

Sustainability of the public debt of WAEMU member states in an approach based on repayment capacity: The case of Senegal

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Abstract: In this article we have carried out a study on the level of debt sustainability of Senegal using an implementation of 'stress-test' within the framework of the analysis of the sustainability of the debt (DSA). Empirically, we performed a simulation on three macroeconomic scenarios using the Vector Auto Regressive (VAR) model. From the reference scenarios, we carried out a stress test by simulating an increase in the interest rate of the debt by 2%, an increase in the dollar exchange rate by 30%, and finally an increase in the annual maturity up to at 15%. The results of the stress test showed that Senegal's debt is at a high level of risk, but not in debt distress. Senegal has no payment difficulties. This allows us to say that Senegal's debt is sustainable. This result shows that efforts have been made in the macroeconomic framework imposed by the IMF at the level of the variables of the debt sustainability framework (DSF), specifically the balance of payments, the public sector, debt and GDP.

Keywords: Debt, DSF, Liquidity, Risk, Stress test, Solvency, VAR

I. INTRODUCTION

The financial liberalization of the 1990s offered new financing possibilities to the countries of sub-Saharan Africa. However, unfortunately it has not solved the debt problems of poor countries. The increase in the sovereign debt of poor countries during the nineties (90) as well as the financial crises have made it possible to highlight the risk of debt sustainability. According to Legrand (2016), the sixties were marked by the independence of many African countries, with rapid growth in the seventies (70). Nevertheless, unfortunately difficulties set in during the years 1980-90, difficulties linked to a succession of crises and marked by a spiral of indebtedness: the debt crisis. Indeed, the end of the 1970s revealed the problem of Third World debt.

At this level, it is necessary to determine the origin of the debt crisis. By carrying out an analysis focused on the interests of creditors, poor countries will be the sole and main responsible for the indebtedness (Berr, and Combarous, 2007). However, the sustainability approach allows for a more balanced analysis of the issue. This approach is fully justified because it makes it possible to distribute responsibilities between the two groups, in order to identify the reasons for the outbreak of the debt crisis. We can distinguish two types of causes. For the first cause, we will point the finger at petrodollars. Indeed, with the first oil shock of 1973, and according to the WB (2019) oil prices increased with a multiplier equal to four (4), which prompted donors to grant loans to poor countries. Part of the profits made by OPEC (petrodollars) are placed in private international banks. So to make this financial windfall profitable, the funds are lent to poor countries, the debts being largely contracted at variable rates. The World Bank adopted this same logic, which is why from 1968 to 1973; it multiplied its loans by 10. Poor countries graciously got into debt and their debts increased 12 times between 1970 and 1980 (WB, 2019). Unfortunately, most poor countries have not injected the money into productive investments to reverse the trend of the trade balance with export activities likely to produce the currency flows needed to repay the debt. Part of the debt contracted was used to finance lavish spending that was not conducive to development (phenomenon of "cathedrals in the desert"). Some leaders have diverted considerable sums to the detriment of the people; hence the name odious debt.

Secondly, we are going to point the finger at the anti-inflationary policies carried out by the developed countries at the end of the 1970s, which resulted in an increase in the interest rate, which was very harmful to the poor countries. In the United States, we witnessed the 'monetarist shock in 1979. Indeed to fight against inflation, the director of the Federal Reserve decided to raise the key interest rate, which resulted in an increase in debt service poor countries, since most are

contracted at variable rates. The situation is made more difficult with the rise of the dollar, and the fall in the price of raw materials.

The 1980s will be declared 'lost for development' a priori, and in many poor countries the economies are placed under the supervision of the BWIs with the implementation of SAPs and the development model: the Washington consensus. Originally, these plans were supposed to be short-term measures enacted by the IMF to guarantee the repayment of loans (stabilization policy). However, they will gradually become true models of liberal development that should apply to any underdeveloped economy like Senegal. Unfortunately, the Washington consensus has never succeeded in putting poor countries on the starting block of development. Indeed, between 1981 and 2020, Senegal visited the Paris Club 15 times to restructure its debt. The latest agreements are signed under the Debt Service Suspension Initiative (DSSI). Indeed, with the Covid-19 crisis, Senegal faced a liquidity crisis for the payment of debt service. Thus, Senegal benefited from a suspension from May 1, 2020 to December 31, 2021, i.e. 21 months. In 2020, Senegal's debt is equal to 9,753 billion, representing 68.8% of GDP (10,295 billion in 2021). The external debt represents 84% against 16% for the internal debt. Regarding the rating of sovereign debt, Moody's and S&P respectively granted Senegal the ratings of Ba3 (penultimate rating) and B+ (worst rating). All these ratings make it possible to pose the problem of solvency risk, hence the following question: **is Senegal's debt sustainable to facilitate repayments without negatively influencing the well-being of the population?** To answer this question we are going to perform a "stress-test" resistance test. Indeed, this debt faces three risks: exchange rate, interest rate and refinancing.

In the context of this article, we will analyze the debt by making a comparison between solvency and sustainability, without forgetting Senegal's debt management strategy. Then we will proceed to the review of the literature and the empirical study on the debt. Finally, we will end with the methodology with the VAR method, and the results of the study.

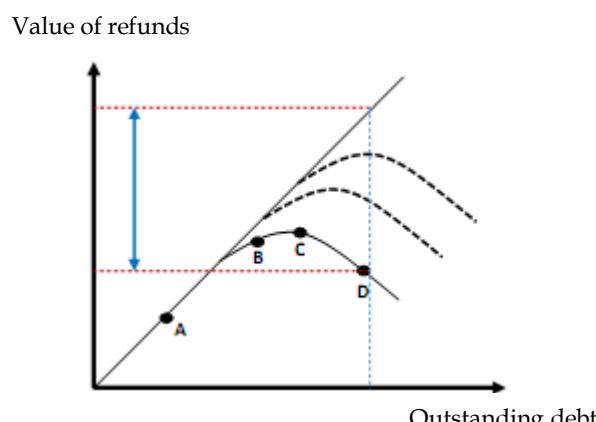
II. DEBT ANALYSIS

2.1. Viability vs Sustainability

According to Berr and Combarous (2007), a country's public debt can be qualified as sustainable if the government is able to repay its debt without resorting to exceptional financial assistance, without being in default and without playing PONZI. Debt sustainability thus makes it possible to focus on the liquidity and solvency of a State. For a debtor state, solvency represents the ability to pay its creditors. According to Sow and Madden (2020), this definition uniquely adopts the view of rich countries and IFIs, as it envisages a treatment of debt solely for allowing creditors to recover the greater part of the sums lent. For a much more thorough analysis, we will approach the issue of debt from the perspective of sustainability, that is to say: how to repay the debt without negatively influencing the well-being of the population? Thus, the analysis will be more balanced, because it will weigh the interests of debtors and creditors.

According to Agenor and Montiel (1996) and Roubini (2001), a State is solvent if the discounted primary surpluses are at least equivalent to the initial public debt. The theoretical foundations of the approach in terms of solvency are the work of authors such as Krugman (1988a, 1988b) and Sachs (1989), through the Laffer curve of debt and the concept of debt burden. These authors provided the basic conceptual foundations of BWI debt reduction policies from 1990: HIPC Initiative (1996) and MDRI (2005). According to Krugman, it is in the interests of creditors to grant debt reductions to increase the likelihood of repayment by debtors.

Figure 1: Laffer curve



If a country faces low debt, the repayment will be made in full at point A (the curve merges with the first bisector). On the other hand, when the stock of debt increases, the probability of default will increase, which results in a discount, i.e. part of the debt will not be paid (point B). So when you are on the wrong side of the curve (to the right of point C) the situation then becomes critical. With an outstanding debt at point D the probability of default becomes high. The debt Laffer curve helps to explain the notion of debt burden, which can be linked to debt service or outstanding debt. If the burden is represented by the service of the debt, the creditors are obliged to provide additional liquidity in order to allow the debtor to honor his commitments (graphically the curve shifts to the right). At the level of the Paris Club, non-conventional treatments are adopted, characterized by the extension of the reimbursement period or the deferred payment (grace period). This option can be successful if you are dealing with a liquidity crisis. On the other hand, if the burden is constituted by the outstanding debt, then it is in the interest of the creditors to grant debt reductions. This is called conventional treatment in the Paris Club with reduction of the interest rate or cancellation of all or part of the debt.

Unfortunately, for Easterly (2002) this approach to solvency has not succeeded because HIPC remain poor and indebted, despite the policies implemented for 25 years. According to Beer and Combarnous (2007) the failure of the solvency approach is linked to the partial analysis of the debt problem oriented solely on the interests of creditors by considering the debtor as the main and sole responsible for its indebtedness. The sustainability approach intends to complete it by adopting a more balanced treatment of the issue by identifying the causes of indebtedness. At this level, we have two: petrodollars and anti-inflationary policies. Once the responsibility has been borne in part by the creditors, the populations of the HIPC should not bear the consequences of a reimbursement, which would be made to the detriment of the satisfaction of their needs. Thus, a balanced treatment must be carried out by integrating the interest of the debtors taking into account the living conditions of the HIPC populations: the basis of the sustainability approach. The bases of this approach can be found in the work of Keynes in 'The economic consequences of peace ([1919], 2002)' In 1999, an unprecedented mobilization of public opinion was organized through the international campaign Jubilee 2000 more the disappointing results of the HIPC initiative. This is what led to its overhaul and the adoption of less restrictive sustainability criteria.

Over-indebtedness can be identified from a payment default, an ethical position but also from DSF. To assess debt sustainability, the BWIs opted for the third logic by comparing debt indicators to indicative thresholds. With this in mind, the IMF and the World Bank jointly adopted the Debt Sustainability Framework (DSF) in April 2005, to periodically review the level of over-indebtedness, in order to place it at a sustainable level. Thus, the DSF has set thresholds so a debt indicator that exceeds its indicative threshold signals a risk of over-indebtedness: low (good policy), moderate or high (bad policy). Viability makes it possible to emphasize the liquidity and solvency of a State. In October 2013, the IMF and the World Bank approved the reform of the discount rate, now at 5%. To assess debt sustainability, debt indicators are compared to indicative thresholds over a 20-year projection period due to the long maturities of LIC debt. The projection horizon can be divided into medium-term (up to 5 years) and longer-term (beyond 5 years) projections.

Table 1: Debt threshold according to DSF

LEVELS	SOLVENCY RATIO PUBLIC DEBT			LIQUIDITY RATIO DEBT SERVICE	
	Exports (1)	GDP (2)	Revenues (3)	Exports (4)	Revenues (5)
WEAK	100	30	200	15	18
MODERATE	150	40	250	20	20
STRONG	200	55	300	25	22

Source: IMF/WB, 2016

- (1) Trend indicator closely related to a country's repayment capacity
- (2) It measures the level of indebtedness in relation to the country's economic activity.
- (3) Measures the level of indebtedness in relation to the government's ability to pay.
- (4) Estimates the proportion of export earnings needed to pay debt service
- (5) Measures the government's ability to finance debt service from domestic resources

The present value (PV) of debt is the discounted sum of all principal and interest payments (debt service), calculated using a given discount rate (β).

$$VA_t = \sum_{t=1}^n (a_t + i_t)(1 + \beta)^{-(t-1)}$$

If the discount rate and the contractual interest rate of the debt are the same, then the PV is equal to the nominal value (or is very close to it), while if the contractual interest rate of the debt is lower than the discount rate, the PV of the debt is lower than its nominal value. The interest rate is not the only vector of concessionality; it can also be granted through the grace period, the frequency of payments and the maturity. If the debt is concessional, its PV is always lower than its nominal value.

Thus in relation to their quality of management, the countries are classified into three groups according to the risk of over-indebtedness: low (so-called "green" countries), moderate ("yellow" countries) or high ("red countries"). Countries must demonstrate progress on debt in order to qualify for BWI relief. The latter will undertake to reduce the debt to an agreed level of sustainability. This is the "decision point" that immediately enshrines debt service relief. The process is carried out in two phases with the decision and completion points, between which the "interim period" takes place.

- Decision point: the country becomes eligible for the initiative after meeting four conditions. At this level, the amount needed to be canceled to bring the debt back to a sustainable level equal to 150% of exports or 250% of State revenue is calculated. Creditors grant interim relief with a reduction in debt service (so-called "flow agreements"), maturities falling during the interim period are canceled or rescheduled
- Completion point: creditors are obligated to provide the poor country with the full debt relief promised at the decision point. Thus, the stock of debt calculated at the decision point becomes definitive for all the bilateral and multilateral creditors concerned.

2.2. Senegal's debt management strategy

Regulation No. 09/2007/CM/Uemoa on the reference framework for public policy and public debt management in WAEMU member states requires member countries to develop a debt management strategy medium term (MTDS). It is a tool developed jointly by the World Bank and the IMF and made available to poor countries. Countries must ensure, in the proposed financing methods, compliance with cost and risk conditions with a view to ensuring the resilience of public finances in particular and the macroeconomic framework in general.

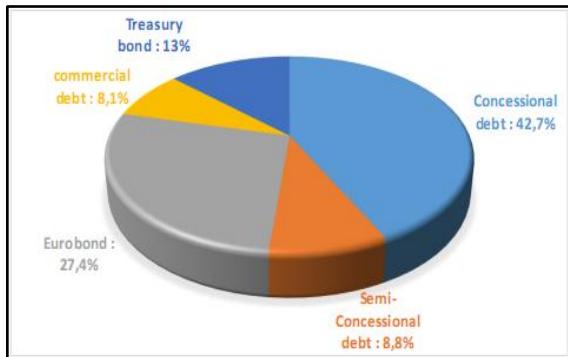
The objective is to diversify the investor base and direct it towards commercial resources denominated in particular in local currency, by actively contributing to the development of the domestic financial market; which allows a reduction in the exposure to the risk of the exchange rate which weighs on the current public debt portfolio, of which nearly 80% would be denominated in foreign currencies in 2020.

In 2020, Senegal's stock of debt is 9753 billion CFA, or 68.8% of GDP, of which:

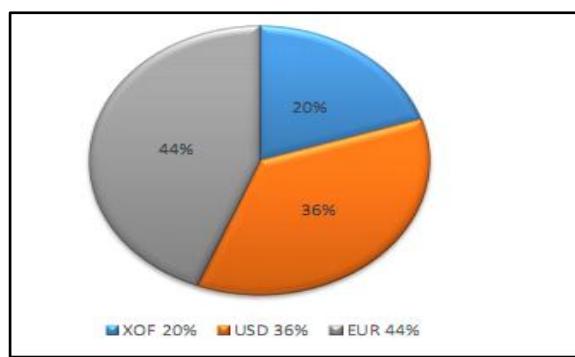
- External debt: 8,202 or 84%
- Domestic debt: 1,551 or 16%

For this same period, we have: exports 2,411 billion, debt service 870 billion (of which interest 364), GDP 13,209 billion, and budgetary receipts 2,829 billion. These data will be used to carry out stress tests based on the reference scenarios (thresholds in terms of solvency and liquidity). Thus compared to 2019, the stock of debt increased by 18.5% (8,231 billion in 2019, or 58% of GDP), with an external debt of 7,302 or 89%, and a domestic debt of 929 or 11%. Between 2019 and 2020, the amount of external debt fell by 12.3%. The total public debt portfolio in 2020 can be analyzed as follows:

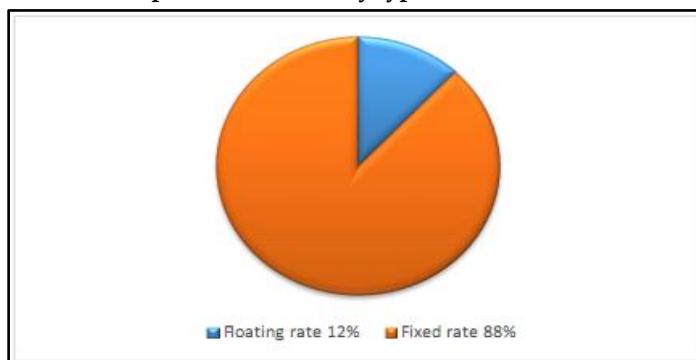
Graph 1: Breakdown by type



Graph 2: Breakdown by currency



Graph 3: Breakdown by type of interest rate



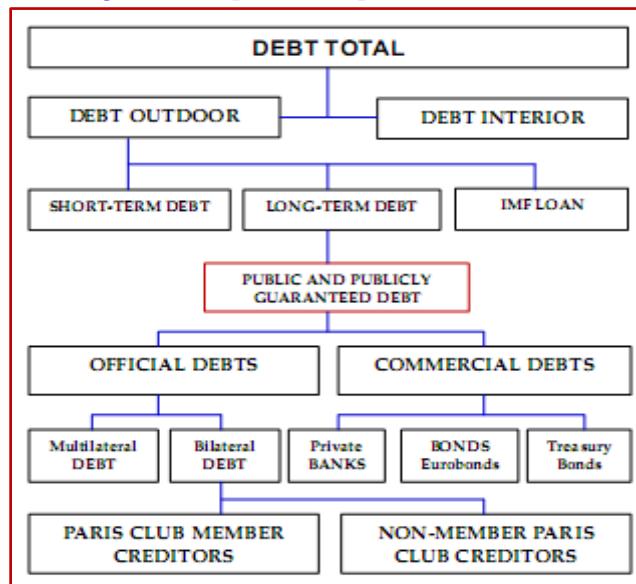
Source: MFB 2020 Annual Activity Report

A vulnerability analysis makes it possible to identify three types of risks

- **Exchange rate risk:** In Chart 2, we can see that 80% of the public debt portfolio is denominated in foreign currencies, including 36% in dollars and similar currencies, with high exposure to exchange rate risk
- **Interest rate risk:** Chart 3 shows us that 88% of total debt is at fixed rates (100% of domestic debt and 86% of external debt) and 12% is at variable rates; 100% external debt.
- **Refinancing risk:** the average maturity of 3.7 years

Another analysis makes it possible to classify the debt into multilateral, bilateral and commercial debt (Figure 1).

Figure 1: Composition of public external debt



The DSF also makes it possible to determine the debt capacity of each country, by calculating a composite indicator (CI) from the weighted average of five variables: the CPIA (Country Policy and Institutional Assessment) rating (macroeconomic management, structural policy, policy of inclusion and justice, institutions and public sector management) achieved by the WB, the country's real GDP growth, remittances, foreign exchange reserves and global growth. Senegal has an IC score of 3.716, which places it among the countries with a high debt capacity. The likelihood of over-indebtedness is positively correlated with the level of indebtedness and negatively with the quality of institutions and public policies (measured by the CPIA) and other country-related factors. The IC is calculated according to the formula below:

$$CI = \beta_1 CPIA + \beta_2 g + \beta_3 \frac{\text{Remittances}}{GDP} + \beta_4 \frac{FER}{M} + \beta_5 \left(\frac{FER}{M} \right)^2 + \beta_6 gw$$

$$\beta_1 = 0.385; \beta_2 = 2.719; \beta_3 = 2.022; \beta_4 = 4.052; \beta_5 = -3.990; \beta_6 = 13.520$$

where g and gw are country growth and world growth, respectively, while all other variables are in percentage except CPIA rating. However, what must be remembered is: **debt capacity is not repayment capacity**, hence the importance of the debt sustainability analysis.

III. THEORETICAL FRAMEWORKS AND EMPIRICAL STUDIES

3.1. Theoretical developments on indebtedness

A public debt is sustainable if the State is able to service its debt without reducing the sums intended for social spending. Unlike individuals, the State does not have a time horizon for indebtedness, which constantly pushes it to borrow to finance long-term collective projects. In general, the public debt to GDP ratio is used to determine the level of indebtedness, but it is not in itself a criterion of sustainability. We can take the example of Japan, the world's third largest economy, operates with a gross debt corresponding to 235% of its GDP in 2020 (i.e. 7,100,000 billion CFA francs), and is doing well compared to other countries. However, this is the place to point out that its debt is 95% domestic, which allows the country to hedge against the exchange risks of the financial markets.

Theoretically, there is no scientific proof of the collapse of a country beyond a certain level of indebtedness. Thus, a country is theoretically considered indebted when the service of the external debt absorbs the major part of the resources for the payment of foreign lenders (Krugman 1988, Sachs 1989, Pattillo et al. 2002). Over-indebtedness results in the deterioration of economic performance, because servicing the debt will increase taxes and could therefore reduce investments. This is why, according to Clements et al. (2003), uncertainty about debt service repayment is an obstacle to perpetuating economic reform. We can distinguish several theoretical approaches to debt: traditional (Keynesian and classical), modern (rational school, alternative vision).

3.1.1 Traditional approaches to indebtedness

➤ Keynesian vision of indebtedness

If we refer to the Keynesian vision, indebtedness should not be a burden for present and future generations because it should stimulate investment. This means that the rate of return must be greater than the interest rate. The same endogenous conception of money (the production capacity is at the origin of the demand for money) is transcribed at the level of indebtedness. In the Keynesian conception, the purpose of indebtedness is to relaunch aggregate demand. The latter, via an accelerator effect, will lead to an increase in investment, which in turn causes an increase in production. Therefore, the flow of budget deficits, which tends to increase the stock of debt, creates economic growth via increased demand and investment. This is what allows us to say that the deficit stimulates investment. However, this Keynesian conception remains valid only in a situation of underemployment of production resources. So we can conclude by saying that the Public Spending Stimulus Plan or Keynesian Stimulus Plan - is the theory that an economy can restart if the state undertakes structural transformation policies with public works.

➤ Classical Ricardian vision

If the Keynesians consider indebtedness as being an accumulation of capital, the classics, on the other hand, equate indebtedness with a future tax and accuse the State with a negative connotation, because of its power to tax the population. If we refer to Ricardo (1817), the loan is considered to be a deferred tax over time to repay debt service regardless of the intergenerational gap. Unfortunately, the behavior of economic agents is guided by an anticipation of

higher taxes, which will result in a drop in investment, because the sector will be taxed by the State for the payment of debt service. However, a reserve may be introduced depending on the nature or quality of the expenditure (operating or investment expenditure) financed by the loan. Normally the loan must make it possible to invest, and the ROI must cover the cost of the loan, that is to say the interest.

3.1.2 Modern approaches to debt

➤ Vision of rational expectations in the face of indebtedness

If the authorship of this theory goes to Ricardo, the basic principle is the work of Barro (1979). Indeed the latter develops his theory from intertemporal utility functions with overlapping generations: Ricardian equivalence. Barro starts from this equivalence by carrying out a more in-depth development by combining the themes of evictions and rational anticipations. Barro posits the hypothesis of a State which finances public expenditure through borrowing, or which opts for a reduction in taxes while leaving public expenditure unchanged. In this case, the economic agents will in turn opt for an anticipation of the increase in taxes that will be necessary for the future payment of debt service. With these two hypotheses, the agents are aware of the existence of a public deficit that will increase the outstanding public debt and use an inflationary policy. The combined accumulation of inflation and the increase in taxes will call into question the credibility of the state. Eventually the agents will make their arrangements to deal with a future tax purge. The solution for this is to increase savings at time t in anticipation of a tax increase at time T_1 . Ultimately, state policy will have no significant impact on the economy, regardless of how deficits are financed.

➤ Alternative visions to the Keynesian theory in the face of indebtedness

Keynesian theory opts for indebtedness to revive the economy. However, alternative approaches explore the impacts of political strategies. For this vision, authors (Alesina and Tabellini, 1989) have put forward the hypothesis of a democracy in which the opposition and the power face each other. In this case, the parties will have distinct choices with respect to the nature of public spending. The party in power can take the option of increasing public spending by going into debt, in order to satisfy its electorate, to stay in power or to put a spoke in the wheels of its opponent. These expenses will be bottlenecks for his political opponent from the point of view of budget management, if the latter comes to power. Still within the framework of this democratic opposition, the government will commit tax revenues today, which will result in a reduction in the future possibilities of spending by its adversary, especially if the debt reaches unsustainable levels. Because of the principle of intangibility of the State, the opposition once in power will be obliged to pay the service of the debt. This will result in an update of electoral promises, especially in relation to social spending, which could upset his electorate. Hence the idea of an electoral strategy through debt. Other authors have also developed models on electoral strategies and political cycles and public debt, notably Persson and Svensson (1989); Aghion and Bolton (1990).

3.2 Review of the empirical literature

Since 2000, many sovereign defaults have been observed around the world. We can cite Argentina (from 2002 to 2005), Indonesia (2002), Paraguay (2003), Venezuela (2004), the Dominican Republic (2005), Grenada (2005), Ecuador (2008). The most worrying case is that of Greece in 2012. The country was faced with a chronic external deficit despite numerous restructurings of its public debt. In fact, Greece benefited in 2012 from the first two rescue plans for an amount of 260 billion euros. Then on June 30, 2015, the country faced a payment default, which enabled it to obtain a third rescue plan for an amount estimated at 86 billion euros. This latest crisis prompted the IMF to analyze debt sustainability; which made it possible to observe its level, which was close to 200% of GDP. It was at this time that the IMF decided to carry out a significant restructuring, in the form of relief, of an amount greater than the plan proposed by the European Stability Mechanism (ESM). The case of Greece is a concrete example of the problem of the unsustainability of the debt. So Greece's fundamental problem stems from the unsustainability of its sovereign debt, which already reached 175% of national GDP at the end of 2013.

Sovereign default can be involuntary, that is to say, a State may be unable to meet its obligations, but it could also be voluntary. Whatever the situation, a payment default will call into question sovereign solvency, which will result in a lowering of the sovereign rating. The first studies on a sovereign default are the work of Eaton and Gersowitz (1981) and the consequence was the exclusion of international markets. Subsequently, other authors have continued research oriented towards possible punitive sanctions after a default in order to encourage the repayment of sovereign debt. The studies are carried out by Bulow and Rogoff (1989), Fernandez and Rosenthal (1990). Therefore, for these authors we can

remember that the main consequences in the event of a sovereign default are the loss of credibility and exclusion from the capital markets.

Other authors have studied the reduction of capital inflows, as a solution to deal with sovereign default (Eaton and Fernandez (1995). The authors took the example of the sovereign default of Russia in 1997. Indeed, after this Otherwise, Foreign Direct Investment (FDI) from Germany to Russia fell by 10%. The situation is observed for FDI from Japan to Russia, which fell from 940 million to 18 million between 1997 and 1999 (Fuentes and Saravia, 2009). Found a decline in FDI flows to defaulting sovereign debtors.

On the other hand, other authors such as Gelos, Sandleris and Sahay (2011) have shown that most defaulting countries manage to regain access to capital markets one or two years after the crisis. The clarification is provided by Cruces and Trebesch (2013) who stipulates that exclusion from capital markets is correlated with the size of the losses suffered by the investor. Studies have shown a strong correlation of the two variables; the greater the losses (the difference in subsequent bond yields is significant), the longer the market exclusion period will be. According to Arellano (2008) countries have chosen the option of default and market exclusion in certain circumstances (such as in the case of a global or specific shock).

IV. RESEARCH METHODOLOGY

4.1 Stress test implementation

There are three categories of resilience tests, standardized scenarios, adapted scenarios, personalized scenarios (IMF, 2017). Standardized stress tests apply to all countries. DSF stress tests are performed by adding a temporary shock to the baseline scenario macroeconomic indicators. There are five (6) of them: GDP growth rate, exchange rate, exports, primary balance, net FDI inflows and transfers, interest rate. The impact of stress tests is transmitted in two ways: through changes in indebtedness and debt service (numerators of debt indicators) and through changes in repayment capacity (denominators of debt indicators). However, we opted for the personalized scenario because of the idiosyncratic risk linked to the Covid-19 pandemic, a serious public health crisis. We opted for a transmission to the numerator using three (3) variables: the interest rate, the exchange rate and the refinancing.

The debt sustainability analysis (DSA) performed in the DSF is based on a baseline scenario representing realistic macroeconomic conditions for the future, given the country's growth potential and economic policy. While the macroeconomic framework data can be projected for a period of 20 years, the projection horizon can be divided into medium-term projections (up to 5 years). Our baseline scenario is shown below. It is also advisable to enter both historical (previous 10 years) and projected (20 years plus the current year) values for most variables.

Table 2: The main aggregates of the macroeconomic framework

MACROECONOMIC AGGREGATES	2020	2021	2022	2023	2024	2025
Real growth rate	-0,7%	5,2%	6,9%	13,7%	14,9%	10,1%
GDP deflator	2,1%	1,7%	1,6%	0,8%	0,6%	-1,8%
Tax pressure rate	16,81%	17,10%	18,88%	19,96%	20,42%	21,08%
Fiscal balance/GDP	-6,14%	-5%	-4,00%	-3,00%	-3,00%	-3,00%
Currentaccount balance/GDP	-11,68%	-9,82%	-8,22%	-7,00%	-7,00%	-7,00%

Source DPES (Department of Prevention and Economic Studies) 2020

In order to reinforce the degree of realism of the reference scenario, resilience tests will be implemented in order to measure the impact of a modification of the main assumptions on which the reference scenario is based, particularly the level of debt. These are interest rate risk, refinancing risk, exchange rate risk. But exhaustively, the reference scenario for on: the balance of payments, the public sector, the debt, the GDP and its deflator, the national currency exchange rate against the dollar and total investment.

4.2. VAR modeling

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Macroeconomic data will be taken from the DPES, and debt data from the Public Debt Department (PDD). As far as the variables are concerned, we will use five of them:

- Outstanding public debt (OPD)
- The Debt service (TDS)
- The interest rate (TIR)
- The exchange rate (TER)
- Refinancing (REF)

Three scenarios will be used in our work.

- The impact of the interest rate on the debt: according to the PDD 12% of the debt is at variable rate and 88% at fixed rate in 2020. Therefore, we are going to script for a 2% increase in variable interest rates in 2021.
- The impact of the exchange rate: according to the PDD, 20% of the debt is in CFA francs, 36% in dollars \$ and 44% in euros €. We are going to script for a 30% depreciation of the CFA against the dollar.
- The impact of refinancing: approximately 9.7% of domestic debt is expected to mature in one year. We will script for a percentage of 15% of the debt for a maturity of one year.

As part of this stress test, the objective is to measure the influence of variables on solvency and liquidity risk. In our model, we have:

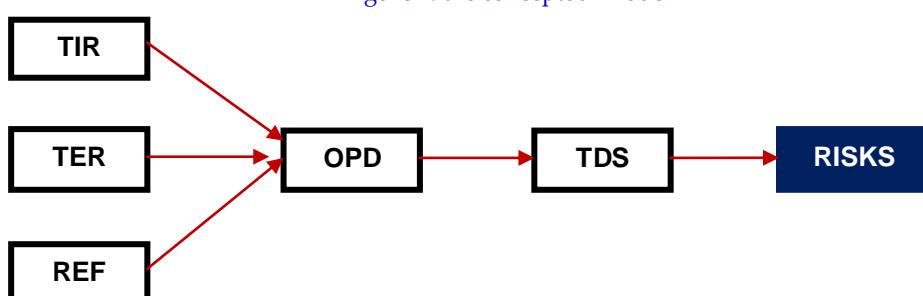
- **Variable to explain:** Solvency and liquidity ratio
- **Explanatory variables:** TIR-TER-REF-OPD-DS

VARIABLES	DESCRIPTION
SVR	Solvency Ratio/GDP/EXP
LQR	Liquidity Ratio/REV
TIR	The interest rate
TER	The exchange rate
REF	Refinancing
OPD	Outstanding public debt
TDS	The Debt service

Our objective is to study the level of solvency and liquidity risk. As part of the methodology, we will refer to the work of Wilson (1997), Boss (2002) and Virolainen (2004) will be used with a VAR model that will estimate the relationship between risks and macroeconomic variables. $Y_t = B_0 + B_1 * X_{t-1} + B_2 * X_{t-2} + \dots + B_j * X_{t-j} + \dots + B_p * X_{t-p} + \eta_t$

Y_t represents the debt index, which takes into account all the macroeconomic factors X_t is the vector of exogenous variables, B_j symbolizes the coefficients associated with the model variables lagged by order j , η_t is the coefficient of shocks or innovations on date t . The model can be conceptualized as follows:

Figure 2: the conceptual model



4.3. Financial scenarios

The basic financial data comes from the DDP and the Ministry of Finance and Budget as of December 31, 2020. However, before establishing the scenarios, we will present the costs and risk indicators of the existing debt portfolio.

Table 3: Costs and risks of the public debt portfolio in 2020

INDICATORS		DEBT 2019			DEBT 2020			VARIATION		
		Debt External	Debt Internal	Debt Total	Debt External	Debt Internal	Debt Total	Debt External	Debt Internal	Debt Total
Amount in billion		7 302	929	8 231	8 202	1 551	9 753	12,33%	66,95%	18,49%
Debt in % GDP		55%	7%	62%	62%	12%	68,8%	13,18%	68,22%	19,39%
Cost of debt	Interest - % GDP	1,4	0,5	2,1	1,4	0,6	1,9	0	0,1	-0,2
	Interest rate	2,9	5,8	3,6	2,8	4,7	3,2	-0,1	-1,1	-0,4
Risk of refinancing	Mean duration Ech.	11	3,6	10	11,2	3,7	9,7	0,2	0,1	-0,3
	Amortized debt /OPD	5,6	15,7	8,3	3,9	8,5	4,8	-1,7	-7,2	-3,5
	Amortized debt/GDP	2,7	1,3	4,8	1,9	1	2,9	-0,8	-0,3	-1,9
Risk of interest rate	Duration to be rescheduled	10,5	3,6	9,8	10,6	3,7	9,3	0,1	0,1	-0,5
	Debt refix/OPD	17,4	15,7	12,2	17,2	8,5	15,5	-0,2	-7,2	3,3
	Debt TIF/OPD	84,3	100	91,7	85,3	100	88,2	1	0	-3,5
Interest rate risk exchange	Foreign Currency Debt/OPD			85,5			80			-5,5
	Domestic debt			14,5			20			5,5

- **Scenario 1:** increase in the TIN by 2 points between the 1st quarter and the 4th quarter of 2021. We will see if the debt will be sustainable with a rise in the TPIB of 2% between the 1st quarter and the 4th quarter of 2021. The TIN being from 3.2% in the 1st quarter of 2021, it will therefore drop to 5.2% in the 4th quarter of 2021.
- **Scenario 1:** TCG increase of 30 points (\$171) between the 1st quarter and the 4th quarter of 2021. We will see if the debt will be sustainable with a TCG increase of 30% between the 1st quarter and the 4th quarter of 2021. The TCG being 573 in the 1st quarter of 2021; it will therefore increase to 744 in the 4th quarter of 2021.
- **Scenario 1:** increase in the REF of 6.3 points between the 1st quarter and the 4th quarter of 2021. We will see if the debt will be sustainable with an increase in the REF of 6.3% between the 1st quarter and the 4th quarter of 2021. The REF being 9.7% in the 1st quarter of 2021, it will therefore increase to 15% in the 4th quarter of 2021.

Table 4: Forecasts of macroeconomic values

PERIODE	TIR	TER	REF
2021T1	0,032	573	0,097
2021T2	0,038	630	0,114
2021T3	0,045	687	0,133
2021T4	0,052	744	0,15

V. EMPIRICAL RESULTS, ANALYZES AND DISCUSSION

5.1. Empirical results

5.1.1 Descriptive analysis

First, we will determine the mean and the standard deviation of the variables. These indicators provide information on the level of performance of the variables.

Table 5: Descriptive statistics of the variables

Variables	Mean	Standarddev.	Min.	Max.
TIR	0.04175	0.0086554	0.032	0.052
TER	658.5	73.58668	573	744
REF	0.12375	0.023372	0.097	0.151
OPD	10480	370	10295	11405
TDS	996	134.355	870	1282
SR1	0.70166	0.0236771	0.69	0.76
SR2	3.5941	0.1277397	3.53	3.91
LR	0.32083	0.0435803	0.28	0.41

Table 6: The correlation matrix

Variables	TIR	TER	REF	OPD	TDS	SR1	SR2	RL
TIR	1.000							
TER	0.0000	1.0000						
REF	0.0000	0.0000	1.0000					
OPD	0.0000	0.9999	0.0000	1.0000				
TDS	0.9899	0.9999	0.9999	-0.2179	1.0000			
SR1	0.0000	0.9965	0.0000	0.9983	-0.2118	1.0000		
SR2	0.0000	0.9998	0.0000	0.9999	-0.2200	0.9984	1.0000	
LR	0.9890	1.0000	0.9990	-0.2190	0.9991	-0.2129	-0.2211	1.0000

We can see a moderate correlation (negative and positive) between most of the variables. In our case, we notice that the strongest correlations are at the level of the TER compared to OPD and TDS, as well as the REF on TDS.

5.1.2. Tests prior to model estimation

To check the stationarity of the series of variables, we opted for the ADF (Augmented Dickey-Fuller) test.

H0: Non-stationarity of the variables

H1: Stationarity of the variables

Table 7: Study of the stationarity of the variables

Variables	Statistical test	Critical value1%	Critical value5%	Critical value10%	P-VALUE Z(t)	OBS
TIR	1.567	-3.750	-3.000	-2.630	0.9978	NON Stat.
TER	1.567	-3.750	-3.000	-2.630	0.9978	NON Stat.
REF	0.535	-3.750	-3.000	-2.630	0.9859	NON Stat.
OPD	-1.869	-3.750	-3.000	-2.630	0.3467	NON Stat.
TDS	-2.236	-3.750	-3.000	-2.630	0.1936	NON Stat.
SR1	-1.844	-3.750	-3.000	-2.630	0.3589	NON Stat.
SR2	-1.848	-3.750	-3.000	-2.630	0.3568	NON Stat.
LR	-2.155	-3.750	-3.000	-2.630	0.2231	NON Stat.

5.1.3. The results of the implementations

In order to determine the impact of the scenarios on the solvency risk, we will insert the latest data for the year 2020 into the VAR model and then at the VAR level, we will make forecasts in order to obtain the variables necessary for the determination stress test result indicators.

Table 8: Cost and risk indicators

INDICATORS		2020	2021			
		Debt Total	T1	T2	T3	T4
Amount in billion		9 753	10 295	10 295	10 295	10 295
Debt in % GDP		68,8%	68,67%	68,67%	68,67%	68,67%
PaymentInterest in % GDP		1,9	1,9	2,25	2,66	3,07
Averageinterest rate		3,2	3,2	3,8	4,5	5,2
REF	Debt due in 1 year (% OPD)	9,7	9,7	11,4	13,3	15
	Amortizeddebt/OPD	4,8	4,8	5,6	6,5	7,3
	Average time to refix - ATM	2,9	2,9	3,3	3,8	4,2
TIR	Average time to refix - ATR	9,3	9,3	9,4	9,1	9,2
	Debt reset/OPD	15,5	15,5	17,4	17,9	18,7
	Fixed Rate Debt/OPD	88,2	88,2	89,6	89,4	88,6
TER	Debt in foreigncurrency/OPD	80	80	83,6	87,2	90,8
	Dollar debt	36	36	39,6	43,2	46,8
	Debt in Euro	44	44	44	44	44

Table 9: Projections for 2021 from Scenario 1 on TIR

Rubriques	2021T1	2021T2	2021T3	2021T4
OPD	10 295	10 295	10 295	10 295
TDS	870	938	1110	1282

Tableau 10:Projections for 2021 from Scenario 2 on TER

	2021T1	2021T2	2021T3	2021T4
OPD	10 295	10 665	11 035	11 405
TDS	870	901	932	963

Tableau 11:Projections for 2021 from Scenario 3 on REF

	2021T1	2021T2	2021T3	2021T4
OPD	10 295	10 295	10 295	10 295
TDS	870	967	1076	1173

5.1.4. Results indicators

After the predictions for the year 2021 concerning the EDT and SDD variables, we will proceed to the calculation of the solvency and liquidity ratios at the level of the three defined scenarios. For this same period, we have: export 2,914 billion, GDP 14,991 billion, and budgetary receipts 3,090 billion.

Table 12: Scenario 1 indicators on TIN

	SOLVENCY			LIQUIDITY	
	OPD/GDP	OPD/EXP	OPD/REV	TDS/EXP	TDS/REV
2021T1	69%	353%	333%	30%	28%
2021T2	69%	353%	333%	32%	30%
2021T3	69%	353%	333%	38%	36%
2021T4	69%	353%	333%	44%	41%

Table 13: Scenario 2 indicators on TER

	SOLVENCY			LIQUIDITY	
	OPD/GDP	OPD/EXP	OPD/GDP	TDS/EXP	TDS/GDP
2021T1	69%	353%	333%	30%	28%
2021T2	71%	366%	345%	31%	29%
2021T3	74%	379%	357%	32%	30%
2021T4	76%	391%	369%	33%	31%

Table 14: Scenario 3 indicators on REF

	SOLVENCY			LIQUIDITY	
	OPD/GDP	OPD/EXP	OPD/GDP	TDS/EXP	TDS/REC
2021T1	69%	353%	333%	30%	28%
2021T2	69%	353%	333%	33%	31%
2021T3	69%	353%	333%	37%	35%
2021T4	69%	353%	333%	40%	38%

5.2. Analysis of results and discussion

Depending on the scenarios, we can see four scenarios in relation to the Public and publicly guaranteed debt (PPG)

- **Low risk.** If none of the PPG debt indicators exceed their respective threshold in the baseline scenario or in the extreme stress test.
- **Moderate risk.** If none of the PPG debt indicators exceeds its respective threshold in the baseline scenario, but at least one indicator exceeds its threshold in the stress tests.
- **High risk.** If any of the PPG debt indicators exceeds its threshold in the baseline scenario. Resilience tests make this situation appear even more pronounced.
- **Over-indebtedness.** The thresholds set for the debt and debt service ratios are exceeded significantly or for an extended period.

Thus, compared to the three scenarios we found that all the ratios slightly exceed the thresholds set by the DSA. This corresponds to a high risk of indebtedness. Actions must be taken to prepare for these shocks and reduce the risk to at least a moderate or low level.

The first analysis to be carried out must relate to the comparison between the ratios obtained after the stress test and the ratios set by the DSA. We have noticed that Senegal's debt is not sustainable enough in the face of the various simulated macroeconomic shocks because all the ratios of our different scenarios have exceeded the thresholds, as indicated in Tables 12, 13 and 14. Indeed, from scenarios 1, 2, and 3 the solvency ratio (in relation to GDP and export) in the 4th quarter of 2020 are respectively 69%, 353% - 76%, 391% - 69%, 353%. The same observation is made for the liquidity ratio at the level of budget revenue in the 4th quarter: 41%, 31% and 38%. This allows us to say that Senegal's debt is not sustainable in the face of exogenous shocks. However, the scenario that has the most impact on Senegal's debt situation is the exchange rate risk. Senegal has understood this situation. Indeed, between 2009 and 2021 Senegal issued Eurobonds

- 2009: 200 million dollars, interest rate 9.25% for a maturity of 5 years
- 2011: 500 million dollars, interest rate 8.75% for a maturity of 10 years
- 2014: 500 million dollars, interest rate 6.25% for a maturity of 10 years
- 2017: 1.1 billion dollars, interest rate 6.25% for a maturity of 15 years
- 2018: 2.2 billion dollars, interest rate 4.75% and 6.75, maturity 10 and 15 years
- 2021: 775 million euros, interest rate 5.375% for a maturity of 16 years

Indeed, because of the exchange rate risk, Senegal subscribed on Wednesday, June 02, 2021 to a new Eurobond issue (sovereign bonds) for 775 million euros, or 508 billion FCFA, with a fixed interest rate of 5.375% over a final maturity of 16 years. The funds obtained will be used exclusively for the redemption of approximately 70% of the Eurobond expiring in 2024 and denominated in dollars, and 30% for the financing of Senegal's participation in the development of

oil and gas projects. Therefore, the redemption of the 2014 Eurobond made it possible to deal with the exchange risk linked to the dollar. By summarizing the three tables, we obtain the table below with the SR and LR.

Table 15: comparison between SR and LR

RUB	ECONOMIC SCENARIOS								
	TIR			TER			REF		
	OPD/GDP	OPD/EXP	TDS/REV	OPD/GDP	OPD/EXP	TDS/REV	OPD/GDP	OPD/EXP	TDS/REV
2021T1	69%	353%	28%	69%	353%	28%	69%	353%	28%
2021T2	69%	353%	30%	71%	366%	29%	69%	353%	31%
2021T3	69%	353%	36%	74%	379%	30%	69%	353%	35%
2021T4	69%	353%	41%	76%	391%	31%	69%	353%	38%

➤ Discussion

The diagnosis of the concept of over-indebtedness is generally made from the crossing of a threshold, either in terms of debt service or in terms of outstanding debt.

The first analysis concerns debt service. At this level, we will focus on the issue of liquidity. Indeed, the debt burden obliges countries to lower certain charges and this could have the negative consequence of reducing investment and social spending. However, in such a situation the country can make PONZI (Ponzi scheme). This will involve borrowing to repay all or part of the debt when cash flow problems arise. This is what Senegal did in 2021; subscribe to a Eurobond to redeem 70% of the 2014 Eurobond. Therefore, the liquidity problem invoked is only relevant if the country is unable to borrow. Moreover, if the country can no longer take out a new loan, it then faces a solvency constraint or a phenomenon of credit rationing. Senegal is not in this situation, because the country continues to raise funds on the national as well as international market. The lack of liquidity to repay does not imply that the debt is not beneficial since the criterion at this level is that the economic profitability is higher than the interest rate.

In the second approach, we focus on the outstanding debt, which is at the heart of the problem. If we refer to the theory of the virtual burden of debt (Reinhart and Rogoff, 2010) we can see that if the outstanding debt exceeds a threshold, the debtor will rationally choose default. Faced with such a situation, a debt reduction will improve the debtor's repayment capacity. This approach will be the theoretical reference for the HIPC initiative of 1996, without determining the over-indebtedness thresholds that should be defined on a case-by-case basis (DSF 2005).

We will start from the theory of debt accumulation to try to assess over-indebtedness as a risk. This theory makes it possible to describe the evolution over time of a debt ratio. The analysis is carried out via a condition of transversality, which can be understood as being a dogma that prohibits the accumulation of an infinite debt (as in the Ponzi games). For an individual this condition seems natural, but on the other hand, it is not the same for a public debt. In theory, a country is an "eternal" entity. Thus, the stock of public debt is nothing other than the discounted sum of future primary budget balances, up to infinity. Therefore, if the budget balance becomes greater than the debt service each year, then the phenomenon of debt accumulation will be inevitable. The only solution is to improve our public revenues, and good management of natural resources. The basic arithmetic to this theory is that the rate of growth must be higher than the interest rate of the public debt.

VI. CONCLUSION

This article aimed to study the level of debt sustainability in Senegal. As part of our study, we simulated three scenarios from a VAR model. We have established scenarios in relation to the interest rate, the exchange rate and the refinancing. Since 2005, the IMF has implemented DSF, which requires a certain approach. As a first step, the country must have comprehensive data on the stock of public and publicly guaranteed (PPG) debt. Secondly, economic projections over 20 years must be formulated, with historical (10 previous years) and projected (20 years plus the current year) values for most variables. Finally, it is necessary to present financing assumptions in relation to the external and internal debt for the period concerned. Thresholds are established to determine the level of indebtedness of LICs. This is why these ratios (solvency and liquidity) are used to assess the resilience of the State of Senegal.

Finally, the results of the stress test showed that Senegal's debt is at a high level of debt risk, but not in over-indebtedness. Already from the reference scenario, the outstanding debt as well as the debt service remained above the set thresholds. Resilience tests have made this situation appear even more pronounced. However, Senegal is not experiencing payment difficulties. This allows us to say that Senegal's debt is sustainable. Better still; a debt sustainability analysis is carried out by the IMF as of July 31, 2019, in relation to the risk of debt distress of countries eligible for the Poverty Reduction and Growth Trust Fund (PRGF). Senegal is classified among the countries at low risk of debt (CDP, 2019, p44). This is what has allowed Senegal to regain access to financial markets and to increase bond issues in recent years, at non-concessional interest rates. Finally, we will focus on the following elements:

- Theoretical contribution: our study allows us to better confirm the Keynesian approach to debt. Indeed, the flow of budget deficits, which tends to increase the outstanding debt, will force the State to borrow to increase investment. This allows us to confirm this postulate of the deficit, which stimulates investment. However, according to this Keynesian conception, this rule remains valid only in a situation of underemployment of production resources; and this is the case of Senegal. Unfortunately, we are also witnessing a modern alternative view of Keynesian debt theory. If Keynesian theory opts for indebtedness for economic recovery, alternative approaches explore the impacts of political strategies. The ruling party may take the option of increasing public spending by going into debt, in order to satisfy its electorate at the expense of investment. Moreover, after elections, the state tends to use its taxing power to pay off its debt; which also confirms the traditional classic Ricardian approach to debt.
- Outlook: Our results force us to draw the implications in terms of financing policies to better consolidate the level of indebtedness. This is the place to recall that the DSF exerts pressure on the PFR without considering human rights. By placing restrictions on external indebtedness, the DSF can also encourage circumvention strategies, with the use of public-private partnerships (PPP) to finance new infrastructures, which accumulate 'off-balance sheet' liabilities and camouflage the true extent sovereign debt. In these PPPs we can cite linked and conditioned debts, more particularly with China, which currently occupies a central place in Africa. Today China (non-member of the Paris Club) is one of the largest creditor nations in the world. Lending to LICs has tripled over the past decade, reaching CFA 98.6 trillion (\$170 billion) by the end of 2020 (AfDB, 2020). Indeed, sub-Saharan Africa is heavily indebted, but the structure of the debt has changed with the emergence on the one hand of China, and on the other hand of Eurobonds. From 2004 to 2020, China's debt vis-à-vis sub-Saharan Africa increased from 2% to 20%.

Since 2005, bilateral debt has fallen sharply to the benefit of bond debt; especially Eurobonds. However, LICs (Low-income countries) can face two types of problems. The first is at the level of a possible restructuring of debts. The central problem is the identification and coordination of creditors for the negotiation. While the Paris Club facilitates negotiation between a debtor state and creditors, it becomes very difficult with a multitude of small holders, dispersed anonymously, without any entity being able to represent them. The second problem is the threat of vulture funds. Also known as 'litigation funds', vulture funds are investment funds that buy back sovereign debt securities from countries in difficulty at a discount and then, in court, demand repayment of all the debt at its initial value, possibly plus accrued interest, penalties and court costs. If the practices are legal, they remain illegitimate and contrary to human rights. We can cite the case of NML Capital, the fund belonging to the American billionaire Paul Singer, which should thus pocket nearly 2 billion dollars, for bonds bought back at 80 million dollars in the years 2002¹.

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