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Assessing public debt sustainability under COVID-19 uncertainty: Evidence from Côte d'Ivoire

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Abstract
This article investigates public debt sustainability, in the context of a novel exogenous shock, by proposing a realistic forecasting procedure. The procedure implies the combination of a Bayesian VAR model and a nonlinear fiscal reaction model to derive a large number of simulated public debt paths and construct a probabilistic debt sustainability indicator. Annual data covering the period from 1970 to 2019 are used in the African context, with Côte d'Ivoire as a case study. Forecasts suggest low probabilities of non-increasing trend and well-contained upside risks (16%–27%) in Côte d'Ivoire for the forecasting period 2021–2024, regardless of the scenario underlying the evolution of COVID-19 and suggesting that the country remains vulnerable to debt distress risks. Government should promote a sound and reliable debt management system to mitigate such risks. Results also highlight the importance of domestic resources mobilization in reducing the country's fiscal vulnerability and building a sustainable post-COVID recovery.

KEYWORDS
Bayesian VAR, Côte d'Ivoire, COVID-19, debt distress risks, debt sustainability

1 | INTRODUCTION

The onset of the COVID-19 virus in 2020 affected all countries, millions of families and lives around the world. It led to a global pandemic which severely endangered the lives of billions of people. From a social and public health perspective, the total number of cases recorded is more than 500 million in the world, causing more than 6 million deaths and showing more than half a million daily new cases by end April 2022 (World Health Organization, 2022). In such a worrying situation, governments around the world have taken urgent measures to contain the health impact of the pandemic. These measures range from total or partial lockdowns, to travel restrictions, closing of non-essential businesses and financial assistance to households in some countries. This is not without consequences for other sectors. Estimates show that the global economy shrank by 3.3% in 2020, whereas it was estimated to grow at 6.1% in 2021 and projected to 3.6% in 2022 (International Monetary Fund, 2021, 2022).

In Africa, despite the relatively attenuated health effects of the pandemic, countries are not spared from considerable economic effects. Indeed, real GDP contracted by 2.1% in 2020, dropping by 5.2 percentage points from the January 2020 pre-COVID-19 projection. The GDP loss for African countries was estimated at between US$145.5 billion and US$189.7 billion in 2020 (African Development Bank, 2020, 2021). Moreover, the COVID-19 pandemic could create contractions in employment and consumption that would lead to an economic recession in Africa and widen both fiscal and current account deficits (Morsy et al., 2021). In Ethiopia, for example, the economic activity contraction was estimated at 14.3% loss in GDP (Aragie et al., 2021). Despite the significant improvement in the lives of people in Africa, the pandemic could push
about 39 million more Africans into extreme poverty in 2021 and 25–30 million jobs could be lost (African Development Bank, 2020). This unprecedented situation has severely affected many sectors, especially tourism, transport, education, international trade, and sovereign debt as well. Consequently, the continent is exposed to many risks such as an increase in sovereign debt burdens, a shrink in capital flows to African countries, with more risk-averse sentiments among investors.

In sub-Saharan Africa, where many developing and fragile countries are located, a health and economic emergency is an issue concentrating the focus of international development institutions and policymakers. Many measures were also implemented to contain the virus and spare the region from the worst of the crisis. Although vital in saving lives, these measures added to the global recession and had a dramatic impact on local economies, prompting sub-Saharan African economies to shrink by an extraordinary 1.9% in 2020, the worst outcome on record (International Monetary Fund, 2021). The COVID-19 crisis has exacerbated the pressure on the region’s development financing challenges, in particular public finances have become more strained and sovereign debt is heading to unsustainable levels. However, despite the uncertainty surrounding the evolution of the pandemic, better prospects were foreseen for the global economy in 2021 and forward, thanks to the discovery of vaccines, and the various actions taken by countries and development partners to bring their economies back to the pre-COVID level. Hence, Africa was projected to recover in 2021 by a 3.4% growth, from its worst economic recession in half a century (African Development Bank, 2022), thanks to resumption of tourism and a rebound in commodity prices among others.

Despite the hope for a quick recovery in the global economy, it should be noted that macroeconomic fundamentals have weakened as a result of the pandemic. A critical concern of such macroeconomic fundamentals is sovereign debt management in countries, especially those with low income and in fragile situations. Going back to the past, the issue of sovereign or public debt started in the 1970s, when the politico-economic principles had been largely dominated by the Keynesian approach according to which governments must play an active role in stabilizing market economies (Greiner & Fincke, 2015). The role of the government includes the use of public expenditures in order to raise aggregate demand, with the spending being financed by public deficits. In particular, in times of low aggregate demand and high unemployment the government must become active in order to restore the full employment equilibrium. As a consequence, public debt rose considerably.

Côte d’Ivoire, since the early 1980s, has suffered from a lasting economic and financial crisis, leading to a wide range of reforms. These reforms were organized within successive structural adjustment programmes (SAP), supported by the French International Cooperation Agency, the International Monetary Fund and the World Bank. A critical component of these programmes was fiscal adjustments, this being justified by the country’s membership to a monetary union which weakens the traditional monetary policy instruments, such as interest rate, foreign exchange and broad money and so forth (Kouassy & Bohoun, 1993). This underscores the importance of the fiscal policy in this country where the public debt ratio rose from 32.6% in 2012 to 41.2% in 2019. In 2020 the ratio was projected at 45.7% (International Monetary Fund, 2021).

Given the critical concerns about the potential economic impact of the exogenous COVID-19 shock on sovereign debt management specifically, the objective of this article is to propose an alternative to the traditional debt sustainability analysis (DSA). It aims at assessing the public debt dynamics, using Côte d’Ivoire as a case study, during a non-historical exogenous shock such as the COVID-19 pandemic and the considerable uncertainty around it. We try to respond to the following question: how reliably forecasts of a country’s public debt dynamics can be performed amid the uncertainty induced by a novel exogenous shock such as COVID-19? In addition, the article will undertake to derive a debt sustainability indicator to assess the level of vulnerability of a country’s fiscal stance, by using a probabilistic approach.

The rest of the article is structured as follows. The next section discusses theoretical and empirical aspects of public debt sustainability. In Section 3, the modelling framework used in the study is presented and some conceptual aspects discussed. The following section is devoted to key findings of the study. The article concludes with some discussions and recommendations about the implications derived from the findings as well as opportunities for future research.
where $d$ is public debt, $g$ is economic growth rate, $p$ is primary surplus to GDP ratio, and $r$ the weighted average of real interest rates on domestic and external debts. From this standard debt arithmetic, it is easy to see that the public debt ratio increases when the real effective interest rate on government debt exceeds the growth rate of GDP, or in other words when the growth-adjusted real effective interest rate is positive, unless there is a sufficient amount of primary surplus. The positive growth-adjusted real effective interest rate rules out Ponzi financing—that is, a process where interest on outstanding debt is paid with new debt, since this would lead to debt explosion. On the other hand, when the growth rate exceeds the real effective interest rate, public debt ratio could be stable or declining even when the primary budget is in deficit and debt is incurred not only to meet interest payments but also primary deficits (Akyüz, 2007).

When public debt rises in an economy, the government must increase future primary surpluses in order to fulfill its intertemporal budget constraint unless it accepts the possibility of default, which is not a good option as a government’s default usually has undesirable effects on its ability to get new borrowing in the future at advantageous costs and on its credibility as well. Higher primary surpluses can be achieved by raising taxes, by reducing public spending or by a rise in GDP that leads to more tax revenues where, of course, a combination of all three measures can be considered too. Another possibility, that arises in monetary economics, is that the central bank raises the money supply and accepts a higher inflation rate such that the real value of public debt declines. In the extreme case when the inflation rate exceeds the interest rate on public debt, the real interest rate becomes negative, leading to a decline in the public debt to GDP ratio.

In monetary economy, it is also possible to distinguish between Ricardian and non-Ricardian regimes with relation to the fiscal theory of price level. According to that theory, the intertemporal budget constraint of the government must hold for some paths of the price level but not for all, in contrast to the budget constraint of private agents. If the government’s intertemporal budget constraint does not hold for any path of the price level, the government follows a non-Ricardian policy and its intertemporal budget constraint only holds in equilibrium. If the intertemporal budget constraint holds for any price path, and not only for the equilibrium price path, the government pursues a Ricardian fiscal policy. Thus, in a non-Ricardian regime, the government would not commit itself in the future to completely match new public debt with future primary surpluses, because some part of the additional debt is to be financed through money creation. In a Ricardian regime, the opposite holds true and future fiscal revenues are expected to be equal to current public debt. However, the fiscal theory of price level is controversial and has been criticized, for example in the contribution by Buitter (2002).

The research analyzing how public debt affects economies has had a long tradition. In the nineteenth century David Ricardo set up the Ricardian equivalence theorem, according to which budget deficits today require higher taxes in future when a government cuts taxes without changing present or future public spending. Given that households are forward looking they will realize that they have to pay higher taxes in the future so that their total tax burden remains unchanged. As a consequence, households will reduce their consumption and increase savings in order to meet the future tax burden. The Ricardian equivalence theorem is based on the government’s intertemporal budget constraint and the permanent income hypothesis. The first principle states that public debt must be sustainable in the sense that outstanding debt today must be equal to the present value of future primary surpluses. The second principle states that households do not base their consumption on current income but on permanent income so that they will not raise consumption as long as their income increases only temporarily. The Ricardian equivalence theorem is intuitively plausible but rests on assumptions that may be difficult to find in real world economies, such as the absence of distortionary taxation or the non-consideration of economic growth.

In the current COVID-19 context and its socioeconomic implications for countries, the issue of public debt sustainability is more than ever of concern. Governments are facing unexpected spending pressures in their effort to respond to the pandemic, including health costs, and social and economic stimulus efforts. Public debt is subject to unforeseen increases in countries where in some cases there is no more space for borrowing. There are two issues arising in this context. First, rates on sovereign bonds are set by the interplay of supply and demand on the securities markets, reflecting investor confidence in a government’s signature. For instance, while 10-year rates in France were around 0 on 15 April 2020, those in Italy stood at around 1.6% the same day, after having reached 2.5% in mid-March, when it became clear that the coronavirus crisis was going to have a substantial impact on public finances, and when the Central Bank did not seem prepared to take any major action to reduce sovereign spreads between euro area member countries (Arquie et al., 2020). For Italy, the equation became even more complicated, as the country’s growth rate had been very low for more than a decade, probably around 0.5% over the long term. It raises the question of explosive debt dynamics, fuelled by new debt flows in excess of the increase in the country’s productive capacity.
Moreover, even in the absence of explosive debt dynamics, the size of the stock of public debt may in itself be problematic for its sustainability. Financial markets may lose confidence in the capacity of public authorities to repay it. It is important to understand that, for the same stock of debt relative to GDP, several situations may arise in which the debt will be considered sustainable or not. These situations are referred to as multiple equilibria. It has been investigated in various analyses. One of the best-known related works is that of Diamond and Dybvig (1983) on bank panics, during which expectations of bank failures lead economic agents to run to their banks to withdraw their funds, ultimately leading to bankruptcies, even though without these massive withdrawals these bankruptcies would not have occurred.

Recently, Lorenzoni and Werning (2019) produced a similar analysis in the case of government debt. At given fiscal policies and prices of government securities, investors form expectations about the probability of a future government default on its debt. These expectations lead investors to predict a future path for government debt, and thus affect future default probabilities, which are reflected in the prices of the securities and, therefore, in the interest rates paid on them. This latter circular mechanism between interest rates and debt accumulation makes the existence of several equilibria possible. Their approach emphasizes two particularly relevant aspects. First, when a crisis occurs, interest rates rise as a result of future default probabilities, but the crisis process may take some time before the actual default occurs. Moreover, the self-fulfilling nature of crises is purely transitory. If the economy remains on the path leading to a crisis for too long, the debt eventually reaches such a level that a return to desirable path is no longer possible. Thus, although initially triggered by self-fulfilling pessimism, the crisis eventually damages the fundamentals of the economy.

This type of analysis highlights the risk faced by a large number of countries that were already burdened with substantial debt stocks before the crisis, and that will see these stocks increase significantly. Economic history teaches us in this respect that public debts tend to increase very rapidly after economic crises. Reinhart and Rogoff (2009) reported an increase of 86% on average in the three years following a banking crisis. Thus, financing increase in public debt caused by a health crisis cannot be achieved by simply issuing securities on financial markets without risking a number of countries being exposed to a new sovereign debt crisis. Faced with a potential wave of sovereign debt defaults, the Group of 20 (G20) members and the Paris Club responded with the Debt Service Suspension Initiative (DSSI), the International Monetary Fund increased lending to poorest countries and the World Bank as well as regional and national development banks provided greater financial resources to developing economies. Although providing vital liquidity, these measures may not prevent all countries from entering into debt distress, particularly those with pre-existing debt vulnerabilities (United Nations, 2020).

Alternatives to public financing through debt are then pointed out in any policy discussion around post-COVID recovery. Indeed, the scale of public expenditures to be incurred in the COVID-19 health crisis is raising heated debates about the appropriate funding. Along these lines, Arquié et al. (2020) highlighted the rehabilitation of money printing as an alternative to public financing. They discussed some theoretical insights into the debate opposing monetization and issuance of additional public debt. They clarified what is happening to current debt and how its sustainability can be assessed, and then examined how current mainstream macroeconomics can be used to rehabilitate the use of monetization of public spending. They also draw attention to the particular democratic challenges implied by such a policy in the euro area context, in terms of balance of powers between European institutions. Another area, largely discussed in public debates is the Domestic Resources Mobilization (DRM) as an underused instrument to build recovery from the pandemic and the road to a sustainable development, especially in low- and middle-income countries.

DRM refers to the generation of savings from domestic resources and their allocation to socially productive investments (Culpeper, 2008). In low-income countries in particular, where social and investment needs are immense, mobilizing domestic resources is particularly challenging, leading them to rely on foreign aid, foreign direct investment, export earnings and other external resources. However, DRM is critical to the long-term sustainability of development efforts (e.g. achievement of the Sustainable Development Goals that cannot be financed only by foreign aid). As a result, DRM is a critical ‘anchor’ for country-led development strategies. Without a substantial effort on DRM, aid, trade and FDI may push developing countries in directions not necessarily consistent with their development priorities. This is particularly compelling with the current health crisis, which puts additional pressure on public finances as a result of large-scale expenditure programmes and tax relief measures adopted as responses to the pandemic and recovery, and at the same time reduces considerably the availability of foreign aid. Thus, leveraging on DRM to ensure post-COVID recovery could be given much more emphasis because it has the capacity to reduce developing countries’ fiscal vulnerability.
2.2 Empirical review

In the public debt context, sustainability is defined in tandem with the notion of solvency. In other words, a government’s fiscal position is considered sustainable when the government is solvent. To be deemed solvent, a government must be expected to honour current and future financial obligations, including implicit commitment to continue providing certain public goods, services and transfers in the future (Debrun et al., 2006). Solvency thus implies that the present value of government’s disbursements (including inherited debt amortization, interest payments and non-interest expenditures) should not exceed the present value of revenues, or equivalently that the present value of future revenues net of non-interest spending (primary balance) should at least cover the existing public debt. The intertemporal budget constraint and the relationship between primary balance and public debt have therefore been at the centre of the literature on debt sustainability.

In practice, the notion of sustainability is less straightforward. First, at a conceptual level, it always implies a judgement as to what constitutes an acceptable strategy for the government to ultimately satisfy its intertemporal budget constraint (Mendoza & Oviedo, 2004). By definition, solvency excludes outright default or forced restructuring. Most analysts would also exclude inflation tax from the set of acceptable strategies, limiting the latter to adjustments in the primary balance. Hence, solvency is only a necessary condition for sustainability, and defining sufficient conditions involves judgement. Second, at a technical level, the forward-looking nature of solvency makes it difficult to assess. No one knows for sure the primary surplus a government will be able (or willing) to generate in 5, 10 or 20 years, nor the future path of interest rates, inflation and productivity growth over that period. Without taking into account uncertainty, assessing solvency would be just an arithmetical exercise. In reality, however, it requires making judgements under uncertainty, as well as the recognition that such judgements are subject to risk.

In recent years, the IMF has developed an approach to debt sustainability analysis (DSA) that is used in surveillance and lending decisions. DSA helps the IMF and policymakers assess the risks associated with short-run macroeconomic forecasts and the policies on which such forecasts are based. The IMF’s assessment relies on medium-term simulations of the debt-to-GDP ratio given specific macroeconomic forecasts and fiscal policy assumptions. Without reliable sustainability thresholds’, however, such estimates per se do not allow one to determine the sustainability of a particular public debt position. Instead, the expected dynamics of the debt-to-GDP ratio over the medium term are interpreted as a signal as to whether underlying policies can be sustained under plausible macroeconomic conditions without endangering solvency. Specifically, a declining trend in the debt ratio signals that government policies are unlikely to jeopardize sustainability, whereas a positive trend or even stabilization at a high level may motivate concerns, especially if other factors, such as fiscal adjustment required to stabilize or reduce debt ratio, likely point to difficulties in keeping debt under control.

Uncertainty about future macroeconomic conditions and fiscal policy inevitably weakens the basis for drawing compelling policy conclusions using such analyses. In fact, standard DSA does recognize the importance of uncertainty, with risks to baseline debt projection appraised through simulating alternative debt paths under less favourable conditions: the ‘bound tests’. This approach to risk assessment is entirely deterministic, however, involving a set of scenarios in which one key variable at a time is hit by an adverse shock, including lower growth, higher interest rates, lower primary balance and exogenous debt increases (such as those resulting from exchange rate depreciation or the recognition of off-budget obligations). The calibration of shocks generally uses a multiple or fraction of the unconditional variance of the underlying series. Although the bound tests approach gives a broad sense of the sensitivity of sustainability assessment to adverse developments, significant methodological limitations undermine its credibility and operational relevance (Debrun et al., 2006). First, both the correlations among shocks and joint dynamic responses of relevant variables are ignored. Indeed, simulated deterministic disturbances can realistically be of only two types: large and transitory, or small and permanent. Second, fiscal policy is assumed not to react to the simulated economic developments, as if a deterministic policy process could reasonably prevail in an intrinsically stochastic environment. Third, in an uncertain world, each individual bound test formally has a near-zero probability of occurrence, making any meaningful quantification of risk impossible.

In order to address the second limitation, which ignores fiscal reaction to economic development, the International Monetary Fund focuses on determining debt thresholds beyond which sustainability could be considered at risk given average fiscal behaviour (International Monetary Fund, 2003). The same study introduces the concept of ‘over-borrowing’, defined as the excess of current public debt over the annuity value of future primary surpluses. Using an expanded version of the dataset in that IMF’s study, Abiad and Ostry (2005) refined the estimation of fiscal reaction functions (including a set of political and institutional variables) and determinants of overborrowing as well. They
calculated the impact of a variety of fiscal and institutional reforms on sustainable debt levels. Other studies have also applied stochastic simulation methods to develop a DSA framework that generates probability measures taking into account interactions among key economic variables. The basic methodology entails applying Monte Carlo simulation methods to a macroeconomic model that captures interactions among key variables like output, interest rates, exchange rate and debt ratio. Simulations generate empirical probability distributions for variables, which enables the likelihood of a given outcome to be assessed. In particular, stochastic simulation methods can provide a measure of the risk that the debt burden rises significantly over the medium term, a key issue in assessing debt sustainability.

Different approaches have been taken to model the interactions among economic variables in stochastic simulation studies. Barnhill and Kopits (2003) applied the value-at-risk methodology to assess fiscal sustainability in a framework that takes into account covariance between risk variables. Some studies examined stochastic simulation experiments using a vector autoregression (VAR) that captures correlation between macro variables, but paid insufficient attention to constraints on the evolution of public debt created by an endogenous response of fiscal policy to debt shocks (Garcia & Rigobon, 2005; Penalver & Thwaites, 2004). Mendoza and Oviedo (2004) applied stochastic simulation methods in a dynamic general equilibrium modelling framework where movements between macro variables are determined by an explicit theoretical structure. In a normative vein, Tanner and Carey (2005) discussed potential fiscal objective functions that might apply in stochastic macroeconomics. Their value-at-risk objective function summarizes the maximum fiscal adjustment that a country is willing to incur in order to prevent further increases in debt, precisely the undesirable outcomes revealed by such stochastic simulations. More recent studies focused their attention on the bilateral relationship between debt and economic growth using the ARDL bound test or vector error correction model (Adamu & Rasiah, 2016; Owusu-Nantwi & Erickson, 2016).

In order to marry the approach to fiscal policy reaction functions from Abiad and Ostry and the stochastic analysis from Garcia and Rigobon, a new approach was proposed by Debrun et al. (2006) to improve understanding of risks surrounding debt dynamics, and explicitly acknowledges the inherently probabilistic nature of DSA exercises. They used a combination of VAR techniques to estimate joint dynamics of public debt's economic drivers, and panel estimation techniques for their fiscal reaction function. Their approach proposes a more nuanced and more credible assessment of long-term sustainability. However, in the COVID context, such approach may fail to account for the novelty and non-historic aspect of the shock. Recently, Primiceri and Tambalotti (2020) showed that it is possible to make some progress on the problem of predicting the economic effects of the COVID shock based on the historical dynamics of macroeconomic variables, without any behavioural assumptions. However, this progress requires unusually strong assumptions for the standards of reduced-form time series modelling. But since assumptions of more structural models are even stronger, their approach is considered a viable complement to other models. Their methodology is based on the idea of ‘synthesizing’ a coronavirus shock from the more typical disturbances that have historically driven macroeconomic fluctuations.

This article will use the same insight to contextualize the approach proposed by Debrun et al. and derive a reliable procedure for debt sustainability analysis under uncertainty surrounding COVID-19 economic effects. More interestingly, by explicitly incorporating the reaction of public authorities in the debt dynamics assessment, this allows the appraisal of some policy measures’ effects on public debt dynamics and some policy formulation. For instance, with regard to countries’ post-COVID recovery, it is possible to access how a certain primary balance path adopted by public authorities can contribute to reducing risks to fiscal vulnerability; or evaluate the effects of a success in DRM through taxation, on fiscal sustainability improvement.

3 | OVERVIEW OF THE SIMULATED PROBABILITY DISTRIBUTION FRAMEWORK

To investigate public debt sustainability under the uncertainty induced by a non-historical exogenous shock, especially the COVID-19 pandemic, a combination of two econometric models is used. More precisely, a modified version of the approach developed by Debrun et al. (2006) is adopted. In their approach, they proposed a probabilistic approach to public DSA using ‘fan charts’. The model consists of three building blocks: an economic block, a fiscal block, and finally a debt dynamics block. The combination of these three blocks allows to derive an arbitrarily large number of debt paths corresponding to different shock constellations.
3.1 Economic block

The first block of our model estimates the joint distribution of shocks calibrated to fit statistical properties of historical data. These properties are captured in a VAR model that (i) describes joint movements among determinants of debt dynamics (GDP growth, interest rate and exchange rate); (ii) provides estimates of conditional variances and covariance of shocks; and (iii) generates a consistent set of projections for the determinants of debt dynamics. However, this VAR model differs from the classical one used by Debrun et al., to account for the unprecedented effects of COVID-19. Basically, the Bayesian hierarchical modelling approach to VAR models (Giannone et al., 2015), adapted by Primiceri and Tambalotti (2020) is used to account for the economic impact of the pandemic. It is used to derive economic variables projections under high COVID uncertainty.

The advantage of using such an approach is threefold: (i) shock constellations needed for the probabilistic sustainability indicator are endogenously produced by the model, unlike in Debrun et al. where shocks are simulated exogenously; (ii) Bayesian VARs allow for overcoming the curse of dimensionality issue usually faced with classical estimation methods. This aspect is particularly relevant with regard to the data availability problems that have to be addressed in the context of the study; and (iii) a COVID shock is explicitly incorporated giving a way to simulate it automatically from the model.

Consider the following two equations, describing the dynamics of a $n \times 1$ vector of macroeconomic variables $y_t$:

$$y_t = G(L)z_t,$$

$$z_t = F(L)e_t.$$  

(1)

(2)

The first expression relates the evolution of $y_t = (r_t^f, g_t, z_t)$ to a vector of exogenous variables $z_t$ and their lags. $r_t^f$ denotes real foreign interest rate, $g$ real GDP growth rate, and $z$ real exchange rate (in log). The second equation expresses $z_t$ as a moving average of a $n \times 1$ vector of shocks $e_t$, whose covariance matrix is normalized to $I_n$. The vector $e_t$ contains a set of orthogonal structural disturbances with an economic interpretation: they might represent taste, technology and policy shocks. Both $G(L) = G_0 + \sum_{i=0}^{\infty} G_i L^i$ and $F(L) = I_n + \sum_{i=0}^{\infty} F_i L^i$ are lag polynomial matrices of suitable dimensions and of potentially infinite order. Dynamics induced by $G(L)$ and $F(L)$ are referred to as internal (endogenous) and external (exogenous) propagation of $e_t$. In this exercise, $y_t$ and $z_t$ are assumed to have the same dimension because empirical estimates will be based on a VAR with the same number of shocks and observables. For the same reason, it is assumed that $G(L)$ and $F(L)$ imply a fundamental representation of $y_t$ as a moving average of $e_t$. Under these assumptions, combining (1) and (2) yields the Wold representation:

$$y_t = \Theta(L)G_0 e_t,$$

(3)

where $u_t \equiv G_0 e_t$ is the vector of forecast errors and $\Theta(L) \equiv G(L)F(L)G_0^{-1}$, with $\Theta_0 = I_n$. According to (3), the effect of $e_t$ on $y_{t+h}$ is given by $\Theta_h G_0$. Therefore, we must know $\Theta_h$ and $G_0$ to infer the dynamic impact of a structural shock on endogenous variables. Coefficients $\Theta_h$ can typically be estimated from data. In contrast, identification of $G_0$ requires additional assumptions, since data are only informative about the covariance matrix of forecast errors, $G_0 G_0^t$, but not about the impact matrix $G_0$. Therefore, inference about dynamic effects of any structural shock requires disentangling its impact on endogenous variables from that of other disturbances. In general, producing credible restrictions that yield the desired interpretation of (some of) elements of $e_t$ is among the most controversial steps in time-series analysis which is the well-known identification problem in structural VAR models.

Adapting this original Bayesian VAR to the COVID-19 situation, the problem is opposite as mentioned by Primiceri and Tambalotti. On one hand, the pandemic’s short-term impact is straightforward to identify because the COVID shock is the overwhelming source of variation in data around the time of the outbreak. Most standard macroeconomic variables have undergone record changes in 2020, which are clearly attributable to the effects of the virus and related shut-downs. These effects are easy to disentangle from those of other disturbances, since the latter are at least an order of magnitude smaller. On the other hand, the historical novelty of the COVID pandemic makes it difficult to estimate its future propagation from historical data, knowing that it depends on the pandemic’s path itself. As a consequence, producing reasonable macroeconomic forecasts with time-series tools requires making some unusually strong assumptions as is the case in this article.

Equation (3) is then modified to account for the effects of the pandemic by including a virus shock $v_t$ as follows:
where the symbol $\circ$ denotes the element-wise product of two vectors, $\vartheta(L) \equiv \Theta(L)G_0e_t + \vartheta(L)r(L) \circ n_0v_t$, \( (4) \)

Assumption 1. $v_t$ accounts for all unanticipated variations of the system starting at the outbreak year. In the case of monthly data analysis, since the COVID shock would have been observed throughout the years 2020 and 2021, $v_t$ may account for $y_{t^*}, y_{t^*+1}, ..., y_{t^*+j^*}$, where $t^* + j^*$ is the last period for which $y_t$ is observable.

Assumption 2. $\vartheta(L) = \Theta(L)$.

If $r(L)$ was a lag polynomial of order zero, the shock $v_t$ would propagate like the specific combination of structural disturbances $\varepsilon_t$ that produces the same forecast error for the observables.

A critical issue implied by this procedure is the estimation of $r(L)$. As pointed out by Primiceri and Tambalotti, the data are not informative about $\{r_L\}_{j^*}$, the components of $r(L)$, which motivates the third assumption.

Assumption 3. $\{r_L\}_{j^*} = \{\hat{r}_L\}_{j^*}$, where $\{\hat{r}_L\}_{j^*}$ must be specified a priori.

$r(L)$ should be interpreted as capturing exogenous dynamics of forecast errors generated by the COVID shock, relative to those associated to forecast errors generated by standard macroeconomic shocks. This insight is useful to calibrate $\{r_L\}_{j^*}$ based on alternative pandemic scenarios. It should be noted that the ability to consider different scenarios about the unfolding of the pandemic represents an advantage of this approach. One important limitation is that it is implicitly assumed that agents form expectations about the future as if the external propagation of COVID shock were similar to that of standard forecast errors. Sizable deviations from this benchmark, as captured by the complexity of the lag polynomial $r(L)$, would violate the Lucas critique. In this respect, the approach is similar to the analysis of ‘modest policy interventions’, which is defined as having a modest impact on agents’ beliefs about the prevalence of a certain policy regime. Another note of caution concerns the linearity assumption for the model which can be seen as more problematic now than in normal times, given the exceptionally large macroeconomic volatility induced by the COVID shock, relative to historical standards.

3.2 Fiscal block

The second block characterizes fiscal behaviour through an explicit fiscal reaction function which has been received more attention in economics literature since its testing approach proposed by Bohn (1995). It is suggested to test whether the primary surplus to GDP ratio is a positive function of the debt to GDP ratio. If that property holds, a given public debt policy can be shown to be sustainable. The test is plausible because it has a nice economic intuition: if governments run into debt today they have to take corrective actions in the future by increasing the primary surplus. Otherwise, public debt will not be sustainable. Statistically, a rise in primary surpluses as a response to higher government debt implies that the series of public debt to GDP should become a mean-reverting process. This holds true as higher debt ratios lead to an increase in primary surplus ratios, making the debt ratio decline and return to its mean. However, mean-reversion only holds if the reaction coefficient, determining how strongly primary surplus reacts as public debt rises, is sufficiently large, as shown by Greiner and Fincke (2015).

To estimate the fiscal reaction function, the specification differs from the model used by Debrun et al. in their algorithm. The difference comes from the belief that the strength of primary surplus reaction to changes in public debt ratio has varied over the period under study. Hence, the model proposed by Greiner and Fincke which incorporates such belief is used. It is assumed that the government chooses a primary surplus to GDP ratio, $s(t) = S(t)/Y(t)$, such that it is a positive linear function of the debt to GDP ratio, $b(t) = B(t)/Y(t)$, and a term that is independent of public debt, $D(t)$ (Bohn, 1995, 1998; Canzoneri et al., 2001; Greiner, 2008).
The primary surplus ratio, then, can be written as:

\[ s(t) = \psi(t)b(t) + \phi(t), \]  

(5)

where \( \psi(t) \) is a time-varying coefficient determining how strong primary surplus reacts to changes in public debt ratio. It is worth noting that non-linear models can be approximated by a linear model with time-varying coefficients. In particular, the approximation is good if the parameter changes smoothly. The term \( \phi(t) \) is assumed to be time dependent and influenced by other economic variables, such as social spending or transitory government expenditures in general. It should be noted also that government can influence \( \phi(t) \) to a certain degree only because it is also affected by the business cycle, for instance, that can affect temporary government spending.

From Equation (5), the following function is derived for estimation:

\[ s(t) = \psi(t)b(t) + \phi^TZ(t) + \epsilon(t), \]  

(6)

with \( s(t) \) the primary surplus to GDP ratio at time \( t \) and \( b(t) \) the public debt to GDP ratio. Other variables that influence primary surplus ratio are included in the vector \( Z(t) \). It contains 1 in its first element, yielding the intercept, and further variables in its other elements. The term \( \epsilon(t) \) represents an error term, that is assumed to be independent and identically distributed following \( N(0, \sigma^2) \).

Variables included in \( Z(t) \) are motivated by the tax smoothing hypothesis on one side, and on the other side by findings from Kouassy and Bohoun (1993) regarding factors determining fiscal deficit and fiscal adjustment in Côte d’Ivoire, as well as findings from Debrun et al. Regarding the former, public deficits should be used such that tax rates remain constant in order to minimize the excess burden of taxation. Thus, regular expenditures should be paid for by ordinary revenues. Unexpected spending should be financed by public deficits. A business cycle variable is also included, the output gap denoted \( Y_{\text{Gap}}(t) \), to account for fluctuations in GDP. It is calculated by subtracting the long-term trend of GDP from its realized values, applying the Hodrick-Prescott filter to real GDP series. Moreover, deviations of real public expenditures from their long-run trend affect the primary surplus ratio too. Like for the business cycle variable, fluctuations of public expenditures around their trend \( G_{\text{Gap}}(t) \) are used. It is computed the same way by applying the Hodrick-Prescott filter.

To estimate Equation (6), \( b(t) \) is substituted by its lagged debt ratio \( b(t-1) \) since budget plans are usually made one fiscal year ahead. Thus potential endogeneity problem induced by \( b(t) \) is taken into account. Hence, (6) can be rewritten as:

\[ s_t = \phi_0 + t + t^2 + s_{t-2} + \psi_1 b_{t-1} + \phi D_{t-1}(b_{t-1} - 50) + \phi^T Z_t + \epsilon_t, \]  

(7)

where \( \phi^T Z(t) = (G_{\text{Gap}}, Y_{\text{Gap}}, G_{\text{c}}, \epsilon) \) with \( G_{\text{c}} \) being the public consumption spending to GDP ratio and \( \epsilon \) is the effective tax rate, measured as total tax revenue to GDP ratio. To estimate the model, penalized spline estimation (Hastie & Tibshirani, 1990; Ruppert et al., 2003; Wood, 2000) is used. It is more flexible than OLS estimation and allows for time-varying coefficients. Thus, the reaction coefficient \( \psi \) in Equation (7) can be estimated as a function of time and used to show the coefficient’s evolution over time: an important assumption in this article.

Allowing for endogenous fiscal policy improves the risk analysis by taking into account plausible policy responses of primary balance to economic shocks and public debt developments.

### 3.3 Debt dynamics block

The third block combines simulated economic scenarios (first block) with estimated fiscal policy response (second block) to produce annual public debt paths. Hence, the latter not only reflect plausible constellations of shocks, but also consistent projections for growth, interest rates, exchange rates and fiscal policy. From simulation results provided by the Bayesian VAR and those of estimated policy responses, a large sample of public debt projections is obtained for each year of the forecasting horizon. Public debt projections are obtained through the following conventional stock-flow identity:

\[ b_t \equiv (1 + g_t)^{-1}[1 + n_t(1 + \Delta z_t)b_{t-1}] - s_t + p_t, \]  

(8)
where $p_t$ represents stock-flow adjustments, for instance due to the recognition of contingent liabilities or the realization of assets.

Corresponding frequency distributions yield a probabilistic assessment of debt dynamics. Specifically, ‘fan charts’ are used to depict confidence bands for varying degrees of uncertainty around the median projection. It has the value added of helping refine the usual debt sustainability assessments, based solely on trends projections.

Once forecast density distributions are obtained through Equation (8), the sustainability indicator proposed by Debrun et al. (2006) is used to assess the level of vulnerability of public debt. Indeed, by getting a probability distribution for debt dynamics, it is now possible to quantify the probability of debt reaching or exceeding a certain level. A policymaker is likely to be interested in whether the country’s debt profile/distribution is a problem or not. One note of caution when using it is that it should be recognized that what is an acceptable risk for one policymaker may be an unacceptable risk for another; risk aversion being subjective rather than something objectively justified.

The sustainability indicator is defined as follows:

$$d_{si} = \Pr(b_{t+\tau} < b_t)^*[1 - \Pr(b_{t+\tau} > (b_t + x))],$$

where $x$ is a positive mark-up over the initial public debt $b_t$. The value of the sustainability indicator increases with the likelihood of desirable outcomes, that is, a non-increasing trend and well-contained upside risks. That value has no intrinsic meaning; it is up to the policymaker to set a critical threshold below which the debt situation would be a cause for concern. Such a threshold essentially depends on the degree of risk aversion and on the perceived need for reduction in debt. These factors are reflected in the mark-up $x$, the level of upside risk deemed acceptable (i.e., how small should $\Pr(b_{t+\tau} > (b_t + x))$ be in order to consider upside risks as well contained), and the desired probability that debt declines in future. The sustainability indicator is the product of two probabilities—the probability of a declining debt ratio and the probability that the debt ratio will not rise by more than the mark-up. Once these probabilities are set, a critical threshold is established. The policymaker can then focus on problematic cases where the indicator’s value falls below the threshold and not worry the rest of the time.

### 4 | APPLICATION TO DEBT SUSTAINABILITY ANALYSIS IN CÔTE D’IVOIRE

#### 4.1 | Country description and data

Côte d’Ivoire is one of the member countries of the West African Economic and Monetary Union (WAEMU), an organization that includes eight states that share a common currency (the CFA franc). After two decades of good economic performance between 1960 and 1980, Côte d’Ivoire entered a long period of economic crisis. Domestic adjustment strategies pursued during the 1980s failed to boost economic activity or minimize deficits (Keho, 2010). As a necessary response to the failure of macroeconomic policies, the country—together with other members—devalued their currency in 1994. This devaluation accompanied by structural reforms led to an encouraging economic recovery and performance was strengthened significantly after 1994 when budget deficits also reduced. Sadly, in 1999, political instability rocked the country and this has since created political and social tensions. The crisis was further complicated by a war beginning on 19 September 2002 which divided the country in two. Since 2004, however, the war officially ceased, with the main players working to find political stability. The presidential election initially scheduled for October 2005 was postponed until 2011, after which a second wave of political instability darkened the Ivorian economic landscape.

Ten years after such a tragedy, the new Ivorian public authorities continue working to restore the social cohesion and put the country back on the path of an emerging country. This was the prevailing context at the start of the COVID-19 pandemic. According to International Monetary Fund (2020), public health risks, deterioration of global context and supply chain disruption will impact negatively the Ivorian economy. Following exceptional COVID-19 related spending in 2020, deficits were projected to return to the pre-crisis level once the crisis abates, providing the basis for the downward path of debt from 2021 onward. In that context, the present value of public debt in percentage of GDP would remain well below the benchmark of 55%. All external public debt burden indicators were assessed to remain below their thresholds, but as in the past, the debt service-to-revenue ratio remains close to its threshold over the medium term, underscoring the need to further boost DRM.
It should be pointed out that reduction in the present value of debt relative to previous DSA is largely driven by the recent rebasing of GDP despite larger borrowing needs. However, public debt in Côte d’Ivoire remains vulnerable to shocks, as expressed by the IMF’s evaluation team. The country’s public debt appears more vulnerable to shocks than assessed at the time of the December 2019 DSA. It is shown by the country’s reduced ability to absorb shocks. Under the standard stress test on exports, the present value of the external debt-to-export ratio would breach the threshold in 2022 and stay above it until 2029 (International Monetary Fund, 2020). Similarly, the debt-service-to-export ratio is expected to breach the threshold at the beginning of 2023 and remain above it. Under the market financing stress test, the debt service-to-revenue ratio would breach the threshold as of 2025 and in the following five years. These results underscore downside risks for debt sustainability originating from external shocks (such as negative terms of trade shocks) and to market financing (such as rising interest rates) that could hit the Ivorian economy. These signals underscore the need to ensure a reduction in deficit as the crisis subsides and implement a prudent medium-term borrowing strategy.

The following section assesses the vulnerability of Côte d’Ivoire with regards to risks towards its public debt sustainability, by using the probabilistic approach described in the previous section. Empirical analysis uses annual data over the period 1970–2019. Data are gathered from various international data sources. Inflation, nominal and real data on GDP are obtained from the WEO database, while public debt series were made available from the Global Debt database and updated through the World Economic Outlook data (April 2021). Data on tax revenue, tax rate and primary balance are retrieved from the Central Bank of West African States (BCEAO) database. Additional public spending to GDP data are obtained from the World Development Indicators database and real exchange rate index from the AfDB’s statistical database. The International Debt Statistics database provides data on the foreign nominal interest rate, proxied in the study by average interest on new external debt commitments. Additionally, several dummy variables were included to control for some macroeconomic events.

### 4.2 Results

#### 4.2.1 Description of data series

Before delving into results’ insights, a historical perspective of fiscal and economic situations in Côte d’Ivoire during the period under study is given, to get a first impression of public debt dynamics in the economy (Figure 1).

Côte d’Ivoire has recorded a continuous rise in its public debt ratio since 2012, after almost two decades of continuous decline. The increasing trend of public debt contrasts with the decreasing path of real GDP growth, suggesting more attention should be paid to the vulnerability risks in Côte d’Ivoire for the coming years. Since 1970, economic activities in Côte d’Ivoire were subject to significant instability throughout the sample period. Figure 2 points out three phases in the GDP growth trend, which depicts two potential structural changes over the period. This has to be taken into account when performing further econometric studies. Moreover, the real exchange rate—and more generally in the CFA zone member countries—fundamentally increased over the sample period, denoting a depreciation of the local currency in real terms, compared to the US dollar.
Real interest rate and primary balance were characterized by a relatively large instability between 1970 and 1995. They became more stable starting from 1995 after the devaluation of the CFA currency. However, a deterioration of the primary balance was observed from 1996, with a positive primary balance since the devaluation up to 2010. From a purely descriptive point of view, these trends indicate potential vulnerability in the country's fiscal position if current trends in economic and fiscal variables are maintained. This is even worrisome, given the COVID-19 pandemic that put a lot of pressure on fiscal position in African countries.

4.2.2 Estimation of the economic block

Results from the first block—namely the economic block—are provided in Table 1. Before estimating the model, a stationarity check is performed, as a crucial aspect in time series estimation techniques. In this case a combination of Augmented Dickey-Fuller and Lee–Strazicich unit root tests (Lee & Strazicich, 1999) is used, the latter accounting for series with structural changes, as suspected in real GDP growth data series. Two out of three economic variables (real GDP growth rate and real interest rate) are stationary in level, the former presenting two structural changes during the period; while the real exchange rate is first difference stationary.

A great benefit of Bayesian estimation techniques, especially prior selection in hierarchical Bayesian VAR used to estimate joint distributions of economic variables in this study, is that they allow for estimating the model in level, even if there is non-stationarity or even cointegration, by providing priors to account for it.
In addition, a convergence assessment of the MCMC algorithm, essential for the stability of the model, is done as well as the diagnostic of residuals’ properties. Visual inspection of trace and density plots suggests convergence of key hyperparameters. The chain appears to be exploring the posterior rather well; no glaring outliers are recognizable (Figure 3).

However, as a supplement to this examination, a more formal test—namely the diagnostic statistics proposed by Geweke (1991)—is performed. The test results confirm the convergence of the model (Table 2).

A look at residuals plots (Figure 4) shows that the residuals have expected properties, then the model can be considered valid.

### TABLE 1  Stationary tests on economic variables

| Variables | Sample period | T  | ADF test Dickey–Fuller statistic | Lee–Strazicich test LM Stat | Break points | Stationarity |
|-----------|---------------|----|---------------------------------|----------------------------|--------------|-------------|
| g         | 1970–2019     | 50 | −6.160*                         | 1977–2012                  | I(0)         |
| logr      | 1970–2019     | 50 | −4.773                          | 1982–1993                  | I(1)         |
| dlogr     | 1970–2019     | 49 | −7.265**                        |                            | I(0)         |
| r         | 1970–2019     | 50 | −4.515**                        |                            | I(0)         |

Note: *, ** denote statistical significance at the 5% and 1%, respectively.

### TABLE 2  Geweke convergence test

| Hyperpriors | ml    | lambda | soc  | sur   |
|-------------|-------|--------|------|-------|
| Geweke Stats.| −0.6169| 1.0034 | −0.3303 | −0.3065 |

Note: If −1.96 < Stat < 1.96, there is convergence for the selected hyperprior.
In addition, Figure 5 presenting the goodness of fit demonstrates a good in-sample and out-of-sample performance, especially for real GDP growth and real exchange rate.

Beside Bayesian VAR model estimates without a COVID shock (used here as a benchmark model), three other models, representing three scenarios about the potential dynamics of the pandemic, are estimated.

(i) A baseline scenario, in which the pandemic gradually disappears by the end of 2024, following the path: 
\[ f_j = 0_{\text{in}1} \quad \forall j > 4 \]
\[ \mathbf{f}_0 = [0.9,0.6,0.3,0.1] \]

(ii) An optimistic scenario, in which the pandemic disappears quickly by the end of 2022, following the path: 
\[ f_j = 0_{\text{in}1} \quad \forall j > 2 \]
\[ \mathbf{f}_0 = [0.9,0.1] \]

(iii) A pessimistic scenario exhibiting a second wave of infections in 2022, according to the path: 
\[ f_j = 0_{\text{in}1} \quad \forall j > 4 \]
\[ \mathbf{f}_0 = [0.9,1.0,0.9,0.6] \]

Figure 6 depicts the three pandemic scenarios, by plotting the coefficients that relate \( f_j \) to \( f_0 \). These scenarios should be interpreted as statements about the ‘intensity’ of the pandemic, relative to its intensity in 2020.

4.2.3 | Estimation of the fiscal block

The results for the estimation of fiscal reaction function are presented in Table 3.

It shows a negative average coefficient for the lagged debt ratio as expected; however, it is not statistically significant. At a 95% confidence level, variables that have significant coefficients are second-order polynomial time trend, lagged primary balance \( s(t-2) \), current public consumption spending and current tax rate. The last two have the expected signs. The dummy variable added to account for the structural break started in 1982 is also highly significant. In addition, at a 90% confidence level, periods where the debt ratio exceeds 50% have a significant impact on primary balance. Hence, higher spending than usual leads to lower primary surplus ratio whereas higher effective tax rates have proven to improve government’s primary balance. The goodness of fit reflected in \( R^2(\text{adj}) = 85\% \) is quite high, indicating a good fit of the model, and the Durbin–Watson test statistic \( DW = 2.07 \) does not indicate correlation of the residuals.
Moreover, as assumed at the beginning of the study, deviation of the reaction coefficient from average is reflected in the smooth term $sm(t)$. The estimated degree of freedom (edf) = 8.08, shows the reaction coefficient $\psi(t)$ is time-varying. In addition, $sm(t)$ is highly significant. The actual value of the reaction coefficient $\psi(t)$ at time $t$, then, is given by the average coefficient as reported in Table 3, plus deviations from that value (Figure 7).

4.2.4 | Derivation of public debt path and sustainability analysis

The results of debt path simulations are presented in Figure 8.

The sustainability indicator is calculated for a chosen mark-up $x = 0.29$ (i.e., 29% of GDP). The choice of the value of $x$ is guided by the willingness to assess sustainability against the debt ratio threshold of 70% stated in the WAEMU convergence criteria (Figure 9).
Assuming constant debt management policies, and that Ivorian policymakers are extremely averse to upside risk, meaning that a 50% level is used as a benchmark to assess high upside debt distress risks, actual values of the indicator are quite low and far from desirable levels for the coming years, that is, non-increasing trends and well-contained upside risks. Indeed, whatever COVID shock scenario is considered, the debt sustainability indicator gives probabilities below 30% for Côte d’Ivoire during the period 2021–2024, meaning high probabilities of increasing trend and low probabilities of well-contained upside risks to the regional threshold. This shows a significant level of vulnerability for the country, based on the assumed level of risk aversion. Hence, much attention should be paid by the Ivorian government, in the management of its debt. Mitigating this vulnerability requires a will from policymakers to pursue strong fiscal effort, despite negative effects of COVID-19.

| TABLE 3  | Summary of results from the fiscal reaction function estimates |
|-----------|-------------------------------------------------------------|
| Variables | Coef.            | $t$-Stat (SE)   | Pr($>t$) |
| Const.    | 0.078            | 0.870 (0.090)  | 0.391    |
| $t$       | 0.015*           | 1.797 (0.009)  | 0.082    |
| $t^2$     | $-0.001^{**}$    | $-2.080$ (0.000) | 0.046   |
| $s(t−2)$  | $-0.561^{***}$   | $-6.569$ (0.085) | 0.000   |
| $b(t−1)$  | $-0.252$         | $-0.835$ (0.302) | 0.410   |
| Bb50      | 0.231*           | 1.914 (0.121)  | 0.065    |
| Gc        | $-0.609^{***}$   | $-3.832$ (0.159) | 0.000   |
| tr        | 0.193**          | 2.265 (0.085)  | 0.030    |
| d$82$     | $-0.047^{***}$   | $-3.799$ (0.012) | 0.000   |
| sm($t$)   | edf = 8.084      | $R^2$(adj) = 85% | DW = 2.072 |

$GCV = 1.7 \times 10^{-4}$

**FIGURE 7** Deviation $sm(t)$ from the average coefficient for $b(t−1)$
4.2.5 | Sustainability analysis following a tax shock

From the literature review, two alternatives to public financing through debt are discussed. The first one proposes rehabilitation of money printing, while the second alternative suggests leveraging on DRM to build a sustainable post-COVID recovery. Knowing that Côte d’Ivoire is part of a monetary union, and as such could not carry a monetary policy in isolation, fiscal policy remains the main instrument under the control of Ivorian public authorities. This section thus focuses on DRM. The idea is to assess the impact on debt sustainability if the country were able to comply with the regional convergence criteria on tax rate that should be 20% at minimum by 2019, through significant improvement in domestic resources collection. The impact of a 20% tax rate on debt sustainability is simulated (Figure 10).

Results show that, although the sustainability index remains below the acceptable threshold of 50% after tax rate shocks, a significant improvement is confirmed in all scenarios. Indeed, regardless of the COVID scenario, an improvement in DRM by bringing the effective tax rate to a level of 20% in the period 2021–2024—as suggested by the convergence pact of the WEAMU—is likely to increase debt sustainability levels by at least 30% by 2024. In other words, leveraging on DRM could help reduce the country’s fiscal vulnerability by about one third.
Forecasting the evolution of the public debt path in response to a novel exogenous shock such as COVID-19 is particularly challenging, since an economic shock of this kind has never been observed in the past. This article has drawn on previous related works and has articulated a set of assumptions that allow building forecast distribution of a vector of macroeconomic variables dictating debt path dynamics, based on historical evolution. Côte d'Ivoire has been used as a case study. Given the uncertainty surrounding the future of the pandemic, as well as difficulties in translating a path for the disease into economic implications, the forecasts presented are a reasonable guide to what might happen to the Ivoirian economy in the future, conditional on assumptions on which they are built. Results suggest that the country remains vulnerable to public debt distress risks in light of the proposed sustainability indicator, hence sending a warning signal to policymakers to stay vigilant and cautious in the management of the country's public debt portfolio in the coming years. In addition, results reveal the importance of DRM in reducing the country's vulnerability, a critical step to build a sustainable post-COVID recovery in developing and emerging countries.

Motivated by the above findings, a sustainable post-COVID recovery could be achieved on one hand, by ensuring sound legal and operational debt management frameworks, demonstrating compliance with international standards and adopted by all countries while accounting for individual specificities. It can be achieved by leveraging on the expertise of the African Legal Support Facility (ALSF), an international organization created by the African Development Bank to assist countries in sovereign debt-related issues among others. ALSF has knowledgeable experience in assisting African countries in legal aspects of debt management systems and could be used to implement a common debt management framework adapted to their specific needs. Another important aspect is to strengthen debt management offices' technical capacity across the continent. Institutions having such expertise (AfDB, IMF, World Bank) could mobilize resources to implement capacity building activities.

On the other hand, countries could leverage on DRM. Many aspects need to be addressed to achieve that. Fighting corruption and tax flight in tax administrations must be a priority for policymakers as significant resources are lost due to these two issues. In addition, promoting formalization of the informal sector is key. Concretely, policymakers could take a broader strategic approach, seeking to register informal firms, in order to protect their rights, entitlements and

![](image-url)  **Figure 10** Sustainability index path with a 20% tax shock from different scenarios

## 5 Conclusion

Forecasting the evolution of the public debt path in response to a novel exogenous shock such as COVID-19 is particularly challenging, since an economic shock of this kind has never been observed in the past. This article has drawn on previous related works and has articulated a set of assumptions that allow building forecast distribution of a vector of macroeconomic variables dictating debt path dynamics, based on historical evolution. Côte d'Ivoire has been used as a case study. Given the uncertainty surrounding the future of the pandemic, as well as difficulties in translating a path for the disease into economic implications, the forecasts presented are a reasonable guide to what might happen to the Ivoirian economy in the future, conditional on assumptions on which they are built. Results suggest that the country remains vulnerable to public debt distress risks in light of the proposed sustainability indicator, hence sending a warning signal to policymakers to stay vigilant and cautious in the management of the country’s public debt portfolio in the coming years. In addition, results reveal the importance of DRM in reducing the country’s vulnerability, a critical step to build a sustainable post-COVID recovery in developing and emerging countries.

Motivated by the above findings, a sustainable post-COVID recovery could be achieved on one hand, by ensuring sound legal and operational debt management frameworks, demonstrating compliance with international standards and adopted by all countries while accounting for individual specificities. It can be achieved by leveraging on the expertise of the African Legal Support Facility (ALSF), an international organization created by the African Development Bank to assist countries in sovereign debt-related issues among others. ALSF has knowledgeable experience in assisting African countries in legal aspects of debt management systems and could be used to implement a common debt management framework adapted to their specific needs. Another important aspect is to strengthen debt management offices’ technical capacity across the continent. Institutions having such expertise (AfDB, IMF, World Bank) could mobilize resources to implement capacity building activities.

On the other hand, countries could leverage on DRM. Many aspects need to be addressed to achieve that. Fighting corruption and tax flight in tax administrations must be a priority for policymakers as significant resources are lost due to these two issues. In addition, promoting formalization of the informal sector is key. Concretely, policymakers could take a broader strategic approach, seeking to register informal firms, in order to protect their rights, entitlements and
assets as entrepreneurs, not only for the purpose of taxing them. Adding to that the lowering of regulatory burden may also help yielding significant results. Furthermore, rationalizing non-productive tax incentives, and the potential offered by digital technology sectors, for instance, are some aspects that need much more attention from public authorities to unlock their potential to generate resources. The expanding mobile money ecosystem offers new opportunities to raise funds. There are some success stories on the continent (M-Akiba sovereign bond example in Kenya) that could inspire new governmental initiatives to raise more resources.

However, some notes of caution should be considered in this analysis: (1) the inclusion of a COVID shock implicitly assumes that agents form expectations about the future as if external propagations of the COVID shock were similar to that of standard forecast errors; (2) the linearity assumption in the COVID shock model can be seen as more problematic now than in normal times, given the exceptionally large macroeconomic volatility implied relative to historical standards. As a final note, results from this study, especially the debt forecasting procedure could serve as a basis for more refined procedures in future studies while providing a reasonable guidance for policymakers in their current debt management strategies.

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