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The New Fiscal Normal

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Vaccinations, Debt, and Fiscal Adjustment in Emerging Economies

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The New Fiscal Normal: Vaccinations, Debt and Fiscal Adjustment in Emerging Economies

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Abstract

What is the potential impact of vaccination programs and different fiscal adjustment scenarios on countries after suffering the macro-fiscal effects of the pandemic? We calibrate a DSGE model with an epidemiological module for the average Latin American and Caribbean economy that uses fiscal policy and vaccination to contain these effects. We find that there is a trade-off in the application of one of these policies. Focusing on vaccination has a high return in saving lives and improving economic growth but a lower fiscal adjustment. We conclude that simultaneous vaccination and fiscal reform is a successful policy combination that helps countries mitigate the health effects of the pandemic, reduce the economic cost of fiscal policy, and move toward a path of fiscal consolidation.

JEL Codes: E17, E62, H30, H51, H60.

Keywords: Epidemics, fiscal policy, macroeconomics, vaccination, vaccination growth multiplier.

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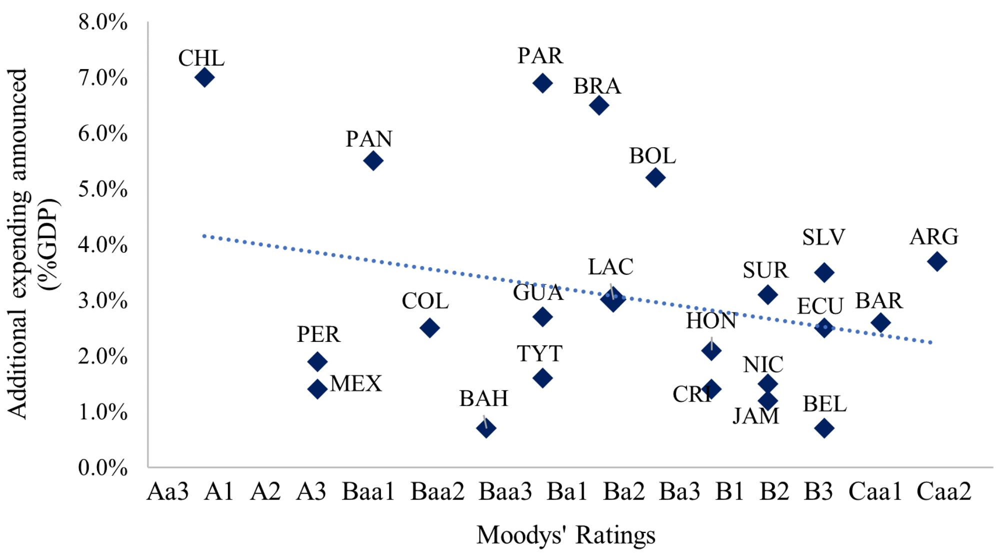
1 Introduction

The Covid-19 pandemic has had devastating consequences in terms of health and caused severe economic and social costs. The countries of Latin America and the Caribbean (LAC) have been severely affected by the spread of the virus, and the crisis they have experienced is unprecedented. Until the first semester of 2021, the pandemic resulted in 30.5 million documented infections and some 971,000 deaths, one of the highest regional statistics in the world. In addition, the effect on economic growth resulted in a 7.4% contraction in GDP, the most significant drop in output in a single year for this region. The shock of the pandemic generated an abrupt triple sudden stop due to a restriction in human mobility, the paralyzed international trade, and the drastic reduction of capital flows (Cavallo and Powell, 2021). In terms of the fiscal sustainability of LAC countries, the pandemic reversed the slow fiscal adjustment that the region was experiencing during the last five pre-pandemic years. As a result, on average, governments mobilized 8.5 pp of GDP to address the health and economic crisis. However, previous fiscal unbalances limited fiscal capacity to respond to the crisis. Figure 1 shows the negative correlation between the additional expending announced by governments in LAC, and the credit ratings of the country. At the institutional level, 70% of the countries with fiscal rules have suspended them, and there is no certainty as to when they will return to them.

Figure 1: Additional expending announced and Credit ratings



In this sense, the policy question currently facing LAC countries is how to return to a path of sustainable fiscal consolidation to avoid a possible debt overhang. To answer this question, this paper develops a DSGE model that integrates an epidemiological module for a small open economy with fiscal policy. The model simulates different scenarios of fiscal adjustment processes based on various tax reform alternatives and vaccination programs. Fiscal policy is modeled so that it responds endogenously to the evolution of the pandemic. A higher number of infected people generates pressures on public spending and government revenues fall due to the slowdown in economic activity, resulting in a higher level of debt.

First, we evaluate a scenario with only the vaccination process while the fiscal policy remains inertial. We find that vaccination programs effectively reduce the persistence of the pandemic and benefit growth as they recover economic activity faster. However, although fiscal balances show a correction compared to the baseline scenario, they fail to correct the increasing trend of public debt. In the second scenario, we analyze the evolution of the pandemic and its macro-fiscal effects as countries carry out fiscal reforms without vaccination. This scenario enables measuring the impact of fiscal adjustment on countries in the region in the absence of vaccines. We find that the effects of the reform on the pandemic are marginal and mainly affect the adjustment of fiscal variables while still having a cost in economic growth. Consequently, reforms prove to help stabilize the debt level. Finally, we simulate a scenario in which fiscal and health policy interact jointly. Combining these policies is optimal for reducing pandemic-related health costs, obtaining better macro-fiscal adjustments, and stabilizing and achieving a reduction in public debt.

Moreover, we present evidence of the impact that different vaccination scenarios could have on economic growth. For this purpose, we document the negotiation processes for the purchase of vaccines by countries in the region and their respective costs. Thus, it is feasible to evaluate the growth multiplier of vaccination under different scenarios of population immunization rates. Under a slow vaccination scenario (0.5% per week), the gains in economic growth are almost 1.7 percentage points of GDP. If the vaccination process is faster (5.0% per week), the additional effect on growth is up to 2 percentage points.

Recent literature provides insight into the economic linkages of the pandemic. A recent study by Atkenson (2020) introduced economics into a simple SIR model to study the human costs of Covid-19 in the United States. On the other hand, Eichenbaum et al. (2020b) employed an SIR model to explore the interaction between economic decisions and the pandemic, extending his analysis for neoclassical and New Keynesian models. The main findings are that people's decisions to restrict consumption and labor supply reduce deaths caused by the pandemic; however, these choices intensify the economic slowdown. This paper applies the same epidemiological framework and extends the analysis by including a fiscal component to evaluate different fiscal adjustment scenarios towards the post-pandemic. In addition, we find that fiscal policy measures may have marginal effects on the pandemic dynamics.

Several authors have been concerned about the most effective social distancing measures to reduce deaths and minimize economic costs. One method introduced by Alvarez et al. (2020) was a linear model of a central planner economy, integrating a SIR module. The study concluded that severe distancing at the beginning of the outbreak with a gradual relaxation until approximately the third month is the best policy option. Similarly, Çakmakl et al. (2020) quantified the macroeconomic effects of Covid-19 by calibrating a SIR-multisectoral model for Turkey. Their findings suggest that the optimal policy is total distancing for approximately one month. Acemoglu et al. (2020) develop a multiple risk SIR model (MR-SIR) in which infection, hospitalization, and mortality rates vary between age groups. The results indicate that policies targeted at risk-age groups significantly exceed standard policies. This has also been explored by Alon et al. (2020), who offer a similar analysis for emerging economies through a macroeconomic model with fiscal capacity restrictions, revealing similar results. This document calibrates the social distancing measures taken by the governments in Latin America and the Caribbean to replicate their impacts on the economy's aggregates. Furthermore, we analyze alternative scenarios of the epidemiological dynamics. On this matter, our model introduces the possibility of implementing vaccination programs that as result immunize the population against the virus, save lives, and accelerate economic growth recovery.

On the other hand, several studies have attempted to characterize the impact of economic policy as a measure to mitigate the effects of the pandemic. Thus, Faria e Castro (2020) use a nonlinear DSGE model to analyze the fiscal policy response to the outbreak of the virus in the United States, finding that the extension of unemployment insurance is the most effective mechanism to stabilize the most vulnerable population. Also, Auerbach et al. (2020) evaluate the effects of Covid-19 restrictions and fiscal policy in a model that reveals the economic slowdown. The results show that base period GDP declines more than what is directly associated with the restrictions. Moreover, the success of the fiscal policy depends on capital costs and socioeconomic factors such as inequality. Benmelech and Tzur-Ilan (2020) address the determinants of fiscal policy during the pandemic. Credit rating turns out to be the most significant component conditioning countries' fiscal spending. Bayer, Born, Luetticke, and Müller (2020)) simulate the effects of an economic lockdown in a medium-scale HANK model and quantify the impact of transfers. In the short run, the authors find that the multiplier of conditional transfers is more significant than its unconditional counterpart and that, in any case, transfers reduce output losses. Accordingly, Bigio et al. (2020) compare the advantages of lump-sum transfers versus a credit policy. The study finds that transfers are more beneficial under a constant public debt path when debt limits are tight, while credit policy is better when they are flexible. Thereon, we replicate the size of the mobilized resources in the Latin American and the Caribbean average country to represent the transfers to households in 2020. Then, using this information, we simulate different scenarios based on the stylized epidemiological facts and measure the response on the main fiscal variables.

In a broader context, Elenev et al. (2020) studies dynamics of macroeconomic equilibrium and how it is affected by government policies concerning adverse pandemic shocks. The study strongly suggests that interventions prevent a much deeper crisis; however, their model predicts an increase in the interest rate on government debt and default on government debt. In addition, Céspedes et al. (2020) builds a minimalist model to identify optimal mitigating policies. The authors conclude that traditional expansionary fiscal policy does not have favorable effects. In contrast, unconventional policies, which are more fiscally costly, appear to maintain a balanced economy in terms of employment and productivity. Finally, Fornaro and Wolf (2020) uses a reduced version of the standard New-Keynesian model to evaluate the effects of macroeconomic policy, evidencing the only negative effect of the pandemic as a short-term supply shock. Therefore, agent's expectations about future growth will not be substantially affected, and the impact on aggregate demand will be small. In contrast, this paper also analyzes and discusses the effects that fiscal and epidemiological scenarios may have on macroeconomic variables but focuses on their post-pandemic implications.

Meanwhile, considering that public policies have been undertaken to mitigate the pandemic outbreak, provide socio-economic attention to the vulnerable population, and buffer the contraction of productive activity, studies that have addressed the fiscal sustainability of countries are relatively scarce. First, Hürtgen (2020) shows the reduction in fiscal space under different Covid-19 pandemic scenarios for a set of euro area countries. The study's estimates indicate that fiscal space as a percentage of national GDP shrinks on average, leading to a high risk of a public debt crisis. Subsequently, Bayer, Born, and Luetticke (2020) highlights the importance of the liquidity channel of public debt in explaining the short- and long-term effects of fiscal policy. Using a HANK model, the authors find that short-term fiscal multipliers are more significant and that additional public debt can successfully raise the real interest rate. In this sense, despite being committed to a long-term passive fiscal policy, the government can intervene in the economic recovery. In this respect, we are concerned about the fiscal sustainability of Latin America after the pandemic. Therefore, our contribution is to perform these analyses in emerging countries where the impact of the pandemic has been dramatic in socio-economic and health terms and where fiscal imbalances have been persistent. Furthermore, we also consider the fiscal constraints related to the adjustment in interest rate spreads due to changes in debt levels.

Emphasizing the effects of the pandemic on emerging economies, Arellano et al. (2020) develop a sovereign default model with an epidemiological module to study how debt default risk affects the ability of these countries to cope with the pandemic. The authors find that debt default risk makes shutdowns more costly by limiting governments' fiscal capacity to support consumption, leading to protracted and expensive debt crises. Espino et al. (2020) build also build a sovereign debt equilibrium. The study predicts that an unexpected shock such as the pandemic leads to a deterioration in trade, reflected in higher inflation, risk of debt default, and a reduction in economic growth.

The factors described above are relevant, and although in our paper we do not discuss distributional and poverty issues, it is important to recognize their impact during the pandemic. However, while previous work is concerned with quantifying and discussing the economic effects during the Covid-19 crisis, we study the macro-fiscal dynamics and distortions after it. This paper does not seek to explain the spending multiplier during the pandemic but how the fiscal consequences of the crisis can be resolved going forward. In this sense, we explore how the economy reacts to post-crisis impulses and analyze alternative epidemiological (vaccination) and fiscal consolidation scenarios. The remainder of this document is structured as follows: Section 2 discusses the model, Section 3 describes the calibration methodology, Section 4 presents the results of the simulations made, and Section 5 summarizes the main conclusions.

2 The Model

In this section, we present the economy's structure, which is susceptible to a pandemic shock. The economy is also vulnerable to social distancing shocks, which affect households' consumption and labor decisions. On the other hand, it is also subject to possible fiscal and health policy scenarios that seek to mitigate the effects of the crisis in the medium term. In general terms, there is a small open economy composed of households that decide on consumption and work and benefit from public goods. There is a representative firm that produces consumer goods using labor and capital. Finally, the government provides the public goods consumed by households and financed by taxing its members, firms and issuing public debt.

2.1 Epidemiology Model

The epidemiological models first proposed by Kermack and McKendrick, 1927 assume that the probabilities governing the transition between different states of contagion are exogenous concerning economic decisions. However, we follow Eichenbaum et al., 2020a for the transition probabilities of infection to depend on the agent's decisions, since consumption and work increase the likelihood of contagion, as they increase contact among people. Therefore, the probability of becoming infected depends on these activities and a random contagion factor.

Following Eichenbaum et al., 2020a, we divided the population into four groups: susceptible (S_t), infected (I_t), recovered (R_t) and deceased (D_t). The first group represents people who have not been exposed to the disease and can become infected. The second considers those who have already contracted the disease and are currently ill. The third group represents those who have survived the disease and have acquired immunity. The last includes those who have died from the virus.

As mentioned above, the probability of becoming infected depends on consumption and hours worked.The number of newly infected is the result of the interaction of infected and susceptible individuals. These interactions are given by

$\gamma_1(S_tC_t^s)(I_tC_t^i) + \gamma_2(S_tN_t^s)(I_tN_t^i)$ where the parameters γ_1 and γ_2 reflect the probability of becoming infected as a result of the interactions of consuming goods and/or working. In turn, $(S_tC_t^s)(I_tC_t^i)$ and $(S_tN_t^s)(I_tN_t^i)$ represent the l consumption and hours worked by susceptible and infected individuals.

In addition, there is a third way people can become infected, related to random activities such as entering an elevator, being in an indoor enclosure, or having contact with an infected object. S_tI_t gives the number of random encounters between infected and susceptible people, and the probability of becoming infected for this reason is γ_3. Therefore, the total number of newly infected is:

$$\Gamma = \gamma_1\left(S_tC_t^s\right)\left(I_tC_t^i\right) + \gamma_2\left(S_tN_t^s\right)\left(I_tN_t^i\right) + \gamma_3\left(S_tI_t\right) \tag{1}$$

In this sense, the number of people susceptible to the virus in each period is equal to the number of susceptible people in the previous period who were not infected. However, it is essential to keep in mind that this population could be affected by the vaccination process. Therefore, once vaccination begins, the susceptible population will gain immunity against the virus with a weekly vaccination rate of θ_t^v :

$$S_t = \left(S_{t-1} - \Gamma_{t-1}\right)\left(1 - \theta_t^v\right) \tag{2}$$

Similarly, the number of people infected by the spread of the virus in period t is equal to the people who were infected at $t-1$ and, who probably did not die (γ_d) or recover (γ_r) from the disease, plus the additional newly infected population.

$$I_t = \left(1 - \gamma_d - \gamma_r\right) I_{t-1} + \Gamma_{t-1} \tag{3}$$

The number of recovered individuals in t is given by the number of people already recovered in $t-1$ plus the recovered from the virus a period earlier. In addition, consistent with the possibility that vaccination processes will eventually begin to operate, this population is affected by the share of vaccinated susceptibles, who are considered to be directly recovered after acquiring immunity.

$$R_t = R_{t-1} + \gamma_r I_{t-1} + \left(S_{t-1} - \Gamma_{t-1}\right)\theta_t^v \tag{4}$$

Finally, the number of deaths refers to the number of people who have died previously and the number of new casualties caused by the disease.

$$D_t = D_{t-1} + \gamma_d I_{t-1} \tag{5}$$

In case this economy is affected by the spread of a pandemic virus, we assume that at $t = 0$, a fraction ϵ of the total population is infected by SARS-COV-2 (Covid-19). So that $I_0 = \epsilon$ and $S_0 = 1 - \epsilon$, considering that the total population is normalized to one.

2.2 Households

Households in the economy are a continuum of *ex ante* identical individuals with measure one. These agents receive utility from the consumption of private (c_t) and public goods, provided by the government (g_t). In addition, they receive utility from leisure, so that each hour of work r (n_t) provides them with a disutility η_t. Each period, person j of type ($j = s, i, r$) knows its nature at the beginning of the period. Moreover, we assume that there is complete information about the spread of the virus so that everyone knows the probabilities of getting infected while consuming (γ_1) or working (γ_2). Households take as input the number of people infected at each t and the aggregate variables for each type.

2.2.1 The Preferences

The following utility function shows the preferences that characterize the behavior of each household member in this economy:

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \left\{ j_t \left[\ln\left(c_t^j + \vartheta g_t^j\right) - \eta \frac{{n_t^j}^{1+\nu}}{1+\nu} \right] \right\}$$

$$j = s,\, i,\, r$$

Where s_t, i_t and r_t indicate the number of susceptible, infected, and recovered household members. Likewise, the variables c_t^s, c_t^i, c_t^r, and n_t^s, n_t^i, n_t^r indicate consumption and hours worked by each type of household member. The parameter ϑ represents the utility perceived by households from the consumption of public goods, while ν is the inverse of the Frisch elasticity of labor supply.

On the other hand, there is a single budget constraint for each household in each period. The budget constraint for the representative agent in this economy is:

$$b_{t+1} + \left(1 + \tau_t^c + \theta_t^l\right)\left(s_t c_t^s + i_t c_t^i + r_t c_t^r\right) + x_t + \tau_t^p =$$
$$\left(\frac{1 + R_{t-1}^h}{1 + \pi_t}\right) b_t + \left(1 - \tau_t^n - \theta_t^l\right)\left[w_t\left(s_t n_t^s + i_t n_t^i + r_t n_t^r\right) + \left(1 - \tau_t^k\right) R_t^k k_{t-1} + \phi_t\right.$$

In this sense, b_{t+1} are the new assets (government debt) in which households invest. x_t is the capital investment; R_{t-1}^h is the national nominal interest rate and; π_t is the inflation rate. w_t is the equilibrium wage that the household takes as given; R_t^k is the interest rate they receive for lending their capital to firms; and ϕ_t and τ_t^p are the firms' profits and lump-sum taxes. In addition, τ_t^c, τ_t^n and τ_t^k are taxes that households pay on consumption, labor and capital (k_{t-1}). Finally, θ_t^l is the variable that constrains individuals' consumption and labor decisions due to exogenous mobility restrictions.

In relation to the capital stock, the law of motion that follows this productive factor is given by:

$$k_t = x_t + k_{t-1}\,(1 - \delta) - \frac{\kappa}{2}\left(\frac{x_t}{k_{t-1}} - \delta\right)^2 k_{t-1} \tag{6}$$

Where δ is the capital depreciation rate and κ represents the investment adjustment costs.

Following Eichenbaum et al., 2020b, we assume that households can affect their likelihood of being infected by the virus through their consumption choices and hours worked. Yet, the household does not internalize the impact of their choices on the aggregate infection rate of the economy.

Solving the optimization problem by different household members, the first-order conditions for susceptible, infected and recovered are:

$$\frac{1}{c_t^j + \vartheta g_t^j} = \lambda_t \left(1 + \tau_t^c + \theta_t^l\right) - \varphi \left(\gamma_1 \, c_t^i i_{t-1} \, \lambda_t^\Gamma\right) \tag{7}$$

$$\varphi = \begin{cases} 1, & \text{if } j = s \\ 0, & \text{otherwise} \end{cases}$$

Where λ_t are the Lagrange multipliers associated with the budget constraint. Likewise, given that $\vartheta < 0$ (complementary), additional public spending would have a negative effect on the marginal utility of consumption. Otherwise, we find that the consumption tax paid by individuals and the social distancing measures constrain their consumption decisions. Moreover, in the case of the susceptible population, their consumption decisions internalize the probability of becoming infected by carrying out these activities.

Similarly, the first-order conditions for labor are:

$$\eta \, {n_t^j}^\nu = \lambda_t \left(1 - \tau_t^n - \theta_t^l\right) w_t + \varphi \left(\gamma_2 \, n_t^i i_{t-1} \, \lambda_t^\Gamma\right) \tag{8}$$

In this case, labor income tax and social distancing also affect household labor decisions. In addition, the susceptible internalize the likelihood of contracting the virus while working, so the dynamics of the pandemic will condition labor supply.

Finally, capital decisions are determined by the optimality conditions derived in the following equation:

$$\begin{aligned} \lambda_t =& \beta \, E_t \, \lambda_{t+1} \left[(1-\delta) + \left(1 - \tau_{t+1}^k\right) R_{t+1}^k \right. \\ & \left. - \kappa \left(\frac{x_{t+1}}{k_t} - \delta\right) \left[\frac{1}{2}\left(\frac{x_{t+1}}{k_t} - \delta\right) - \frac{x_{t+1}}{k_t}\right]\right] \end{aligned} \tag{9}$$

2.2.2 Intertemporal Decisions of Susceptible, Infected and Recovered People

Once the optimization problem faced by each household member in this economy has been solved, it is possible to define their optimal consumption and labor trajectories in terms of the intertemporal decisions they must face in this regard.

Euler Condition on Consumption

First, the optimal consumption path defined for susceptible, infected, and recovered individuals will smooth their consumption over time. This is because decisions will be conditioned by their expectations of the future utility of consumption and the expected return of the public debt they hold. On the other hand, in the specific case of susceptible individuals, the probabilities of acquiring the disease while engaging in consumption activities will also condition the intertemporal decisions they make about these activities. Finally, consumption taxes paid by households distort their consumption behavior and marginally affect the probability of being infected by the virus. This is because tax changes may or may not incentivize consumption activities. The optimal consumption path is as follows:

$$\frac{1}{1+\tau_t^c+\theta_t^l}\left[\frac{1}{c_t^j+\vartheta g_t^j}+\varphi\left(\gamma_1\, c_t^i i_{t-1}\,\lambda_t^\Gamma\right)\right]=$$
$$\beta\, E_t\,\frac{1}{1+\tau_{t+1}^c+\theta_{t+1}^l}\left[\frac{1}{c_{t+1}^j+\vartheta g_{t+1}^j}+\varphi\left(\gamma_1\, c_{t+1}^i i_t\,\lambda_{t+1}^\Gamma\right)\right]\left[\frac{1+R_t^h}{1+\pi_{t+1}}\right]$$

Euler Condition on Labor

In terms of optimal labor decisions over time, different types of representative household members choose the amount of work they offer based on their expectations about the future work disutility and the expected return on their financial debt. Moreover, intertemporal labor choices of this population will also be conditioned by the probability of becoming infected while working. Taxes on household labor income also distort their optimal labor decisions and affect the individuals' likelihood of becoming infected by the virus while working. The following equation describes the optimal labor path:

$$\frac{\eta\, n_t^{j^\nu}-\varphi\left(\gamma_2\, n_t^i i_{t-1}\,\lambda_t^\Gamma\right)}{(1-\tau_t^n-\theta_t^l)\,w_t}=\beta\, E_t\left[\frac{\eta\, n_{t+1}^{j^\nu}-\varphi\left(\gamma_2\, n_{t+1}^i i_t\,\lambda_{t+1}^\Gamma\right)}{(1-\tau_{t+1}^n-\theta_{t+1}^l)\,w_{t+1}}\right]\left[\frac{1+R_t^h}{1+\pi_{t+1}}\right]$$

2.3 Firms

The consumer goods provided in this economy are produced by a continuum of competitive firms using intermediate goods as inputs. Therefore, each intermediate good i is produced by a continuum of monopolistic firms.

2.3.1 Final Good Producers

The representative competitive firm produces the final good Y_t based on the technology described below:

$$Y_t=\left(\frac{P_{i,t}}{P_t}\right)^{\frac{\sigma}{\sigma-1}}Y_{i,t}$$

In this sense, $P_{i,t}$ denotes the price of the intermediate good $Y_{i,t}$, while the parameter σ is the profit margin set by the firm producing the intermediate input. P_t symbolizes the price of consumer goods and is given by:

$$P_t = \left(\int_0^1 P_{i,t}^{-\frac{1}{\sigma-1}} di \right)^{-(\sigma-1)}$$

2.3.2 Intermediate Goods Producers

On the other hand, intermediate goods producers operate in a monopolistic market for each intermediate product i. These firms hire capital and labor as inputs to run their production. Consequently, monopolist i takes the price P_t from the demand function of final goods firms to maximize its profits:

$$\phi_t = P_t Y_t - P_t mc_t Y_t \tag{10}$$

The aforementioned subject to the technology $Y_{i,t}$ and real marginal cost mc_t is defined by:

$$Y_{i,t} = A\, k_{t-1}^{1-\alpha}\, n_t^{\alpha}$$

$$mc_t = \frac{w_t^{\alpha}\, {R_t^k}^{1-\alpha}}{P_t A\, \alpha^{\alpha}\, (1-\alpha)^{1-\alpha}}$$

Finally, given a continuum of identical monopolistic firms in the economy, we assume that each firm chooses its price ($P_{i,t}$), which is subject to pricing frictions as proposed by Calvo, 1983. Therefore, a fraction of the firms $1-\xi$ reoptimizes its price, while the remaining proportion ξ fixes the same price as the previous period ($P_{i,t} = P_{i,t-1}$). Consequently, the optimal price that each firm chooses in period t is $\tilde{P}_t$ such that it maximizes:

$$\max_{\tilde{P}_t} E_0 \sum_{j=0}^{\infty} (\xi\beta)^j \lambda_{t+j} \left(\tilde{P}_t Y_{i,t+j} - P_{t+j} mc_{t+j} Y_{i,t+j} \right)$$

2.4 Central Bank

In the economy there is a Central Bank that rules a monetary policy that selects the national interest rate following a Taylor-type rule according to the following equation:

$$R_t^h = \overline{R}^h + \zeta_\pi \ln\left(\frac{\pi_t}{\overline{\pi}}\right) + \zeta_Y \ln\left(\frac{Y_t}{\overline{\overline{Y}}}\right) \tag{11}$$

Where $\overline{R}^h$ is the equilibrium domestic interest rate, and ζ_π and ζ_Y are the inflation and output gap coefficients of the Taylor rule.

Given that the economy's asset market is open to foreign investors, the international interest rate applied to government debt issued by the government follows the approach proposed by Schmitt-Grohé and Uribe, 2003, so that:

$$R_t^* = \overline{R}^* + \psi \left[e^{\left(\frac{b_t}{Y_t} - \bar{b}\right)} - 1 \right]$$

In this case, $\overline{R^*}$ is the foreign interest rate in equilibrium and ψ is the risk premium that the foreign market charges to the government for having a debt level higher than $\bar{b}$.

2.5 Government

The government spends resources on public goods g_t^j that give utility to each type j of household member. Specifically, it spends $g_t = g_t^s + g_t^i + g_t^r$. It also collects taxes on household consumption, labor, and capital income and it offers government bonds to households, and pays them an interest rate R_t^h, and to foreign investors an interest rate R_t^*.

Therefore, the government's budget constraint is given by:

$$b_t + \tau_t^c c_t + \tau_t^n n_t w_t + \tau_t^k r_t^k k_{t-1} + \tau_t^p = \left[\upsilon R_t^h + (1-\upsilon) R_t^* \right] b_{t-1} + g_t \tag{12}$$

Where υ is the share of bonds sold to domestic investors, which we assume to be exogenous.

2.5.1 Expenditure

Since the economy is susceptible to the pandemic, the government must spend resources on improving the healthcare system to satisfy the needs of the sick population. Precisely, the number of infected people in the economy will determine the dynamics of spending, spending on health services will depend on the number of sick people in each period. Therefore, the law of motion of public spending on each type of agent j is such that:

$$g_t^i = \rho_i \, \overline{g}^i + (1-\rho_i) \, g_{t-1}^i + \mu_i i_{t-1} + e_t^i$$

$$g_t^s = \rho_s \, \overline{g}^s + (1-\rho_s) \, g_{t-1}^s + \mu_s \theta_t^v s_t + e_t^s$$

$$g_t^r = \rho_r \, \overline{g}^r + (1-\rho_r) \, g_{t-1}^r + e_t^r$$

Where ρ_j is the regression parameter and $\overline{g}^j$ is the steady state value of spending on each type of agent j. μ_i and μ_s are parameters governing the additional spending on sick and susceptible. Finally, e_t^j is an idiosyncratic shock.

2.5.2 Lump-Sum Taxation

As for lump-sum taxes paid by households, we assume that this type of taxation adjusts procyclically with the output gap. Tax collection is also consistent with the decline in output.

$$\ln\left(\tau_t^p\right) = +\left(1-\rho_p\right)\ln\left(\tau_{t-1}^p\right) + \rho_p\left(\ln\left(\tau_{ss}^p\right) + \omega_p \ln\left(\frac{Y_t}{Y_{ss}}\right)\right) + e_t^p \tag{13}$$

Where $(1-\rho_p)$ is the autoregressive parameter and ω_p is the reaction of the tax rate to the output gap. Finally, e_t^p is an idiosyncratic shock.

3 Calibration

Table 1 summarizes the values of the structural parameters that govern the dynamics of the model and replicates the steady-state of the average LAC country during 2019. Additionally, as the model simulations intend to replicate the economic and social effects of the pandemic shock and show the macro-fiscal adjustment under different fiscal and health policy scenarios, a weekly calibration of the parameters is performed to enable epidemiological interaction and economic variables without losing representativeness.

Table 1: Calibration of Parameters

Parameter	**Value**	**Definition**	**Source**
γ_1	$1.59*10^{-7}$	Probability of infection due to consumption	Calibrated
γ_2	$1.11*10^{-4}$	Probability of infection due to work	Calibrated
γ_3	0.348	Probability of randomly infection	Calibrated
γ_d	0.01	Probability of dying	Data
γ_r	0.49	Probability of recovering	Data
β	0.99	Intertemporal discount factor	Literature
η	0.0028	Labor disutility	Calibrated
ν	0.8	Frisch elasticity of labor supply	Calibrated
ϑ	-0.8	Utility from public goods consumption	Calibrated
δ	0.0012	Capital depreciation rate	Literature
α	0.83	Share of labor in production	Calibrated
A	10.45	Total factor productivity	Calibrated
σ	1.35	Fixed price markup	Literature

ξ	0.98	Calvo price stickiness	Literature
ζ_π	1.5	Taylor rule inflation coefficient	Literature
ζ_Y	0.0096	Taylor rule output gap coefficient	Literature
ψ	$0.2^{*}10^{-5}$	Risk premium factor	Calibrated
υ	0.7	Share of bonds held by domestic investors	Data
ρ_i	0.95	Persistence of public expenditure shock on infected population	Calibrated
μ_i	$3^{*}10^{4}$	Share of public expenditure on infected population	Calibrated
ρ_s	0.95	Persistence of public expenditure shock on susceptible population	Calibrated
μ_s	$2.3^{*}10^{3}$	Share of public expenditure on susceptible population related to vaccination	Calibrated
ρ_r	0.95	Persistence of public expenditure shock on recovered population	Calibrated
ρ_{τ^p}	0.1	Persistence of lump-sum tax shock	Calibrated
ω_{τ^p}	3.5	Output gap weighting of lump-sum taxes	Calibrated

3.1 Epidemiological Module

To calibrate the parameters driving pandemic dynamics in the model, following Eichenbaum et al., 2020a, we also assume that it takes 14 days to recover or die from Covid-19 infection. In this sense, we determine that $\gamma_r + \gamma_d = 7/14$. However, from the epidemiological data available for LAC countries, it is possible to obtain the weekly average death rate (0.02).The mortality probability is $\gamma_d = 0.01$, and the likelihood of recovery is $\gamma_r = 0.49$.

Moreover, using the standard SIR model proposed by Kermack and McKendrick, 1927, we calibrate the contagion probabilities through consumption (γ_1), work (γ_2), or random activities (γ_3) as $1.59^{*}10^{-7}$, $1.11^{*}10^{-4}$, and 0.348. These values replicate the average cumulative contagion dynamics of LAC. Finally, the share of the population initially infected by the virus is $\epsilon = 0.001$.

3.2 Consumption and Labor

As for households, we set the intertemporal weekly intertemporal discount factor at $\beta = 0.99$, as shown in Eichenbaum et al., 2020a. In addition, the disutility of labor, the Frisch elasticity of labor supply, and the utility that households receive from the consumption are calibrated to reproduce the magnitude of the response of individuals to the pandemic shock in terms of their consumption and labor decisions. The obtained values are $\eta = 0.0028$, $\nu = 0.8$, and $\vartheta = -0.8$.

3.3 Output

The capital depreciation rate is set based on typical values found in previous literature ($\delta = 0.06/52$). The labor share of output ($\alpha = 0.83$) is calibrated to represent the average participation coefficient in LAC countries. As for the total factor output ($A = 10.45$) is fixed so that the combination of productive factors corresponding to the average country in the region replicates the aggregate output obtained from the WEO database. The fixed price margin ($\sigma = 1.35$) that firms set on their marginal cost is drawn from the range of values estimated by Christiano, Eichenbaum and Trabandt, 2016. Finally, the Calvo price sickness takes a standard value of $\xi = 0.98$ and is adopted from work developed by Eichenbaum et al., 2020a.

3.4 Fiscal and Monetary Policy

First, concerning the central bank's decisions, the Taylor rule's inflation and output gap coefficients are calibrated to be consistent with monetary policy through adjustments in the domestic interest rate. Accordingly, these parameters are set to $\zeta_\pi = 1.5$ and $\zeta_Y = 0.0096$. In addition, since the model represents a small open economy, the international interest rate is modeled following Schmitt-Grohé and Uribe, 2003, where the ψ parameter takes a value of $0.2{*}10^{-5}$. This is consistent with the weekly risk premium charged to the average LAC country for exceeding its target debt level.

Second, the share of domestic investors in public debt ($\upsilon = 0.7$) is obtained from the debt composition information available for LAC countries. The share of public spending on the infected population ($\mu_i = 3{*}10^4$) is calibrated so that total expenditure reflects additional spending for countries in the region during the 2020 health emergency. Similarly, the share of public expenditure on susceptible population ($\mu_s = 2.3{*}10^3$) is set so that total expenditure also incorporates the additional spending to mitigate the economic effects of the pandemic and the cost of the vaccination processes. The ρ_{τ^p} parameter takes a value of 3.5, which aligns the decline in government revenues with the contraction in growth evidenced in the first year of the pandemic. Finally, we calibrate the persistence parameters of public spending on different household members ($\rho_i = \rho_s = \rho_r = 0.95$) predicting the expected temporary nature of the additional spending used during the economic and social crisis.

4 Results

This section describes the results of different simulation scenarios. First, a reference scenario is simulated based on the epidemiological model calibrated for the average LAC country. This scenario includes a mobility restriction during the first three months of the pandemic, where governments took harsh measures to prevent the contagion of their population. However, as the data show, adherence to restrictions decreases over time. We use this scenario as a benchmark to compare what happens when (i) vaccines are included, (ii) tax reforms are implemented, and (iii) both vaccines and tax reforms are incorporated into the model.

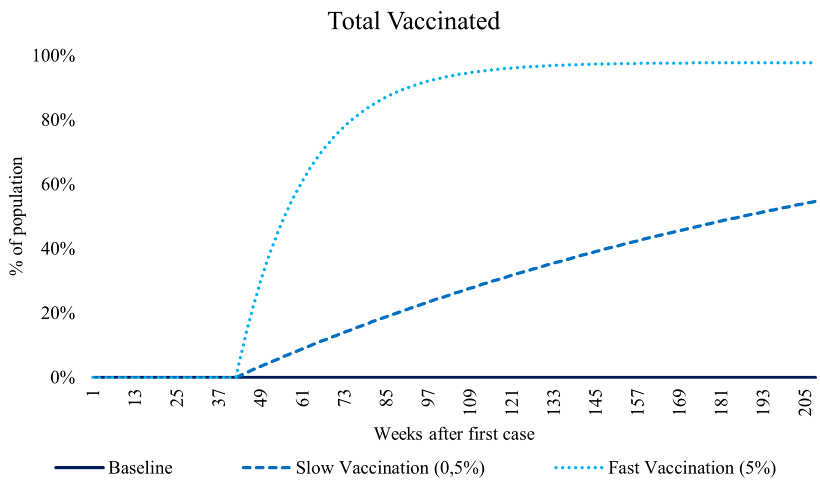
4.1 Basic SIR-Macro Fiscal Model With and Without Vaccination

For this first simulation, we include vaccination in the model, and we assume that governments spend resources on vaccines. As a result, susceptible individuals include the probability of being vaccinated in their decision-making process, as described in section 2.1.

We present three scenarios: first, the baseline scenario in which vaccination is not incorporated, implying that $\theta_t^v = 0 \quad \forall t$. Second, a "Slow Vaccination" scenario in which the weekly vaccination rate equals 0.5% of the susceptible population. This is consistent with the vaccination rate of the average LAC country. Finally, the third scenario is one in which there is a "Fast Vaccination", which translates to 5% of the susceptible population being vaccinated every week. Since the beginning of the vaccination process, it is in line with Chile's vaccination rate until May 2021. The vaccination process began in the 42nd week after the pandemic started, equivalent to the third week of December 2020 in LAC.

Figure 2 shows the dynamics of the vaccination process. In the "Fast Vaccination" case, one year after the beginning of the vaccination process (week 94), 91% of the population is vaccinated. In the same week, the "Slow Vaccination" scenario reaches the only 22% of the vaccinated population. As a consequence, the epidemiological variables react. Figure 3, Panel A shows that the susceptible population decreases drastically in the "Fast Vaccination" scenario, reaching the cut-off (1%) 133 weeks after the first case of Covid-19 in the region. On the other hand, the "Slow Vaccination" case shows a much higher percentage of the population still susceptible to the virus by that time (61%). At the same time, the baseline reports that by week (133) 92% of the population may be infected.

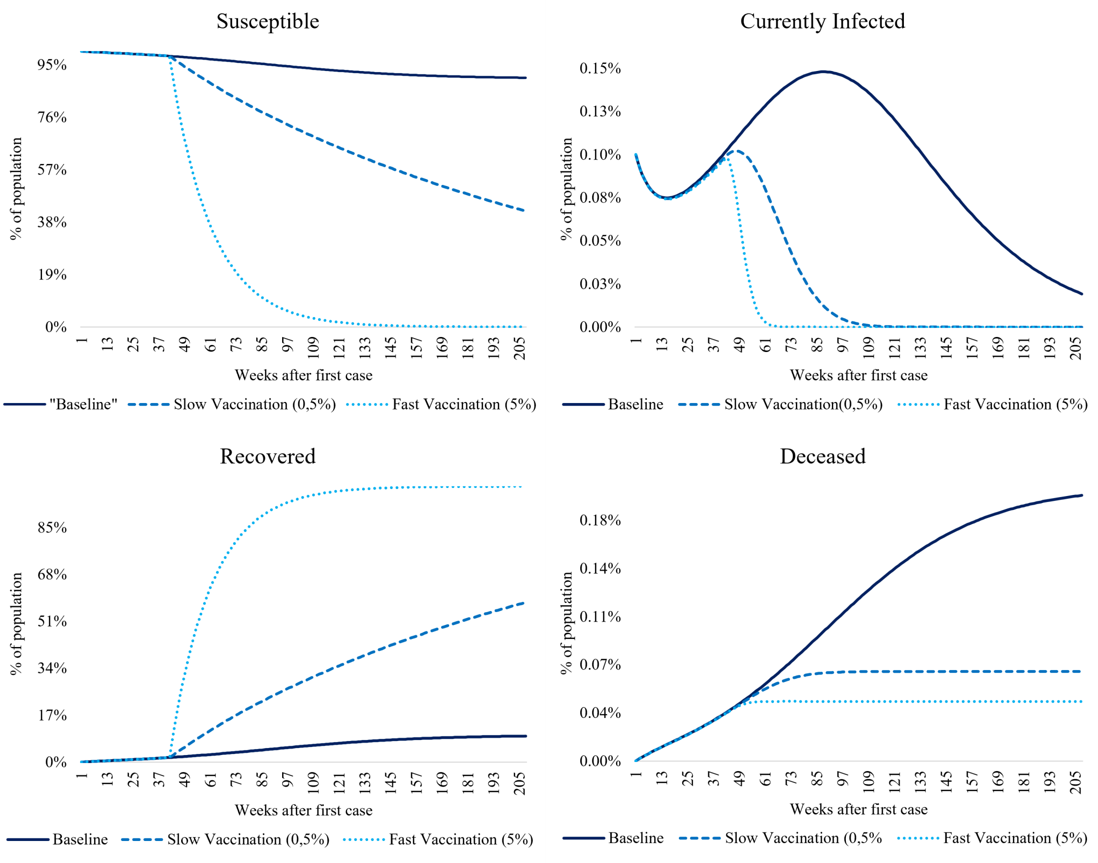
Figure 2: Vaccination



The actual infected population (Figure 3, Panel B) shows a non-linear trend. At the beginning of the pandemic, the number of infected people decreases as governments adopt extreme measures to prevent infection. However, as time passes, compliance with restrictions decreases, implying an increase in infection. After week 43, the vaccination process stops the growth of active cases. In the "Fast Vaccination" scenario, the infected population is virtually zero at week 60, while in the "Slow Vaccination" case, it is achieved at week 97. If vaccination is not implemented, active cases peak 88 weeks after the first case and are zero only after 259 weeks.

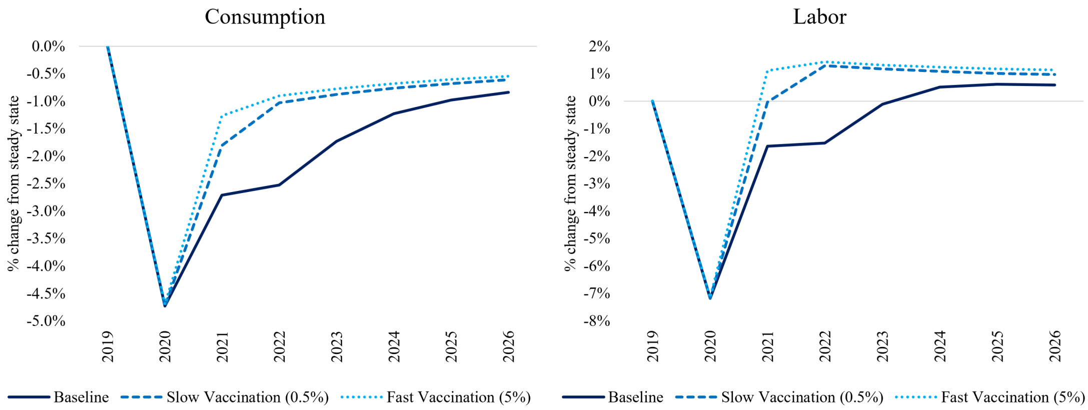
The recovered population shows different trends from the susceptible population. The "Fast Vaccination" case has almost its entire population recovered by week 133, the "Slow Vaccination scenario" has nearly 40% of its population overcome the disease, while the baseline shows only 7.5% recovered. The total number of people who die from the virus is drastically reduced due to the vaccination process (Figure 3, Panel D). While the deceased population is 0.04% and 0.07% of the total population in the Fast and Slow Vaccination scenarios, it reaches 0.19% without no vaccination. For the average LAC country, this implies a difference between 53000 and 45000 people.

Figure 3: Impact on Epidemiological Variables



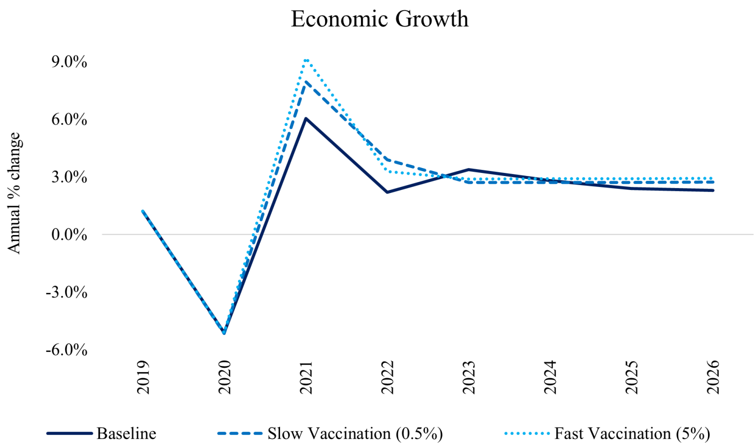
As literature has shown, epidemiological variables affect the decisions of the agents in the economy. Similarly, household consumption and labor decisions have an impact on the infection rate. Thus, when vaccination occurs, and consumers are aware of its rate and its impact on the infected population, both consumption and labor recover quicker with vaccines than without them (Figure 4).

Figure 4: Impact on Macroeconomic Variables



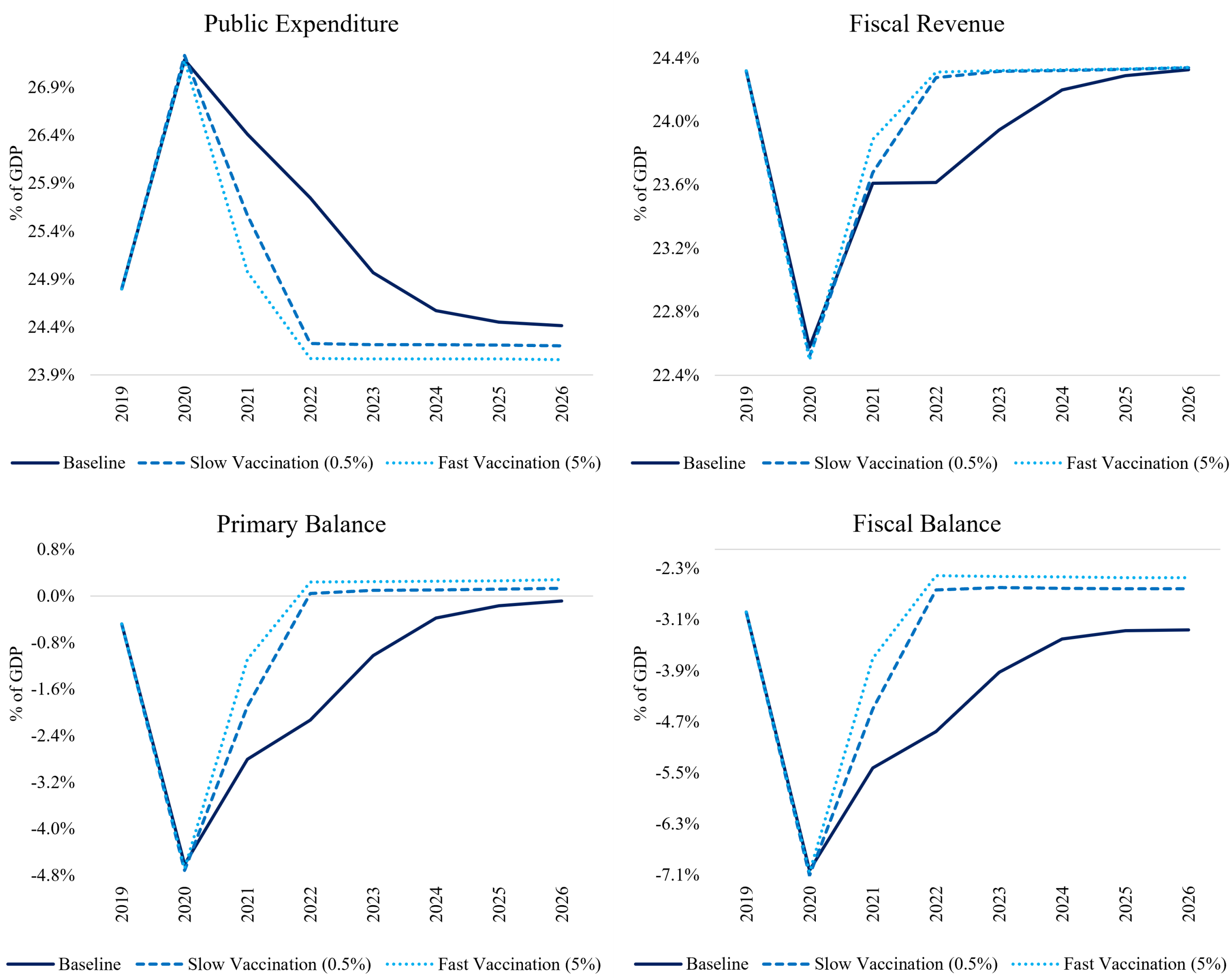
Aggregate output is affected by the pandemic, as found by: Eichenbaum et al., 2020a, Acemoglu et al., 2020, Atkenson, 2020 and others. With the average LAC country calibration, the result is a 5.1% slowdown in economic activity. As consumers adjust their consumption and labor levels, economic activity recovers. With the vaccination process implemented in 2021, economic growth is expected to be higher for those cases with higher vaccination rates. In the following years, as the economy returns to steady state, the vaccination premium on economic growth decreases but remains at levels above the baseline scenario.

Figure 5: Impact on Aggregate Variables



Since the government reacts to the pandemic as the number of infected people increases, in 2020, public spending increases from 24.8% to 27% of GDP. This increase corresponds to that observed in the average LAC country. As vaccination is implemented, public spending increases by an extra 0.2% and 0.1% of GDP in 2020 in fast and slow vaccination scenarios. For the post-pandemic period, as the economy recovers faster with vaccination than without it, the additional costs spent to cope with the crisis can be quickly eliminated (Figure 6, Panel A).

Figure 6: Impact on Fiscal Variables

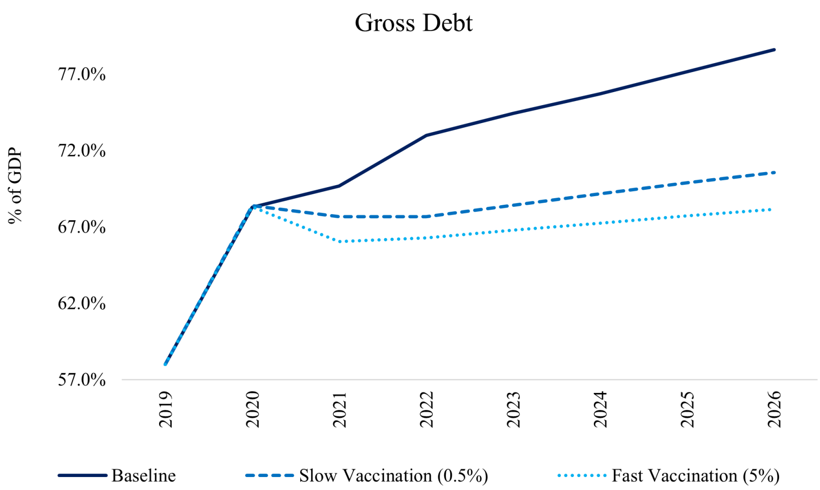


Tax revenues are the same for all three scenarios in 2020, since consumption, labor, and capital, the tax base, decreased their levels with the crisis. For 2021, panel B shows a faster recovery of tax revenues when there are rapid vaccination programs. By 2022, with vaccinations, income returns to its steady state. The reference scenario, in contrast, has a slow recovery, reaching 24.3% of the GDP in 2026.

Dynamics of the primary and overall fiscal balance follow the movements of public spending and revenues: they fall in 2020 to 4.7% and 7% of GDP. After the first year of crisis, the recovery is slow in the baseline scenario, reaching the 2019 primary balance level in 2024. As for the overall fiscal balance, the pre-pandemic level is not achieved due to higher debt interest levels. However, with vaccination, the recovery of both fiscal balances is faster, and by 2022 they reach levels above those observed in 2019.

Finally, gross debt increases during the crisis as deficits rise. Nevertheless, since the economy is still running primary deficits after the pandemic, public debt keeps increasing. When vaccination is present, gross debt to GDP is lower, although its trend does not change. In 2026, while the baseline scenario projects debt of 79% of GDP, the scenarios with slow and fast vaccinations show levels of 71% and 68% of GDP.

Figure 7: Debt as percentage of GDP

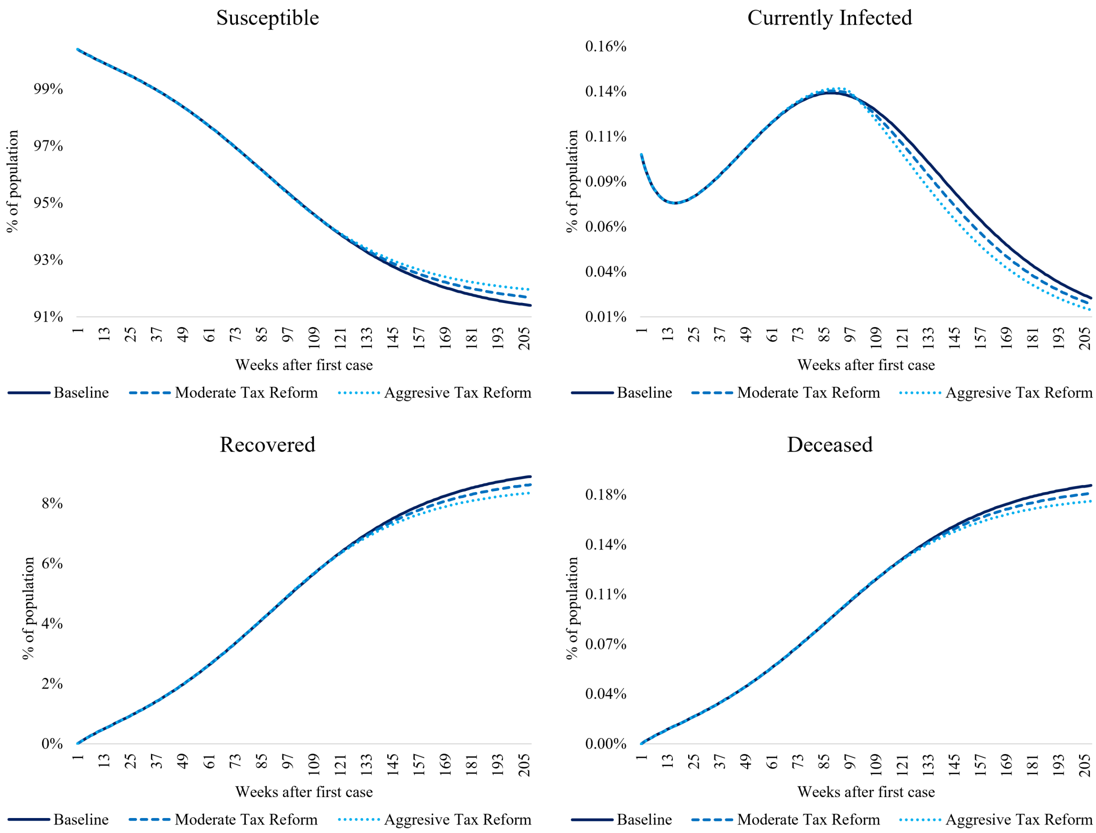


4.2 Basic SIR-Macro Fiscal Model With and Without Tax Reform

The second simulation includes tax reforms in the model. We assume that the government introduces a tax reform in 2022. By calibrating the increase in consumption tax (τ_t^c), labor tax (τ_t^n), and capital tax (τ_t^k) such that in a "Moderate Tax Reform" scenario, fiscal revenue increases in 1% of GDP, and in an "Aggressive Tax Reform" scenario, fiscal revenue increases in 2% of GDP. The baseline scenario is the same as the one presented in the 4.1 section; therefore, it incorporates neither tax vaccinations nor tax reforms.

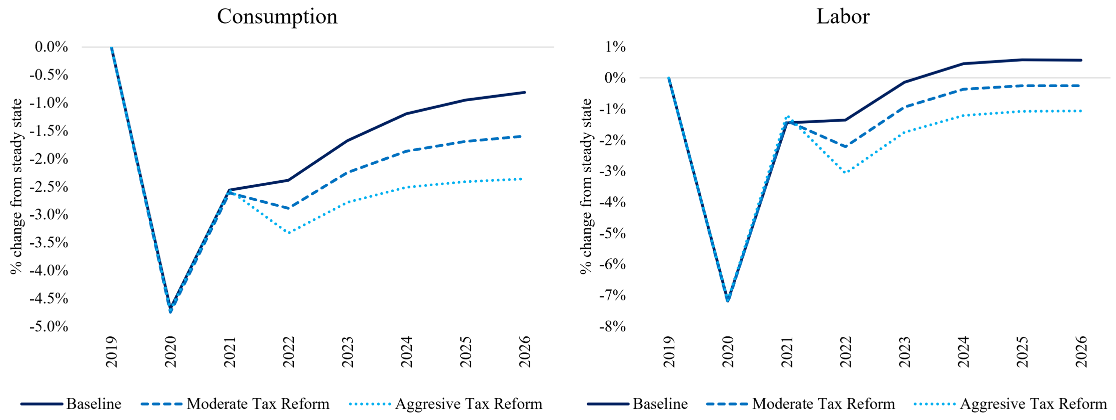
The results show that, since taxes distort households' consumption and work decisions, and these decisions affect the infection rate, tax reform has a marginal impact on the dynamics of the epidemiological variables in the model. Figure 8, Panel A shows how, with more aggressive tax reform, the number of susceptible people in the economy remains higher. It responds to the dynamics of the currently infected population (Panel B), reaching a lower level of infection each period after introducing the reform compared to the baseline. These outcomes result from changes in both consumption and labor. As agents adjust their decisions due to the tax increase, the probability of infection decreases. Consequently, the number of people who recovered almost four years after the first case is lower with moderate and aggressive tax reforms due to declines in contagion. As a result of lower infections, the number of deceased individuals also decreases. For the average LAC country, increasing tax levels generates a reduction in deaths of 4800 and 10800 persons in the Moderate and Aggressive scenario.

Figure 8: Impact on Epidemiological Variables



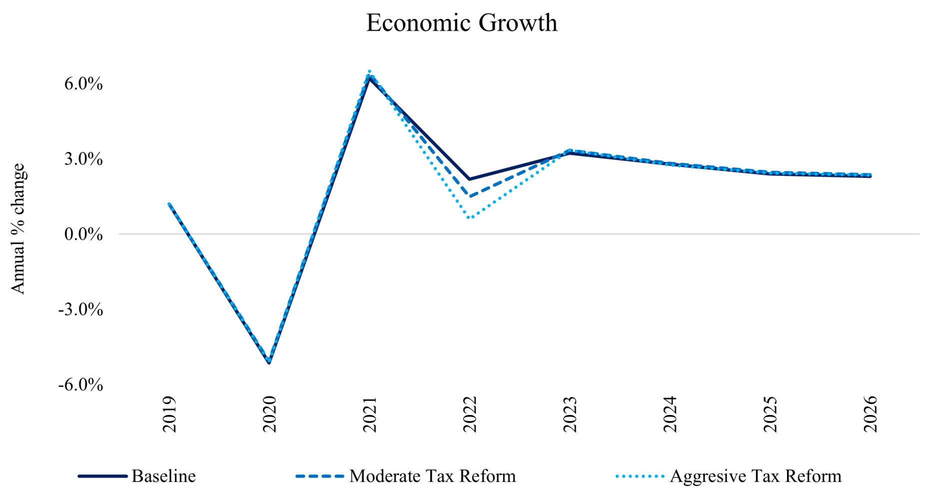
Macroeconomic variables at the aggregate level are also affected by the tax reforms. Consumption, for example, is reduced due to the higher consumption tax incorporated with the reforms. Likewise, labor responds with lower levels of hours worked by households, as higher tax rates reduce labor output (Figure 9).

Figure 9: Impacts on the Macroeconomic Variables



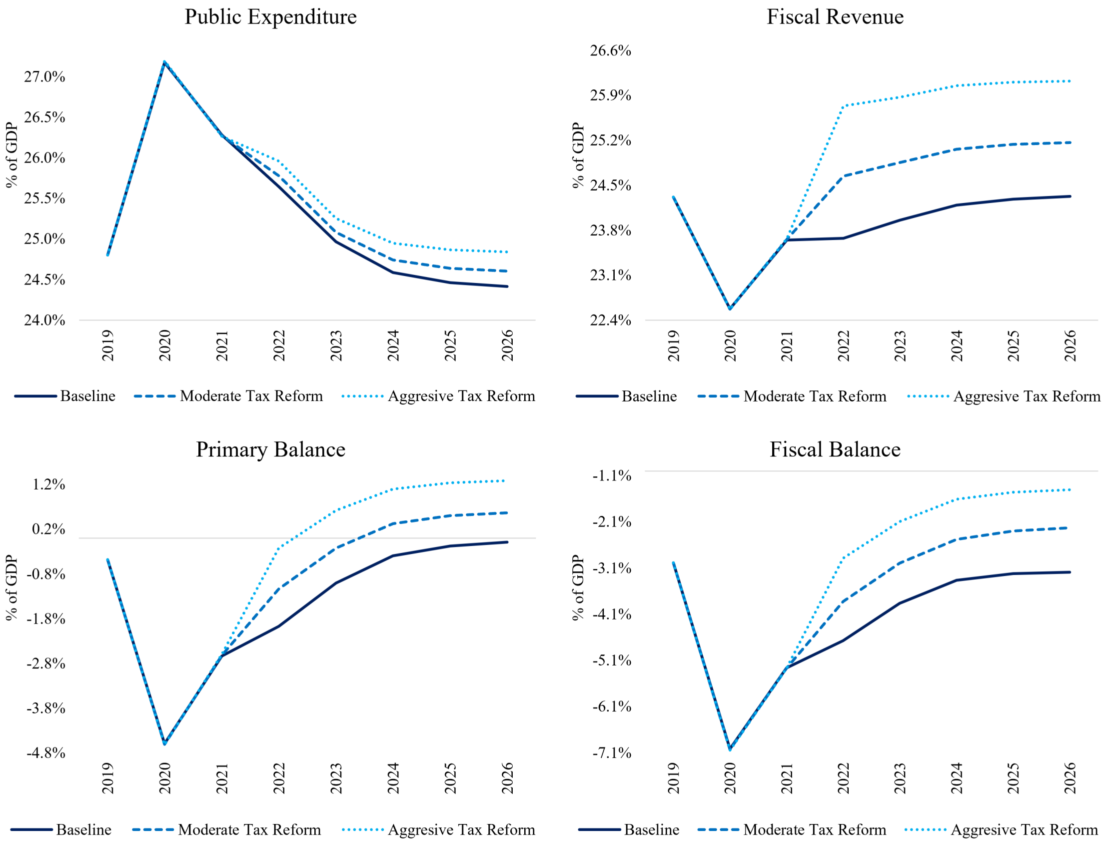
At the aggregate level, with lower demand for consumer goods and lower working hours offered by households, total output decreases with higher tax rates. This distortion entails a cost in terms of economic growth after the implementation of the reforms. In 2022 the baseline scenario presents an economic growth rate of 2.2%, compared to 1.5% and 0.6% for the moderate and aggressive tax reforms. Despite this, the difference between the scenarios narrows toward the medium term, reaching levels of 2.3% in 2026.

Figure 10: Impact on the Aggregate Variables



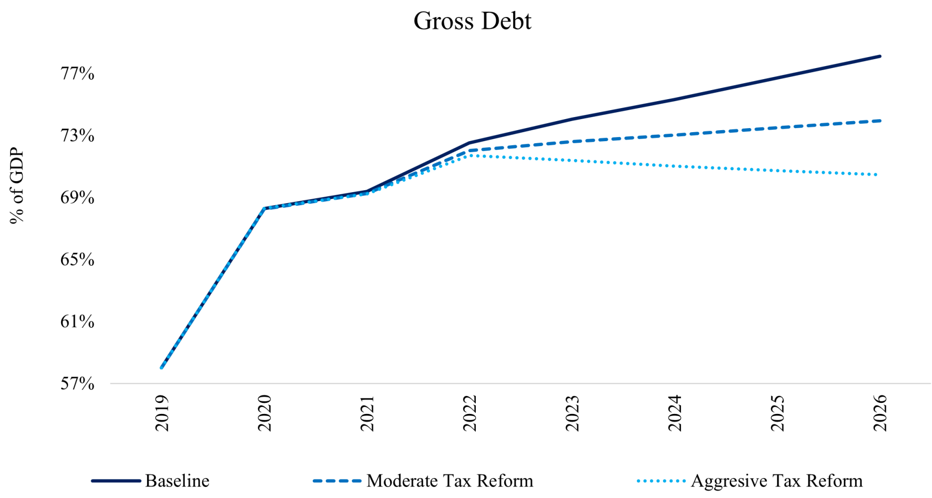
On the fiscal side, public spending as a percentage of GDP slowly returns to its pre-pandemic level after the crisis. However, when tax reforms are included, the distortion on output results in the ratio (Public Expenditure/GDP) remaining higher for a longer time (Figure 11, Panel A). On the other hand, with higher tax rates, revenues increase in 2022 and persist at higher levels (Panel B). As a result, the primary balance recovers faster with reforms. In 2026, an aggressive fiscal adjustment yielded a primary surplus of 1.3% of GDP. Under the moderate scenario, the surplus is lower (0.7% of GDP) (Panel C). As for the overall balance, dynamics are similar: the fiscal deficit is reduced between 1 and 1.8 percentage points since introducing the reform in 2022 (Panel D).

Figure 11: Impact on the Fiscal Variables



Higher tax revenues and an increase in the primary surplus succeed in stabilizing gross debt. Figure 12 shows how the primary balance starts to turn positive, and gross debt is held at levels of 74% and 70.5% of GDP with moderate and aggressive tax reform, respectively. However, slow economic activity and high paid interest rates prevent debt from decreasing. Despite this, only implementing fiscal reforms in 2022 could reduce debt by up to almost 8 percentage points compared to the reference scenario.

Figure 12: Debt as Percentage of GDP

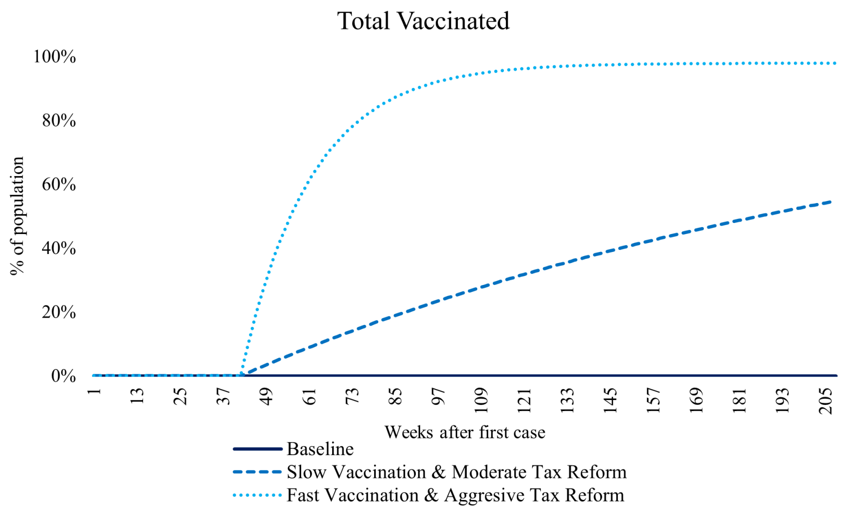


4.3 Basic SIR-Macro Fiscal Model with both Vaccination and Tax Reforms

The third simulation shows what happens if both vaccination and tax reforms are incorporated into the model. We present three scenarios: (i) The baseline scenario has neither vaccination nor tax reforms. (ii) A medium scenario, having a slow vaccination rate equal to 0.5% of susceptible persons vaccinated each week and moderate tax reform that increases tax revenues by 1% of GDP. iii) The aggressive scenario, which has a fast vaccination rate equal to 5% of susceptible people vaccinated each week and an aggressive tax reform that increases tax revenues by 2% of GDP.

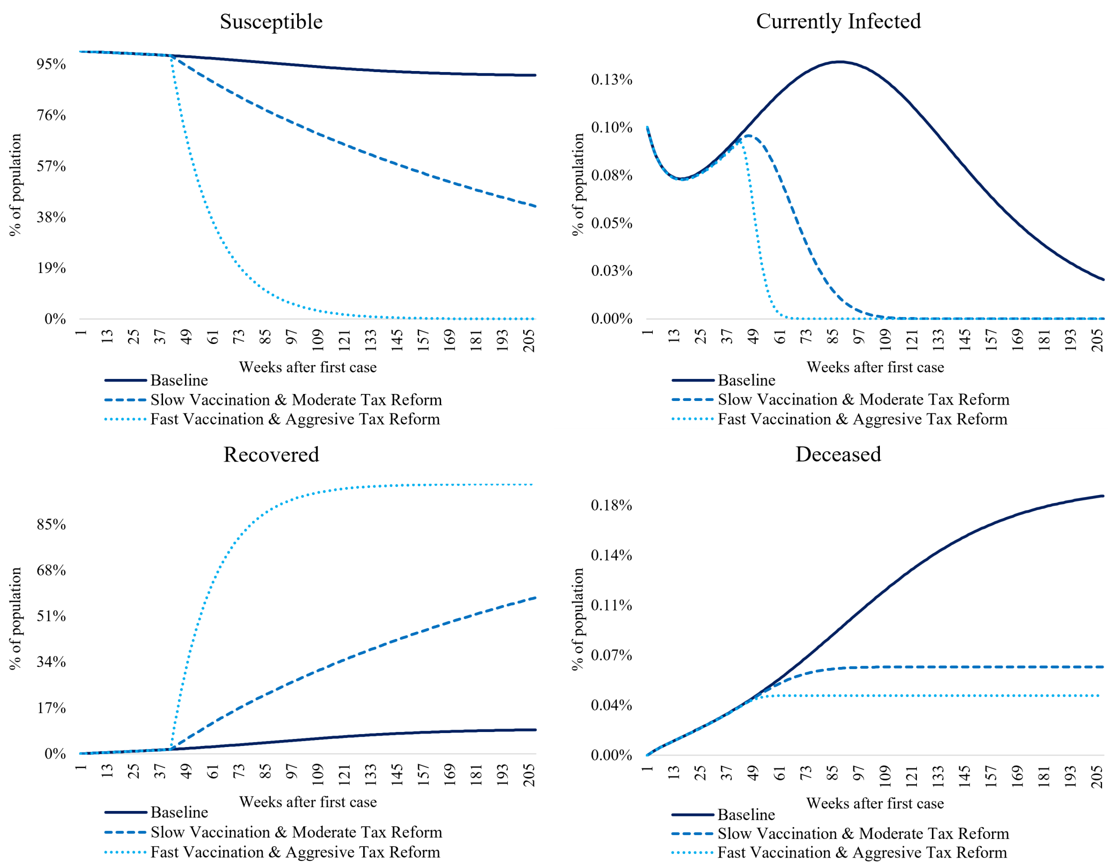
The results show the introduction of both vaccination and tax reforms distort agent decisions, leading to different epidemiological effects. Figure 13 shows the vaccinated population each week whose dynamics are similar to those observed in section 4.1.

Figure 13: Vaccination



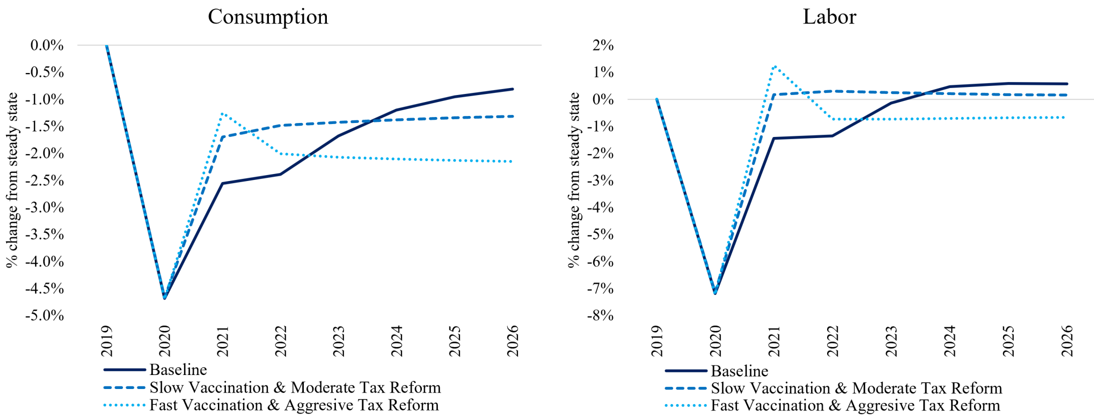
The first and second simulations showed opposite results in the susceptible and recovered populations for epidemiological variables. However, the effect of vaccination is more significant in the epidemiological variables (Figure 14). The dynamics of the susceptible and recovered population are similar to the one described in section 4.1, but with slightly lower levels. For those currently infected and deceased, the results of each of the stimuli (vaccines and tax reforms) go in the same direction, implying a lower infected population and lower deaths when the two actions are applied together.

Figure 14: Impact on Epidemiological Variables



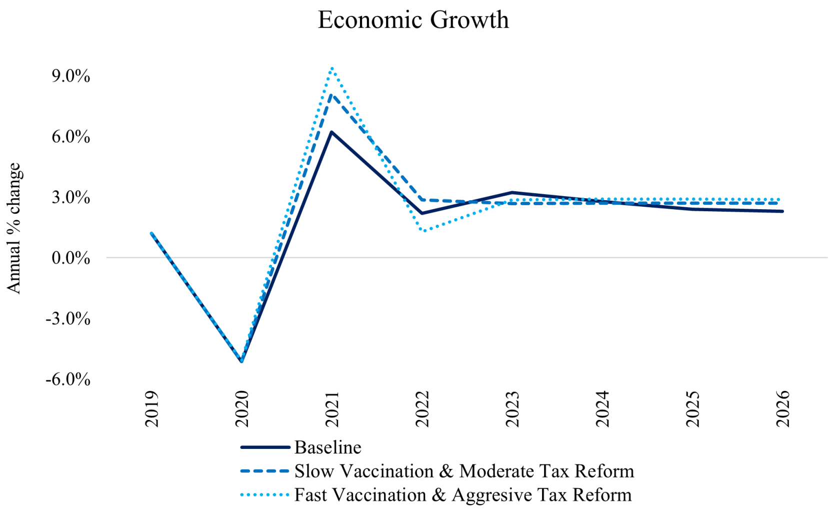
Overall, both consumption and labor increase due to the vaccination process and decrease due to the tax reforms. However, despite the acceleration in recovery by 2021 due to vaccination, towards the medium-term distortions generated by the reform places consumption and labor at a lower level relative to 2019 (Figure 15).

Figure 15: Impact on Macroeconomic Variables



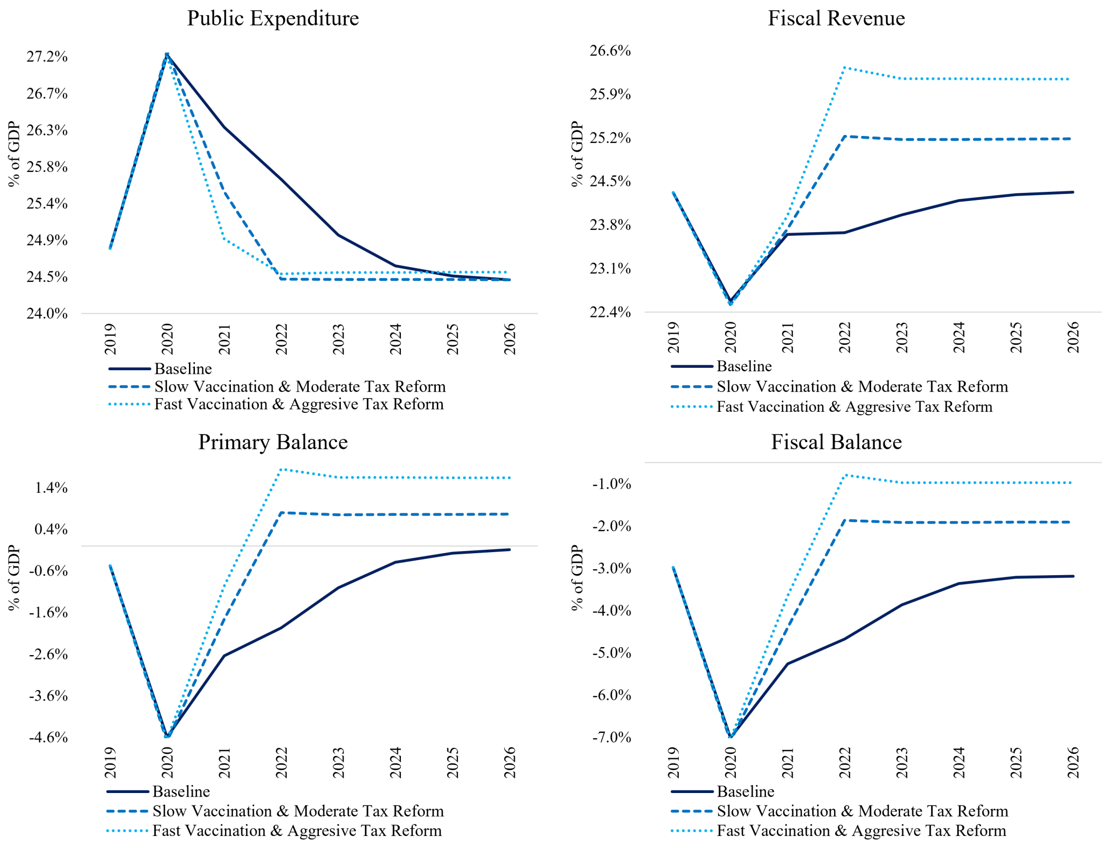
Due to consumption and labor dynamics, economic growth is higher in 2021, when vaccination has occurred. However, tax-generated distortions reduce the output boost described in section 4.1. Nevertheless, if we compare these results to those presented in section 4.2, the output dynamics are better: vaccines compensate for the economic loss due to the tax reform during its implementation. In this sense, the economic slowdown with the implementation of reforms is less significant in 2022: In the most severe scenario, the economic growth is 1.3%, which is 0.7 percentage points higher than in the scenario with aggressive tax reform and without vaccination. In addition, vaccination also offsets fiscal distortions to growth over the medium term. As a result, by 2026, economic growth is up to 0.6 percentage points higher than in the baseline scenario.

Figure 16: Impact on Aggregate Variables



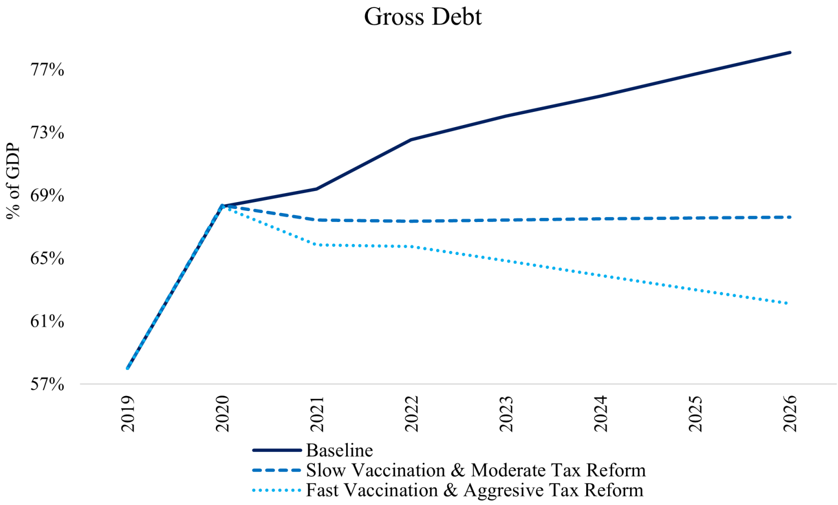
From a fiscal point of view, public spending as a percentage of GDP decreases when vaccination begins. However, the fiscal distortions introduced by the tax reform prevent spending from adjusting toward lower levels concerning the baseline scenario (Figure 17, Panel A). Therefore, in the aggressive and moderate scenario, public spending stabilizes near 24.5% of GDP. In this simulation, tax revenues show the same dynamics described in section 4.2 (Panel B). As a result, both the primary and fiscal balances recover faster when both vaccines and tax reforms are introduced than when only one of them is implemented. The primary balance reaches surplus in 2022 in the aggressive scenario and then remains at a constant positive level of 1.6% of GDP. On the other hand, the moderate scenario also reaches primary surpluses in the same year but stabilizes at least 0.8 percent of GDP (Panel C). Similarly, the overall balance exceeds its pre-pandemic levels in 2022 in the aggressive and moderate scenarios (Panel D).

Figure 17: Impact on Fiscal Variables



Faster recovery of the primary and overall balance makes it possible for gross debt to decline. For example, figure 18 shows how, as the economy recovers from the crisis and fiscal balances adjust, gross debt decreases in 2021 by 2.5 and 0.9 percentage points of GDP in the aggressive and moderate scenarios, while it continues to increase in the baseline scenario. In the following years, the debt remains on a steady path of adjustment and convergence as a primary surplus is achieved and economic growth remains stable, at least in the aggressive scenario.

Figure 18: Debt as Percentage of GDP

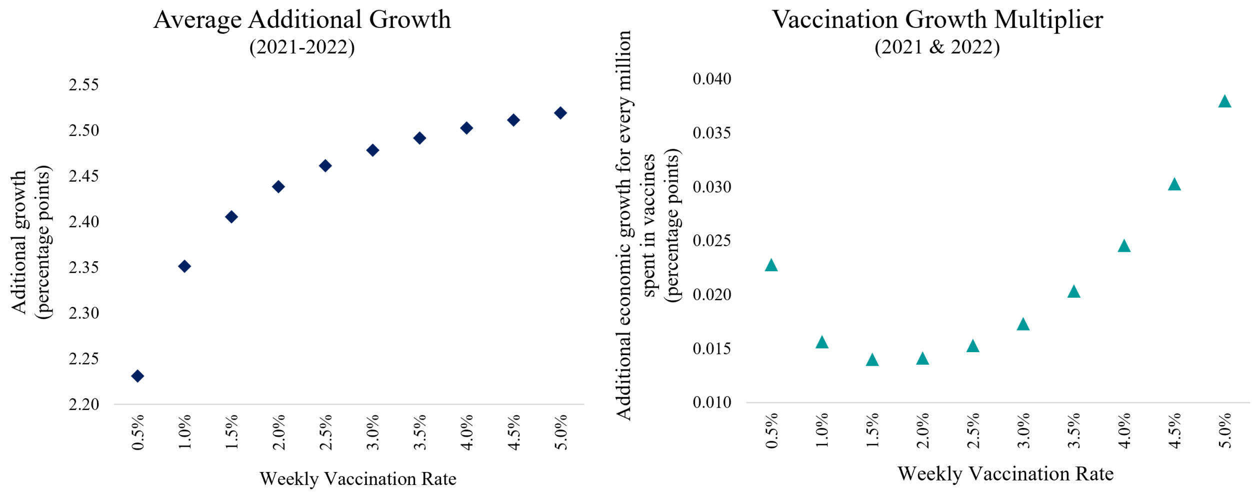


5 Vaccination Growth Multiplier

As shown in section 4.1, there is a positive impact of vaccination on economic activity. Specifically, we estimated the vaccination growth multiplier as the additional growth generated by each million dollar spent on vaccines. Since Covid-19 vaccines became available, LAC countries have established contracts with pharmaceutical companies around the world, according with UNICEF 2021. For an average country, the total expenditure of all contracts has account for US1.2 billion. On average, each country has contracted 86.1 million vaccine doses, so 85.3% of the population is covered and the cost of each dose is 14 dollars.

Using this calculations, we simulate different weekly vaccinations rates to evaluate the additional impacts on economic growth. In this sense, we applied weekly vaccinations rates between 0.5% and 5% on susceptible population, which implies 40% of total population vaccinated at the end of 2022, and 98%, respectively. Then, we computed the economic growth obtained in 2021 and 2022 for each scenario. The figure 19 Panel A shows that, compared to the baseline scenario, the weekly vaccination of 0.5% of the susceptible population increases the economic growth in 2.2 percentage points. As vaccination rate gets faster, additional growth increases in a concave way, such that a weekly vaccination rate of 5% increases economic growth in 2.5 percentage points.

Figure 19: Vaccination Additional Growth and Multiplier



This dynamic is due to the impact that vaccination has on the economy, which stimulates the return to the steady state of production factors and consumer demand. However, once equilibrium growth is reached, vaccination does not generate additional effects on growth.

In the same way, this work calculate annual vaccine spending for different vaccinations rates, and compare it with the gain in economic growth each year. We find that, two years after the vaccination process started, every extra million spent on vaccination generates an economic growth rate of 0.023 percentage points, in the slowest vaccination rate simulated (0.5% of susceptible population vaccinated every week). On the other hand, when the same calculation for the fastest vaccination rate scenario is performed, the fiscal multiplier for vaccines is 0.04 percentage points of additional economic growth with every million dollars spent on vaccines.

However, since the vaccination process is expensive for governments, there is a U-shape relationship between vaccination rate and additional economic growth. We found that the multiplier is positive for all scenarios. Nevertheless, there is a threshold in which, above that point, the impact of fast vaccination is high and it increases with faster weekly vaccination rates. Thus, when rates are over 2% (nearly 85% of the population vaccinated at the end of 2022) the relationship becomes positive: a higher weekly vaccination rate implies a higher additional economic growth for every million spent in vaccines.

This non-linear relationship is because vaccination is a mechanism that allows the economy to return to its pre-pandemic dynamics. When there is a significant amount of vaccinated population in the economy, agents react to the low probability of infection and increase their consumption and labor supply. However, in order that the economic gain exceeds the costs of the vaccination process, relative to the immediately slower vaccination rate, it is necessary to vaccinate 2% or more of the susceptible population each week. Figure 19, Panel B shows this non-linear relation.

Moreover, there are benefits in terms of lower population death and fewer infections that the multiplier do not includes in the calculation. Specifically, for an average country in LAC with a weekly vaccination rate of 0.5%, the total deaths due to the virus are nearly 23 thousand, while, an average country with a vaccination rate of 5%, at the end of the pandemic, has 15 thousand deaths. This means that, in addition to the growth gain by a fast vaccination policy, there are important benefits in saving people.

6 Conclusions

One of the critical challenges that Latin America and the Caribbean face is identifying how to resume its fiscal consolidation process and adjust to new levels of indebtedness that do not negatively affect its economic growth. In this paper, we find that the process of fiscal consolidation must be simultaneously accompanied by fiscal policies that promote higher levels of revenue collection and efficient vaccination programs. In this regard, we find that a scenario in which susceptible individuals are vaccinated at a rate of 5% per week and a reform that increases tax revenues by an additional 2 percentage points of GDP is implemented. Thus, one year after the vaccination process begins, 91% of the population would be vaccinated, and the death rate would be 0.04% compared to 18% in the baseline scenario. As for fiscal variables, the primary balance would reach a surplus in 2022 and remain at a constant positive level of 1.6% of GDP. Similarly, the overall balance exceeds its pre-pandemic levels from 2022. The faster recovery of both the primary and global balance makes it possible for gross debt to decline by 2.5 percentage points of GDP in 2021 and, in the following years, to place it on a stable path of fiscal consolidation when a primary surplus is achieved, and economic growth remains stable.

Finally, it is essential to determine the vaccination growth multiplier because it enables us to identify the impact of these programs on the reactivation of economic activity and, therefore, on growth. In addition, we find a non-linear relationship between vaccine spending and economic growth. This suggests the possibility that optimal spending on vaccination may amplify the impact on economic growth.

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