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ARTÍCULO

FISCAL SUSTAINABILITY AND UNIVERSAL PENSIONS: PUBLIC PENSIONS IN ECUADOR

Margarita Velín-Fárez

Velín-Fárez, M. (2025). Fiscal sustainability and universal pensions: Public pensions in Ecuador. *Cuadernos de Economía, 44*(95), 997-1023.

This paper aims to assess the impacts of several pension reforms on the economic welfare and main macroeconomic variables in the Ecuadorian economy, where the government covers 40% of the retirement benefits. We use an overlapping generations model, where two types of simulations are carried out for balancing the government's budget: 1) income taxes and social security contributions; and 2) consumption taxes (value added tax, or VAT) that finance pensions, considering tax evasion as well. The simulations suggest that the elimination of the government's financing of contributory pensions, along with a reduction of the replacement rate to 50%, leads to a welfare gain of 15.8%, and an increase in steady-state GDP and private consumption of 13.5% and 6.4%, respectively. Results are even higher if VAT is used instead.

Keywords: Pension reforms; universal pensions; taxation; Dynamic General Equilibrium; Sustainability; Latin America.
JEL: H55, H20, E62, D58.

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Velín-Fárez, M. (2025). Sostenibilidad fiscal y pensiones universales: Las pensiones públicas en Ecuador. *Cuadernos de Economía, 44*(95), 997-1023.

Este artículo tiene como objetivo evaluar los impactos de algunas reformas de pensiones en el bienestar económico y en las principales variables macroeconómicas de Ecuador, en el que el Gobierno financia el 40 % de las pensiones contributivas. Para el efecto, utilizamos un modelo de generaciones solapadas con dos tipos de simulaciones que equilibran el presupuesto del gobierno: 1) una combinación de impuestos a los ingresos y con contribuciones a la seguridad social; y 2) impuestos al consumo (IVA) en lugar de las contribuciones a la seguridad social (considerando también el efecto de la evasión de impuestos). Los significativos resultados sugieren que los efectos de estas reformas, específicamente, la eliminación del 40 % del pago a las pensiones contributivas (para mantener el principio de contributividad de las pensiones) y la reducción de la tasa de sustitución al 50 % del salario, permitirían una ganancia en el bienestar económico del 15,8 %, y un incremento del PIB y del consumo privado en estado estacionario del 13,5 % y 6,4 %, respectivamente. Los resultados serían aún mayores si el IVA financia las pensiones.

Palabras clave: reforma de las pensiones; universalización de las pensiones; impuestos; modelos de equilibrio general con generaciones solapadas (CGE-OLG); sostenibilidad fiscal; América Latina.
JEL: H55, H20, E62, D58.

INTRODUCTION

Over the past three decades, governments worldwide have recognised the need to reform pay-as-you-go (PAYG) pension systems due to financial sustainability problems caused by factors such as an aging population with low fertility rates and increased longevity (Fehr, 2009, 2016; Gruber & Wise, 2004; Holzmann & Palmer, 2006), as well as lower growth and weak fiscal conditions—particularly, because of many unexpected shocks due to COVID-19—. In response, some countries have implemented parametric reforms, such as, extending the period of time for computation of pension benefits, and introducing incentives to late retirement or sustainability factors. Others, have undertaken public pension reforms to increase revenue for financing public pensions, by means of raising payroll taxes or value added tax (VAT)[1] —as in the case of Japan— (Maebayashi, 2019). However, in an effort to reduce poverty among the elderly, governments may also consider other resources and pension schemes, such as universal, non-earnings-related pension benefits funded through VAT in countries with a large informal[2] sector, which may be more efficient than financing through income or payroll taxes limited to the formal labour market, as shown in the analysis of the Mexican case by Antón et al. (2013).

After the World Bank's recommendation in its 1994 report, "Avoiding the Old Age Crisis", many countries in Latin America introduced pension system reforms during the 1980's and 1990's (Olivera, 2016). The Ecuadorian PAYG scheme has its origins in the 1942 system, however, due to the myopia of policy-makers and society, no reforms have been made since then. This fact could be possible because the government pays 40% of the contributory pension expenditures[3], as an instrument for maintaining the financial sustainability of the pension system. Nevertheless, since 2015, it has been facing a negative financial gap in its pension system, that keeps growing due to the upward trend in the pension coverage rate and the downward trend in the proportion of workers in the formal sector of the economy[4] (Velín-Fárez, 2021). Thus, with an aging population similar to that of developed countries, Ecuador's pension system will likely be even in an even worse situation in the future if no reforms are made.

Unlike most pension systems in the world that are designed under a contributory principle, the Ecuadorian system is not entirely contributory, placing pressure on the fiscal budget, which is an important element to be considered in an evaluation of the pension system. Unfortunately, existing studies of the Ecuadorian pension system are based on actuarial analysis only. The mandatory government payment of

[1] For details of every reform in each Organisation for Economic Co-operation and Development (OECD) country, see OECD (2005), OECD (2015), OECD (2017), OECD (2019), OECD (2021).

[2] In this paper, informality is referred to lack of social security coverage.

[3] This fact breaks the principle of contributivity.

[4] In 2021, the social security coverage rate was 42%-related to the economically active population-, i.e., the informality rate would be 58%, and the pensioner coverage rate, measured as the number of pensioners out of the population over 65 years old, was 37%.

40% of the contributory pension expenditures has been defended using the argument that the pension system is unbalanced and that it is a constitutional right of pensioners. Therefore, recommendations to reform the pension system have focused only on increasing the contribution rate and delaying the legal retirement age. As it is well-known that pension reforms have both welfare and macroeconomic impacts arising from general equilibrium effects, two main questions arise: i) What would be the effects of eliminating the 40% government-financed share of contributory pension expenditures on macroeconomic variables and economic welfare? and ii) what would the impact be on macroeconomic variables and welfare change if the replacement rate were reduced? Additionally, as Ecuador is one of the countries in Latin America and the Caribbean with the highest degree of informality in the labour market, which lowers the level of social security contributions and thus pensions (Velín-Fárez, 2021), a third research question arises: what would be the effect if pensions were financed through consumption taxes instead of payroll taxes?

Due to the complexity of CGE-OLG models, and particularly because of data availability, almost all existing models have been built for developed economies, largely with data from the United States[5]. Studies of the macroeconomic effects of pension reforms in developing countries are scarce. In the specific case of Ecuador, as far as the author knows, this may be the first work to explore the effects of pension reforms on macroeconomic variables. It complements similar works carried out in Latin America, including the Glomm et al. (2009) study of the early effect of retirement in Brazil and the Schmidt-Hebbel (1997) study of the effect of informality in the case of Chile. Thus, we start with the simplest model for a first approximation. The numerical analysis is based on a three-periods CGE-OLG model in the tradition of Auerbach and Kotlikoff (1987) as presented in Fehr and Kindermann (2018), taking into account some particularities of the Ecuadorian economy, namely that a fraction of aggregate pensions is financed with consumption and income taxes as opposed to social security payroll taxes, i.e., there is no pure contributory pension system[6]. We carry out two types of simulations: Simulation I, in which income taxes balance the government's budget, and Simulation II, in which pensions are financed by consumption taxes, considering tax evasion as well, i.e., a fiscal reform for universal pension. In each type of simulations, we carried out a sensitivity analysis related to the elements of the pension system by highlighting its properties, i.e., reforms that affect the generosity of pension benefits, the government-financed share of pension expenditures, and an overall reform package incorporating both these policies. Simulation I is designed to answer the first two questions, whereas Simulation II addresses the third research question.

Results suggest that the current design of the Ecuadorian PAYG pension system has negative effects on the economy, i.e., a decrease of savings, income, and welfare of current and future generations. In Simulation I, even though changing from

[5] See Fehr (2016) and Fehr (2009) for good surveys about CGE models dealing with pension systems.

[6] Discussions about this issue and its consequences on the fiscal budget can be found in Conde-Ruiz (2014) and Devesa and Doménech (2020).

a partially tax-financed to a fully contribution-financed pension system has weak effects on equilibrium, which is clear since taxes and contributions are very similar instruments in the current model, it is very important to make evident that Ecuador's current taxation structure has hidden taxes to subsidise a few. This contributes to regressiveness and leaves out informal workers. In order to find an "ideal scenario" that fully finances the pension system but smooths the fiscal taxation pressure on household income and the reduction of welfare, we highlighted the case in which the replacement rate is roughly 0.5 and the equilibrium in the long-run is satisfied with a roughly 14% contribution rate. This would lead to an increase in welfare, private consumption, and GDP of 15.79%, 6.42%, and 13.53%, respectively. Of course, the elimination of the payment of the 40% from the government has an effect on income taxes—reduction—. However, since tax evasion estimations are not considered in Simulation I, income taxes could be maintained so as not to affect the fiscal budget. Regarding Simulation II, findings confirm the conclusions of Antón et al. (2013) and Maebayashi (2019) that financing pensions by means of VAT instead of social security payroll taxes would bring about higher welfare gains and economic growth, where, in the "ideal scenario" and considering tax evasions, there would be an increase in welfare, private consumption, and GDP of 21.44%, 10.39%, and 15.7%, respectively. Even without explicitly modelling a dual labour market with an informal sector, it seems to contribute to reducing old age inequalities and poverty. Nevertheless, as is mentioned in Lora and Fajardo-González (2016), care must be taken when analysing the effect of pension reforms from this perspective, as this policy may induce further informality—related to unregistered firms—[7]. They provide a broad empirical assessment of the effects of payroll, value-added, and corporate income taxes on labour outcomes in Latin American economies. Their findings suggest that the impacts of different taxes vary significantly. Depending on workers' perceived value, payroll taxes either increase labour costs and lead to job losses, or enhance labour participation without raising costs for firms. However, VAT might promote informality, particularly for firms operating outside the formal sector, as the self-enforcing nature of VAT applies mainly to formal businesses. The evasion of VAT by firms may serve as an incentive to remain informal, balancing the cost of taxes with the limitations of informal operations.

The balance of this paper is as follows. The Ecuadorian pension system is briefly described in the following section. Section 3 outlines the basic structure of the model, while section 4 explains the calibration strategy and the initial benchmark equilibrium. In Section 5, some reform scenarios from Simulations I and II are reported and discussed. Finally, Section 6 offers concluding remarks and a discussion of the results.

[7] Lora and Fajardo-González (2016) defines "informality rate" as the ratio between the number of persons in informal sector employment and the total number of employed persons. A worker is informal if (s)he either works in a small firm—those with up to five workers—, or is self-employed or is an unpaid worker.

AN INTRODUCTION TO THE ECUADORIAN PENSION SYSTEM[8]

Ecuador, a small and dollarised country in South America, has one of the highest pension replacement rates in the world, provided by a defined contribution pay-as-you-go (PAYG) pension system that is characterised by its high level of generosity and very low coverage (Conde-Ruiz & González, 2016; OECD, 2021; OECD-IDB-WB, 2014). As a result, Ecuador's pension system has the highest *gross pension wealth* indicator in the world[9], even higher than the Dutch system, which was positioned as one of the best (A-grade) systems in the 2021 Mercer CFA Institute Global Pension Index[10]. Ecuador's pension wealth is 23.2 (25.6) times annual individual earnings for males (females) (OECD-IDB-WB, 2014), while the Dutch system has a pension wealth of 13.1 (14.2) times annual individual earnings, respectively (OECD, 2021).

The contribution rate for all insurances (old age, health, labour risks, and unemployment) is paid by employees and employers and totals 20.60%. The contribution rate for old-age insurance specifically is 10.46%. In addition to these contributions, the Social Security Law mandates that government provides 40% of the benefit expenditures, i.e., a contributory pension subsidy. It is worth noting that, according to Montoya et al. (2018), the average subsidy for Ecuadorian contributory pensioners is 70%, which is 42 percentage points higher than the average pensioner in Latin American and Caribbean countries.

The legal age for retirement depends on an individual's contribution record, but it can begin as early as age 60. If an individual has made 480 contributions (equivalent to 40 years), they can receive full pension benefits. Pension benefits are calculated based on an individual's contributions to the social security system and their previous earnings, resulting in an average replacement rate of approximately 80%. The simulation model described in the next section tries to take these important features into account.

Before conducting an analysis of pension reforms, it is important to mention the four main objectives of a pension system (Blake, 2006):

- *Consumption smoothing* throughout the lifetime, i.e., when individuals are of working age, they make contribution payments through payroll taxes. Thus, when they retire, they receive a pension until death as the counterpart of those contributions.

[8] For a detailed description of the Ecuadorian pension system, see Velín-Fárez (2021).

[9] Pension wealth is "relative to individual earnings that measures the total discounted value of the lifetime flow of all retirement incomes in mandatory pension schemes at retirement age", where the discount rate is 2%. It is "expressed as a multiple of gross annual individual earnings" (OECD, 2017).

[10] This Index takes into account the adequacy, sustainability and integrity of pensions, and compares 47 retirement systems across the globe, covering nearly two-thirds of the world's population.

- *Insurance* for the entire lifespan of individuals to mitigate a longer expected lifespan.
- *Redistribution* of earnings to low-earning pensioners. This is an intra-generational sharing aim.
- *Poverty prevention*. It is used to relieve basic needs at old-age. Hence, this and the third objective are part of the public policies aimed at guaranteeing a minimum quality of life for society and helping the more vulnerable social groups.

The current Ecuadorian pension system provides coverage to a low percentage of the population[11], which does not allow these objectives to be met for all the population. On the other hand, the system presents additional problems, such as inequalities, a taxation structure that contributes to regressiveness, and a negative financial gap (Velín-Fárez, 2021). Thus, the Ecuadorian pension system needs to discuss technical reforms. A well-designed reform should align with broader economic objectives, focusing on improving these issues and considering a long-run sustainable system, adequate pension, intra- and inter-generational equality, and welfare. Since the purpose of this work is to have an initial macro approach to the evaluation of the Ecuadorian pension system, as well as the social welfare effect on households, it covers a part of this discussion.

THE MODEL ECONOMY

The economy is a three-period overlapping generation model in the tradition of Auerbach and Kotlikoff (1987) that takes into account the model framework of Fehr and Kindermann (2018) as well as many features of Fehr (1999) and Fehr (2000) for studying pension reforms in the Ecuadorian economy. With a flexible demographic structure, it consists of consumption choices (agents belonging to the same generation are identical) given the preferences and budget constraint of households, the production sector, and the government. In the first period, individuals work and save for the second period of life; in the second period, they work and save for the third period; and finally, in the third period, they retire and consume all their savings. The government obtains revenue from consumption, income and payroll taxes, engages in public spending, and pays retirement benefits. Since we are concerned with the impacts of the pension system on the economy, we abstract from corporate profit taxes and government debt, as in the work of Fehr (2000). The model assumes that labour and capital income taxes are equal[12] and that an amount of public goods supplied by the government is included in individual utility function in an additively separable manner.

[11] In 2021, the social security coverage rate was 42%-related to the economically active population-, i.e., the informality rate would be 58%, and the pensioner coverage rate, measured as the number of pensioners among the population over 65 years old, was 37%.

[12] This assumption is based on the fact that the Ecuadorian government levies a uniform tax on income from labour and capital.

The production sector is represented by a constant returns-to-scale Cobb-Douglas aggregate production function with inputs of labour and capital. In the government sector, two institutions have the power to levy income and payroll taxes for financing consumption: the fiscal authority that collects taxes to provide public services, and the social security system that provides retirement benefits. Since public debt is not included, the intertemporal government budget is balanced through taxation.

Demographics

The model economy is populated by overlapping generations of individuals who have a maximum lifespan of three periods, N_t, N_{t-1}, N_{t-2} and abstracts from life span uncertainty. N_t is the number of the cohort in period t, which enters the labour force. The population grows at rate $n_{p,t}$, i.e.,

$$N_t = (1 + n_{p,t})N_{t-1} \tag{1}$$

Time is discrete and each period represents 20 years. In period t the total population TP_t size is:

$$TP_t = N_t + N_{t-1} + N_{t-2} \tag{2}$$

where N_t+N_{t-1} is the workforce in period t and N_{t-2} is the retiree population.

Households

The model assumes that all agents have identical preferences and rational behaviour. Agents decide how much to consume (c_t), and consequently save (a_t), in different periods of their lives. They pay taxes on income (labour and capital) and consumption. They also pay a payroll tax in the period t in exchange for receiving pension benefits in the third period of life pen_{t+2}. The model also abstracts from leisure. Thus, it is assumed that the utility function is time-separable, meaning that lifetime utility can be expressed as a function of individual functions of consumption in each period. Moreover, it is assumed that the utility function has the form of the nested, constant elasticity of substitution (CES). The lifetime utility (U_t) of a representative agent born in period t is formulated as:

$$U_t = u(c_{1,t}) + \beta u(c_{2,t+1}) + \beta^2 u(c_{3,t+2}) \tag{3}$$

where $c_{s,t}$ is the consumption of the period $s = \{1,2,3\}$ at the respective time $t = \{t, t+1, t+2\}$, and the parameter β is the household's discount factor. The periodic utility function, $u(c_{s,t})$ is given by:

$$u(c_{s,t}) = \frac{c_{s,t}^{1-\frac{1}{\gamma}}}{1-\frac{1}{\gamma}} \qquad (4)$$

where $\gamma \geq 0$ is the inter-temporal elasticity of substitution between consumption of different years. The changes in the utility (U_t) would be measured as a gain or reduction in the economic welfare of households.

The dynamic budget constraints in the three different periods are defined as

$$p_t c_{1,t} = w_t^n - a_{2,t+1} \qquad (5)$$

$$p_{t+1} c_{2,t+1} = w_{t+1}^n + R_{t+1}^n a_{2,t+1} - a_{3,t+2} \qquad (6)$$

$$p_{t+2} c_{3,t+2} = R_{t+2}^n a_{3,t+2} + pen_{t+2} \qquad (7)$$

where p_t is the consumer price at each period of life, which includes the consumption tax rate τ_t^c, and $a_{2,t+1}$ and $a_{3,t+2}$ denote saving for the next periods of life. The net wage (w_t^n) and the net interest rate (R_t^n) at time t are defined as

$$w_t^n = w_t(1 - \tau_t^w - \tau_t^p) \qquad (8)$$

$$R_t^n = 1 + r_t(1 - \tau_t^r) \qquad (9)$$

where τ_t^w and τ_t^p are the labour income and payroll taxes; τ_t^r is the capital income tax; w_t and r_t are the marginal product of labour and capital, respectively, to be defined below (see equations (17) and (18)). Therefore, the inter-temporal budget constraint of the household is given by:

$$p_t c_{1,t} + \frac{p_{t+1} c_{2,t+1}}{R_{t+1}^n} + \frac{p_{t+2} c_{3,t+2}}{R_{t+1}^n R_{t+2}^n} = w_t^n + \frac{w_{t+1}^n}{R_{t+1}^n} + \frac{pen_{t+2}}{R_{t+1}^n R_{t+2}^n} = W_{1,t} \qquad (10)$$

where $W_{1,t}$ represents the lifetime resources at period t, i.e., the present discounted value of future resources net of taxes (income, consumption and pension contribution) and future pension benefit.

The resulting first order conditions, together with the constraint (Eq. (10)), define the following consumption for each period

$$c_{1,t}^{-\frac{1}{\gamma}} = \frac{\beta R_{t+1}^{n} p_t c_{2,t+1}^{-\frac{1}{\gamma}}}{p_{t+1}} \tag{11}$$

$$c_{2,t+1}^{-\frac{1}{\gamma}} = \frac{\beta R_{t+2}^{n} p_{t+1} c_{3,t+2}^{-\frac{1}{\gamma}}}{p_{t+2}} \tag{12}$$

Thus, given the consumption at period one, the optimal consumption, and consequently savings, are derived from equations (11) and (12). Note that consumption at each period, as well as savings for the second and third periods, depend on the net wage and interest rates, consumer prices, and pension benefits. Before solving the optimisation problem, all aggregate variables are normalised to the size of the newborn size. Hence, it is assumed that each working household at period t (cohorts born at period t, and $t-1$) supplies one unit of labour inelastically. The aggregate per capita labour supply in period t is given by

$$L_t = \frac{1}{N_t}(N_t + N_{t-1}) = 1 + \frac{N_{t-1}}{N_t} = \frac{2 + n_{p,t}}{1 + n_{p,t}} \tag{13}$$

The aggregate per capita assets in period t becomes

$$A_t = \frac{a_{2,t}}{1 + n_{p,t}} + \frac{a_{3,t}}{(1 + n_{p,t})(1 + n_{p,t-1})} \tag{14}$$

Note that $a_{2,t}$ and $a_{3,t}$ are savings of the two older cohorts that have saved in the previous years. The aggregate per capita consumption in period t is given by

$$C_t = c_{1,t} + \frac{c_{2,t}}{1 + n_{p,t}} + \frac{c_{3,t}}{(1 + n_{p,t})(1 + n_{p,t-1})} \tag{15}$$

The production side

The economy has a large number of identical firms and the sum of them is normalised to unity. They are competitive and produce a single good from aggregate capital and labour. The production function is represented by the Cobb-Douglas type with constant returns-to-scale, i.e.,

$$Y_t = F(K_t, L_t) = K^{\propto} L^{1-\propto} \quad \text{or} \quad y_t = Y_t / L_t = k^{\propto} \tag{16}$$

where Y_t is the aggregate output, K_t is the aggregate capital stock, L_t is the aggregate labour input and α is the capital share in production. Profits of firms are maximised by renting capital from the capital market, which depreciates at rate δ, and hiring labour from households. The interest and wage rates at time *t*, derived from the first-order and zero profit conditions, are of the form:

$$r_t = \alpha (k_t)^{\alpha-1} - \delta \quad (17)$$

$$w_t = (1-\alpha)(k_t)^{\alpha} \quad (18)$$

The aggregate output, Y_t, can be used for consumption in the same period as production takes place or it can be used for increasing the next period's capital stock, i.e., for investment (I_t),

$$I_t = \left(1 + n_{p,t+1}\right)K_{t+1} - (1-\delta)K_t \quad (19)$$

Government sector

The government collects taxes and social security contributions from households for financing the public consumption (G_t) and pension benefits (PB_t), where, $PB_t = pen_t N_{t-2}$. Thus, the government has two budget constraints.

Since our focus is on the impact of the pension system on the economy—as in the work of Fehr (2000)—, we abstract from government debt and corporate profit taxes that are equivalent to income taxes on households (owners of firms). The government budget constraint in period *t* is as follows:

$$\underbrace{T_t = G_t}_{T_t^1} + \underbrace{\theta PB_t + (1-\theta)}_{T_t^2}PB_t \quad (20)$$

where T_t^1 is aggregate tax revenues from consumption and income taxation, i.e.,

$$T_t^1 = \tau_t^c C_t + \tau_t^w w_t L_t + \tau_t^r r_t A_t \quad (21)$$

and T_t^2 is the aggregate payroll taxes, given by

$$T_t^2 = \tau_t^p w_t (N_t + N_{t-1}) \quad (22)$$

θ is the government-financed share of the aggregate pension benefits PB_t, i.e., it could be ranging between 0 and 1.

In contrast to the model of Fehr and Kindermann (2018), we separate PB_t (in equation (20)) by two ways of financing, one from a direct payroll tax and another from consumption, and (labour and capital) income taxes. This structure is similar to the work of Fehr (1999) and Fehr (2000), with general taxes used to subsidise contributory pensions. This feature resembles the current situation of the Ecuadorian pension system and allows the analysis of an additional tax that is needed for paying contributory pensions in PAYG unbalanced pension systems.

The amount of public good G_t in per capita terms is given as

$$G_t = \frac{1}{N_t}(N_t g_1 + N_{t-1} g_2 + N_{t-2} g_3) = g_1 + \frac{g_2}{1+n_{p,t}} + \frac{g_3}{(1+n_{p,t})(1+n_{p,t-1})} \quad (23)$$

where g_s, with $s = 1,2,3$, represents the proportions of every cohort—young, middle, and old— in public goods. Even though public consumption enters into the utility function of the households, it does not interfere with household decisions on consumption since the utility function is assumed to be additively separable in private and public consumption.

The pension system

This section presents the government budget for pension payments to retirees (T_t^2). Equation (20) shows the budget balance of a PAYG pension system with some important characteristics of Ecuador's institutional setting, particularly the financing (1 - θ) of aggregate pension benefits PB_t partly with social security contributions and partly (θ) with income and consumption taxes. After substituting PB_t in the expression of T_t^2, we arrive at

$$\tau_t^p w_t (N_t + N_{t-1}) = (1-\theta) pen_t N_{t-2} \quad (24)$$

The left part of equation (24) represents the aggregate compulsory earnings base corresponding to the wage payroll. Thus, this system consists of a payment by a payroll tax τ_t^p and transfers (pen_t) between the young and older generations.

The pension system's budget must be balanced in each period, therefore, the national contribution rate, τ_t^p, satisfies the budget constraint, i.e.,

$$\tau_t^p = \frac{(1-\theta) pen_t}{w_t (2+n_{p,t})(1+n_{p,t-1})} \quad (25)$$

where the pension benefit pen_t is

$$pen_t = \kappa_t w_{t-1} \tag{26}$$

where κ_t is the replacement rate.

When θ is zero, pension payments would have to be financed only by contributions, i.e., the pension system would be purely contributory.

Equilibrium

In the stationary equilibrium (long-run equilibria), individual behaviour is consistent with the aggregate behaviour of the economy, i.e., households maximise intertemporal utility, firms maximise profits, the government balances its budget and factor and goods' markets clear. To express the equilibrium in terms of stationary variables only[13], notice that the mass of all individuals in our economy is normalised to one in every period *t*.

Definition 3.1. A *stationary equilibrium*, for a specified government fiscal and pension policy, is given by household decisions, prices, wages, interest rates, tax rates, social security contribution rate, government contribution to the PAYG pension system, such that the following conditions are satisfied:

- The household decisions $c_{1,t}$, $c_{2,t+1}$, $c_{3,t+2}$ (Eqs. 11 and 12) solve the household decision problem (Eq. 3)[14] subject to the respective budget constraint (Eq. 10).
- Factor prices equal the marginal product of capital and labour, i.e., equations (17) and (18).
- Factor markets clear, i.e.,

$$A_t = K_t \tag{27}$$

  The labour market is always balanced, since the labour supply of household L_t substitutes into the production function (Eq. 16).
- The government budget (Eq. 20) must be balanced in each period.
- The goods market clears, so that:

$$Y_t = C_t + G_t + I_t \tag{28}$$

[13] A characteristic of steady states is the fact that per capita variables are constant over time. Thus, the time index *t* can be omitted in all equations; however, we kept it so as to have a better understanding of the model.

[14] Changes in utility are measured as a gain or reduction in the economic welfare of households.

CALIBRATION OF THE BENCHMARK MODEL

This section discusses the approach for parameterising and obtaining the benchmark model (*BM*)—that is assumed to be in an initial steady state equilibrium—in accordance with the Ecuadorian economy. For simplification, we assume that the economy is in stationary competitive equilibrium in 2014[15] and in the long-run steady state[16], respectively.

The parameter values of the benchmark model as well as the results of the selected macroeconomic and fiscal variables of the initial equilibrium of the OLG model are presented on Table 1. Below, the details of the benchmark model calibration are provided using external data sources or calibrated from model equilibrium solution.

The *endogenous* variables in the model are the household decisions c_1, c_2, c_3, a_2, a_3, factor prices (r, w), the pension payroll tax rate (τ^p), aggregate quantities, and a tax rate, which can be the rate of consumption (τ^c), labour income (τ^w) or capital income (τ^r). In our case, since the VAT is unique and 'not categorised', it is very sensitive and has not been changed since 2000, when Ecuador's monetary model was dollarised. We therefore left VAT as an exogenous variable, and income taxes for adjusting the government's budget as endogenous tax rates. These assumptions correspond to Simulation I. In Simulation II, however, —because of the discussion about universal pensions financed by VAT— consumption tax is assumed to be an endogenous variable, while income taxes are exogenous variables. In Ecuador, there is a uniform income tax on income from both labour and capital, thus $\tau^w = \tau^r$. In 2014, the revenue from taxation of goods and services was 7.04% of the GDP and aggregate consumption was 60.48% of the GDP, resulting in a consumption tax rate of 12.09%—almost exactly the VAT (12%)—.

The *exogenous* parameters are the population growth rate n_p, the household preference parameters (γ, β), technology parameters (α, δ), government parameters

[15] The main source is the only available Social Accounting Matrix for 2014, published by the Central Bank of Ecuador (BCE, 2017), as well as, whenever possible, the average data from 2000 to 2014.

[16] There are two categories of solutions for OLG models (Kudrna et al., 2022): steady-state solutions and transition path solutions from one steady state to another. The first one becomes applicable when we assume that policy configurations and all exogenous variables are given and remain constant and that there has been enough time for the economy to fully adapt to these settings. In this scenario, endogenous variables such as the wage rate maintain a constant value over time. Households from different generations with the same characteristics encounter the same economic conditions (albeit at different points in time), leading to identical behaviours. Similarly, on the production side, a firms'steady-state decisions remain unchanged over time. The second one encompasses gradual adjustments spanning multiple periods to transition the economy from one steady-state to another. In this scenario, endogenous variables undergo changes over time until they converge towards the new steady state. Throughout this transitional phase, both households and firms contend with a shifting economic environment, leading to adjustments in their decisions. In this study, we focus on the steady-state implications, providing a discussion of the main behaviour of the macroeconomic, fiscal, and welfare effects (in the long-run). Thus, we left the transition path solution for further research, in which we could also study other issues, such as the aging transition, for instance.

(g_j, τ^c) and the replacement rate of the pension system (κ). These exogenous variables are set as follows. The model's life cycle has three periods: young, middle and old age. Each period covers 20 years; agents become adults at age 25 and can live to age 85. Households supply labour until retirement age, mandatory at age 65. The annual population growth rate is 1.85%, which is the average annual growth during the last 25 years, i.e., a periodic growth rate of 44,28% ($n_p = 1.0185^{20}$-1). Regarding the household preference parameters, the inter-temporal elasticity of substitution (γ) is set to 0.5, which implies an individual relative risk aversion of 2. This is within the range of commonly used values (Auerbach & Kotlikoff, 1987; Glomm et al., 2009; İmrohoroğlu & Kitao, 2009; Fehr & Uhde, 2013; Kudrna et al., 2022). The annual capital-output ratio is 1.44[17], so that the annual time discount factor β is set at 0.9756.

Table 1.
Values of Main Parameters of Benchmark Model (initial equilibrium)

Parameter	Symbol	Value	Sources/comments
Demographics			
Population growth	n_p, t	1.85%	United-Nations (2017)
Preference Inter-temporal elasticity of substitution	γ	0.50	commonly used values
Time discount factor	β	0.97	capital output ratio of 1.44
Production technology Capital share in production	α	0.3303	Cabezas-Gottschalk (2016)
Depreciation of capital (annual)	δ	0.15	Calibrated**
Macroeconomic and fiscal variables Government expenditure per capita**:	g_1	0.05	
	g_2	0.02	
	g_3	0.01	
Replacement rate	κ	0.8	see Velín-Fárez (2021)
Share of pension expenditures financed by government	θ	0.4	Social Security Law of Ecuador
Consumption tax rate	τ^c	0.1209	Data/Calibrated*
Labour income tax rate	τ^w	0.1664	Calibrated[a]
Capital income tax rate	τ^r	0.1664	Calibrated[b]
Contribution rate	τ^p	0.1362	Calibrated**

(Continued)

[17] It was calibrated assuming a depreciation rate of 15% and an interest rate of 8%.

Parameter	Symbol	Value	Sources/comments
Consumption tax revenue	$\tau^c C/Y$	0.0818	Calibrated** [c]
Labour income tax revenue	$\tau^w wL/Y$	0.1115	Calibrated** [d]
Capital income tax revenue	$\tau^r rA/Y$	0.0435	Calibrated**
Government Consumption	G/Y	0.1485	Calibrated[e]
Private Consumption	C/Y	0.6770	Calibrated[f]
Investment	I/Y	0.1010	Calibrated[g] **
Interest rate (in % p.a.)		7.96	Calibrated

* Derived from BCE (2017). ** See main text for more details. [a] In 2014 (derived from BCE (2017)): 12.46%. [b] In 2014 (derived from BCE (2017) and assuming 1% of capital income tax revenues): 3.16%. [c,d] In 2014 (derived from BCE (2017)): 7.04% and 4.5%, respectively. [e,f,g] 2000-2014 (average values derived from data of Central Bank of Ecuador): 12%, 64%, and 23%, respectively.

With respect to technology parameters, we set the capital share in production to $\alpha=0.3303$ (Cabezas-Gottschalk, 2016). Therefore, the wage share is equal to 0.6697. The annual depreciation rate of capital (δ) is 15%, derived by assuming that the capital output ratio is 1.44, and considering an investment to GDP ratio of 24.71%.

The aggregate government expenditure (G) is set as a fraction of GDP and calibrated to be around 14% (BCE, 2017), and the government expenditure per capita is set as higher expenditures for the younger population than for the older, i.e., $g_1=0.05$, $g_2=0.02$, $g_3=0.01$. The model captures the key interaction between the pension system and the remaining tax system, which is most important in the present context. The PAYG pension takes into account the 40% government-financed share of pension expenditures, i.e., $\theta=0.4$ and a replacement rate that represents roughly 80% of the last wage, $\kappa=0.8$ (Velín-Fárez, 2021). Labour and capital income taxes, τ^w and τ^r, adjust to clear the government budget constraint from computing the initial steady state, and the replacement rate determines the payroll tax rate.

Overall, the model matches up the basic economic and fiscal structure of Ecuador quite well. Since it is a closed economy model, the interest rate is defined endogenously by private savings, which yields that investment is not very well matched by the model[18]. The government sector is not represented very well because it neglected some important features such as government debt and corporate taxes. However, it does not have significant consequences on the objective of the paper as well as on the research questions, especially because the government budget

[18] The empirical high value of 23% could be because most of it had been carried out by the government through debt, which is not considered in our model.

is balanced through taxes[19]. Regarding the capital income tax, it was estimated assuming that the amount of its corresponding revenues is 1% of the GDP. Thus, the tax rates on labour and capital are 12.46% and 3.16%, respectively.

Regarding the capital income tax, it was estimated assuming that the amount of its corresponding income is 1.

The empirical labour income tax revenue is quite low, result of the high weight of the shadow economy[20].

SIMULATION RESULTS: POLICY EXPERIMENTS

In this section, we apply the calibrated model to explore the implications of pension policy reforms in Ecuador, including the effects on macroeconomic variables and household welfare. We carry out two types of simulations–related to taxes that balance the government's budget–, taking into account the following policy reforms: reforms that affect the generosity of the pension benefit (reduce of replacement rates, κ), the government-financed share of pension expenditures, θ (elimination), and an overall reform package incorporating these both policies (in a context of an "ideal scenario"). The simulations are the following:

- Simulation I: Reforms in which income taxes balance the government's budget.
- Simulation II: Reforms in which consumption taxes finance pensions (with and without tax evasion), where there is no payroll payment contribution to the social security. In the case of no tax evasion, we set the income taxes equal to the ones in the benchmark case (16.64%), while, in the case of tax evasion, a different taxation structure is assumed: τ^w=10% and τ^r=25%.

  This type of simulation pretends to discuss the proposal of Levy (2010) and Antón et al. (2013) to implement a universal pension financed through VAT, in which there is a shift in taxation from labour to consumption. According to the argument, this reform would eliminate different treatment between salaried and non-salaried workers and would improve the coverage of workers in the informal sector[21]. It would be more efficient than pensions

[19] Moreover, since this work is a theoretical model, results have not been taken into account literally. In addition, note that a CGEOLG model looks towards analysing in the long-run, so in the present study the debt would be paid through taxes (which would imply higher taxes). Furthermore, it is important to note that there is an implicit assumption that households are the owners of corporates.

[20] According to Medina and Schneider (2017), Ecuador had an average shadow economy of 33.6% of the GDP from 1991 to 2015.

[21] Since our model does not contain a formal-informal dichotomy as the work of Antón et al. (2013) does—the work of Antón et al. (2013) is a static model that does not consider the interactions of different households, i.e., it does not consider an OLG model, which is very important when analysing pension systems and even more for public finances when the system is managed by government—, an in-depth analysis of informality in Ecuador was not possible. Nevertheless, as

financed by payroll taxes because evading VAT is less probable than evading contributions to social security and less costly.

For Simulation II, where tax evasions are included, T_t^1 from eq. (20) is expressed as,

$$T_t^1 = \Phi_c \tau_t^c C_t + \Phi_w \tau_t^w w_t L_t + \Phi_r \tau_t^r r_t A_t \quad (29)$$

Where Φ_c,Φ_w and Φ_r are the percentages of taxes collected by the fiscal authority for the consumption, labour income, and capital income taxes, respectively. In the tax evasion scenario, we assume that only 40% of workers would pay income taxes ($\Phi_w = 0.4$)[22], and there is 25%[23] of VAT (and capital income tax) evasions, i.e., $\Phi_c = \Phi_r = 0.75$. Table 2 recaps the pension policy reforms carried out under the two types of simulations.

Based on the benchmark model (BM) with a PAY pension system in period $t = 0$, we introduce a pension reform in period $t = 1$ and compute changes in economic welfare (measured as a gain/reduction of the utility) and macroeconomic variables in a new long-run equilibrium.

Table 3 summarises the results for the selected macroeconomic variables and welfare implications of the pension reforms for both simulations, assuming parametric changes (reduction of the replacement rate (κ) from 0.8 to 0.5—but maintaining the government-financed share of pension expenditures) or elimination of the government subsidy)[24].

In the first and the second entry-column, the effects for Simulation I are displayed, while the remained columns present the case for Simulation II. Comparing the first entry column with the second one, we notice that the reform of just reducing the replacement rate instead of eliminating the contribution of the government, would bring about a lower reduction of the income taxes (4.45 percentage points (p.p.)). Regarding the social security contribution, in the first case, it would be reduced by 5 p.p. while in the second one, it would have to be increased by 9.08 p.p., since the fall in income taxes would be high. This fact denotes the high pressure that the

the purpose of our paper is to produce a macro-view of the impact of pension reforms on Ecuador's macroeconomy and the economic welfare effects on households, we conduct this exercise.

[22] This value is assumed considering the level of 'adecuado' employment mentioned in Velín-Fárez (2021), which is related to be levied.

[23] This value is assumed considering the minimum level of shadow economy between 1991 and 2001, and because now the Internal Revenue Service has improved the technology for collecting taxes and also considering that cash use is declining, and card use is growing (Mitchell & Robert, 2019).

[24] We carry out several simulations with alternative replacement rates (from κ = 0 to κ = 1) and government-financed shares of pension expenditures (from $\theta = 0$ to $\theta = 0.4$); which can be provided upon request.

government is facing with this type of subsidy[25]. However, the long-run welfare (higher in the first case) would increase since savings and private consumption would rise. Consequently, capital stock and wages would both rise as well as capital-output and GDP. Government consumption would decrease more in the first case. Thus, under Simulation I, private consumption, GDP and economic welfare are likely to increase 2.81%, 11.88%, and 12.68%, respectively.

Table 2.
Summary of pension policy reforms

	Simulation I	**Simulation II**	
	No tax evasion	**No tax evasion**	**With tax evasion**
	income taxes ($\tau^w = \tau^r$) balance the government budget	consumption taxes (τ^c) balance the government budget. $\tau^w = \tau^r$ = Initial equilibrium. $\tau^p = 0$	consumption taxes (τ^c) balance the government budget. $\tau^w = 10\%$, $\tau^r = 25\%$ $\tau^p = 0$
Reform 1 (R1): reduction of the replacement rate	$\Delta\kappa$	$\Delta\kappa$	$\Delta\kappa$
Reform 2 (R2): elimination of the 40% government-financed share of contributory pension expenditures	$\Delta\theta$	$\Delta\theta$	$\Delta\theta$
Reform 3 (R3): overall package: elimination of the 40% financed share of pension expenditures and reduction of the replacement rate	$\Delta\theta + \Delta\kappa$	$\Delta\theta + \Delta\kappa$	$\Delta\theta + \Delta\kappa$

[25] In 2021, the 40% government-financed share of pension expenditures represented 7% and 2% of the State General Budget and the GDP, respectively. Nonetheless, they will continue to increase because the number of pensioners is increasing and the number of contributors is decreasing, which would lead to an unsustainable system (Velín-Fárez, 2021).

Table 3.
Macroeconomic and welfare effects of policy reforms (R1 y R2) in long-run (in %)a

	Simulation I		Simulation II					
			No Tax Evasions			With Tax Evasions		
	R1: $\theta = 0.4$, $\kappa = 0.5$	**R2: $\theta = 0$, $\kappa = 0.8$**	**NR: $\theta = 0.4$, $\kappa = 0.8$**	**R1: $\theta = 0.4$, $\kappa = 0.5$**	**R2: $\theta = 0$, $\kappa = 0.8$**	**NR: $\theta = 0.4$, $\kappa = 0.8$**	**R1: $\theta = 0.4$, $\kappa = 0.5$**	**R2: $\theta = 0$, $\kappa = 0.8$**
Consumption taxes (p.p.)	0.0	0.0	-0.1	-6.1	-13.7	24.37	14.1	-1.4
Income taxes ($\tau^w = \tau^r$) (p.p.)	-4.45	-10.11	0.0	0.0	0.0	-6.64*	-6.64*	-6.64*
Contribution rate (p.p.)	-5.11	9.08	-13.62	-13.62	-13.62	-13.62	-13.62	-13.62
Wage rate	11.88	1.78	6.28	13.53	6.28	7.45	15.70	7.45
Interest rate (p.a.) (p.p.)	-1.21	-0.19	-0.6	-1.37	-0.66	-0.78	-1.57	-0.78
Private Consumption/GDP	2.81	4.13	13.32	11.05	28.9	-3.62	-3.63	18.82
Government Consumption/GDP	-10.62	-1.74	-5.91	-11.92	-5.91	-6.94	-13.57	-6.94
Capital-output ratio (annual)	25.56	3.63	13.14	29.35	13.14	15.69	34.4	15.69
GDP	11.88	1.78	6.28	13.53	6.28	7.45	15.7	7.45
Economic welfare	12.68	3.66	15.19	19.65	23.7	5.33	12.05	20.18

Note: [a]All changes are reported as percentage differences to the benchmark model (BM), except for consumption taxes, income taxes, contribution rate, and interest rate, which are reported in percentage points.
NR means No reforms in θ or κ. p.p. means percentage points
*Results are presented for τ^w. For τ^r, there is an increase of 8.36 p.p.

In the case of Simulation II (from third entry column), we analyse the case where consumption taxes (VAT) balance the government's budget, i.e., VAT finance pensions. In the case of no tax evasion, we set the income taxes equal to the ones in the benchmark case (16.64%), while in the case of tax evasion, a different taxation structure is assumed: $\tau^{w} = 10\%$ and $\tau^{r} = 25\%$. In both cases, a zero-contribution rate is set.

The first effect of a zero-contribution rate would be the elimination of the hidden taxation structure related to the contributory pension subsidy. The results of this exercise are very important for understanding the effects of balancing the government's budget (including a pension system) through VAT instead of income taxes. On the other hand, note that results of economic welfare (comparisons between the same type of reforms) are higher since the assumptions allow individuals to have higher earnings (because taxes are lower) for consuming and saving, which consequently lead to an increase in aggregate capital and a decrease in the interest rate. Nevertheless, regarding the GDP and the annual capital-output, the results are higher in the case of tax evasions. We first present (in 3rd and 6th entry column), results related to cases in which there are no reforms in the replacement rate or in the government-financed share of pension expenditures, but only related to taxes. As a consequence, in the case of no tax evasions, economic welfare would increase substantially compared to the benchmark because of no payroll taxes or increases in taxes that would lead to higher effects on wages and private consumption. Of course, with tax evasion and lower income taxes, it would be necessary to increase the consumption tax for balancing the government budget, which would be high (24 p.p.). This exercise shows that government subsidy and high pension replacement rates require high taxes that cause distortions on consumption decisions and consequently on welfare. However, as Antón et al. (2013) argue, in the case of higher VAT rates, they would "have a contradictory impact on the fiscal balance. On the one hand, they increase revenues; on the other, they induce more evasion and informality" (p. 32).

In the fourth and fifth columns, the cases are displayed in which parametric reforms would be carried out, R1 and R2. In the case of elimination of the pension subsidy (R2), the economic welfare would be higher, even compared to the third column since it would have the almost same effect on the macroeconomic variables as resulting from a significant reduction of VAT and consequently higher private consumption. Because tax evasions would have a significant impact on tax revenues, it would be necessary to increase VAT in order to reach the long-run steady state. This effect would lead to reduce resources of households, decreased consumption, and lower welfare. Therefore, if tax evasion is considered under policy reforms R1 and R2(seventh and eighth columns), the results of these variables show lower figures than in the scenario of no tax evasions. On the other hand, the results of wage, annual capital-output and GDP, would be higher. Thus, pensions financed by VAT would be more efficient than pensions financed by income taxes.

Regarding an overall reform package, which incorporates a reduction of the replacement rate and a null government-financed share of pension expenditures ($\theta = 0$)—in a context of an ideal scenario—, it contributes to a macro view of the consequences of the taxation structure under the principle of contributivity, i.e., pensions are financed only by contribution rates (Conde-Ruiz, 2014; Devesa & Doménech, 2020). It also simulates a reduction of income taxes instead of contribution rates when policy makers are seeking ways to reduce the fiscal taxation pressure upon household labour income (Conde-Ruiz, 2014). Thus, to find the Ecuadorian pension system's "ideal scenario" in which it is fully-financed but smooths the tax burden on income (focusing on the economic welfare of households), the contribution rate is pinning down. In our case, the equilibrium in the long-run would be satisfied with a contribution rate of 14%. Therefore, the optimal replacement rate would be roughly 0.5 ($\kappa = 0.5$). Table 4 presents the results (including the initial equilibrium for easier analysis—in the first entry column—), which suggest that there would be significant increases in GDP and welfare associated with financing schemes based on either the elimination of the government subsidy and the reduction of the replacement rate (Simulation I), or the substitution of payroll taxes by VAT (Simulation II). Thus, in the case of Simulation I (second entry column), the economic welfare, private consumption, and GDP would increase 15.8%, 6.42%, and 13.53%, respectively. While in the case of Simulation II (third and fourth entry column), it would be, for the case of no tax evasion, 25.1%, 20.79% and 13.53%, respectively; and for the case of tax evasion, 21.44%, 10.39%, and 15.7%, respectively.

Overall, financing pensions through VAT instead of income taxes appears to produce a higher long-run welfare gain in a dynamically efficient economy, which confirm the conclusions of Antón et al. (2013) and Maebayashi (2019) that financing pensions by VAT instead of social security payroll taxes would bring about higher welfare gains and economic growth.

Table 4.
Initial Equilibrium and macroeconomic and welfare effects in long-run under "an ideal scenario" reforms (R3)

	Simulation I		**Simulation II**	
	Initial Eq. $\theta=0.4, \kappa=0.8$	**LRE*** $\theta=0, \kappa=0.5$	**LRE: NTE*** $\theta=0, \kappa=0.5$	**LRE: WTE*** $\theta=0, \kappa=0.5$
Consumption tax (p.p.)	12.09**	0.0	-14.63	-1.91
Labour income tax (p.p.)	16.64**	-11.84	0.0	-6.64
Capital income tax (p.p.)	16.64**	-11.84	0.0	8.36
Contribution rate (p.p.)	13.62**	0.0	-13.62	-13.62
Wage rate*		13.52	13.52	15.70

(Continued)

	Simulation I		Simulation II	
	Initial Eq. $\theta=0.4, \kappa=0.8$	**LRE*** $\theta=0, \kappa=0.5$	**LRE: NTE*** $\theta=0, \kappa=0.5$	**LRE: WTE*** $\theta=0, \kappa=0.5$
Interest rate (p.a.) (p.p.)	7.96**	-1.36	-0.71	-1.57
Private Consumption/GDP[b]	67.70**	6.42	20.79	10.39
Government Consumption/GDP[b]	14.85**	-11.92	-11.92	-13.57
Capital-output ratio (annual)	1.44	29.34	29.34	34.4
GDP*		13.53	13.53	15.7
Economic welfare*		15.8	25.1	21.44

Note: LRE means 'Long-Run Equilibrium'. NTE means 'No Tax Evasions'. WTE means 'With Tax Evasions'. *Reported as percentage differences to the Initial Equilibrium. ** in %.

DISCUSSION AND CONCLUSIONS

Motivated by the work of Velín-Fárez (2021), we have used a OLG model to study the effects of pension reforms on long-run macroeconomic variables and welfare in the case of the Ecuadorian economy. Unlike most pension systems that are designed under a contributory principle, the Ecuadorian system is only partially contributory—with 40% of the benefits financed by government resources— and has a high level of generosity and low coverage due to high level of informality in the labour market. Thus, we focused on the much-debated proposed reform to eliminate that government-financed share of contributory pension payments, as well as to reduce replacement rates of earnings-related pensions, and universalise pensions financed by VAT. We used a three-period OLG economy based on Auerbach and Kotlikoff (1987) that takes into account the model framework of Fehr and Kindermann (2018) and many features of Fehr (1999) and Fehr (2000) calibrated to data from Ecuador in which income taxes (Simulation I) and consumption taxes (Simulation II) balance the government's budget. Simulation II also considered the decreasing revenue effect of tax evasion. The results led us to the following conclusions.

First, reducing the 40% government-financed share of pension benefits while maintaining the generous pension of 80% of past earnings, would have a low impact (up to 3.66% of economic welfare) on the equilibrium of the current pension system. Because pensions are partly funded through taxes, income taxes would have to be reduced by nearly the same percentage points as the contribution rate would have to increase, i.e., a 10.11 percentage points decrease and 9.08 percentage points increase, respectively. Note that the taxation structure at initial equilibrium has *hidden taxes*, in the sense that income taxes are not recognised as an additional contribution rate to pension benefits. This suggest that younger generations would have to pay a double tax for financing the pension benefits of the older generation. Although our work does not perform a non-contributory analysis, it is necessary to highlight that the contributivity principle is broken because contributory pensions are financed by income and consumption taxes. This means that non-contributory workers would also be entitled to receive pensions (Conde-Ruiz, 2014).

Second, if the reform's primary objective is to reduce the generosity of pensions (maintaining the current 40% government contribution to pensions), the results show higher economic welfare gains with reductions of income taxes and contribution rates compared to the initial equilibrium. Nevertheless, in the spirit of a transparent fiscal taxation structure—in the sense of contributivity principle—combining both policy reforms, i.e., elimination of 40% and reduction of replacement rates, resulted in ever higher gains and a reduction in its regressive effect. Although the model was calibrated to the Ecuadorian economy, this message also applies to other countries with a PAYG pension system scheme, where governments finance earnings-related pension benefits through a combination of taxes. In Spain, for instance, since 2017 the government has transferred resources from general taxes to the Social Security Administration by means of "loans" to cover the gap between revenues from payroll taxes and pension benefits.

To find an "ideal scenario" that fully finances the pension system but smooths the fiscal taxation pressure on household income and the reduction of welfare, we highlighted the case in which the replacement rate is roughly 0.5 and the equilibrium in the long-run is satisfied with a roughly 14% contribution rate. This leads to a reduction in income taxes[26], which means that net wages would be higher and, as a result, private consumption would increase. Of course, income tax revenue and public consumption would decrease, while savings and capital would increase significantly, leading to a fall in the interest rate (1.37 percentage points). The effect on welfare, private consumption, and GDP would be an increase of 15.79%, 6.42%, and 13.53%, respectively, for the case of Simulation I (when income taxes balance the government budget).

Third, when VAT revenues, instead of payroll taxes, were used to finance pensions (Simulation II), welfare gains were higher than those achieved under similar parametric reforms, even taking into account the possibility of tax evasion. This supports the conclusions of Antón et al. (2013), and Maebayashi (2019), who, in the case of Japan, argues that public pensions financed by VAT are more growth-friendly than those financed by payroll taxes. Nevertheless, caution must be exercised when analysing the effect of pension reforms from this perspective, as it may induce further informality—related to unregistered firms– (Lora & Fajardo-González, 2016). Results, under the tax evasion scenario, suggest that the

[26] The elimination of the payment of the 40% from the government has an effect on income taxes—reduction—. However, since in the Simulation I there is not considered tax evasion estimations, the income taxes could be maintained so as not to affect the fiscal budget.

effect on welfare, private consumption, and GDP, would be an increase of 15.79%, 6.42%, and 13.53%, respectively.

Since our main goal was to develop a macro-view of the effects of a PAYG pension system and its reforms on the Ecuadorian economy, we have abstracted from some potentially important issues, including leisure and uncertainty. We leave all these issues for future research. The quantitative results must be interpreted cautiously. Nevertheless, we believe that this first macro approach to the evaluation of the Ecuadorian pension system is a useful starting point for future discussions of policy reforms in Ecuador. We also think it provides insights for other economies with unbalanced PAYG pension systems, where either income or consumption taxes finance earnings-related pensions.

Finally, although the analysis of the political viability of the analysed reforms is beyond the scope of this work, it is important to mention that these could be implemented through strategies such as those carried out in Peru, where after an intense work–which lasted approximately 9 years–, pension academics, together with constitutionalists and social communicators, brought about changes in the Peruvian Constitution (an old article that made reference to acquired rights about pensions–regardless of the financial situation of the system– was changed to one that guaranteed the right to a long-run sustainable pension, i.e., it allows to carry out intertemporal adjustments without political processes)[27], otherwise it would be not possible (see Velín-Fárez et al., 2024) for more details about pension reforms that have been declared as unconstitutional).

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