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A Global Shock with Idiosyncratic Pains: State-Dependent Debt Limits for LATAM during the COVID-19 pandemic

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A Global Shock with Idiosyncratic Pains: State-Dependent Debt Limits for LATAM during the COVID-19 pandemic *

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Abstract

Fiscal sustainability in five of the largest Latin American economies is examined before and after the COVID-19 pandemic. For this purpose, the DSGE model in Bi (2012) and Hürtgen (2020) is used to estimate the Fiscal Limits and Fiscal Spaces for Peru, Chile, Mexico, Colombia, and Brazil. These estimates advance the empirical literature for Latin America on fiscal sustainability by offering new calculations stemming from a structural framework with alluring novel features: government default on the intensive margin; dynamic Laffer curves; utility-based stochastic discount factor; and a Markov-Switching process for public transfers with an explosive regime. The most notable additions to the existing literature for Latin America are the estimations of entire distributions of public debt limits for various default probabilities and that said limits critically hinge on both current and future states. Results obtained indicate notorious contractions of Fiscal Spaces among all countries during the pandemic, but the sizes of these were very heterogeneous. Countries that in 2019 had positive spaces and got closer to negative spaces in 2020, have since seen deterioration of their sovereign debt ratings or outlooks. Colombia was the only country to lose its positive Fiscal Space and investment grade, thereby joining Brazil, the previously sole member of both groups.

JEL Classification: E32, E62, H20, H30, H50, H60. *Keywords:* State-Dependent Debt Limits, Latin America, Fiscal Space, Fiscal Sustainability, Default, Public Debt, COVID-19, Global Methods

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Un choque global con dolores idiosincráticos: Límites de Deuda Estado-Dependientes para LATAM en la pandemia de COVID-19 [*]

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Resumen

Antes y después de la pandemia de COVID-19 se examina la sostenibilidad fiscal de cinco de las economías más grandes de Latinoamérica. A través de métodos globales se resuelve el modelo DSGE, desarrollado en Bi (2012) y Hürtgen (2020), para estimar los Límites y Espacios Fiscales de Perú, Chile, México, Colombia y Brasil. Estas estimaciones expanden la literatura empírica sobre la sostenibilidad fiscal en Latinoamérica, al ofrecer nuevos cálculos provenientes de un modelo con varias características enriquecedoras: default del gobierno en el margen intensivo; curvas de Laffer dinámicas; factor de descuento estocástico de hogares aversos al riesgo; y transferencias públicas que siguen un proceso de Markov-Switching con un régimen explosivo. Las adiciones más destacables a la literatura existente para Latinoamérica son las estimaciones de distribuciones de límites de deuda pública para distintas probabilidades de default y que éstas dependen de los estados presentes y futuros de la economía. Los resultados indican que en 2020, si bien hubo heterogeneidad, se dieron contracciones notorias de los Espacios Fiscales en todos los países a raíz de la pandemia. Los países que en 2019 tuvieron espacios positivos y se acercaron a espacios negativos en 2020 han experimentado desde entonces deterioros de las calificaciones crediticias (o perspectivas) de su deuda soberana. Colombia fue el único país que en la pandemia perdió su Espacio Fiscal positivo y el grado de inversión de su deuda; antes del choque sólo Brasil tenía estas características.

Clasificación JEL: E32, E62, H20, H30, H50, H60.
Palabras Clave: Límites de Deuda Estado-Dependientes, Latinoamérica, Espacio Fiscal, Sostenibilidad Fiscal, Default, Deuda Pública, COVID-19, Métodos Globales

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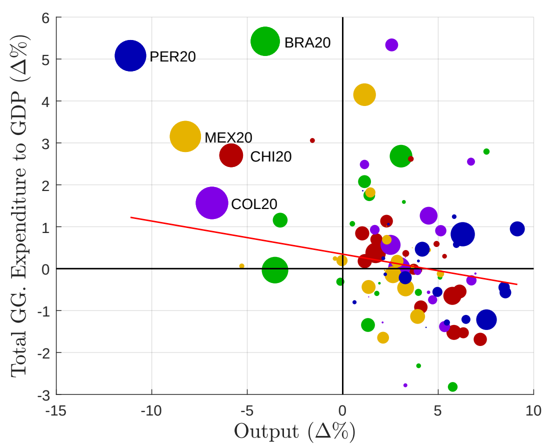
1 Introduction

In the midst of a crisis, a government's ability to use its fiscal policy to counteract the shock and alleviate the damage is crucial. Around the globe, COVID-19 has proved to be no exception to this. Governments have put in motion large-scale fiscal programs to support health systems and private income losses (Deaton (2021)), while enduring important reductions of their tax revenues on account of major economic contractions.

The Latin American and Caribbean region has been a notorious example of the latter, enduring its worst economic crisis so far and the largest GDP contraction in the developing world during the pandemic (ECLAC (2021)). In turn, this fatal mix of lower fiscal revenues and larger public expenditure has come with rising public debt levels. Figure 1 shows that during the pandemic five of the largest Latin American economies experienced, at the same time, sharp economic contractions, sizable fiscal expansions, and substantial debt increases. As a matter of fact, ECLAC has pointed out that up to 2020 Latin America was the most indebted region of the developing world and expressed concern about governments' ability to continue the fight against the pandemic and boost the much-needed recovery in the following years.

Figure 1: Output Growth, Government Expenditure and Public Debt growth

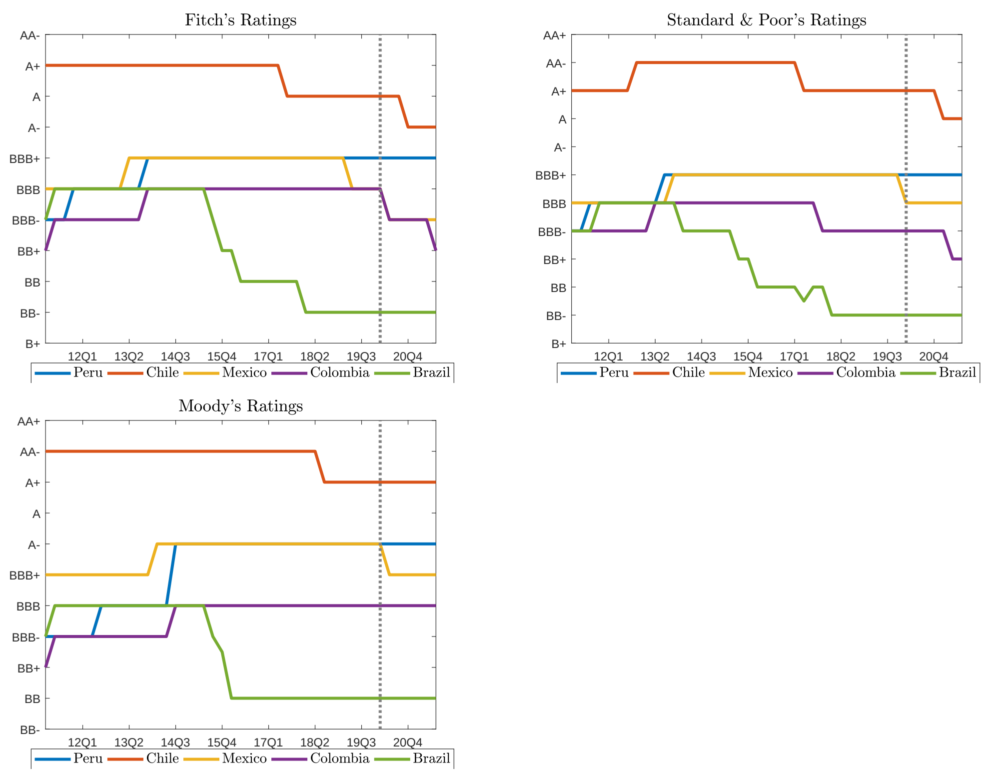


Note: The Figure shows the relationship between the economic growth (x-axis) and fiscal expansions (y-axis) for Peru (blue dots), Chile (red dots), Mexico (yellow dots), Colombia (purple dots) and Brazil (green dots). The negative-slope solid-red line fits a standard linear regression of the data. Additionally, the size of the dots is a function of the gross debt growth (absolute year-over-year variation), that is, a bigger dot represents a relatively higher growth in debt for each economy. The labels depict the relation of the variables in 2020 during the COVID-19 pandemic.

This paper applies the closed economy DSGE model, originally proposed in Bi (2012) and recently used in Hürtgen (2020), to Peru, Chile, Mexico, Colombia, and Brazil (hereafter LATAM), in order to evaluate their fiscal sustainability before and after the COVID-19 pandemic. The model yields estimates of each country's Fiscal Limits and Fiscal Space, which measures how much room governments have to issue debt before reaching over-indebtedness. These estimates are then compared to sovereign debt ratings. In line with ECLAC's concerns, the results obtained indicate notable contractions of Fiscal Spaces for all countries during 2020 with an average -23.4pp shrinkage as a share of GDP. Furthermore, countries that in 2019 had positive spaces and ended up markedly closer to negative spaces in 2020 (Mexico, Chile and Colombia), have since seen deterioration in their sovereign debt ratings or outlooks. Most notably, Colombia was the only country to lose its positive Fiscal Space and also the only one to lose its investment grade. Previous to the pandemic, only Brazil had already a negative Fiscal Space and a sovereign debt rating below investment grade.

In a way, sovereign debt ratings dynamics across the region, as seen in Figure 2, illustrate how debt markets have reacted to the fiscal and macroeconomic consequences of the pandemic since its outbreak. Nonetheless, it also shows that fiscal sustainability in LATAM has been a pressing issue in the last couple of years, even before the COVID-19 crisis, with various changes in ratings outlooks for Colombia, Mexico, and Chile, and a downgrade for Brazil in 2015. For that reason, the Fiscal Limits and Fiscal Spaces estimated in this paper for 2019 provide new evidence about fiscal sustainability in LATAM far beyond the COVID-19 crisis assessment.

Figure 2: Evolution of Sovereign Debt Ratings in LATAM (2010Q4-2021Q2)



Note: The graph depicts sovereign debt ratings for each country from 2010Q4 to 2021Q2, according to the three main rating agencies. These ratings are translated into a common scale as shown on y-axis. The dotted vertical line in each panel indicates the period of the COVID-19 outbreak (20Q1).

In fact, there are many ways in which these estimates enrich the empirical literature about fiscal sustainability in LATAM. Although there has been ongoing research about Fiscal Limits and Fiscal Spaces for Latin American countries, few papers have used the same framework to estimate simultaneously the debt limits for several countries and compared them based on common ground. A recent work along these lines can be found in Lozano-Espitia & Julio-Román (2020), who build on the methodology presented in Ghosh et al. (2011) of calculating government's fiscal fatigue to determine debt limits and Fiscal Spaces, and find great heterogeneity among Latin American countries. Despite the value of their estimates, the more structural approach we propose corroborates this result while offering new insights and features that derive from a richer setup. The most enriching characteristic is that the method estimates a whole distribution of public debt limits for several default probabilities rather than the usual point estimate. Ultimately, this makes it a very ample benchmark to compare other debt limits estimations and pair them with their implicit default probabilities. Throughout the paper, Fiscal Spaces will be calculated with respect to the debt limit corresponding to a default probability of 5%, since after said threshold non-linearities between debt and default become more steep.

Another innovative attribute is that the distributions contain debt limits that strongly depend on the current state of the economy, thus the name State-Dependent Debt Limits (SDDL), in addition to the most usual effect of expectations about the future on today's limits. Indeed, this made the technique so ideal to assess the effects of COVID-19 on each country's debt limits. Following the methodology employed in Hürtgen (2020), in order to produce the Baseline Scenario the model is calibrated country by country with annual data from 1994-2019 to match their respective macroeconomic and fiscal profiles. Then, realizations of public expenditure and GDP are input into the model to build the COVID-19 scenario. Additionally, to stress the importance of current and future states in SDDL estimations, the model includes a Markov-Switching process for public transfers with an explosive regime. As documented by Flamini et al. (2018), explosive public transfers are a key characteristic of developing economies' fiscal structure and can be a potential source of fiscal insolvency for LATAM. By the same token, when the pandemic strikes, all the countries considered are assumed to be in an explosive regime with high persistence.

More specifically, one can highlight at least three other important aspects of the model that are uncommon in the fiscal sustainability literature. First, there is imperfect fiscal commitment, given that the government can default on its debt and make this choice on the intensive margin. Note that this modeling choice is vital to construct distributions and not point estimates of debt limits. Second, future fiscal balances are not discounted with a real interest rate, but with a utility-based stochastic discount factor consistent with risk-averse households. Third, the model allows for a closed-form solution of the Dynamic Laffer Curves for each period in the horizon and these are used to guide tax policy. By virtue of assuming that tax rates are always at the peak of these curves, the estimated Fiscal Limits are thus more stringent than in other methods.

Putting all these pieces together, the framework allows to sort countries by their Fiscal Spaces in the Baseline scenario as follows: Peru, Chile, Mexico, Colombia and Brazil. One important result is that in spite of the heterogeneous fiscal responses and economic contractions, said order is not altered in the COVID-19 scenario. What's more, this order is mostly consistent with sovereign debt ratings: in 2019 only Brazil was below investment grade, and Peru and Chile had higher ratings than Mexico and Colombia. Surprisingly, after the COVID-19 shock in 2020 just Peru and Brazil suffered no change in their sovereign debt ratings nor in their ratings outlooks. Whereas the result for Peru is very intuitive in view of its large Fiscal Space, Brazil's is much more baffling. However, the model suggests that this might had to do with the fact that its large government size and high ratio of transfers to GDP already implied a negative Fiscal Space in 2019. This is further corroborated by its debt longstanding status of no investment grade.

Prominently, among the countries considered, Colombia stands out as the biggest loser of the pandemic in fiscal terms. In light of the model, the loss of Colombia's positive Fiscal Space in 2020 for a broad range of default probabilities is mainly due to its significant rise in public expenditure (second highest), high ratio of transfers to GDP and an already tight Fiscal Space in 2019 (second lowest). As a result, this paper underscores the fragility of Colombia and Brazil's fiscal sustainability and provides evidence of their need to undergo structural fiscal reforms in the short run. In any case, Mexico and Chile shall not be overlooked in the analysis, as they also had modifications in their ratings outlooks after the sharp reductions of their Fiscal Spaces in 2020. It is worth noting that, despite these countries had reasonably similar reductions of their Fiscal Space, the factors causing them were different across the two. Chile's reduction was caused by a substantial fiscal expansion, whilst Mexico's was mainly due to the decline in its GDP (second largest).

Altogether these results speak of the great heterogeneity existing across LATAM in terms of their quantitative response to the COVID-19 shock, even though qualitatively they all ended up with less Fiscal Space. This means that generalizations about the pandemic's fiscal consequences can be misleading, especially when thinking about potential fiscal reforms or international financial assistance provided by multilateral institutions. On top of that, it highlights the relevance of the methodology to understand the extent to which the pandemic affected fiscal sustainability in the region and evaluate how it might change in the years to come. Thereupon, the framework will remain as a useful tool to keep track of Fiscal Spaces in the region and compare them through the lenses of a structural model, with all the valuable insights this entails.

In sum, this paper mainly contributes to two different streams of the literature. First, it broadly relates to the recent works of Deaton (2021); Forero-Alvarado et al. (2021); Arellano et al. (2020); Acemoglu et al. (2020); Eichenbaum et al. (2020); Krueger et al. (2020); Deb et al. (2020); Jones et al. (2020); Atkeson (2020); Argente et al. (2020); Baker et al. (2020) by providing another measure of the consequences brought by the COVID-19 pandemic through the quantification of the fiscal costs it had in Latin America. Given that this region was vastly affected by the pandemic, this costs are of the utmost importance to identify critical solvency risks, guide policy decisions, help prioritize international assistance, and shape strategies to achieve a sustainable recovery in Latin America. Second, as it has been said before, the paper offers empirical evidence that expands the fiscal sustainability literature in Latin America found in Aguiar et al. (2016); Mendoza & Oviedo (2004); Aguiar & Gopinath (2006); Arellano (2008); Cuadra et al. (2010); Lozano-Espitia et al. (2019); Lozano-Espitia & Julio-Román (2020); Lozano-Espitia & Arias-Rodríguez (2020); Betancur & Libos (2020). This expansion is especially valuable since our paper addresses the subject by calculating Fiscal Limits and Fiscal Spaces distributions, which represent abundant new estimations that serve as benchmarks for future research and policymakers.

The rest of the paper is organized as follows. Section 2 presents the model and the calibration strategy, as well as the data used to implement it. Section 3 starts by laying out the model mechanisms through the analysis of Colombia, the country most affected by the pandemic in fiscal terms. It then proceeds to expand the scope of the methodology to the rest of Latin American countries and performs a thorough comparison of the estimated Fiscal Limits and Fiscal Spaces for each country. Section 4 concludes.

2 Model

The model, as developed in Bi (2012) and Hürtgen (2020), is used in this paper. It features a closed economy with three types of agents: households, firms and government. These agents interact in a dynamic and stochastic general equilibrium environment with markets for labor, goods and debt.

Households

The economy is populated by an infinite number of identical households of measure one. The representative household maximizes the expected present value of its lifetime utility by choosing how much to consume, C_t, hours to work, $(1 - L_t)$, and public debt to demand, B_t.

$$\max_{C_t, L_t, B_t} \quad E_0 \sum_{t=0}^{\infty} \beta^t u\left(C_t, L_t\right) \tag{1}$$

$$s.t \quad C_t = W_t (1-\tau_t)(1-L_t) + Z_t + B_t q_t - (1-\Delta_t) B_{t-1} \tag{2}$$

where $\beta \in (0,1)$ is the discount factor, W_t is wage, τ_t is the labor tax, Z_t are public lump-sum transfers, B_t is a one period non-contingent bond issued by the government, q_t the price of said bond and $\Delta_t \in [0,1]$ measures the share of the standing public debt on which government defaults. Household's utility is measured by a logarithmic separable function, just as in Bi (2012); Hürtgen (2020):

$$u(C_t, L_t) = log(C_t) + \phi log(L_t)$$

Firms

Firms produce a homogeneous consumption good, Y_t, in a perfectly competitive market and using a linear technology that only depends on labor, $(1-L_t)$:

$$Y_t = A_t (1-L_t) \tag{3}$$

where A_t is the Total Factor Productivity (TFP). This TFP is stationary and evolves over time as a discrete Markov chain, characterized by the set $A = \{\underline{A}, A_2, \ldots, A_{n^A}\} \in \mathcal{A}$, and the transition probability matrix, $\pi(A'|A)$, following:

$$\pi(A'|A) = Pr(A_{t+1} = A'|A_t = A) > 0 \quad \forall \{A, A'\} \in \mathcal{A} \tag{4}$$

Wages are determined in equilibrium and are equal to the marginal productivity of labor. As a consequence of the assumed characteristics about the utility function and the production technology, in equilibrium, wages are equal to the TFP:

$$W_t = A_t \tag{5}$$

Government

Government collects taxes through a distortionary tax on labor, τ_t, issues a non-contingent bond with maturity of one period, B_t, with price, q_t and has the possibility to default on a fraction of the debt, Δ_t.[1] Let the government revenues be $T_t = \tau_t W_t (1-L_t)$. Government resources are used in debt repayment, and to finance public expenditure, G_t, and lump-sum transfers to households, Z_t.

[1] In Bi (2012), the government chooses the share of debt it defaults on from an empirical distribution once the debt exceeds the fiscal limit.

The government budget constraint is given by,

$$\tau_t W_t (1 - L_t) + B_t q_t = (1 - \Delta_t) B_{t-1} + G_t + Z_t \tag{6}$$

Government expenditure is stationary and evolves over time as a discrete Markov chain, characterized by the set $G = \left\{G_1, G_2, \ldots, \bar{G}\right\} \in \mathcal{G}$, and the transition probability matrix, $\pi(G'|G)$, following:

$$\pi(G'|G) = Pr(G_{t+1} = G'|G_t = G) > 0 \quad \forall (G, G') \in \mathcal{G} \tag{7}$$

Lump-sum transfers to households fluctuate randomly following a Regime Switching process of two regimes: one in which the transfers are stationary ($S_{z,t} = 1$), in which case they take their long-run value ($\bar{z}$); and another one in which transfers are explosive ($S_{z,t} = 2$) and grow at a rate μ^z. The latter regime represents, in turn, an additional pressure on the government's fiscal balance. This assumption follows Bi (2012), who documents that in developed economies, between 1970 and 2007, transfers to households as a share of GDP had a growing trend. This pattern is also present in Latin America and, as has been shown by Flamini et al. (2018), this trend is expected to continue. As said, lump-sum transfers to households follow:

$$Z_t = \begin{cases} \bar{z} & \text{if } S_{z,t} = 1 \\ \mu^z z_{t-1} & \text{if } S_{z,t} = 2 \quad \text{with } \mu^z > 1 \end{cases} \tag{8}$$

Transition between regimes is described by the probability transition matrix:

$$\pi^{S_Z}(S'_Z|S_Z) = \begin{bmatrix} p^z & (1 - p^z) \\ (1 - q^z) & q^z \end{bmatrix} \quad \text{for} \quad \{p^z, q^z\} \in [0, 1) \tag{9}$$

The explosiveness of transfers is captured by two conditions. The first one requires that $\mu^z > 1$, that is, once the explosive regime is reached, transfers to households grow at a rate μ^z, until a stochastic signal (given by $\pi^{S_Z}(S'_Z|S_Z)$) switches the state of the economy towards the stationary regime. The second condition requires that the stationary regime is not an absorbing state, that is, $p^z \in [0, 1)$.

We follow the methodology in Tauchen (1986) for the discretization of the TFP and government expenditure processes. This discretization represents a technical difference to Bi (2012); Hürtgen (2020) as they simulate the exogenous processes normally distributed starting from a given initial condition of the exogenous states. Conversely, in this document the processes are allowed to take realizations only from a given discrete "menu". This exploits the fact that computing a closed-form solution for the government's revenue-maximizing tax rate is feasible in the model. Hence, by using the discretization technique aforementioned, it is possible to map each state of the economy to the optimal allocations and prices consistent with the peak of the government's Dynamic Laffer Curve.

2.1 State-Dependent Debt Limit and Fiscal Space

In this methodology, Fiscal Limit is the discounted present value of every possible future fiscal surplus in which labor tax rate is at the peak of the Dynamic Laffer Curves, conditional to the initial state of the economy. Fiscal Space is defined as the difference between the estimated Fiscal Limit and the observed current gross debt-to-GDP ratio.

It is worth underlining that a paramount characteristic of this methodology is that multiple possible present and future states of the economy are considered when computing the limit and not only the long-run expected values of aggregate productivity, government expenditure and transfers to households (nor they worst realizations, see Mendoza & Oviedo (2004); Lozano-Espitia et al. (2019)).

Hence, in light of these definitions and the model's structure, the fiscal limit is defined by equation:

$$\mathcal{B}^*\left(A_t, G_t, S_{Z,t}\right) = \sum_{j=0}^{\infty} \beta^{t+j} \frac{u_c^{max}\left(A_{t+j}, G_{t+j}\right)}{u_c^{max}\left(A_t, G_t\right)} \left(T_{t+j}^{max}\left(A_{t+j}, G_{t+j}\right) - G_{t+j} - Z_{t+j}\left(S_{Z,t+j}\right)\right) \tag{10}$$

where $T_t\left(A_t, G_t\right)$ corresponds to the government's revenue at time t and $u_c\left(A_t, G_t\right)$ refers to the marginal utility of one additional unit of consumption. The superscript max indicates that a given period said variable is evaluated at the government's revenue-maximizing tax rate, that is, the tax rate at the peak of the dynamic Laffer curve.

This limit calculation features three fundamental characteristics. First, as mentioned earlier, the fiscal limit, $\mathcal{B}^*\left(A_t, G_t, S_{Z,t}\right)$, depends on every possible current and future realizations of the TFP, government expenditures and transfers to households. As a consequence, an economy's fiscal structure in terms of long-run values, persistences and volatilities of the exogenous processes, as well as the explosiveness degree of transfers, will determine the debt-to-GDP ratio that the government may sustain given a default probability. By considering every possible current and future realization of exogenous processes, the fiscal limit consists on a distribution (rather than a point estimate) of debt-to-GDP ratios that the government is solvent to sustain for a given default probability[2].

Second, the estimated Fiscal Limit Distribution is consistent with the preferences of risk-averse households. All future fiscal surpluses are discounted by the stochastic discount factor, $\beta^{t+j}\frac{u_c^{max}(A_{t+j},G_{t+j})}{u_c^{max}(A_t,G_t)}$, rather than by the difference between the long-run values for real interest rates and output growth, as it is common in the fiscal sustainability literature (Bohn, 2008; Betancur & Libos, 2020; Ghosh et al., 2011; Lozano-Espitia et al., 2019; Lozano-Espitia & Julio-Román, 2020).

The third and final characteristic is related to the assumption of evaluating the Fiscal Limit Distribution at the peak of the dynamic Laffer Curves. This feature of the model implies that even if the government sets a revenue-maximizing tax rate, bad realizations of the TFP, considerable increments of public expenditure or explosive transfers to households might stress fiscal balances enough to push debt-to-GDP ratios to levels where government finds it better to default on its debt[3].

Note that the dependency of the fiscal limit to the initial state of the economy makes the methodology advantageous to analyze how fiscal sustainability changes with the advent of the COVID-19 pandemic. In order to do so, we build two main macroeconomic and fiscal scenarios.

The first one refers to an initial situation in which variables are on their long-run expected values and fluctuate to infinity following the already described processes. This scenario is what we call the Baseline Scenario and allows us to set a benchmark for comparison. The second scenario refers to an initial situation in which variables have been shocked by the COVID-19 crisis. It is characterized by three main features that put a considerable pressure on the government's fiscal balance. On the one hand, there is a significant output decline, captured in the model by an exogenous drop in initial productivity to the crisis level, $\underline{A}$. Such productivity drop reduces the tax base irrespective of the tax rate and thus, it yields a lower government revenue despite the tax rate is set at the peak of the dynamic Laffer curve. Second, it captures the observed fact that governments endured the pandemic by increasing their public expenditure. To reflect this, initial public expenditure reaches the historically high level, $\overline{G}$. Third, the fact that transfers to households in LATAM grow notably over time is included in the simulation by considering that transfers to households start in the explosive regime.

Together, these two scenarios constitute a comparison exercise between the government's fiscal sustainability at the beginning of 2020, before the pandemic stroked, and the one with which it starts in 2021, after a full year of enduring the sanitary and economic emergency.

[2]For a detailed discussion on the simulation technique, see Appendix A

[3]Hürtgen (2020) explores the implications of using observed tax rates rather than those at the peak of the Laffer Curves, finding that it will further contract fiscal limits.

2.2 Data and Calibration

As mentioned earlier in the introduction, the model is calibrated for Peru, Chile, Mexico, Colombia, and Brazil. The model is calibrated on an annual periodicity and incorporates information from National Accounts and the General Government fiscal balance between 1995 and 2020, subject to the International Monetary Fund (2021b,a)[4] data availability. Table 1 summarizes the calibration of the model parameters and long-run relations.

As in Bi (2012); Hürtgen (2020), the time devoted to labor and leisure activities, and the long-run value of the TFP are normalized to one. The discount factor, β, is set at 0.85. Although the latter implies a higher impatience rate than in European Union economies, according to Bi (2012); Hürtgen (2020), this assumption is consistent with the low values found in the sovereign default literature (Aguiar et al., 2016; Aguiar & Gopinath, 2006; Arellano, 2008; Hamann, 2002; Mendoza & Yue, 2012). The time devoted to labor activities, $(1-\overline{L})$, in the long-run is taken from Lozano-Espitia & Arias-Rodríguez (2020). The relative preference for leisure activities in the utility function, ϕ, is calibrated to reproduce the long-run consumption to GDP ratio of each country and therefore, it could differ among countries. Similarly, the government-related long-run ratios are calibrated to match the sample mean (1995-2019) of the total general government income as a share of GDP, $\frac{T}{Y}$, the primary outlays of the general government as a share of GDP (excluding transfers to households), $\frac{G}{Y}$, and the general government transfers to households as a share of GDP, $\frac{Z}{Y}$.

To characterize the TFP Markov process, the cyclical component of the constant-prices GDP is used as proxy. Similarly, to characterize the government outlays Markov process, we use the cyclical component of the primary expenditure. The cyclical components are estimated with a standard Hodrick-Prescott filter. From each cyclical component series, the standard deviation σ, and the first-order autocorrelation, ρ are computed. With respect to transfers' long-run growth rate, μ^Z, it is calibrated to reproduce the average annual growth rate of the social security transfers to households as a share of GDP between 2015 and 2065, according to the estimates of Flamini et al. (2018).[5] Finally, for the transfers regime switching specification we take the regime transition probabilities from Bi (2012); Hürtgen (2020), $p^Z = q^Z = 0.975$, which implies an average persistence at each regime of 40 years.

In the COVID-19 scenario, two relevant statistics are calibrated: i) the size of output drop as a proxy of the TFP shrinkage, and ii) the increase of public expenditure to bear the pandemic. For each country's observed output drop, we compute the decline of the GDP at constant prices. The data, as well as each country's increase

[4]For a detailed discussion of the data sources see Appendix B.

[5]In Appendix C we present a brief summary with the projections of the General Government social security transfers as share of GDP for each economy.

of public expenditure, are taken from the International Monetary Fund's (IMF) World Economic Outlook (WEO) and Fiscal Monitor on its April 2021 issue, International Monetary Fund (2021b).

Table 1: Parameters and Long-run ratios calibration

Parameter	**Symbol**	**Country**				
		Brazil	**Chile**	**Colombia**	**Mexico**	**Peru**
Discount Factor	β	0.850	0.850	0.850	0.850	0.850
Working Hours	$1-\overline{L}$	0.337	0.410	0.380	0.430	0.367
GG Income to GDP	$\frac{T}{Y}$	0.393	0.235	0.285	0.219	0.203
GG Transfers to GDP	$\frac{Z}{Y}$	0.157	0.114	0.129	0.128	0.041
GG expenditure to GDP	$\frac{G}{Y}$	0.199	0.107	0.153	0.095	0.147
Long-run Transfers Growth	μ^z	1.019	1.012	1.010	1.015	1.019
TFP persistence	ρ^A	0.586	0.555	0.648	0.386	0.599 -
TFP std. dev.	σ^A	0.033	0.040	0.028	0.029	0.058
GG expenditure persistence	ρ^G	0.311	0.626	0.746	0.486	0.442
GG expenditure std. dev.	σ^G	0.059	0.061	0.082	0.065	0.051
COVID-19 Scenario						
Drop in TFP	$A-\underline{A}$	0.040	0.058	0.068	0.082	0.110
Public Expenditure increase	$\overline{G}-G$	0.088	0.082	0.040	0.006	0.073
Public Gross Debt 2019	b^{2019}	0.88	0.28	0.52	0.53	0.27
Public Gross Debt 2020	b^{2020}	0.99	0.33	0.63	0.60	0.35

3 Results

Once the framework is developed and calibrated, it is possible to estimate for each of the countries considered the Fiscal Limit Distribution (FLD) and the COVID-19 crisis' impact on Fiscal Spaces (FS). In the first place, Colombia's estimations are presented to outline the main mechanisms of the methodology and to compare the results with some other recent works on fiscal sustainability for Colombia. Subsequently, the estimations for Peru, Chile, Mexico and Brazil are reported, with its corresponding expected impact of the COVID-19 crisis.

3.1 Estimations for Colombia

Figure 3 summarizes the main results for Colombia. The vertical lines correspond to the General Government gross debt observed in 2019 (solid black line) and the 2020 debt reported in WEO, April 2021 (green dashed line). The solid blue line refers to the estimated Fiscal Limit Distribution of the baseline scenario, while the red dashed-line refers to the estimated Fiscal Limit Distribution of the COVID-19 scenario.

In the Baseline Scenario, as it was mentioned before, the estimated distribution corresponds to the debt level that the government is able to sustain given a default probability and an initial condition in which variables take their long-run expected values. The estimation exhibits non-linearity on the debt level that the government is able to sustain given a default probability. For debt-to-GDP ratios below 71%, the probability that households perceive that the government defaults on its debt is close to 0%. Nonetheless, once debt exceeds this cut-off, default probability increases rapidly, moving from a sustainable debt of 71.2% with only 1% default probability to a very likely default episode (*i.e.* 99% default probability) with an associated debt level of 86.8%.

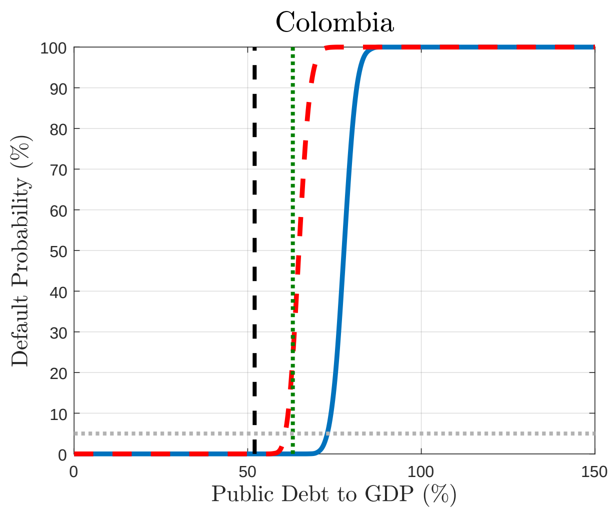
These results are mainly guided by fundamentals of the Colombian economy such as public revenues, expenditure, the transfers to households scheme and the long-run estimated hours worked. In this scenario, the Fiscal Space is defined as the difference between the estimated Fiscal Limit Distribution of the baseline scenario, given a default probability, and the gross debt-to-GDP ratio observed in 2019 (52%). As in Hürtgen (2020), we estimate the Fiscal Space considering a default probability of 5%. Therefore, the estimated Fiscal Space for Colombia in the baseline scenario is 20.99%, which can be seen as ample considering it represents about 40% of the country's 2019 debt levels.

Regarding the COVID-19 scenario, the impact on the Fiscal Space can be decomposed into two factors: 1) the leftwards displacement of the estimated Fiscal Limit Distribution and, 2) the observed increase of gross debt in 2020. As for the first factor, the methodology allows us to quantify the movement of the estimated Fiscal Limit Distribution on behalf of the expected GDP fall and the expected increase of government expenditure to cope with the COVID-19 crisis. Recall this scenario refers to an initial situation described by a severe crisis, in which there is a higher pressure on the general government's fiscal balance. Consequently, the results point out that for a default probability of 1% (100%), in the COVID-19 scenario, the government is able to sustain a debt-to-GDP ratio of 59.4% (73.2%). This implies that, due to the expected GDP contraction and the outstanding increase of public expenditure, for any given default probability the debt that the government is able to sustain is between 12pp and 14pp lower than in the baseline scenario.

The second factor contracts the Fiscal Space even further through the expected increase of the debt-to-GDP ratio. Despite the model allows us to estimate the pandemic's impact on the estimated Fiscal Limit Distribution, the increase of the debt-to-GDP ratio in 2020 is exogenous and observed at the starting point. Moreover, it is straightforward that a higher expected value of debt-to-GDP would shrink the Fiscal Space even if the impact on the estimated Fiscal Limit Distribution were negligible. With this in mind, the marginal effect of the observed increase of the debt-to-GDP ratio in Colombia from 52% in 2019 to 63% in 2020, implied a Fiscal Space shrinkage of 11pp.

Hence, the net effect on the Fiscal Space is jointly determined by the the more contracted estimated Fiscal Limit Distribution of the COVID-19 scenario and the higher observed debt in 2020. Once again, considering a default probability of 5%, the results suggests Colombia's government began 2021 with a negative Fiscal Space of -2.20%. This means that the country's Fiscal Space shrank in about 23pp during the COVID-19 crisis. Such contraction, means that starting the 2021 fiscal year Colombia's government is facing a significantly higher risk perception of agents about its probability of defaulting. Insofar, given Colombia's current debt level this default probability is positive and close to 24%. In Table 2, there is a summary of the estimated fiscal limit and space for Colombia given different values of default probability.

Figure 3: Estimated Fiscal Limit Distribution for Colombia



Note: The dashed vertical black line refers to the Colombian General Government gross debt observed in 2019. The dotted vertical green line refers to the observed gross debt in 2020 (see, International Monetary Fund (2021a)). The solid blue line corresponds to the estimated Fiscal Limit Distribution of the baseline scenario. The red-dashed line refers to the estimated Fiscal Limit Distribution of the COVID-19 scenario.The horizontal gray-dotted line corresponds to a reference line which depicts the 5% probability of default.

Table 2: Estimated fiscal limit and space in Colombia

Prob. Default	**Fiscal Space (%) (Fiscal Limit(%))** 2019	2020	Δ
1%	19.19 (71.2)	-3.61 (59.4)	-22.81 (-11.8)
5%	20.99 (72.9)	**-2.20 (60.8)**	-23.19 (-12.2)
50%	25.75 (77.7)	1.75 (64.8)	-24.00 (-13.0)
95%	30.49 (82.5)	6.14 (69.1)	-24.35 (-13.4)
100%	34.85 (86.8)	10.17 (73.2)	-24.67 (-13.7)

Note: The values reported outside the parenthesis refer to the Fiscal Space while those inside of the parenthesis are the estimated fiscal limit values given the default probability. The first column refers to the baseline scenario (2019), while the second column refers to the COVID-19 scenario (2020). The third column reports the different between 2020 and 2019 (Δ).

Table 3 shows that the results obtained are consistent with other estimations of the fiscal limit for Colombia. Methodologies followed by Lozano-Espitia & Julio-Román (2020); Betancur & Libos (2020) consider a model in which there exists the possibility of defaulting on debt and the debt limit is characterized as the maximum value that debt could take before it goes down an explosive path. If this happens agents' risk valuation is consistent with a situation in which it does not exist a finite interest rate that compensates the lenders, thus making the default an imminent situation.

Table 3: Colombian Public Debt Limit Estimation in the recent literature

Debt Limit (% of GDP)	Methodology	Article
59.4–73.2	**State-Dependent Public Debt Limit**	**Méndez-Vizcaíno, Moreno-Arias (2021)**
68.4	Public Debt Limit with Fiscal Fatigue (Splines)	Lozano-Espitia & Julio-Román (2020)
77–89	Public Debt Limit with Fiscal Fatigue (Deterministic)	Betancur & Libos (2020)
60–69	Public Debt Limit with Fiscal Fatigue (Stochastic)	

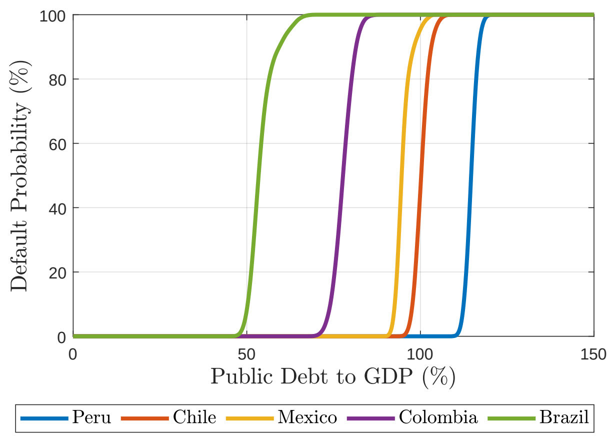
3.2 Estimations for other LATAM countries

The procedure described in the previous subsection for Colombia is now replicated for Peru, Chile, Mexico and Brazil to estimate their Fiscal Limit Distributions and Fiscal Spaces. Despite these countries geographical and cultural proximity, COVID-19 caused heterogeneous macroeconomic adjustments among them. An important part of this variation might had to do with their structural macroeconomic and fiscal disparities. Precisely, these structural differences are taken into account in the FLD's calculations up to 2019. Moreover, because debt limits hinge on current and future states of the economy, the calculations for 2020 are also influenced by the initial macroeconomic structure of each country and by the cyclical changes during the year of crisis.

The estimations of FLD's and FS's are presented in Table 4. These results can be first interpreted in an ordinal fashion, notwithstanding the structural differences that might exist between economies. Long-run estimates of hours worked, as well as public revenues, expenditures, and transfers to households can make a big difference in the shape and level of the Fiscal Limit Distributions for both scenarios and in the degree to which Fiscal Spaces are tighten by the shock. In fact, to make a fair comparison it is worth noting that estimated FLD's are well defined, even at high debt-to-GDP levels, and that are an economy's fiscal conditions what allows it (or not) to generate large fiscal surpluses and sustain higher (lower) public debt levels for the same default probability, relative to others.

In terms of Fiscal Limit Distributions, an ordinal analysis in the Baseline scenario can be quickly carried out performing an stochastic ordering of the CDF's graphed in Figure 4. By virtue of this analysis, is easy to see that Peru stands as the country with largest fiscal limits and Brazil as the one with the smallest. Notice that each country's distributions have strict stochastic dominance over the next one, which allows us to perform the debt limit analysis using any specific probability.

Figure 4: Stochastic Ordering of the Fiscal Limit Distributions for LATAM



Accordingly, Table 4 evidences that, for a default probability of 1%, Peru (110.8%) and Chile (95.9%) stand as the countries that can sustain higher debt levels. Such results turn out to be aligned with rating agencies' perceptions of sovereign risk, since these two countries' sovereign bonds are rated as safer than their peers in the region (Chile A and Peru BBB+)[6]. Consistent with the sovereign debt ratings dynamics presented in the introduction, Mexico (91.2%) and Colombia (71.2%) would be on a similar pre-pandemic fiscal situation and follow the first batch. Again, their weaker performance is supported by rating agencies' sovereign risk perceptions, which in 2019 held them at investment grade but below Peru and Chile ratings (BBB for both). In Colombia, this situation is due to larger government size, lower long-run surplus and higher transfers to GDP (although, with the lowest expected long-run growth in the region). In Mexico the result is mainly explained by both a lower long-run primary balance estimate and a high ratio of transfers to GDP. Lastly, Brazil (47.9%) exhibits the tightest Fiscal Limit Distribution before the pandemic stroked. In light of the model, Brazil's fiscal situation is explained by a very large government size and the highest transfers as share of GDP of the region.

The ranking described for Fiscal Limits also holds in terms of Fiscal Space. Peru and Chile have the widest FS's at a 5% default probability with 84.84% and 69.07%, respectively. Their large FS's are explained by their far right FLD's, as well as for

[6]These ratings are consistent with Fitch ratings of sovereign bonds at the end of 2019. Table in Appendix D shows ratings evolution according to the Big Three Agencies.

their observed low debt-to-GDP ratios relative to the rest of the countries of the region in 2019. Mexico and Colombia tighter Fiscal Spaces are due to tighter fiscal limits and higher debt-to-GDP ratios. Notably, the methodology suggests that in 2019 Brazil already had a negative Fiscal Space, in contrast to the rest of the countries considered which received the shock with positive space.

Table 4: Fiscal Space (%) (Fiscal Limit (%))

	Peru			Chile		
	2019	**2020**	Δ	**2019**	**2020**	Δ
1%	83.82 (110.8)	49.89 (85.3)	-33.92 (-25.5)	67.87 (95.9)	45.43 (77.9)	-22.44 (-17.9)
5%	84.84 (111.8)	**50.64** (86.0)	-34.20 (-25.8)	69.07 (97.1)	**46.44** (78.9)	-22.62 (-18.1)
10%	85.45 (112.4)	51.06 (86.5)	-34.38 (-25.2)	69.71 (97.7)	47.02 (79.5)	-22.68 (-18.2)
25%	86.45 (113.4)	51.83 (87.2)	-34.62 (-26.5)	70.84 (98.8)	48.05 (80.5)	-22.79 (-18.3)
50%	87.63 (114.6)	52.73 (88.1)	-34.89 (-26.7)	72.18 (100.2)	49.29 (81.8)	-22.88 (-18.4)
75%	88.78 (115.8)	53.70 (89.1)	-35.08 (-26.8)	73.63 (101.6)	50.63 (83.1)	-22.99 (-18.5)
100%	92.95 (119.9)	57.44 (92.8)	-35.51 (-27.1)	79.94 (107.9)	55.92 (88.4)	-24.02 (-19.5)
	Mexico			**Colombia**		
	2019	**2020**	Δ	**2019**	**2020**	Δ
1%	38.17 (91.2)	21.10 (81.6)	-17.07 (-9.6)	19.2 (71.2)	-3.61 (59.4)	-22.81 (-11.81)
5%	39.10 (92.1)	**21.92** (82.4)	-17.17 (-9.6)	20.99 (72.9)	**-2.20** (60.8)	-23.19 (-12.2)
10%	39.62 (92.6)	22.39 (82.9)	-17.22 (-9.7)	22.09 (74.1)	-1.39 (61.6)	-23.48 (-12.5)
25%	40.53 (93.5)	23.16 (83.7)	-17.37 (-9.9)	23.84 (75.8)	-0.04 (63.0)	-23.79 (-12.8)
50%	41.61 (94.6)	24.12 (84.6)	-17.49 (-9.9)	25.75 (77.7)	1.75 (64.7)	-24.00 (-13.0)
75%	42.97 (95.9)	25.36 (85.9)	-17.60 (-10.4)	27.72 (79.7)	3.49 (66.5)	-24.24 (-13.2)
100%	50.82 (103.8)	32.12 (92.6)	-18.71 (-11.2)	34.85 (86.8)	10.17 (73.2)	-24.68 (-13.7)

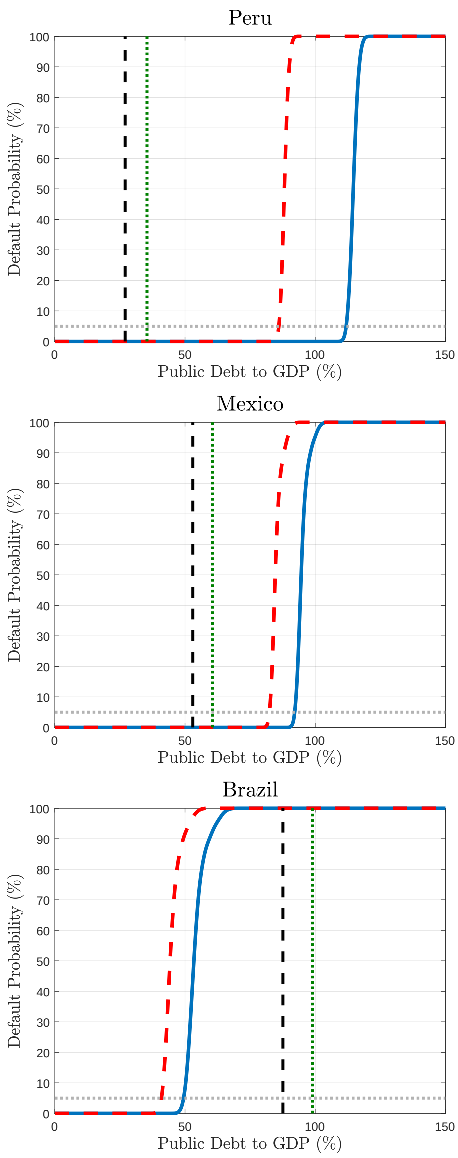
	Brazil		
	2019	**2020**	Δ
1%	-39.03 (47.9)	-59.20 (39.7)	-19.59 (-8.3)
5%	-38.33 (49.4)	**-57.95** (40.9)	-19.74 (-8.4)
10%	-37.36 (50.2)	-57.29 (41.6)	-19.88 (-8.5)
25%	-35.58 (51.7)	-56.10 (42.8)	-20.18 (-8.8)
50%	-34.48 (53.5)	-54.60 (44.3)	-20.47 (-9.2)
75%	-31.93 (55.6)	-52.68 (46.2)	-20.73 (-9.4)
100%	-19.05 (68.2)	-41.87 (57.0)	-22.47 (-11.2)

Note: The values reported outside the parenthesis refer to the fiscal space while those inside of the parenthesis are the estimated fiscal limit values given a default probability. The first column refers to the baseline scenario (2019), while the second column refers to the COVID-19 scenario (2020). The third column reports the difference between 2020 and 2019 (Δ).

The estimations of the Fiscal Limit Distribution and Fiscal Space of the COVID-19 scenario depicted in Figure 5 rise a paramount issue. Even though the pandemic shock was a global phenomenon, its macroeconomic effects diverged among countries and thus, its impacts on fiscal sustainability might importantly differ. Ultimately, this means that the set of policies and reforms each country needs to put in place, as well as any international financial assistance coming from multilateral institutions must be provided on a country-specific basis and after a thorough assessment of how the pandemic impacted their fiscal accounts.

Peru notably exemplifies this point. In 2019, it had the largest Fiscal Space and farthest Fiscal Limits, but its Fiscal Limit Distribution actually suffered the greatest contraction in 2020 due to the pandemic. This result is reasonable in view of the 11.1% output decline observed in 2020, the largest among chosen economies, and the considerable increase on its public expenditure as a share of GDP 7.3pp. We estimate that the Peruvian Fiscal Limit Distribution had a leftwards shift of -25.5pp (27.1pp) for a default probability of 1% (100%). Conversely, the Chilean economy had the mildest movement on its FDL, with a reduction of 18pp and 19.5pp for default probabilities of 1% and 100%, respectively. Chile had the second largest public expenditure expansion (8.2pp), but had a lower output drop than most of its peers in the region (-5.8%). Hence, in 2020 the magnitudes in which the FLD shrank for Mexico, Colombia and Brazil because of the pandemic lie somewhere between those of Peru and Chile.

Figure 5: Fiscal Limit Distributions for LATAM



Note: The dashed vertical black line refers to the General Government gross debt observed in 2019. The dotted vertical green line refers to the observed gross debt in 2020 (see, International Monetary Fund (2021b)). The solid blue line corresponds to the estimated Fiscal Limit Distribution of the baseline scenario. The red-dashed line refers to the estimated Fiscal Limit Distribution of the COVID-19 scenario. The horizontal gray-dotted line corresponds to a reference line which depicts the 5% probability of default.

Regarding Fiscal Space estimations, Peru and Chile remain ahead, in that order, despite their divergent results in terms of FDL's. However, Peru's FS is indeed distinctly shrunk, going from 84.84% in 2019 to 50.64% in 2020. Chile had also a significant reduction (22.62pp) of its FS, but ended up closer to Peru than before the COVID-19 since the margin with Peru went from -15.77pp in 2019 to only -4.20pp in 2020. Interestingly, the lowest impact on Fiscal Space was that of Mexico, with only a 17.2pp drop, preserving a smaller but positive Fiscal Space of 21.92%. During the pandemic, Mexico's government had a renowned scanty response of its public expenditure (only 0.06pp, which is 6.6 times smaller than the second lowest) to face the pandemic and a modest increase of its gross debt.

Perhaps the most striking result was observed for Colombia. As evidenced in Figure 5, Colombia was the only country whose Fiscal Space had a sign change among all the countries considered, albeit it did not have the greatest FS contraction. Hence, the latter is primarily a consequence of its already tight Fiscal Space in 2019 (second lowest) and its large expansion of public expenditure to attend the sanitary and economic crisis. Consequently, during 2020 the COVID-19 crisis sent Colombia to the group of economies that lack a positive FS of which Brazil was already a member. In fact, Brazil's fiscal sustainability remained fragile, despite it had the second lowest reduction of its FS.

These results are compared in Table 5 with previous estimates in Lozano-Espitia & Julio-Román (2020). Note that in spite of the different approach and time frame of our methodology, the estimated Fiscal Limits are reasonably similar. Greater differences can be seen in the estimated FS's, evidencing the heterogeneous effects of the COVID-19 shock, which our methodology is able to capture through its SDDL computations. A notable addition that can be easily spotted in the Table is that, contrary to Lozano-Espitia & Julio-Román (2020), this model is capable of estimating a FLD and FS's for Brazil.

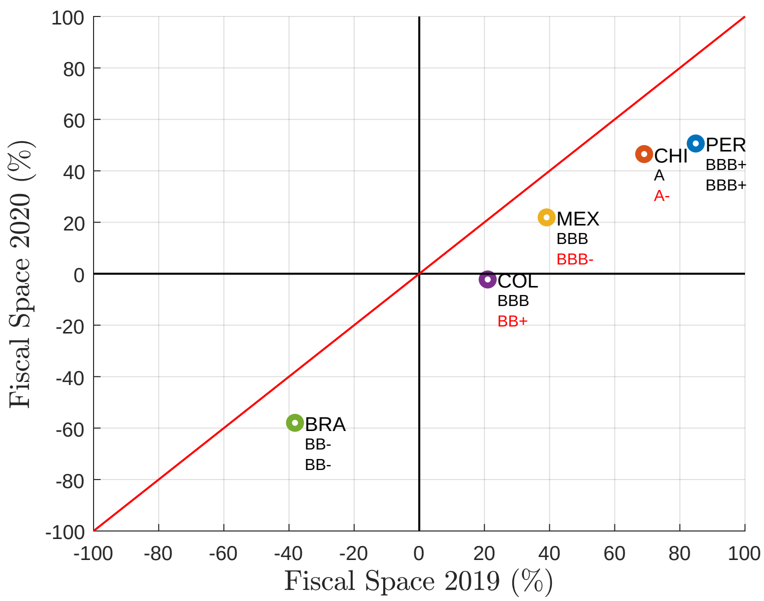
Table 5: LATAM Public Debt Limit Estimation in the recent literature

	MV-MA	**LE-JR**
Peru	50.6 (86.0)	49.9 (76.0)
Chile	46.4 (78.9)	39.4 (65.0)
Mexico	21.6 (82.4)	15.9 (69.5)
Colombia	-2.2 (60.8)	16.2 (68.4)
Brazil	-57.9 (40.9)	N.A. (N.A.)

Note: The values reported outside the parenthesis refer to the fiscal space while those inside of the parenthesis are the estimated fiscal limit. MV-MA refers to our estimations, while LE-JR refers to Lozano-Espitia & Julio-Román (2020). In MV-MA, the reported values correspond to the COVID-19 scenario with a 5% default probability.

Figure 6 summarizes the movements of FS among the pool of economies considered and compares them with changes in sovereign bonds ratings. The graph illustrates five key points that underpin the coherence of the results obtained by the model's estimations. First, COVID-19 contracted FS in every economy considered, given that all of them are located below the 45° line. Second, the ordinal analysis performed prior to the pandemic holds in 2020, even though changes in FS's were heterogeneous. Third, despite the important reduction of Peru's FS, the fact it still has the largest space could explain that it preserved its sovereign debt rating unchanged. The other country to retain its rating was Brazil, which according to our methodology already had a negative Fiscal Space prior to the pandemic, a result consistent with a sovereign debt rating below investment grade. Fourth, Mexico, Chile and Colombia all had changes in their sovereign ratings, but only the latter had both a sign change in its FS and clear reduction of its rating. Fifth, Brazil and Colombia are the only countries to finish 2020 with negative FS and sovereign ratings below investment grade.

Figure 6: Changes in Fiscal Spaces and in Sovereign Ratings



Note: The continuous red line is a 45° reference line. Each dot in the scatter-plot is a country, whose coordinates are given by its Fiscal Spaces in 2019 (x-axis) and 2020 (y-axis). Below each dot are the Sovereign ratings for 2019 (first line) and for 2020 (second line). The former, corresponds to the last observed rating by Fitch before the pandemics outbreak (2020Q1), while the latter corresponds to the up-to-date rating issued by Fitch (2021Q3). To the right of the vertical continuous black line are countries with positive FS in 2019 and above the vertical continuous black line the ones with positive FS in 2020. Only Colombia and Brazil feature negative FS's in the scenarios considered.

As a matter of fact, the weakness of Colombia's and Brazil's public finances, according to our methodology, sheds light on the extent to which the pandemic put pressure on fiscal balances, thereby increasing the perception of default risk on their public debt. Irrespective of the probable rise of tax bases along with economic recovery in 2021, to gradually regain positive Fiscal Spaces and markets' confidence in the years to come, Colombia and Brazil need to discuss and implement prompt and clear-cut structural fiscal reforms.

4 Concluding Remarks

Public debt sustainability and the broadness of Fiscal Space in various Latin American countries has been recently addressed in the literature Lozano-Espitia & Julio-Román (2020) finding great heterogeneity among them. Building on the work of Bi (2012); Hürtgen (2020), we provide new empirical estimates for the region that corroborate this result, but offer new insights by considering a DSGE model with several novel features. First, contrary to the commitment widely assumed in fiscal sustainability literature, government can default on its debt and make that choice on the intensive margin facing a utility-based stochastic discount factor. In turn, this provides a distribution of public debt limits for several default probabilities rather than the usual point estimate. Third, it includes explosive public transfers as a potential source of fiscal insolvency for LATAM countries (See Flamini et al. (2018)). Fourth, the calculations are particularly stringent, by virtue of assuming that tax rates are always at the peak of the Dynamic Laffer Curves. Fifth, a salient aspect of the model is that it takes into account the influence of the initial state of the economy in debt limits calculations.

Using this framework we find Peru, Chile, Mexico and Colombia all had positive Fiscal Spaces in 2019 (ranked in that order) and only Brazil already had a negative one. These results are mostly consistent with sovereign debt ratings: only Brazil was below investment grade, and Peru and Chile had higher ratings. Although these estimates expand the existing empirical fiscal literature for LATAM, the State-Dependent nature of this method makes it ideal to assess the impact of COVID-19 on fiscal sustainability. In fact, we find that all the countries endured important contractions of their Fiscal Spaces during 2020. Interestingly enough, we see that only Peru and Brazil (largest and shortest Fiscal Spaces, respectively) have not suffered any change in their sovereign debt ratings or outlooks since the outbreak of the pandemic. In the case of Brazil, this might had to do with the fact that it was already below investment grade. Moreover, Colombia, the only country that lost its positive Fiscal Space in 2020, is the only one that has lost (in 2021) its investment grade so far. The fragility of public finances in Colombia and Brazil suggested by our estimates evidences their need of structural fiscal reforms in the short run. Mexico and Chile, the next in line to Colombia in 2020 eventually saw changes in their outlooks, and hence, must be observant of their fiscal performance as well.

In a sense, these results speak of the usefulness and pertinence of the methodology to understand the extent to which the pandemic affected fiscal sustainability in the region and identify in each country possible reform opportunities. Nevertheless, this evidence must be followed by a thorough analysis in each country, as there are various political and economic aspects out of the scope of our methodology, such as: SOE channels, commodities, informality and evasion, strategic default, or social unrest. Therefore, these limitations constitute intriguing possibilities for future research.

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Appendix

A Simulation

The simulation algorithm to compute the Fiscal Limit Distribution is the following:

1. Select an initial state of the economy from the triplet $(A_t, G_t, S_{Z,t})$
2. Simulate the exogenous processes $(A_t, G_t, S_{Z,t})$ following the decision rules described in Section 2, for $t = 1, ..., T$, being T long enough to compute the discounted expectations. In our case, we choose $T = 350$.
3. Compute the stochastic discount factor and the fiscal surpluses evaluated at the peak of the dynamic Laffer curve for every $t = 1, ..., T$.
4. Evaluate the discounted sum of future fiscal surpluses, $\mathbf{B}^* (A_t, G_t, S_{Z,t})$
5. Repeat steps 2-4 a big number of times ($N^{sims} = 10000$) in order to have sufficient draws to compute the Fiscal Limit Distribution.
6. Select a new initial state from the triplet $(A_t, G_t, S_{Z,t})$ and repeat steps 1-5.

B Data Sources

Table 6: Data and Sources

Variable	Symbols	Source
Working Hours	$\bar{L}$	Lozano-Espitia & Arias-Rodríguez (2020)
General Government Revenues, Transfers and Expenditure	$\bar{T}/Y$,$\bar{Z}/Y$,G/Y	IMF Government Finance Statistics (GFS) October release data according to the data availability (1995-2019). From this database: Transfers: Subsidies+Grants+Social Benefits+ Miscellaneus Other Expense. Expenditure: Expense net of Interest expenses and Transfers
Transfers Growth	μ^z	Average projected annual growth of the General Government transfers on the healthcare and pensional system between 2015 y 2065. Data from Flamini et al. (2018)
Productivity process	ρ^A,σ^A	Characterization of the constant prices GDP from the WEO release of October 2020 (1980-2019)
Expenditure process	ρ^G, σ^G	Characterization of the General Government primary expenditure from the October 2020 release of WEO (1980-2019) -
COVID-19 Scenario		
Drop in productivity	$A-\underline{A}$	Constant prices GDP variation between 2019-2020. Data from the WEO release of April 2021
Increase of emergency expenditure for the COVID19	$\bar{G}-G$	Fiscal Monitor: Database of Country Fiscal Measures in Response to the COVID-19 Pandemic. April 2021. Above the line measures. Additional spending or foregone revenues (% GDP)
General Government Gross Debt 2019	b^{2019}	WEO release of April 2021
General Government Gross Debt 2020	b^{2020}	WEO release of April 2021

C Projections of General Government transfers to households as share of GDP

Table 7: Projections of General Government social security transfers to households as share of GDP

	Brazil		**Chile**		**Colombia**		**Mexico**		**Peru**	
	2015	**2065**	**2015**	**2065**	**2015**	**2065**	**2015**	**2065**	**2015**	**2065**
Healthcare Transfers	4.6	12.0	4.1	4.8	5.5	14.3	3.3	8.7	1.0	2.9 -
Pensional System Transfers	11.2	29.5	3.8	9.5	5.1	3.0	1.7	1.8	3.1	7.7
Total	**15.8**	**41.5**	**7.9**	**14.3**	**10.6**	**17.3**	**5.0**	**10.5**	**4.1**	**10.6**

Source: Authors using information from Flamini et al. (2018)

D LATAM Ratings

Table 8: Ratings

Peru

Moody's			
Rating	Ch.	Watch	Effective
A3	U		07-14
Baa2	U		08-12
Baa3	U		12-09
Ba1	U	*+	09-09
Ba1	U		08-08
Ba2	U		07-07
Ba3	U	*+	03-07
Ba3			07-99

S&P			
Rating	Ch.	Watch	Effective
BBB+	U		08-13
BBB	U		08-11
BBB-	U		07-08
BB+	U		11-06
BB	U		06-04
BB-	D		11-00
BB	U		06-00
BB	D	*-	05-00
BB			12-97

Fitch			
Rating	Ch.	Watch	Effective
BBB+	U		10-13
BBB	U		11-11
BBB-	U		04-07
BB+	U		08-06
BB	U		11-04
BB-	D		04-01
BB	U	*+	11-00
BB-	D		09-00
BB			10-99

Chile

Moody's			
Rating	Ch.	Watch	Effective
A1	D		07-18
Aa3	U		06-10
A1	U		03-09
A2	U	*+	11-08
A2	U		07-06
Baa1	U	*+	03-06
Baa1			05-99

S&P			
Rating	Ch.	Watch	Effective
A	D		03-21
A+	D		07-17
AA-	U		12-12
A+	U		12-07
A	U		01-04
A-	U		01-95
BBB+	U		12-93
BBB			12-92

Fitch			
Rating	Ch.	Watch	Effective
A-	D		10-20
A	D		08-17
A+	U		02-11
A			12-05

Mexico

Moody's			
Rating	Ch.	Watch	Effective
Baa1	D		04-20
A3	U		02-14
Baa1	U		01-05
Baa2	U		02-02
Baa3	U		03-00
Ba1	U	*+	02-00
Ba1	U		08-99
Ba2	U	*+	06-99
Ba2	U		02-99
Ba2	D	*-	09-98
Ba2			02-91

S&P			
Rating	Ch.	Watch	Effective
BBB	D		03-20
BBB+	U		12-13
BBB	D		12-09
BBB+	U		10-07
BBB	U		01-05
BBB-	U		02-02
BB+	U		03-00
BB	D		02-95
BB+			07-92

Fitch			
Rating	Ch.	Watch	Effective
BBB-	D		04-20
BBB	D		06-19
BBB+	U		05-13
BBB	D		11-09
BBB+	U		09-07
BBB	U		12-05
BBB-	U		01-02
BB+	U		05-00
BB			08-95

Colombia

Moody's			
Rating	Ch.	Watch	Effective
Baa2	U		07-14
Baa3	U		05-11
Ba1	U		06-08
Ba2	D		08-99
Baa3	D	*-	09-98
Baa3	U		09-95
Ba1	U	*+	05-95
Ba1			08-93

S&P			
Rating	Ch	Watch	Effective
BB+	D		05-21
BBB-	D		12-17
BBB	U		04-13
BBB-	U		03-11
BB+	U		03-07
BB	D		05-00
BB+	D		09-99
BBB			06-93

Fitch			
Rating	Ch	Watch	Effective
BB+	D		07-21
BBB-	D		04-20
BBB	U		12-13
BBB-	U		06-11
BB+	U		06-07
BB	D		01-02
BB+	D		03-00
BBB-	D		09-99
BBB			08-94

Brazil

Moody's			
Rating	Ch.	Watch	Effective
Ba2	D		02-16
Baa3	D	*-	12-15
Baa3	D		08-15
Baa2	U		06-11
Baa3	U		09-09
Ba1	U	*+	07-09
Ba1	U		08-07
Ba2	U	*+	05-07
Ba2	U		08-06
Ba3	U	*+	08-06
Ba3	U		10-05
B1			09-04

S&P			
Rating	Ch.	Watch	Effective
BB-	D		01-18
BB	U		08-17
BB	D	*-	05-17
BB	D		02-16
BB+	D		09-15
BBB-	D		03-14
BBB	U		11-11
BBB-	U		04-08
BB+	U		05-07
BB	U		02-06
BB-	U		09-04
B+			07-02

Fitch			
Rating	Ch.	Watch	Effective
BB-	D		02-18
BB	D		05-16
BB+	D		12-15
BBB-	D		10-15
BBB	U		04-11
BBB-	U		05-08
BB+	U		05-07
BB	U		06-06
BB-			02-06

Source: Bloomberg.

Note: Ch. refers to the change in rating and/or watch (U: Up, D:Down). Watch corresponds to the prospective outlook of each economy (stable:, positive:*+, negative:*-). Effective refers to the date in which the rating becomes effective (Month-Year).


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