capital K , using a standard Cobb-Douglas production function. Although the model considers that the share of total labor compensation is fixed, $1 - \alpha$, it allows for changes within the types of labor.² From the first order conditions of this optimization problem, we find the relative demand of factors as functions of their relative prices, marginal cost as a function of productivity and factor prices, and optimal price.

$$\alpha \frac{Y(j)}{K(j)} = \frac{(1 + \tau^k)R}{P(j)} \quad (21)$$

$$(1 - \alpha) \frac{Y(j)}{L(j)} (1 - \theta) \left(\frac{L(j)}{L^H(j)} \right)^{1/\eta} = (1 + \tau^{FH}) \frac{w^H}{P(j)} \quad (22)$$

$$(1 - \alpha) \frac{Y(j)}{L(j)} \theta \left(\frac{L(j)}{L^L(j)} \right)^{1/\eta} (1 - \theta_L) \left(\frac{L^L(j)}{L^F(j)} \right)^{1/\eta_L} = (1 + \tau^{FL}) \frac{w^F}{P(j)} \quad (23)$$

$$P(j) = \frac{\xi}{\xi - 1} MC \quad (24)$$

where $MC = \frac{1}{A} \left(\frac{(1 + \tau^k)R}{\alpha} \right)^\alpha \left(\frac{w}{1 - \alpha} \right)^{1 - \alpha}$, $w = (\theta^\eta (w^L)^{1 - \eta} + (1 - \theta)^\eta ((1 + \tau^{FH}) w^H)^{1 - \eta})^{1/(1 - \eta)}$, and $w^L = (\theta_L^{\eta_L} (w^I)^{1 - \eta_L} + (1 - \theta_L)^{\eta_L} ((1 + \tau^{FL}) w^F)^{1 - \eta_L})^{1/(1 - \eta_L)}$.

2.3 Government

Government expenditure takes the form of lump-sum transfers to high- and low-skilled households, and it is fully funded by taxes. This transfer may vary between each type of household, which is consistent with reported data on public healthcare expenditure in Colombia. In the baseline model, we assume that healthcare expenditure has no impact on labor productivity. However, in Sections 5.2.1 and 5.2.2 we analyze alternative scenarios in which higher spending on healthcare increases labor productivity and life expectancy, respectively. Accordingly, the expenditure is given by:

$$G_t = g_t^H N_t^H + g_t^L N_t^L \quad (25)$$

where g_t^H and g_t^L are the expenditures per person, for high and low skilled households, respectively, and are defined by the public authority. For modeling purposes, we consider these expenditures as:

$$g_t^x = g_{ss}^x + \epsilon_t^x, x \in \{H, L\} \quad (26)$$

where $\epsilon^{H,L}$ can be transitory or permanent shocks. Note that total expenditure can change either because of public policy or because the mass of households is changing.

²One possible extension is to consider a CES aggregation at the top level.

On the income side, the government receives revenue from taxes on labor (firms and households), firms' profits, and consumption. The total income is given by:

$$T_t = (\tau_t^H + \tau_t^{FH})w_t^H L_t^H + (\tau_t^L + \tau_t^{FL})w_t^F L_t^F + \tau_t^k R_t K_t + \tau_t^c (C_t^H + C_t^L) \quad (27)$$

Finally, assuming balanced budget, we get that $G_t = T_t$.

2.4 Labor Market and the Minimum Wage

As previously established, our economy has three types of labor: high-skilled, and formal and informal low-skilled. The interaction of demand and supply determines employment and wages for informal low-skilled labor and high-skilled labor, given the optimal decisions of firms and households. However, in the case of low-skilled formal labor, we assume an exogenous minimum wage, above the competitive equilibrium, that results in the demand-side determination of the level of employment. In our model, there is an interdependence between the two types of low-skilled labor, that reflects the mobility between formal and informal workers, capturing the central elements of models used to analyze minimum wage policies (e.g., Gramlich, 1976; Mincer, 1976). Finally, the exogenous minimum wage is calibrated so that the initial unemployment rate is 10% (individuals who seek employment at that wage but are unable to do so due to restrictions on the demand side).

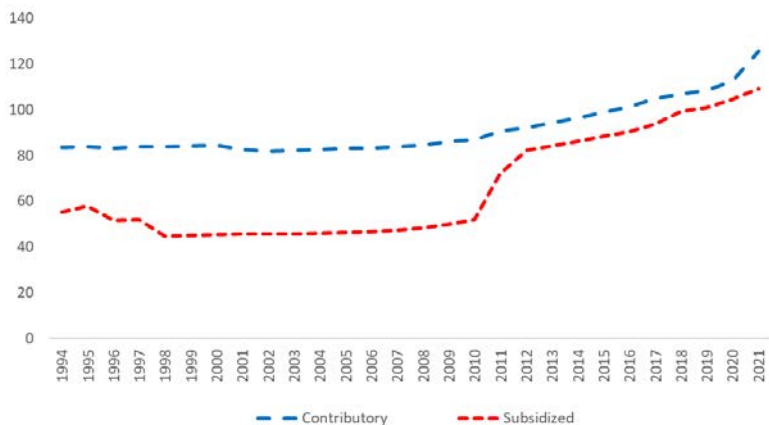
3 Healthcare system in Colombia

Law 100 of 1993 defines a dual-affiliation regime for healthcare in Colombia, depending on worker formality status. Specifically, formal workers and their family members are enrolled in the contributory regime, which, by definition, pays social security benefits. The remaining population is enrolled in a subsidized regime funded by government resources. Thus, financing healthcare depends on two primary sources: direct and indirect. First, formal workers pay 4% of their wages for healthcare financing. Additionally, their employers contribute 8,5% of the salary if it exceeds ten monthly minimum wages. The second source depends on government transfers, which are financed by general purpose taxes and public debt. According to official records in 2019, 48.2% of total financing came from the contributions made by firms and employees.

Another key element of the legislation is the annual budget per person, which we refer to as g in our model. This value covers the insurance risk premium, administrative costs of providing healthcare, and guarantees the profitability of providers. The value of g differs according to age, geographic location, and sex, reflecting alternative morbidity profiles. It also differs according to the regime in which the

individual is enrolled, with a higher value for the contributory system. Figure 1 shows the evolution of real per capita healthcare costs by regime type between 1994 and 2022. Since 1995, the value of g has been lower in the subsidized regime, and before 2010, it was approximately half the value in the contributory regime. In 2011, a reform increased the monetary value for subsidized system. Since then, equalizing per capita expenditures among healthcare regimes has been a central issue in the discussion of healthcare system reforms.

Figure 1: Evolution of real health expenditure per person.



Note: Index UPC contributory 1994 = 100.

By 2023 healthcare coverage in Colombia was 99,12%, while enrollment in the contributory regime was 47,5%. This gap makes healthcare financing heavily dependent on the government budget. Besides increasing population coverage, other factors have affected healthcare expenditure in Colombia. These include, widening the coverage of medical treatments and medicines in the basic bundle, and subsidizing healthcare of migrants from Venezuela.

In the coming years, global trends and country-specific policies will put some pressure on the financial stability of the healthcare system in Colombia. We focus on three: population aging, the equalization of per capita expenditure across regimes, and price/technological increases in the provision of medical treatments and services. In Table 1 we report the increase in expenditure projected under each of these scenarios. To quantify the effect of population aging, we combine data from DANE population projections with the current distribution of healthcare expenditure by age, gender, and regime. The second factor considers the equalization of the value g for the two regimes. Finally, we extrapolate the increase on real costs of medical treatments and medicines based on their trend during the last ten years. For this, we use information from the different baskets on the consumer price index from DANE. These three factors combined explain an increase of 25% on real healthcare expenditure in

the coming years. We include a final computation in Table 1 that extrapolates the real growth of per capita healthcare expenditure in the contributory regime from 2010 to 2020 for the next eight years. We also consider that expenditure in the two regimes is equalized. As seen in the table, this computation produces a higher increase in healthcare expenditure, that might capture other dynamics in the sector.

Table 1: Percentage Growth of g 2022 - 2030

Scenario	Contributory	Subsidized	Total
Aging	7,1%	7,3%	7,3%
Aging + Equalization	7,1%	28,6%	17,3%
Aging + Equalization + Higher costs	14,2%	37,0%	25,0%
Equalization + extrapolation	27,7%	41,85%	35%

* Own calculations based on Ministry of health and DANE.

4 Model Calibration and Parameter Selection

We calibrate the model to the Colombian economy using an annual frequency. We set the parameter values using a combination of literature for Colombia (González et al., 2011), international evidence (Krusell et al., 2000; Whalen & Reichling, 2017), and targeting some steady state ratios to time-series averages. The values from the literature and data are reported in Table (2), while the targeted values with their corresponding targets are displayed in Panel A of Table 3.

Before matching the model with the data, we categorize Colombian workers according to their labor income relative to the minimum wage using data from the Colombian Household Survey (GEIH) from 2010 to 2019.³ In particular, we define high-skilled formal workers as those with earnings exceeding 1.1 times the minimum hourly wage, low-skilled formal workers as those with earnings between 0.9 and 1.1 times the minimum hourly wage, and, the remaining individuals are categorized as low-skilled informal workers.⁴ Given these thresholds, we calibrate the relative productivity between low- and high-skilled workers (θ) to obtain a wage ratio of 2.7, and the relative productivity between formal

³The National Administrative Department of Statistics (DANE) conducts the GEIH, a continuous household survey that investigates employment, income, hours, and other labor market-related variables.

⁴Workers surveyed in the GEIH do not always report the wage stated in their contract, but the actual wage they receive. This discrepancy can arise due to factors such as social security discounts and subsidies. By using a range to define minimum wage earners, we are able to account for these variations.

and informal low-skilled workers (θ_L) to yield a wage ratio of 2.3. We define the mass of high-skilled households (N^H) as 52%, which is consistent with the data, and set the disutility of low-skilled labor (ψ_I) to match an informal employment share of 40%. Similarly, we obtain the disutility of high-skilled labor to match the wage share of 64% for this type of worker. To define the initial level of the minimum wage (w_{min}) we target a level of low-skilled formal employment 10% below than in a competitive market.

The remaining parameters in the production function are the capital share (α), depreciation rate (δ), and total factor productivity (A_{ss}). These values are chosen to match an investment over GDP of 22.5%, capital over GDP of 3.0, and a normalized GDP of one in the steady state.

It is important to highlight that our calibration algorithm perfectly matches all the long-run ratios. For the long-run equilibrium, we assume that the net foreign debt is 50% of GDP ($A_{ss}^f = 50\%$), the risk premium is one ($\Phi_{ss} = 1.0$), and government expenditure is ($G/Y = 4.3\%$). This implies a transfer of 0.043 for high-skilled households and 0.0407 for low-skilled households, which is consistent with the health expenditure per person in Colombia for the two regimes. Total government expenditure in healthcare, represented by g_{ss} , involves the computation of its proportion relative to GDP over the period spanning from 2019 to 2021. This computation exclusively considers the direct costs associated with Unified Healthcare Provision for both healthcare regimes. To perform this analysis, we use data from the Social Security Resource Administration Office.

Colombia's healthcare system is financed through two primary mechanisms. First, the contributory regime involves contributions made by formal workers who are required to pay 4% of their wages for healthcare financing. Additionally, firms contribute a 8,5% of an employee's salary if it exceeds ten monthly minimum wages.⁵ Second, the government provides transfers to finance healthcare expenditure for individuals in the subsidized regime, and the annual budget is determined based on annual healthcare expenditure per individual, which is denoted by g^H and g^L , and in the data differs between the two regimes. In particular, subsidized expenditure g^L accounts for approximately 90% of the expenditure in the contributory regime, g^H .

To determine the tax rates, we use official information and make some adjustments to reproduce the sources of public healthcare expenditure, according to which almost 50% of the funding comes from direct contributions, and the rest from other taxes (consumption and capital). To guarantee a balanced

⁵Since Law 1607/2012 the contributions from formal workers who earn less than 10 minimum wages are covered by government budget.

budget for the government and to close the model in the initial steady state, we allow consumption taxes to adjust freely. According to this calibration, 57% of the expenditure is financed with direct contributions (labor taxes), in particular, 46% from taxes to high-skilled labor and the remaining 11% to formal low-skilled labor. Regarding taxes on consumption and capital, they finance 33% and 23% of the expenditure, respectively. Finally, to check how the model adjusts the data, Panel B of Table 3 compares some non-targeted moments with official data from the labor market. As we can see, the model closely replicates employment and wage shares.

Table 2: Definition of Parameters and Values from Literature and Data

Param.	Definition	Value	Param.	Definition	Value
Panel A. Literature**					
β	discount factor	0.95	ν_I	Frisch elast. IL	1.5
σ	intertemporal elast.	1.0	η	elast. subs. H and L	1.01
ν_H	Frisch elast. H	1.0	η_L	elast. subs. F and I	1.50
ν_F	Frisch elast. FL	1.5	ξ	elast. of subs. interm.	10
Panel B. Data					
N_H	share of H Hhs	0.52	τ^{FL}	tax FL labor (firms)	0.00
g_{ss}	Government expenditure	0.043	τ^H	tax H labor (Hh)	0.04
g_{ss}^L	transfers to L	0.04	τ^L	tax FL labor (Hh)	0.04
τ^{FH}	tax H labor (firms)	0.02	τ^k	capital taxes	0.01

* Param. stands for Parameter, elast. for elasticity of substitution, Hh for households. and interm. for intermediates.

** González et al. (2011), Krusell et al. (2000), and Whalen and Reichling (2017)

5 Macroeconomic Effects of Healthcare Funding

In this section, we analyze the macroeconomic implications of financing a gradual and permanent increase in healthcare expenditure in Colombia using alternative taxes. Our benchmark scenario extrapolates, for eight years, the observed real growth in per-capita healthcare expenditure in the contributory system between 2010 and 2022 and considers a gradual convergence of the value of the expenditure between subsidized and contributory system during the same eight-year period. Then, real healthcare expenditure per person remains constant in the two systems. This simulation implies

Table 3: Targeted, Non-Targeted Moments and Parameters

Panel A. Targeted Moments				
Target	Value	Parameter	Description	Value
Y	1.0	A_{ss}	total factor Prod.	1.285
K/Y	3.0	α	capital share	0.387
I/Y	0.225	δ	depreciation of K	0.075
A_{ss}^f/Y	-0.50	A_{ss}^f	foreign assets	-0.50
G/Y	0.043	g_{ss}^H	transfers to H	0.045
g_{ss}^L	$0.9g_{ss}^H$	g_{ss}^L	transfers to L	0.041
w^H/w^F	2.7	θ	relative prod. H and L	0.447
w^F/w^I	2.3	θ_L	relative prod. F and I	0.349
employment share I	0.4	ψ_I	dis-utility labor IL	0.431
wage share H	0.64	ψ_H	dis-utility labor H	1.474

Panel B. Non-Targeted Moments

Moment	Model	Data
employment share H	0.307	0.303
employment share FL	0.293	0.308
wage share IL	0.134	0.18
wage share FL	0.226	0.201

Prod. stands for productivity, H for High-skilled, IL for informal low-skilled, and FL for formal low-skilled workers. Employment share $x \in \{I, FL, H\}$ is defined as $(L^x)/(L^H + L^I + L^F)$. The wage share for $x \in \{I, FL, H\}$ is defined as $(w^x L^x)/(w^H L^H + w^{IL} L^I + w^{FL} L^F)$.

that the real healthcare expenditure per person in the contributory system increases by 3.1% per year, while in the subsidized system, it increases by 4.5%. Thus, the accumulated increases in our analysis are 27.7% and 41.85%. These values are higher than the reported on Table 1, which implies that population aging, equalization, and higher costs explain between 50% and 90% of the total increase in healthcare expenditure.

For our simulations, we assume that the increases in healthcare expenditures per person, or transfers to households g^H and g^L , are exogenous, while the closing tax rate is endogenous. In other words, in

each period, given the exogenous increase in expenditures, the model finds the corresponding tax rate that ensures a balanced fiscal budget. We analyze four financing options that involve changing a single tax at a time. The taxes considered are consumption (τ^c), use of capital (τ^k), hiring high-skilled labor (τ^{FH}), and hiring low-skilled labor (τ^{FL}). Except for consumption tax, the other financing schemes directly impact the relative demand for production factors. As we will see later, this distinction is important for the results.

Finally, we consider that the economy starts at a steady state and learns about the behavior of personal health care expenditure and the corresponding closing tax for the following eight years. The economy then transitions to a new long-run equilibrium with higher transfers and taxes. For this equilibrium transition, we use the perfect foresight option in Dynare, see Adjemian et al. (2011).

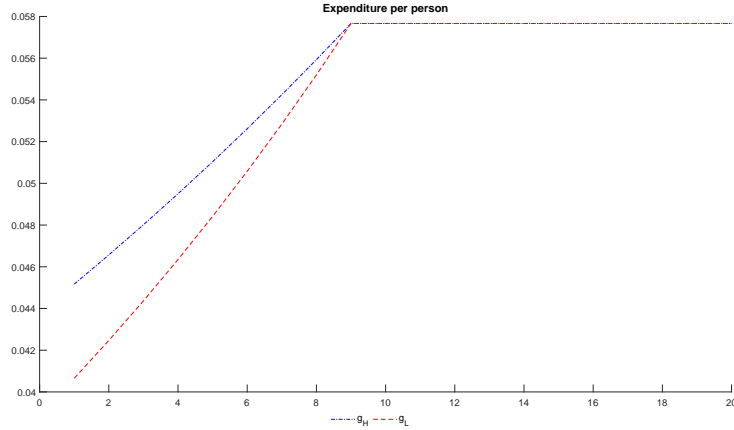
Using this setup, three groups of simulations were performed. Our benchmark case analyzes the macroeconomic and welfare effects of financing additional healthcare expenditure, regardless of the externality of health expenditure on other variables. The other two scenarios consider that healthcare expenditure affects labor productivity and life expectancy (discount factor). Under these scenarios, the negative effects of higher taxation might be reduced.

5.1 Benchmark results

The dynamics of the healthcare expenditure per person in each household is plotted in Figure (2). In period 1, the economy starts at the initial equilibrium, and agents learn that expenditure will increase gradually over the next eight years. Given our calibration, health expenditure per household is different in the initial equilibrium (0.045 vs. 0.04), but gradually equalizes after year 2 until parity in year eight. The dynamics of the main macroeconomic variables under the four financing schemes is plotted in Figure (3). Panel (a) illustrates the increase in healthcare expenditure as a share of output, which differs across alternative taxes. As depicted in Panel (b), higher expenditure increases tax rates in all scenarios, leading to greater distortions in the economy and negatively affecting GDP (Panel c), investment (Panel d), and consumption (Panel e). Despite the generalized negative effects for all funding options, the magnitudes differ across scenarios. That said, consumption taxes are the least distorting (in terms of aggregate production), in contrast to taxes on hiring low-skilled formal labor.

Focusing on the implications of financing with consumption taxes, we observe two important channels that explain why the negative effects are smaller with this option. First, to fund the additional healthcare expenditure, the increase in the tax rate is relatively small, 2.0 versus 4.6 percentage

Figure 2: Health expenditure per person

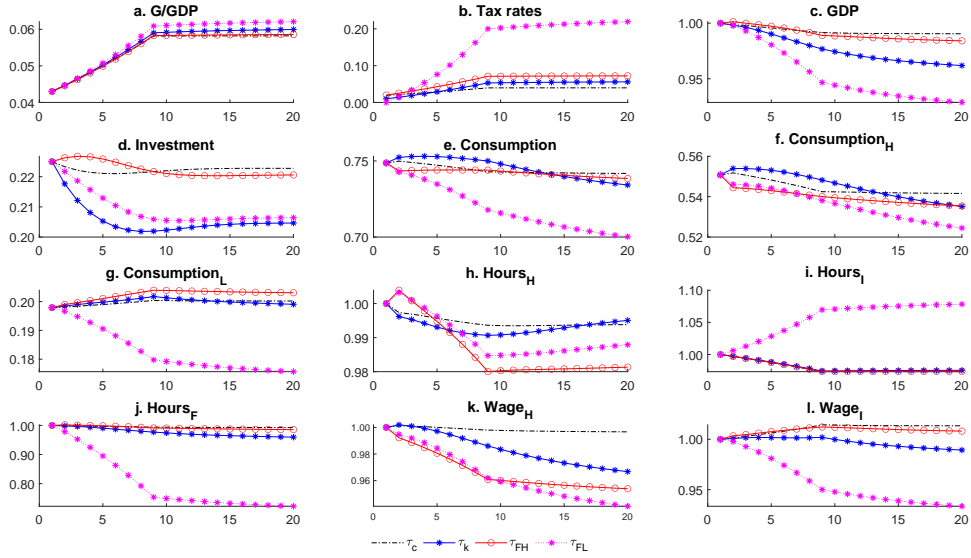


Note: g_H and g_L stand for individual transfers to high-skilled and low-skilled households, respectively.

points (in the second-smallest increase, Panel (b)). Given that consumption represents approximately 75% of output, a small increase in the tax rate is sufficient to generate the necessary resources to finance additional expenditure. Second, as this is a general tax, it does not affect firms' optimality conditions and does not distort capital usage or labor hiring, as can be seen in Panels (d), (h), (i), and (j), showing a general decrease in the usage of factors of production, and does not favor or punish the use of a particular one, as in other options. The impact on firms is reflected in the decline in the aggregate demand. As a result, the long-term GDP falls by 0.95% compared to declines ranging from 1.6% to 7.1% under alternative financing schemes. Regarding household-specific variables, higher healthcare expenditure implies an increase in transfers. In the case of low-skilled households, these transfers compensate for higher taxes, boost consumption, Panel (g), and discourage informal labor supply. As a result, informal employment drops, and informal wages increase (Panels i and l). This low-skilled consumption behavior is also observed for schemes that do not affect the hiring of formal low-skilled workers. On the other hand, the reduction in aggregate demand leads firms to hire fewer formal workers, both high- and low-productive, causing a contraction in their employment and wages (Panels (h), (j) and (k)).

The remaining financing options modify the relative price of labor and capital and affect the optimal behavior of firms. As a result, aggregate production experiences a higher drop. In the extreme case, funding additional expenditure with taxes on hiring formal low-skilled labor generates an output drop of 7.1%. In this scenario, to maintain a balanced budget, the tax rate increases from 0% to 22%, as shown in Panel (b) of Figure 3. As reported in the calibration section, low-skilled formal labor

Figure 3: Macroeconomic response to an increase in public expenditure.



Note: Initial values for G/Y , τ , GDP , I , C , C_H , and C_L correspond to the steady state before the shock. Labor market variables, h_H , h_I , h_F , w_H , w_I , are expressed relative to the initial steady state.

represents 30% of total employment, accounts for 23% of wage income in the economy, and represents 12% of GDP. According to these numbers, formal low-skilled income accounts for a relatively small fraction of the total output and justify the 22 pp increase in the tax rate (more than 10 times the increase in consumption taxes). On the production side, higher hiring costs discourage firms from employing formal, low-skilled workers. In competitive circumstances, this would push wages down; however, because of real minimum wage rigidity, this cannot happen and the adjustment implies a higher drop in employment. As a result, formal low-skilled labor declines by 28% in the long run (Panel (j)), reducing the income of hand-to-mouth households. In contrast to the first scenario, consumption taxes (higher Government transfers) do not compensate for the labor income drop, and low-skilled consumption falls. In response, they increase the supply of informal labor, causing an increase in informality and a drop in informal wages (Panels (i) and (l)). These results show that funding additional expenditure with taxes to hire formal low-skilled workers seems to be the least desirable option. Not only does output fall the most, but inequality also increases the most.

The last two schemes refer to financing through taxes on capital, τ^k , and taxes on hiring high-skilled labor, τ^H . In each case, the direct effect manifests through a higher reduction in demand for the respective factor (capital or skilled labor). In particular, with τ^k investment declines by 9.0%,

whereas with τ^H high-skilled employment decreases by 1.9%. In both schemes, the increase in the tax rate is similar, around 5 pp, and passes on higher production costs that affect the demand for complementary factors of production, such as low-skilled labor. In terms of macroeconomic aggregates, taxing the use of high-skilled labor is better than taxing capital because the drop in output is smaller and consumption inequality decreases.

Although aggregate and high-skilled consumption fall in the four schemes, the qualitative effects on low-skilled consumption depend on the financing scheme. In particular, we observe that low-skilled labor consumption only falls when additional expenditure is financed by taxes on hiring formal low-skilled labor. Under these scenarios, healthcare transfer is not sufficient to offset the income drop from formal workers, and hand-to-mouth households experience a fall in consumption. These results are relevant for policymakers who intend to reduce income and consumption inequality through transfers, as implied by the model that the financing scheme of public health policy can also serve as a mechanism for redistribution.

The observed variations in the effects of tax schemes on output, consumption inequality, and employment (both formal and informal) highlight the importance of designing healthcare financing policies carefully. Policymakers should consider potential trade-offs between fiscal sustainability and economic performance when selecting tax schemes.

5.1.1 Welfare Analysis

As noted in the previous section, all financing schemes affect households' decisions in terms of consumption and labor, which are variables that determine the value of utility. This section explores how welfare changes under alternative financing schemes. For this, we calculate the present discounted value of utility under each scenario and compare it with the value of remaining in the initial steady state. To avoid social welfare considerations, we present only the change in welfare for each individual household. The welfare variation was calculated using the following equation:

$$\Delta\%Welfare_j^H = \frac{PV_j^H - PV_{ss}^H}{|PV_{H,ss}|} * 100 \quad (28)$$

where

$$PV_j^H = \sum_{t=0}^{\infty} \beta^t \left(\frac{(c_t^H)^{1-\sigma}}{1-\sigma} - \psi_H \frac{\nu_H}{1+\nu_H} (h_t^H)^{\frac{1+\nu_H}{\nu_H}} \right);$$

$$PV_{ss}^H = \frac{1}{1-\beta} \left(\frac{(c_{ss,0}^H)^{1-\sigma}}{1-\sigma} - \psi_H \frac{\nu_H}{1+\nu_H} (h_{ss,0}^H)^{\frac{1+\nu_H}{\nu_H}} \right)$$

j corresponds to each funding option and the subscript $ss,0$ indicates the initial steady-state values. Similar calculations were performed for the low-skilled households. Table (4) reports the changes in

welfare for both households. For comparison, we also report the change in the GDP and in welfare from the initial steady state to the final state. These three results are striking. First, high-skilled households are always worst-off with respect to the initial equilibrium; however, financing with consumption taxes reduces welfare losses. Second, low-skilled households are better when additional taxation does not directly affect the hiring of formal low-skilled labor. Third, financing with taxes to hire formal low-skilled labor is the least desirable option because they magnify welfare losses for both households; they also generate the highest output drop in the long run. We finally observe that the steady state comparisons magnify the negative effects of the policy. In all cases, the welfare losses are bigger than in the dynamic calculation. Two facts explain this difference. On the one hand, the static comparison does not consider the timing of the policy, which takes several years to be fully implemented. On the other hand, the economy takes some time to fully adjust to the shock due to capital adjustment costs, and substitution forces across the different factors of production.

Table 4: Welfare and GDP change under alternative funding options.

Tax	$\Delta\%Wel^H$	$\Delta\%Wel^L$	$\Delta\%GDP_{ss}$	$\Delta\%Wel_{ss}^H$	$\Delta\%Wel_{ss}^L$
τ^c	-2.07	0.87	-0.95	-3.04	1.08
τ^k	-3.24	1.11	-3.81	-8.88	0.97
τ^{FH}	-3.64	1.71	-1.59	-5.67	2.00
τ^{FL}	-6.55	-2.27	-7.13	-13.07	-3.73

Given these results, we have different metrics to evaluate the effects of higher taxation to finance the additional healthcare expenditure. If we only care about economic activity, the least distorting option is the consumption tax. Alternatively, if we care about inequality or increasing welfare for low-skilled households, taxes on hiring high-skilled labor become a good alternative.

5.2 Alternative scenarios

In this section, we present two extensions to our benchmark setup and an alternative shock. First, we assume that healthcare expenditure has an externality on labor productivity. Second, we consider that higher healthcare expenditure increases life expectancy. These two scenarios aim to capture some of the positive externalities that higher healthcare expenditure might have on the economy. For simplicity, both extensions are exclusive from each other. Finally, the alternative shock consists of changing the population size of high- and low-skilled workers, without affecting the expenditure per individual in each household. This scenario helps us understand the effects of migration shocks, which

have been relevant for Colombia during the last decade.

5.2.1 Positive externality on labor productivity

So far, we have assumed that Government expenditure on healthcare is a lump-sum transfer to households and has no effect on labor productivity. However, many authors have found that investing in human capital through health and education expenditures has a positive effect on labor productivity and income per capita (Bloom & Canning, 2009; Bloom et al., 2004, 2019; Breton, 2013; Gyimah-Brempong & Wilson, 2004; Howitt, 2005; Mankiw et al., 1992; Weil, 2007). In Weil (2014) words: *“healthier individuals are more productive, learn more in school, and, because they live longer, face enhanced incentives to accumulate human capital”*.

Motivated by this literature, we extend our benchmark analysis to include the positive externality of health expenditure per household on labor productivity. In particular, we modify the production function in equation (19) by considering that any increase in health expenditure per household above the initial level, $g_{L,0}, g_{H,0}$, increases labor productivity. For illustrative purposes, it is important to clarify that an increase in per capita expenditure leads to an immediate increase in productivity. However, in reality, this process may take several years, so we should interpret the short-term effects with caution.⁶ Parameters γ_L and γ_H establish the size of the externality on labor productivity, and $g_{L,0}$ and $g_{H,0}$ are the expenditures per person in the initial steady state. This equation guarantees that the models with and without productivity externalities start at the same equilibrium.

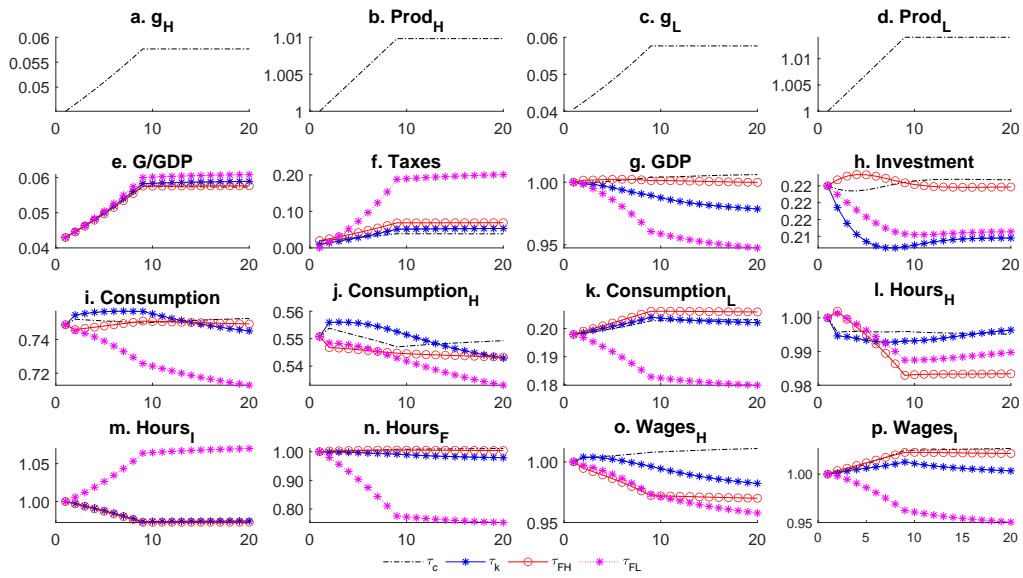
$$L_{it} = \left[\left(\frac{g_{L,t}}{g_{L,0}} \right)^{\gamma_L \frac{\eta}{\eta-1}} \theta (L_{it}^L)^{\frac{\eta-1}{\eta}} + \left(\frac{g_{H,t}}{g_{H,0}} \right)^{\gamma_H \frac{\eta}{\eta-1}} (1-\theta) (L_{it}^H)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \quad (29)$$

According to Barro et al. (1996), an increase in life expectancy of 40% leads to a higher per capita income growth of 1.4%. Consistent with these estimations and following the most recent evidence Weil (2014), we set an elasticity factor, γ , of 4% and repeat the analysis in the previous section. As shown in Panels (a) and (c) of Figure 4 this value implies that increasing health expenditure per person in the contributory system by 27.7% leads to a high-skilled labor productivity gain of 1.0%. Similarly, increasing the individual transfer for low-skilled households 41.85% raises their labor productivity 1.4%, Panels (b) and (d).

Unlike the baseline model, under this alternative setup, the adverse effects of increasing taxes to finance additional healthcare expenditure are attenuated by higher levels of labor productivity for both high-skilled and low-skilled workers. In particular, for each funding option, we observe smaller

⁶In Appendix Appendix A we consider that this effect on labor productivity takes some time.

Figure 4: Macroeconomic response to an increase in public expenditure. Model with externalities.



Note: Initial values for $G/Y, \tau, GDP, I, C, C_H$, and C_L correspond to the steady state before the shock. Labor market variables, h_H, h_I, h_F, w_H, w_I , are expressed relative to the initial steady state. g_H and g_L stand for transfers to high-skilled and low-skilled households.

drops in output, consumption, and investment, Panels (g) to (i) of Figure (4). In the case of financing with consumption taxes, we see a small expansion of GDP in the long-run (0.6 %). Higher labor productivity counteracts the negative distortions of taxes by reducing the marginal costs of labor for firms, boosting employment, and increasing worker income. By comparing Figures (3) and (4), we see that, for all alternative funding options, wages for high-skilled and informal workers drop less with labor productivity externalities. Qualitatively, the results and mechanisms described for the baseline model hold under this alternative version. In particular, the most distorting option in terms of GDP and welfare is financing additional expenditure through taxes on formal low-skilled labor. In contrast, financing with consumption taxes is the most viable option if the main interest is to increase output. While, funding with taxes on high-skilled labor, is the preferred one in terms of reducing consumption/welfare inequality.

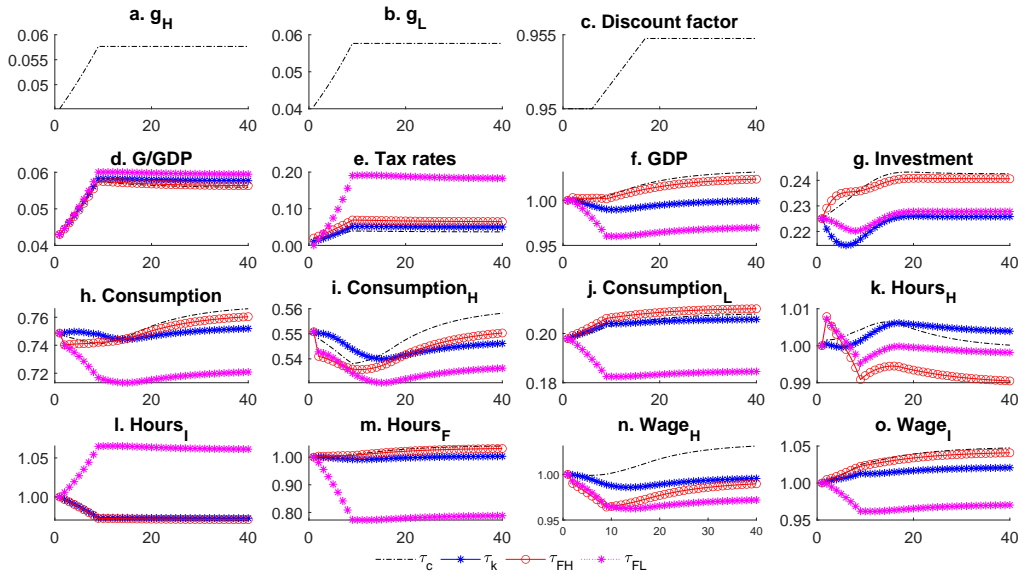
As a final remark, it is important to note that healthcare expenditures that increase labor productivity can counterbalance the negative effects of higher tax rates. However, even if healthcare expenditure is assumed to increase productivity, the negative effects of financing schemes other than consumption taxes or taxes on the formal employment of high-skilled workers are not offset by productivity gains. The timing of the reforms is also important, especially when productivity gains are not one-to-one with health expenditures. In Appendix Appendix A we modify this scenario in two ways. First, we consider that the effects of higher expenditure on labor productivity are not immediate and take four years. Second, we assume a stronger externality. Under this alternative version, in the long run, GDP increases in three of the four funding options. The only contracting scheme is the taxation of formal low-skilled workers. However, due to the lagged response in productivity, during the first few years, the economy experiences output drops in all cases. In terms of welfare, both households experience improvements in three out of the four taxing options. This scenario highlights the importance of understanding the short-, medium-, and long-run effects of policy design as well as their potential effects on labor productivity.

5.2.2 Life expectancy: Discount factor

Finally, we consider a case in which higher expenditure in healthcare increases the discount factor by 0.5% in the long run as a proxy for life expectancy. During the transition, we assume that an increase in the discount factor comes with a 4-year lag. Panels (a) and (b) of Figure (5) plot the dynamics of healthcare expenditure per individual in each household, and Panel (c) shows the effects on the discount factor. The macroeconomic effects of this shock are plotted in Panels (d) to (o).

In contrast to the baseline scenario, there is a positive impact on investment across all financing schemes. A higher discount factor leads to reduced impatience among high-skilled households, causing them to postpone their current consumption, increase savings, and boost capital accumulation. As capital rises, labor productivity increases, leading to increased labor demand from firms and higher wages. Compared with our benchmark scenario, all variables perform better, with some experiencing growth and others declining to a lesser extent. Essentially, the discount factor's positive effect mitigates the adverse effects of higher taxation. Specifically, in cases involving funding through consumption taxes or taxes on hiring high-skilled labor, we note a long-term increase in total output, ranging between 2 and 3%. The qualitative findings regarding funding options remain consistent. In this context, consumption taxes are the least distorting choice concerning GDP, whereas taxes on hiring formal low-skilled labor still generate the highest output drop.

Figure 5: Macroeconomic response to an increase in public expenditure. Effects on life expectancy.



Note: Initial values for G/Y , τ , GDP , I , C , C_H , and C_L correspond to the steady state before the shock. Labor market variables, h_H , h_I , h_F , w_H , w_I , are expressed relative to the initial steady state. g_H and g_L stand for transfers to high-skilled and low-skilled households

5.2.3 Change in population size

Finally, we analyze the effects of increasing the mass of each household on the economy. The purpose of these simulations is to understand how the relative shares of high- and low-skilled households affect the funding sources of public health expenditure. For this purpose, we consider two alternative scenarios. First, we increase the proportion of high-skilled households by 5%, from 0.52 to 0.532, which increases the total population by 2.6%. In the second case, we increase the number of low-skilled households by 5%, from 0.48 to 0.50, thereby increasing the total population by 2.4%. These two scenarios can be associated with migration shocks, similar to those analyzed by Hamann et al., 2021. For these two cases we keep health expenditure per individual constant, and we analyze how the additional population affects the funding sources and the aggregate activity in the long run, in particular GDP and GDP per capita.

As shown in equation (25), total health expenditure depends on two factors: the masses of high- and low-skilled households and the transfers per individual to each household. In the two alternative scenarios, we consider that total expenditure increases only by changing the masses of households while keeping individual transfers constant at the initial steady state. On the income side, equation (27) implies that tax revenue is endogenous because it depends on wages, employment, consumption, interest rate, and capital. Due to this endogeneity and the fact that the labor force is increasing in both cases, *ex-ante*, we do not know if the economy requires higher or lower taxes to fully finance the additional expenditure. As in our benchmark scenario, we consider the same four alternative taxes to keep a balanced budget.

Table (5) reports our simulation results for the two population shocks. To simplify the analysis, we focus on the long-run changes in three variables only: taxes, GDP, and GDP per capita. Regardless of the financing scheme, increasing the size of the population, either high- or low-skilled, has a positive effect on total output. However, the results are different in per-capita terms. While increasing the high-skilled population has a positive effect on income per capita, the effect is the opposite for a higher low-skilled population. This result is consistent with the findings of Hamann et al. (2021) and highlights the asymmetry of labor productivity in the production process. Another interesting result is that increasing the high-skilled population augments Government revenue by more than its expenditure; thus, to maintain a balanced budget, the economy requires lower taxes. In other words, there are direct and indirect contributions from high-skilled workers to finance the healthcare system. On the contrary, when the low-skilled population increases, government expenditure increases more than revenue, and the economy requires higher taxes to maintain a balanced budget.

Table 5: Change in population shares

Scenario		$\Delta\%N_H$			$\Delta\%N_L$		
Tax	τ_{ini}	$\Delta\tau$	$\Delta\%Y$	$\Delta\%(Y/N)$	$\Delta\tau$	$\Delta\%Y$	$\Delta\%(Y/N)$
τ^c	1.94	-0.07	3.95	1.32	0.08	1.01	-1.36
τ^k	1.00	-0.15	4.08	1.45	0.16	0.88	-1.48
τ^{FH}	2.00	-0.18	3.99	1.35	0.19	0.98	-1.39
τ^{FL}	0.00	-0.55	4.17	1.53	0.60	0.79	-1.57

Note: τ_{ini} stands for initial tax rate. τ_{ini} and $\Delta\tau$ are multiplied by 100.

6 Conclusion

During the next decade, the Colombian health system required an increase in public expenditure of around two percentage points as a share of GDP. To maintain a sustainable system, higher expenditures demand a permanent increase in the sources of funding, mainly taxes. This study analyzes the macroeconomic effects of alternative financing schemes through the lens of a dynamic general equilibrium model for a small open economy with fragmented labor markets. We calibrate the model for Colombia and analyze the macroeconomic effects of funding additional health expenditure with five alternative options, including taxes to consumption and the use of factors of production, such as capital and labor.

Our results indicate that funding option matters for aggregate dynamics and consumption inequality. We find that the most desirable option in terms of output is financing with taxes on consumption. This result can be explained by two mechanisms. First, to finance the additional expenditure, the tax rate needs to increase by around 2.0 pp, which is smaller than in the other options (between 4.6 and 22 pp). Second, consumption taxes are general taxes and do not affect the optimality conditions of firms, unlike taxes on the use of factors of production, capital, and labor. In contrast, the least desirable option is funding with taxes on hiring formal low-skilled labor. In this case, due to the small share of this type of labor, the economy requires a large increase in the tax rate. In addition, firms' decisions are distorted and informality is encouraged.

Regarding inequality, healthcare transfers serve as tools to enhance the income distribution. If this is an objective of the policy, a potential approach would involve financing additional expenditures through taxes on hiring high-skilled labor. In such a scenario, low-skilled households witness an income

boost from increased transfers, whereas the tax burden falls on high-income households. Finally, our findings underscore the significance of healthcare expenditure in relation to labor productivity and life expectancy. When additional spending positively impacts one of these variables, it mitigates the adverse effects of higher taxation and, in certain situations, fosters long-term improvement in economic activity.

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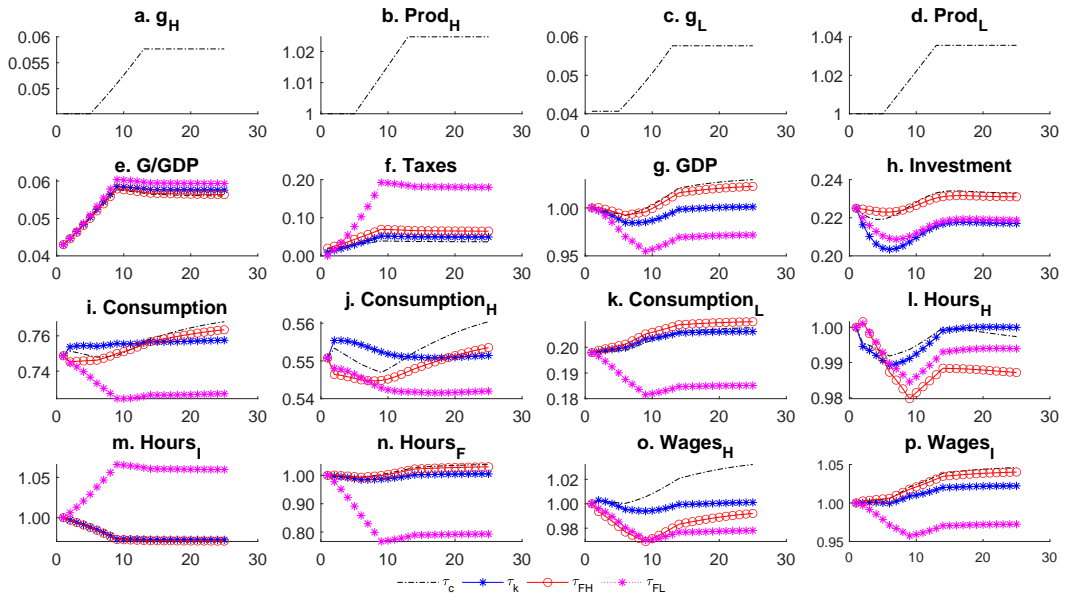
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Appendix A

Higher and lagged positive externality of healthcare expenditure on productivity

In this appendix, we assume that the additional expenditure on healthcare per household has a lagged effect on labor productivity, and it takes four years to be effective, as in Figure (A.1). Also, we consider a stronger effect of healthcare expenditure on labor productivity, $\gamma = 0.1$.

Figure A.1: Macroeconomic response to an increase in public expenditure. Model with High Externalities in labor productivity and lagged effect on productivity.



Note: Initial values for $G/Y, \tau, GDP, I, C, C_H$, and C_L correspond to the steady state before the shock. Labor market variables, h_H, h_I, h_F, w_H, w_I , are expressed relative to the initial steady state.