Do The WAEMU Member States Still Have Fiscal Space? Answering By "Optimal Taxation Approach"

Y. M. Isaac AMEDANOU

CERDI Laboratory, Clermont Auvergne University, Clermont Ferrand, FRANCE

Abstract. This paper, based on the optimal taxation approach, highlights the existence of an unexploited fiscal space within WAEMU that member States can use to finance their productive investments. Using Scully and quadratic models through nonstationary heterogeneous panels estimation techniques - Pooled Mean Group (PMG) and Mean Group (MG) estimators - the results provide evidence of inverse U-shaped tax-growth relationship. Our results show that since 1980, the fiscal performances recorded by the WAEMU countries are sub-optimal. The optimal level of taxes which maximizes growth over the period $1980-2017$ is 20.1% of GDP. Compared to the average tax rate of 12.6% of GDP over the study period, there is an additional uncollected tax revenue of 7.5% of GDP. Most importantly, the findings clearly show the existence of a fiscal margin that allows the mobilization of additional tax revenues in order to finance more productive investment expenditures, and thus simulate the level of economic activity by making less use of debt. The paper recommends taking measures focused on promoting fiscal citizenship, broadening of the tax base and strengthening of tax and customs administrations, especially the taxpayer tax reporting system.

Keywords: Fiscal space · optimal taxation · growth maximization · Scully Model · PMG estimator.

1 Introduction

Many developing countries, particularly those in Sub-Saharan Africa, are more and more dealing with the problem of raising additional fiscal resources to meet their growing public spending needs. For (Culpeper & Bhushan, 2010) domestic resources allow developing countries to have flexibility and freedom in the policies implemented with this freedom subject to constraints in the form of terms and conditions set by donors. Resource mobilization based on fiscal instruments is therefore the main sustainable and predictable source of financing for development and thus provides usable budget margins for the purpose of funding priority expenditures, especially in terms of investment in economic infrastructure and basic social services. Musgrave (1959) attributes three traditional functions[1] to fiscal policy: allocation of resources, income redistribution, and economic stabilization. Tax revenues are therefore an essential tool for financing growth and development.

In the recent years, the economic activity of WAEMU[2] member States has remained dynamic with an average growth rate of 6% over the period $2012-2017$, driven by investments in infrastructure, rigorous private consumption and favorable agricultural harvests, in a context of price stability. However, this economic growth has been accompanied by an increase in the ratio of public debt to GDP which stands at 47.8% in 2018 (WAEMU, 2018)[3]. This increase in public debt may reflect a low recovery of tax revenues

[1]Allocation function arises from the socially unsatisfactory and sub-optimal nature of market functioning. This is the reason why the state intervenes to meet social needs. Redistribution aims at correcting the inequalities generated by the primary distribution of income, in the sense of greater social equity. As for the stabilization function, it differs from the previous ones in that it results from the vagaries of the economic situation, which may lead to inflation and unemployment.

[2]The West African Economic and Monetary Union (WAEMU), includes 8 West African countries including Benin, Burkina Faso, Cote d'Ivoire, Guinea Bissau, Mali, Niger, Senegal and Togo. Its objective is to unify national economic areas, to transform the Union into a buoyant and attractive market for investors, and to consolidate the macroeconomic framework of the member States, through the harmonization of their economic policies, in particular their fiscal policies, as well as by strengthening their common currency.

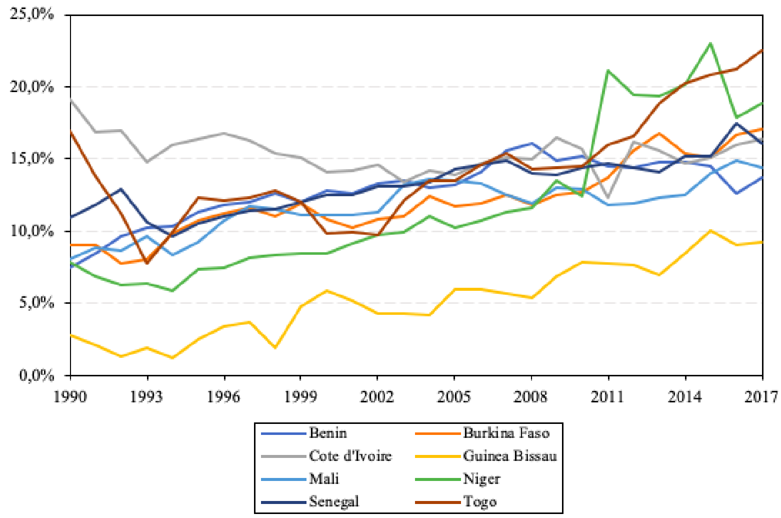
[3]Semi-annual implementation report of multilateral surveillance, WAEMU Commission, December 2018.

in member states, suggesting that government use indebtedness to finance the economy at the expense of additional fiscal resources.

Within WAEMU zone, the contribution to revenues by taxes remained low especially in the 1980s due to the existence of tariff barriers to trade, as well as low contribution to revenues by consumption taxes, particularly VAT. Before the 1990s, VAT was implemented only in two of the eight countries (Cote d'Ivoire in 1960 and Senegal in 1980). This low revenue mobilization in the 1980s therefore, motivated countries to undertake the fiscal transition which, essentially, was based on the substitution of domestic tax resources for decreasing tariff revenues.

Actually, in the zone, the tax burden[4] rate remains low and below the minimum of 20% of GDP set by ECOWAS and recommended by the United Nations Development Program (UNDP) for the financing needs of ambitious development plans such as sustainable development goals. For example, the tax burden represents on average 35% of GDP in OECD countries and is a main way to finance public goods and services. Nevertheless, in the early 2000s, some revenue collection performance was recorded in the WAEMU countries.

Fig. 1: Trends of tax rate in WAEMU Member States



Source: Author's calculation based on data taken from CBWAS
Note: CBWAS = Central Bank of West African States

The Figure 1 above shows that, between 2000 and 2017, Togo has significantly increased its level of tax revenue mobilization, which has been above 20% of GDP since 2016. Other countries also had modest performances where the tax burden rates reached in 2017, 13% in Benin, 14% in Mali, 16% in Senegal and Cote d'Ivoire, 17% in Burkina Faso and 18% in Niger. On the other hand, Guinea-Bissau, for its part, is still experiencing enormous difficulties because of the weakening due to various political crises. However, it has made very little progress and its tax revenue collection rate has stood at 9% of GDP.

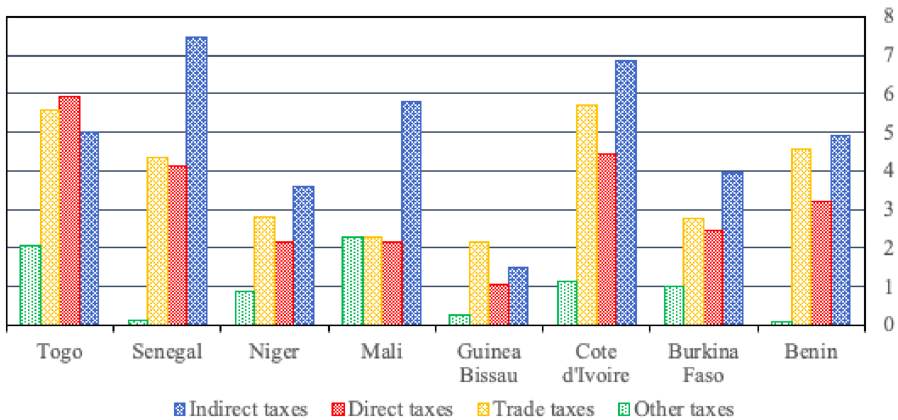
These performances in the collection of tax revenues in the countries of the zone can be explained in particular by the increase in indirect taxes, mainly due to VAT adopted by all member states (except Guinea-Bissau) and Togo was the latest to have introduced it in 1995. The high contribution of indirect taxes would be partly due to the tax harmonisation achieved in the Union. Thus, a common tax directives

[4]The tax burden rate, defined as an indicator for measuring the weight of taxes in a country's economy, is the total amount of tax revenue collected, expressed as a percentage of GDP, and indicates the share of production that is levied by the state in the form of taxes. It can therefore be considered as an indicator of state control over the resources produced by the economy. This is a key indicator of tax policy that allows for measures to improve tax revenues and fight against tax fraud and tax evasion. It is also a context and a mechanism for guiding the allocation of an economy's resources, in particular through fiscal incentives, and changing the redistribution of income and wealth.

have made it possible to regulate direct and indirect taxation in the member States since the end of 1998. This coordination has resulted in a change in the structure of tax revenues from more contributory domestic tax revenues to door-to-door tax revenues. For example, WAEMU has succeeded in defining a base for corporate tax and has regulated its rate between 25% and 30%. As for VAT, the rate is between 15% and 20%. With the exception of Niger whose rate is 19%, and Guinea-Bissau which does not have VAT but rather a general sales tax of 15%, countries currently apply VAT at a rate of 18%. The other areas of VAT harmonisation are based on extending its scope, the threshold for VAT liability, the tax base and the approximation of the arrangements for taxing and reimbursing credits.

The following Figure 2, presents the tax revenue structure of the WAEMU countries. The averages of the different tax components are expressed as a percentage of GDP. The graph shows that direct taxes are the weakest link in the mobilization of tax revenues within the zone. They are generally taxes on corporate profits and personal income taxes, and are much lower than indirect taxes. In countries such as Burkina Faso, Benin, Mali, Niger, Cote d'Ivoire and Senegal, indirect taxes accounted for just over double the direct taxes. On the other hand, direct and indirect taxes are the same in OECD countries, and each account for an average of 11% of GDP. As a result, it appears that the mobilization efforts in WAEMU focus much more on indirect taxes, in particular the VAT, than on corporate and personal income taxes. This structure reflects the economies in which informal activities predominate. Indeed, most of the inputs used in informal production comes from formal industries and this leads to its indirect taxation since VAT revenues borne on inputs cannot be refunded because informal industries are not subject to VAT.

Fig. 2: Components of tax revenue in WAEMU member States (1980-2017)



Source: Author's calculation based on data taken from ICTD and Mansour
ICTD = International Centre for Tax and Development

Two essential factors may explain the low level of tax revenue, namely tax evasion and the predominance of the informal sector. In fact, production activities not reported to the tax authorities are considered economically as informal. In 2014, within WAEMU (excluding Guinea Bissau), the average share of informal sector accounted for 50% of GDP. This predominance of the informal sector is linked to agricultural activities, in part, food and cash crops, livestock and fisheries. Farm households produce food crops for self-consumption, and therefore these products escape the market and are not subject to taxes. In addition, the agricultural sector has more than half of all informal jobs.

This significant size of the informal sector that is difficult to tax, generates a tax revenue shortfall for each member State, and thus constitutes a second factor of low tax revenue mobilization. However, this paper examines the optimality of tax return in WAEMU economies. Thus, we will answer the following questions: does the Scully curve exist in WAEMU member States? If so, at what level is it? Otherwise, what is the optimal level of taxation which maximizes growth in WAEMU context?

The optimal taxation approach is of great interest for the estimation of fiscal space. This is because it establishes a long-term relationship between economic growth and tax rate in contrast to the potential tax or tax gaps approach which allows us to rather assess the effectiveness of tax systems. The optimal tax approach allows us to show that ,WAEMU countries can increase the tax revenues necessary for sustained economic growth and the transformation of their economies without necessarily compromising the ability of economies to generate wealth. In this light, we believe that the optimal taxation approach is more effective in showing the existence of fiscal space than the potential tax or tax gaps approach.

To our knowledge, this paper is the first attempt focusing on the analysis of the growth-maximizing tax rate in the WAEMU zone. It's also the first one using the nonstationary heterogeneous panels estimation techniques while almost all studies are based on time series data. This paper should be useful both for researchers because of its empirical approach in the context of WAEMU, and for policy makers by providing to them some suggestions for improving the tax collection system to increase tax revenues.

The following sections of this paper are organized as follows: Section 2 carries out a review of the theoretical and empirical literature on the assessment of tax burden. Section 3 describes the methodological approach adopted, presents data analysis and relevant sources of data, and Section 4 discusses the findings. And, the last section concludes with policy implications of the optimal tax policy.

2 Literature review

2.1 Theoretical review

Endogenous growth models that emerged in the early 1990s with the externality of public spending on infrastructure clearly reflect the non-linear effects of taxation on long-term growth. The works of Barro (1990) shows that an increase in the tax rate provides resources to finance productive public expenditure needs but reduces the marginal productivity of private capital. There is therefore a threshold effect in the long-term taxation-growth relationship. Laffer (1981) argues that taxation can be detrimental to the economy. It postulates through the assumption of an inverse U-shaped, for the existence of tax revenues threshold. As the marginal tax rate rises, tax revenues rise to a maximum because from 100% there is erosion of tax base. Keynesian analysis of taxation is based on the principle that economic agents work to satisfy a need for well-being. It argues that high taxation will result in two effects: a substitution effect whereby economic agents may decide to work less and devote the remainder of their time to other activities, and an income effect that results in incentives for economic agents to work harder to recover their initial well-being. Smith (1776) already noted that tax could harm the activities that finance it. This intuition was modeled by a curve similar to the Laffer curve, presented in the works of Dupuit (1844). Increasing tax rates beyond its optimal level will have a negative impact on labor supply through a substitution effect whereby economic agents may decide to reduce working time by dedicating themselves to other types of work, or activities such as leisure or untaxed activities giving rise to informal economies and situations of tax fraud and evasion. Thus, there would be a tax rate not to exceed under penalty of discouraging work and the formation of income and thus a decrease in tax revenues.

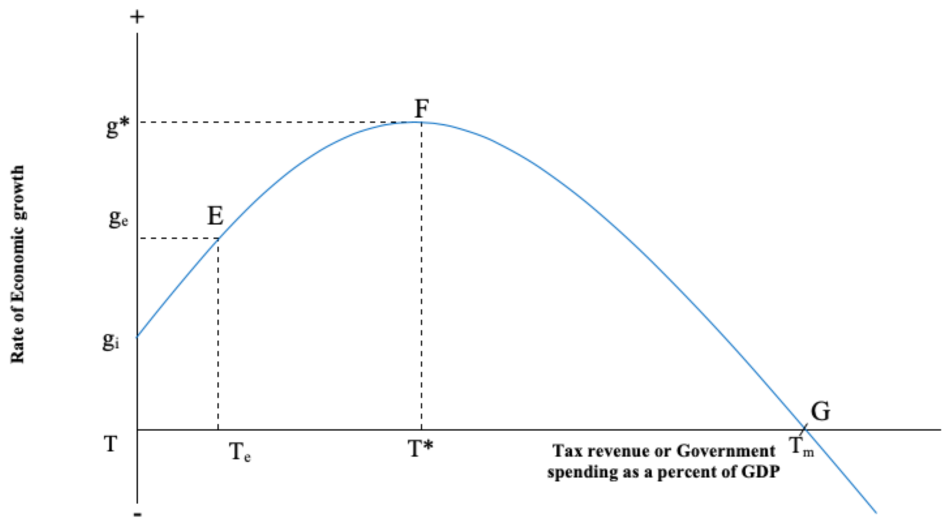
Scully (1991) shows a functional relationship between economic growth and the size of government in a given country. It illustrates this postulate from an inverted U curve called the Scully curve shown in Figure 3 below. The x-axis measures government expenditures as a percentage of national income assumed equal to tax revenues as a percent of GDP, and the y-axis represents the rate of economic growth. The inverted U-shaped curve shows the existence of a functional relationship between economic growth and the level of government spending.

The economic analysis underlying the shape of the Scully curve is as follows. First, we consider that the share of tax revenue in GDP equal to zero is associated with the growth rate (g_i). This growth rate is low because the economy is sub-optimal when the state does not provide any goods and services that are actually financed by the tax revenues collected. Under these conditions, private agents provide their own security, enforce contracts, establish standards and measures, and generally operate without the provision of many public goods and services provided by governments.

Second, we consider that in this country, there is a private sector using the supply of capital, labor and many other resources. In this case, the government taxes and spends (T_e) percent of GDP. The level of government activity then leads to a rate of economic growth (g_e). The highest growth is the result of the benefits from public goods and services provided through tax revenues, which increases overall economic efficiency in the private sector. This high efficiency results from positive externalities for the private sector due to the production of public services such as education, health, security, justice, infrastructure, monetary stability, national defense etc. Thus, at this low level of taxation corresponding to public expenditure, the deterrent effects of taxation on labor, saving and investment and risk-taking are negligible.

However, all economic activity is characterized by diminishing marginal returns. In this case, government expenditure financing individual projects is a priori meeting the most urgent needs and exploiting appropriate opportunities for the substitution of inefficient private activities. As government spending grows, other government-funded projects gain less and less productivity. At a certain level, the marginal productivities of increased public spending cancel each other out. This point corresponds to T^* in Figure 3 where tax revenues as a percentage of GDP (assumed to be equal to government expenditures) maximize the rate of economic growth. Any further increases in tax revenues and hence in government spending beyond point T^* translate into negative effects on economic growth: the Scully curve begins to decline. Thus, Figure 3 shows that at a maximum tax level (T_m), there corresponds a zero-growth rate, and that beyond, the growth rate becomes negative.

Fig. 3: Scully Curve



Source: Adapted from Chao and Grubel (1998)

Then, what are the transmission channels through which a high taxation of economic activities results in negative externalities starting from a certain given threshold? The existing literature argues that the non-linear effects of taxation on economic growth are transmitted through several mechanisms.

First, higher size of taxation of labor income can discourage labor supply. Thus, an increase in the tax rate reduces the net salary and generates a substitution effect as well as an income effect. The substitution effect reduces work incentives to the benefit of leisure with a lower opportunity cost. On the contrary, the income effect results in an incentive to work because of the decline in the real income of the individual as a result of the increase in the tax rate. Similarly, taxation can affect labor supply through taxes on consumption, which push up product prices thus reducing the real wage rate.

High tax rates can accentuate economic distortions through their impact on saving and investment. Withholding taxes on capital income reduce the net return on savings and lead as in the case of labor supply, to a substitution effect and an income effect. The substitution effect results in a decrease in savings incentives and pushes individuals to increase their current level of consumption to the detriment of their future consumption, the opportunity cost of which has decreased. As for the income effect, on the contrary, it results in a fall in the real income of the individual, which leads the latter to reduce his current consumption. When the substitution effect is greater than the income effect, then it discourages savings and taxation discriminates against future consumption expenditure. This phenomenon generates a loss of collective well-being by creating a sub-optimal level of inter-temporal transfer of resources.

Taxation could also have a disincentive effect on business investment decisions. In fact, the levies increase the cost of capital and exert through this channel, a disincentive effect on private investment expenditure. This results in aa shortage of the capital stock and therefore decreases the productivity of the labor factor. Differentiated taxation of the factors of production, especially the capital factor, is also a source of economic distortion. In most cases, there are significant differences between the marginal effective tax rates on capital income, depending on the type of investment, the source of financing and the domicile of the company. As post-tax real rates of return on investments in substitutable assets tend to converge, the result is a misallocation of resources induced by tax policy and low productivity of the capital stock than in the case where all capital income are subject to a uniform rate.

Another mechanism through which taxation affects the productive efficiency of an economy is the taxation of realized capital gains. In an economy where capital gains are taxed only at the time of their realization, the owners of securities are encouraged to postpone the realization of their gains over time: this is the "locked-in" effect. These behaviors lead to a loss of economic efficiency because they cause relative price volatility, inefficient equity management, and a delay in project maturity affecting the discounted value of tax payments.

2.2 Empirical review

Although several recent empirical studies have examined the relationship between the level of taxation and economic growth, there is a lack of such studies in developing countries (Keho, 2010). While there is unanimity in the literature on the non-linearity between taxation and long-term economic growth, the main empirical results obtained are the subject of several controversies, because of the specificity of the tax structures of the countries, the variables selected, methodological approaches, as well as some results varying over time within the same country. The empirical results of Barro (1990) based on a sample of poor and rich countries have shown that a high level of taxation has negative impacts on growth (Eaton, 1981, Skinner, 1987). Engen and Skinner (1992) have shown that a 2.5 percentage point increase in the tax burden would probably reduce long-term growth rates by 0.18 points based on data from a sample of 107 over the period $1970 - 1985$. Plosser et al. (1992) and Myles (2000) confirm these results, highlighting a negative effect of taxation on per capita growth rate in 22 OECD countries during the period $1960 - 1980$. For Leibfritz et al. (1997), a 10-point increase in the tax rate would reduce the growth rate by 0.5 percentage point in OECD economies.

Scully conducts a series of studies to determine the optimal tax level. He finds that a tax rate about 20% of GDP corresponds to a maximum growth rate. Scully (1991) uses a quadratic model with a sample of 103 countries over the period $1957-1987$, and observes that a tax rate of 19.3% would maximize growth. In 1995, using data from $1949-1989$ data, it shows that a tax rate between 21.5% and 22.9% of the Gross National Product would maximize economic growth in the United States. Scully (1998) makes the same estimates over the period $1950-1995$ and obtains an optimal tax rate of 21%. Scully (1996) highlights the existence of threshold effects in New Zealand over the period $1927 - 1994$. The results place the optimal tax rate at around 21% of GDP, with an annual growth rate of 4.8%.

Kennedy (2000) makes three criticisms of Scully's paper on the effect of taxation on economic growth (Scully, 1996). These criticisms where about the specification of the model, the test of homogeneity degree and spurious estimate of the optimal tax rate. Answering Kennedy's criticisms, Scully found that the result is not affected by incorporating factor inputs into the model, that the function is homogeneous of degree one, and that the growth maximizing tax rate is about 20 percent of GDP, as in the original paper (Scully, 2000). Scully (2003) used two different models - Barro (1990) and Scully (1996) - over the period from 1960 to 1990, and concluded that the tax rate that maximizes economic growth in the United States is 25.1 and 19.3% respectively. Scully (2006) re-examined the US data $(1929-2004)$, but for this paper using its own methodology developed in 1996 and concludes that the optimal tax rate is 23% of GDP.

Several other studies have used the Scully method to estimate the optimal size of taxation. These studies have resulted in very heterogeneous results. Chao and Grubel (1998) present some historic data about taxation by Canadian government between 1929 and 1996, and the optimal tax rate that maximizes economic growth determined using the Scully method is 34% of national income. Abdullaev, Konya, et al. (2014) have applied the Scully method to Uzbekistan data for the period 1996 – 2011 and found that the tax rate is 22% of GDP in 2001 and is 31.25% of GDP after 2001. With a modified Scully (1996) model, Davidsson (2012) concludes with a low tax rate of 11.1% of GDP in 12 randomly selected countries for the period 1982 to 2012. The results obtained by Saibu et al. (2015), showed optimal rates of 15% in South Africa over the period 1964 – 2012 and 30% in Nigeria over the period 1970 – 2012. In South Asian countries, Husnain et al. (2015) removing the government's balanced budget assumption, introduce the term deficit into the Scully model. They find that a tax rate of 13.78% would maximize economic growth over the period 1975 – 2012. Similarly, Motloja et al. (2016), applied the Scully optimization model to quarterly data collected before (i.e 1994 : $Q1$-2009 : $Q2$) and after (i.e 2009 : $Q2$-2016 : $Q2$) the 2009 crisis and set an optimal tax rate for South Africa of 22% of GDP in the post-recession period. Amgain (2017) applied the Scully (1996) and quadratic models to data from 32 Asian countries over the period 1991 – 2012, and found that the growth maximizing tax-rate is about 18% of GDP.

Scully (1998) also determines the optimal tax rate for several developed countries based on the same econometric model used to determine the optimal tax rate in the United States (Scully, 1996). The selected sample of countries includes the United States (1929 – 1989), Denmark (1927 – 1988), United Kingdom (1927 – 1988), Italy (1927 – 1988), Sweden (1927 – 1988), Finland (1927 – 1988) and New Zealand (1927 – 1994). Estimates suggest an optimal average tax rate of 20% and range from 16.6% for Sweden to 25.2% for the United Kingdom. However, the levels of taxation observed are higher and range from 34.1% in the United Kingdom to 51.6% in Denmark. These results show that taxation policy in developed countries is characterized by tax rates above optimal rates, which translates into lower growth rates in these countries. Aydin, Esen, et al. (2019) explore the impact of taxation on economic growth in transition economies, using a dynamic panel threshold model of 11 Central and South-eastern European and Baltic countries during the transition process between 1995 and 2014. The results suggest that the optimal size of taxes which maximizes growth rate is approximately 18 percent of GDP for full transition economies, 18.5 percent for developing economies, and 23 percent for developed economies. Branson and Lovell (2001) estimated the optimal tax burden for New Zealand over the period 1946 – 1995 from a linear programming model. They concluded that beyond 22.5% of GDP, taxation would become a source of economic distortion.

The empirical review reveals that studies on the tax-growth relationship within the WAEMU region are scarce. However, some of them cover a number of countries. Keho (2010) using annual data covering the period from 1960 to 2006, finds that the optimal tax rate was between 22.1% and 22.3% of GDP in Cote d'Ivoire. Similarly, by examining the optimal level of taxation in Togo over the period from 1960 to 2016, Amedanou (2019) found an optimal tax rate of 22.6% of GDP. In Burkina Faso, with annual data covering the period 1960 – 2012, the optimal tax rate is found to be 29.1% of GDP (CAPES, 2014). A brief review of empirical literature has been summarized in Table 8 (see Appendix A). Thus, our paper attempts to contribute to the empirical literature by estimating the optimal size of taxation which maximizes growth in WAEMU counties over the period 1980 – 2017.

3 Methodology, data and sources

3.1 Methodology approach

The purpose of this paper is to estimate the optimal level of taxes which maximizes growth rate for WAEMU member states. The tax rate refers to the share of tax revenue in GDP and economic growth measured by the growth rate of real GDP per capita. By doing so, this study focuses on two models. We first estimate the Scully optimization model Scully (1996) and the quadratic model.

Scully Optimization Model

Scully (1996) has developed an econometric model to determine the tax rate that maximizes economic growth. This model is preferred over empirical specifications based on the assumption of a quadratic trend between the level of taxation and economic growth. Otherwise, the results of these empirical models are consistent only when the data contain a concave parabolic trend described by the Laffer (1981) curve.
Scully considers that there are two sectors of activity within an economy: the public and private sectors. In this model, one-year tax revenues are used to finance public expenditure $G_t = \tau(Y_t)$, where (τ) is the tax burden rate and Y_t is the national income or GDP. The share of untaxed national income $(1-\tau)Y_t$, is used to finance the production of goods and services in the private sector. The level of domestic production is determined by the combination of products provided by the public and private sectors. Thus, to determine the optimal tax level, we specify a Cobb-Douglas production function as follows:

$$Y_{i,t} = \delta(G_{i,t})^{\alpha}[(1-\tau)Y_{i,t-1}]^{\gamma} \tag{1}$$

In this equation, Y is national output or GDP, G government spending to finance the production of public goods, the tax rate (τ) in year (t) of countries (i). Then δ, α and γ are the parameters.

To obtain the optimal tax rate that maximizes economic growth, we estimate the following equation (11) by a Pooled Mean Group (PMG) regression and obtain the value of the coefficient α. The different stages in obtaining this estimated equation (11) and the assumptions used are presented in Box 1 in the appendix. The slope of the independent variable (α) in log form can be directly interpreted as an elasticity and corresponds to the tax threshold maximizing economic growth. It is expressed as a percent of gross domestic product.

$$\log\left[\frac{1+g}{1-\tau}\right] = \lambda_i + \theta_t + \log\delta + \alpha\log\left[\frac{\tau}{1-\tau}\right] + \epsilon_{i,t}$$

This model is estimated without control variables (see Scully, 1996, 2000). But many economists criticize the Scully model to be inappropriate for determining the exact tax rate that would maximize economic growth (e.g. Sieper, 1996; Chapple, 1997; Easton, 1999; Kennedy, 2000 and Hill, 2008). Kennedy (2000) argues that taxation is not the only determinant of the growth rate, and since other factors influence growth, he considers that Scully's model gives a spurious and biased estimate of growth-maximizing tax rate because the contribution of capital goods to output are omitted in the production function. Scully (2000) responds to these criticisms by noting that the contribution of previously-accumulated capital and the technological changes in the aggregate production function are implicitly captured by the presence of the lag production term $Y_{i,t-1}$ in the current production function, and also demonstrates that incorporating factors inputs into the model does not change the analytical findings. Another issue in the model is the assumption of balanced budget. In fact, few countries have a balanced budget and in addition all countries in the sample have budget deficit over the entire period of the study. Nevertheless, the Scully method provides some insight for determining the optimal level of taxation to maximize economic growth.

Quadratic Model

In empirical studies, the non-linear relationship between the tax burden and economic growth is examined through econometric specifications taking into account an asymptotic distribution of the tax rate consistent with the Laffer (1981) and Scully (1996). This method consists in estimating equations in quadratic forms and is based on the assumption of an inverted U-shaped curve, which would justify the positive effect that the level of the tax burden would have on economic growth before the threshold beyond which the effect becomes negative. Thus, we specify a following growth model as a quadratic polynomial of the tax rate, associating some control variables:

$$g_{i,t} = \lambda_i + \theta_t + \delta y_{i,t-1} + \beta\tau_{i,t} + \psi\tau_{i,t}^2 + \phi' Z_{i,t} + \epsilon_{i,t} \tag{2}$$

where $g_{i,t}$ is the growth rate, $\tau_{i,t}$ is tax rate measured in terms of percent of GDP, $y_{i,t-1}$ is initial GDP per capita measuring the conditional convergence of the model and implies that countries with the highest

GDP per capita[5] face a low growth in comparison to those who have lower per capita GDP, and $Z_{i,t}$ is the set of control variables i.e. the vector of other relevant variables identified in empirical studies as factors affecting the economic growth rate of the zone, i denotes the country, t denotes the temporal fixed effect common to all countries and allows controlling the trend effect of the economic growth rate and $\epsilon_{i,t}$ is the idiosyncratic random error and is identically and independently distributed (iid) over i and t. Thus, we use as a control variable the growth rate of deficit[6] that represents a tax variable with direct effects on investment decisions and growth, the growth rate in capital stock measured by the share of total investment in GDP, the degree of openness that represents the share of foreign trade in GDP i.e. the sum of exports and imports relative to GDP, the share of shadow economy, the population growth rate and finally the growth rate of the terms of trade.
The optimal tax rate τ^*_{opm} from (2) that maximizes economic growth is obtained by differentiating $g_{i,t}$ with respect to (τ) and expressing the resultant equation in terms of τ^*_{opm} yields:

$$\tau^*_{opm} = -\frac{\beta}{2\psi} \tag{3}$$

3.2 Data and sources

In this paper, we used an unbalanced panel data for 8 WAEMU member States from the period 1980 to 2017. The details of the construction, definition and source of each variable is presented in Table 9 (see Appendix A).

Since our study is based on high temporal panel data, unit root and cointegration tests were used. We thus use three panel unit root tests, namely the test of Levin, Lin, and Chu (2002), the test of Im, Pesaran, and Shin (2003) and that of Maddala and Wu (1999) and Choi (2001)[7]. Levin et al. (2002) assuming for the homogeneity of the conclusion as to the presence of a unit root, propose to test the hypothesis ($H_0 : \rho = 0$) of presence of unit root for all the individuals of the panel against ($H_1 : \rho<0$) of absence of unit root. Thus, either we accept the hypothesis of a unit root for all the individuals in the panel, or the hypothesis of a unit root for all individuals is rejected (see Levin et al. (2002) for further details). Im et al. (2003), develop another test based on the model with individual effects and without a deterministic trend similar to model 2 in Levin et al. (2002), considering that it is unlikely that in the event of rejection of the unitary root hypothesis, we can accept the hypothesis of an autoregressive root common to all individuals. The peculiarity is that it allows under the alternative hypothesis, both a heterogeneity of the autoregressive root ($\rho_i \neq \rho_j$) and a heterogeneity as to the unit root in the panel (Hurlin & Mignon, 2005). Maddala and Wu (1999) postulate for a heterogeneity of the autoregressive root and propose a non-parametric test of Fisher (1932). This test is based on the levels of significance i.e. probability values of N individual tests of independent unit root. Let $p_i = F_{Ti}(q_i)$ be the p-value associated with a test statistic (q_i) of the null hypothesis of unit root for a given individual (i) where (F) represents the distribution function associated with the individual statistic (q_i) for a sample of size (Ti). The (q_i) test statistic can be chosen as the t-statistic of an ADF test or the statistic of any other test of the null unit root hypothesis (e.g. Phillips & Perron, 1988).

Table 1 below presents the results of null hypothesis unit root tests for each of our variables. The Levin et al. (2002) test were not administered for tax burden, square of tax burden, deficit growth, and shadow economy because they have missing values, whereas the Levin et al. test requires strongly balanced data. All tests reveal that the variables GDP per capita growth, population growth, investment, terms of trade growth, deficit growth, share of agriculture and openness are stationary while tax burden, square of tax burden, Initial GDP per capita and shadow economy are non-stationary. Thus, we considered it appropriate to administer panel cointegration tests to examine the existence of a potential long-term relationship.

[5]Initial GDP per capita is the one year lag of GDP per capita

[6]The growth rate of deficit is calculated as revenue minus total expenditure, expressed as a percent of GDP.

[7]Maddala and Wu (1999) and Choi (2001) use statistics from the Augmented Dickey Fuller (ADF) and Phillip Perron (PP) tests.

Table 1: Results of Unit roots tests

Variables	Tests	Statistics	P-values	Stationary or Not Stationary
GDP per capita growth	Levin, Lin and Chu	-6.81	0.00	ST
	Im, Pesaran and Shin W-stat	-9.27	0.00	ST
	ADF- Fisher Chi-square	146.73	0.00	ST
Tax burden	Levin, Lin and Chu	-	-	-
	Im, Pesaran and Shin W-stat	0.85	0.80	NST
	ADF- Fisher Chi-square	13.54	0.63	NST
Square of tax burden	Levin, Lin and Chu	-	-	-
	Im, Pesaran and Shin W-stat	0.82	0.79	NST
	ADF- Fisher Chi-square	18.13	0.31	NST
Initial GDP per capita	Levin, Lin and Chu	1.96	0.98	NST
	Im, Pesaran and Shin W-stat	1.92	0.97	NST
	ADF- Fisher Chi-square	23.45	0.10	NST
Population growth	Levin, Lin and Chu	-5.21	0.00	ST
	Im, Pesaran and Shin W-stat	-6.45	0.00	ST
	ADF- Fisher Chi-square	105.93	0.00	ST
Investment	Levin, Lin and Chu	-1.47	0.07	ST
	Im, Pesaran and Shin W-stat	-2.13	0.01	ST
	ADF- Fisher Chi-square	41.14	0.00	ST
Terms of trade growth	Levin, Lin and Chu	-8.72	0.00	ST
	Im, Pesaran and Shin W-stat	-10.16	0.00	ST
	ADF- Fisher Chi-square	156,69	0.00	ST
Deficit growth	Levin, Lin and Chu	-	-	-
	Im, Pesaran and Shin W-stat	-3.78	0.00	ST
	ADF- Fisher Chi-square	51.36	0.00	ST
Share of agriculture	Levin, Lin and Chu	-2.49	0.00	ST
	Im, Pesaran and Shin W-stat	-2.63	0.00	ST
	ADF- Fisher Chi-square	36.94	0.00	ST
Openness	Levin, Lin and Chu	-1.91	0.02	ST
	Im, Pesaran and Shin W-stat	-2.57	0.00	ST
	ADF- Fisher Chi-square	36.35	0.00	ST
Shadow economy	Levin, Lin and Chu	-	-	-
	Im, Pesaran and Shin W-stat	0.63	0.73	NST
	ADF- Fisher Chi-square	18.41	0.30	NST

Source:Authors' estimation

Westerlund and Edgerton (2007) proposed a panel cointegration test[8] with several structural breaks, using an error-correction model to examine whether or not there is error correction for the global panel or groups of individuals. The error correction tests assume the following data-generation process in which $t = 1, \ldots, T$ is the time-series, $i = 1, \ldots, N$ index the cross-sectional units, the values of p_i and q_i represent respectively, the number of lags and leads, while d_t contains the deterministic components that we assume to be equal to $(1,t)^{'}$ and consequently $\Delta Y_{i,t}$ is generated with a constant and a trend in the co-integration relationship.

$$\Delta y_{i,t} = \alpha_i^{'} d_t + \delta_i (y_{i,t-1} - \theta_i^{'} x_{i,t-1}) + \sum_{k=1}^{p_1} \delta_{i,k} \Delta y_{i,t-k} + \sum_{k=-q_i}^{p_1} \lambda_{i,k} \Delta x_{i,t-k} + \epsilon_{i,t} \quad (4)$$

However, in order to estimate the error correction parameter δ_i by using least squares method, we can write the previous (4) as:

$$\Delta y_{i,t} = \alpha_i^{'} d_t + \delta_i y_{i,t-1} - \beta_i^{'} x_{i,t-1} + \sum_{k=1}^{p_1} \delta_{i,k} \Delta y_{i,t-k} + \sum_{k=-q_i}^{p_1} \lambda_{i,k} \Delta x_{i,t-k} + \epsilon_{i,t} \quad (5)$$

[8]This is a more general criterion of cointegration from the Pedroni (1999) test which offers the possibility of taking into account the multiple structural breaks in both the level and the trend of a cointegrated panel regression with different methods of constructing statistics to test the null hypothesis of no co-integration.

where $\beta_i^{'} = -\delta_i\theta_i^{'}$, and the parameter δ_i determines the speed at which the system corrects back to the equilibrium relationship $y_{i,t-1} - \theta_i^{'}x_{i,t-1}$ after a sudden shock. Both middle terms include lags operators and directions of Δ_x to ensure the exogeneity of x_i. The four panel cointegration tests of Pedroni (1999) are all based on the least squares estimates of δ_i in equation (5) and its t-ratio. For appropriate values of p_i, estimates are made separately $\forall i$. If $\delta_i = 0$, then there is no error correction which implies that $y_{(i,t)}$ and $x_{(i,t)}$ are not cointegrated. If δ_i <0, then there is error correction which implies that $y_{(i,t)}$ and $x_{(i,t)}$ are cointegrated. We run a total of four tests, all based on group average and pooled panel: in case of no reject, the bootstrap procedure is used to obtain the robust critical values. The results from the cointegration tests are recorded in the following Table 2.

Table 2: Results of Westerlund's cointegration tests

Dependant variable: GDP per capita growth				
Variables	Tests	Statistics	P-values[9]	Cointegration or No cointegration
Tax burden	Gt	-4.45	0.05	Cointegrated
	Ga	-36.56	0.07	Cointegrated
	Pt	-9.98	0.03	Cointegrated
	Pa	-26.09	0.19	No Cointegrated
Square of tax burden	Gt	-4.76	0.01	Cointegrated
	Ga	-31.97	0.14	No Cointegrated
	Pt	-10.21	0.06	Cointegrated
	Pa	-28.56	0.11	No Cointegrated
Population growth	Gt	-5.18	0.04	Cointegrated
	Ga	-36.99	0.77	No Cointegrated
	Pt	-11.81	0.71	No Cointegrated
	Pa	-40.56	0.74	No Cointegrated
Investment	Gt	-5.37	0.00	Cointegrated
	Ga	-48.31	0.00	Cointegrated
	Pt	-12.84	0.01	Cointegrated
	Pa	-41.36	0.00	Cointegrated
Terms of trade growth	Gt	-5.53	0.03	Cointegrated
	Ga	-43.81	0.00	Cointegrated
	Pt	-12.12	0.05	Cointegrated
	Pa	-39.88	0.02	Cointegrated
Initial GDP per capita	Gt	-5.54	0.01	Cointegrated
	Ga	-24.05	0.08	Cointegrated
	Pt	-12.67	0.45	No Cointegrated
	Pa	-26.59	0.26	No Cointegrated
Deficit growth	Gt	-4.55	0.07	Cointegrated
	Ga	-37.18	0.03	Cointegrated
	Pt	-11.48	0.02	Cointegrated
	Pa	-38.38	0.00	Cointegrated
Share of agriculture	Gt	-4.49	0.03	Cointegrated
	Ga	-47.17	0.00	Cointegrated
	Pt	-11.11	0.03	Cointegrated
	Pa	-39.26	0.00	Cointegrated
Openness	Gt	-4.71	0.01	Cointegrated
	Ga	-41.14	0.02	Cointegrated
	Pt	-11.31	0.01	Cointegrated
	Pa	-37.88	0.00	Cointegrated
Shadow economy	Gt	-4.41	0.12	No Cointegrated
	Ga	-42.06	0.58	No Cointegrated
	Pt	-13.47	0.41	No Cointegrated
	Pa	-40.40	0.71	No Cointegrated

Source:Authors' estimation

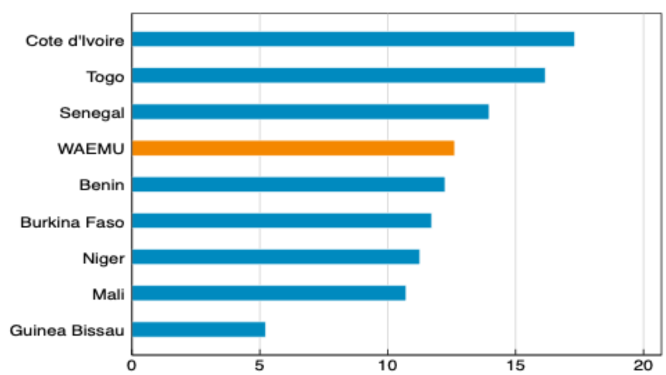
[9] G_t, G_a and P_t, P_a are respectively the group-mean and the panel statistics. The null hypothesis of no cointegration for all countries in the panel is considered in the Westerlund's panel cointegration tests. Large negative values of the test statistics imply that the null hypothesis can be rejected. The p-values are for one-sided test based

Typically, in panel cointegration tests, the presence of cross-sectional dependence makes inference based on the asymptotic normal distribution inadequate. To account for cross-sectional dependence, inference must be based on the robust p-values that generated by using the bootstrap approach of Westerlund and Edgerton (2007). The results from the robust p-values of the cointegration tests in our study suggest the existence of a cointegration relationship between GDP per capita growth and the determinants of the economy in the WAEMU region. As a result, two nonstationary data techniques were used: the Pooled Mean Group (PMG) estimator which relies on a combination of pooling and averaging of coefficients (Pesaran, Shin, & Smith, 1997) and the Mean Group (MG) estimator which relies on estimating N time-series regressions and averaging the coefficients (Pesaran & Smith, 1995). Then Hauman's test was conducted to choose the best technique. Indeed, the PMG estimation procedure estimates the model assuming that the long-term effects are forced to be equal in all individuals or special groups. On the other hand, the short-term coefficients are allowed to differ. For the MG technique, the model coefficients are calculated from the weighted average of the fully heterogeneous non-containment model.

Descriptive analysis

Figure 4 below illustrates the average size of tax revenues as a percentage of GDP over the period 1980-2017. This graph shows that the average level of tax burden in 6 countries in the zone is less than 15 percent of GDP. These are countries such as Burkina Faso, Benin, Guinea Bissau, Mali, Niger and Senegal. The average tax revenue for the entire sample over the period is 12.6 percent of GDP, which remains low compared to the average in Africa at 19.1 percent of GDP and that of other regions in the world as in Latin America standing at 22.3 percent of GDP where tax structures are comparable to those in Africa. Only Cote d'Ivoire has average tax revenues above 17 percent of GDP.

Fig. 4: Status of average tax burden in WAEMU countries (1980-2017)

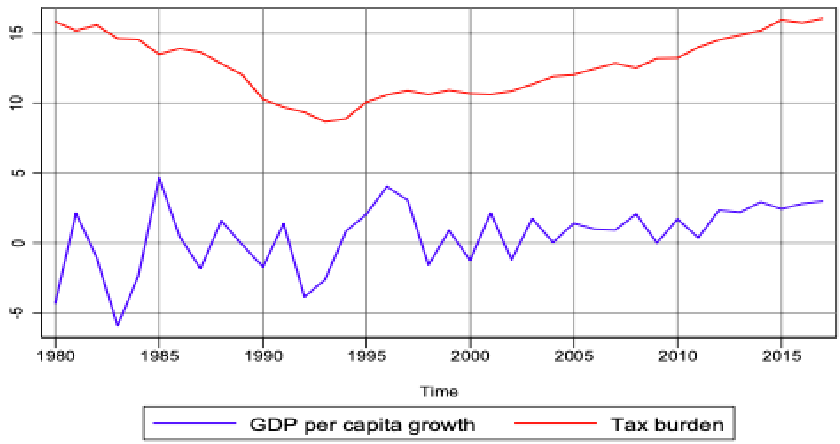


Source: Author's calculation based on data taken from CBWAS
CBWAS=Central Bank of West African States

By observing the linear relationship between tax level and growth, we find a quasi-positive correlation. Figure 5 below shows the trends in average tax burden and per capita GDP growth rate. The average tax rate is represented by the upper line, and the lower line represents the average growth of GDP per capita. We find that the relationship between the two variables is subject to positive externalities. The underlying argument of this positive relationship is such that the size of taxation in the WAEMU countries remains low, and therefore cannot create distortions as in the case of countries with strong taxation.

on the asymptotic normal distribution, and the robust p-values are for one-sided test based on the bootstrapped distribution. We use 1000 bootstrap replications in our cointegration test.

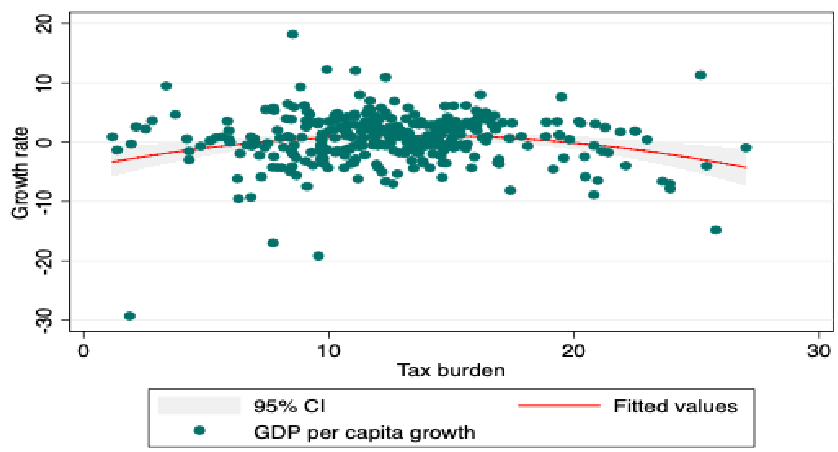
Fig. 5: Linear relationship between tax burden and Growth in WAEMU



Source: Author's calculation based on data taken from WDI and CBWAS
CBWAS=Central Bank of West African States

If we observe the Figure 6 below, illustrating the non-linear effects of taxation on growth, we find an inverted U-shaped relationship. On this graph, the tax burden is in x-axis and per capita GDP growth is in y-axis. The curve shows up to a certain threshold, probably between 15-20 percent of GDP, taxation has a positive impact on growth and beyond this threshold, the impact becomes negative.

Fig. 6: Quadratic line fit between tax rate and growth in WAEMU Member States



Source: Author's calculation based on data taken from WDI and CBWAS
CBWAS=Central Bank of West African States

Table 3 below shows both evolution of the annual average rate of tax burden and economic growth rate over the period 1997 − 2016, subdivided in five-year[10] period, for the countries of the Economic Community

[10]Two arguments justify the use of the five-year average. The economic argument considers that the five years are reasonable enough to capture the influence of taxation on economic growth. But less than five years, tax-financed public investments in the form of large public infrastructure projects will not be implemented. In contrast, a period longer than five years may call into question the reliability of the statistical relationship between revenue shocks and expenditure and the public decision-making process. The statistical argument considers that measuring variables as five-year averages limits noise in high-frequency data from measurement errors. Dollar and Kraay (2002) advise using the five-year averages to avoid the unnecessary introduction of noise in the synchronization of distribution data and other variables considered.

Of West African States, ECOWAS. This table shows that countries in the WAEMU zone have a higher tax burden than other ECOWAS countries. However, the difference in average GDP growth per capita remains ambiguous. The table also provides information on the country homogeneity effect of the relationship between taxation and economic growth in west African countries.

Table 3: Taxation - Growth relationship in ECOWAS Countries, 1997–2016

Five-year average (%) of	1997-01	2002-06	2007-12	2012-16	1997-01	2002-06	2007-12	2012-16
	GDP per capita growth				Tax burden			
WAEMU countries								
Benin	2.15	0.58	0.77	2.01	12.8	14.3	15.4	14.3
Burkina Faso	2.95	3.24	2.44	2.21	11.2	11.7	12.6	15.4
Cote d'Ivoire	-0.90	-1.56	-1.18	6.33	15.0	14.1	15.6	16.2
Guinea Bissau	-4.32	-0.40	1.98	0.36	4.9	5.1	6.8	8.5
Mali	3.82	1.73	1.01	1.05	11.0	13.2	12.6	13.3
Niger	-0.03	0.02	0.67	2.76	8.5	10.7	13.8	15.1
Senegal	2.12	1.56	0.36	2.37	15.5	17.7	18.6	19.4
Togo	-0.61	-0.40	2.09	3.17	12.2	14.4	15.7	18.9
ECOWAS countries outside WAEMU								
Cape Verde	7.94	5.20	4.04	0.43	15.2	18.8	20.0	18.5
Gambia	10.87	-1.05	0.38	0.00	10.9	11.9	14.4	15.8
Ghana	9.66	2.82	5.34	2.62	9.7	12.5	13.2	14.7
Guinea	7.68	0.62	1.78	3.14	7.7	8.4	10.1	13.7
Liberia	-0.75	-4.48	3.32	0.60	11.9	12.2	17.0	19.1
Nigeria	0.86	6.13	4.14	0.93	7.7	8.2	7.2	N/A
Sierra Leone	-3.13	5.65	3.10	2.85	6.6	8.6	8.7	10.0

Source:Author's calculation based on data taken from ICTD and WDI

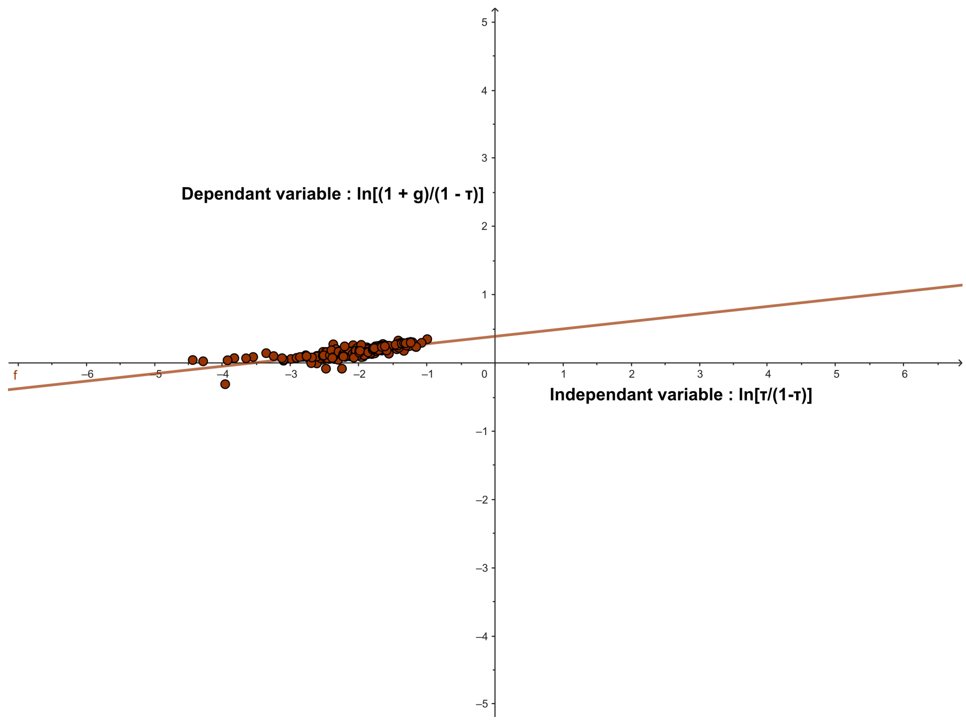
For example, if we look at the WAEMU countries, we note that tax revenues as a percent of GDP followed an upward trend over the period. At the same time, growth rates of GDP per capita similarly showed an increasing trend. Thus, the increase in taxation levels is accompanied by an improvement in living conditions in the countries. However, this remark raises the problem of the effects of a structurally weak level of taxation on economic growth within WAEMU. However, it should also be noted that in some countries, such as Burkina Faso and Guinea Bissau, greater mobilization of tax revenue as a percentage of GDP has resulted in lower levels of welfare, especially over the last 10 years. Outside the WAEMU zone, the increase in tax revenues as a percent of GDP has been followed by a decline in living standards in countries such as Ghana, Gambia, Guinea and Cape Verde. Observations from some countries remain inconsistent. For example, Nigerians saw their standard of living deteriorate despite the lowering of the tax rate on end-period values in particular. The relationship between tax and growth in other countries such as Liberia and Sierra Leone remains ambiguous. It should therefore be noted that within the ECOWAS region, countries have an annual tax level of less than 20 percent of GDP (minimum tax revenue as a percent of GDP set by the ECOWAS convergence criteria) and low average rates of economic growth. In all countries tax revenue levels as a percent of GDP remain below the required tax threshold. These countries, however, have an untapped budget space that can enable them to generate more tax revenue that can maximize economic growth rates. This observation partially answers our problem concerning the existence or not of a tax potential within WAEMU member States.

In the case of the WAEMU countries, this conclusion is consistent with Figure 6 which illustrates the non-linearity between the level of taxation and economic growth. On the other hand, this graphical representation does not take into account the other factors besides the tax burden, which determine economic growth. This may eventually call into question the margin of the optimal tax rate identified. As a result, it seems imperative to carry out an empirical investigation in order to more accurately detect the tax-growth relationship within WAEMU.

4 Empirical results

The results of the Scully model estimation (equation (11)) are presented in Table 4. The model is defined such that the dependent variable includes logarithm of $(1+g)$ divided by $(1-\tau)$, and the independent variable includes logarithm of tax revenue as a percent of GDP (τ) divided by $(1-\tau)$. The coefficient (α) associated with the independent variable $ln[\tau/(1-\tau)]$ is an elasticity and corresponds to the optimal tax burden. Figure 7 below shows the regression line and the empirical observations. We represent on the x-axis the independent variable and the dependent variable is represented in the y-axis.

Fig. 7: Parameter estimation and regression line of Scully Model



Source: Author's calculation

The unit root test (Table 4) showed that dependent variable $ln[(1+g)/(1-\tau)]$ is stationary while the independent variable $ln[\tau/(1-\tau)]$ is nonstationary. The cointegration tests of (Westerlund & Edgerton, 2007) were also carried out and the results are shown in Table 5. However, considering the non-stationarity and the increase in time observations in our panel of 8 WAEMU countries over $1980-2017$, we use two nonstationary dynamic panels estimation techniques: the mean-group (MG) and the pooled mean-group (PMG) estimators.

Table 4: Results of Unit root tests of Scully Model

Variables	Tests	Statistics	P-values	Stationary or not Stationary
Dependante variable	Levin, Lin and Chu	-	-	-
	Im, Pesaran and Shin W-stat	-3.06	0.00	ST
	ADF- Fisher Chi-square	38.97	0.00	ST
Independant variable	Levin, Lin and Chu	-	-	-
	Im, Pesaran and Shin W-stat	0.48	0.68	NST
	ADF- Fisher Chi-square	12.69	0.69	NST

Table 5: Results of Westerlund's cointegration tests of Scully Model

Dependant variable				
Variables	Tests	Statistics	P-values	Cointegration or No cointegration
Independant variable	Gt	-4.80	0.04	Cointegrated
	Ga	-43,19	0.02	Cointegrated
	Pt	-11.05	0.24	No Cointegrated
	Pa	-31.54	0.13	No Cointegrated

The Hausman statistic obtained from the test is 0.36 (p-value = 0.5466) and follows a Chi2 distribution, meaning that the PMG estimator is preferred. The coefficient of the independent variable given by the PMG estimator is found to be 0.145. Therefore, the optimal tax burden that would maximize economic growth in the WAEMU is 14.5 percent of GDP.

Table 6: Empirical estimation of the Scully model

Δ(Dependant variable)	Pooled Mean-Goup Estimator (Pesaran et al., 1997, 1999)	Mean-Group Estimator (Pesaran & Smith, 1995)
LR		
Independent variable	0.145***	0.139***
	(0.000)	(0.000)
SR		
Error correction term (ec)	-0.979***	-1.023***
	(0.000)	(0.000)
Δ(Independent variable)	0.093**	0.087**
	(0.015)	(0.025)
Constant	0.451***	0.462***
	(0.000)	(0.000)
Number of Observations	279	279
Number of Countries	8	8
Efficient estimator	Yes	No
Hausman test/ Ho: difference in coefficients not systematic		
Statistic	Chi2(1) = 0.36	
Pvalue	Prob>Chi2 = 0.5466	

Note: Pvalues in parentheses.*,**, and *** denote significance levels at 10%, 5%, and 1%, respectively. Estimations are done by using xtpmg routine in Stata. The dependent variable corresponds to the transformed expression for the growth rate, and the independent variable corresponds to the transformed expression for the tax rate. Pooled mean group and mean group, both controlling for country and time effects. While the first Panel (LR) shows long-run effects, and the second panel reports both short-run effects (SR) and the speed of adjustment (ec). Hausman test is indicating that PMG is consistent and efficient estimation.

Since the Scully model has been much criticized, we use an alternative method which consists in estimating a quadratic relation integrating the square of the tax burden. This model includes a number of control variables. Next, we carry out two robustness tests, the first for political stability by introducing the variables regulation of political participation and the durability of political regime, and the second for quality of institutions by introducing a synthetic index of institutional quality[11].

The Pooled Mean Group estimator was used for estimating the quadratic model. The choice of this technique is based on the Hausman test. The results of Hausman test are shown in Table 8 in appendix. The Hausman statistic is 1.88 ($pvalue = 0.5986$) and indicates that the PMG estimator is more efficient and consistent than MG under null hypothesis. Thus, the PMG estimator is retained for the following estimates. The model is valid since the error correction term is negative ($ec = -1.235$) and statistically non-zero ($pvalue = 0.010$). The tax burden has a positive effect on growth with the coefficient 1.166, while the square of the tax burden has a negative effect with the coefficient -0.034, and both are significant

[11]Variables such as the regulation of political participation, the durability of political regime and the synthetic index of institutional quality are clearly defined in the Table 10 in Appendix.

at 1%. The signs of the coefficients confirm an inverse U-shaped relationship between tax burden and economic growth. The optimal tax burden has been calculated in the table by using the formula as derived in equation 3 and found to be 17.24% of GDP. Up to this point the tax burden has a positive effect on growth, and growth starts with decreasing beyond this point.

But since the idea is to take into account the omitted variables in the Scully model, we estimate the quadratic model by adding the control variables. The results are presented in the following Table 7 (column 1), and show that the model is seem to be more sensitive. The error correction coefficient is negative and statistically non-zero ($ec = -2.103$; $pvalue = 0.042$). In the long run, economic growth is determined by the growth rate of terms of trade, the share of shadow economy, investment, the degree of openness and the share of value added in agriculture. Shadow economy, the growth of investment and the share of agriculture have a positive impact while the growth rate of terms of trade and the degree of openness have a negative impact. But, in the short term, it is the variables population growth rate and shadow economy that influence economic growth, and both of which have a negative impact. The optimal tax rate estimated for this model is 18.88% of GDP.

The sensitivity tests of the results are presented in the right part of the Table 7. The variable Initial per capita GDP has been removed from sensitivity analysis because of collinearity due to the fact that institutions are likely to be endogenous. Thus, it is imperative for countries to mobilize time and resources to build strong institutions. In other words, the richer the country, the more likely it is to have good institutions and thus political stability.

First, we test the sensitivity of the threshold to political stability (columns 2 and 3). Aizenman and Jinjarak (2005) have shown that political stability improves the collection of VAT. This suggests that the conditions of political stability are favorable to the tax revenues mobilization, and thus would have an impact on the estimated optimal tax rate. Indeed, we use two variables of political stability (Aizenman & Jinjarak, 2005) including the durability of the political regime and the regulation of political participation, which we introduce one after the other. Considering the result of column 2 the durability of the political regime has not a significant impact. However, the model is valid, since the error correction coefficient is negative and statistically non-zero ($ec = -1.008$; $pvalue = 0.000$). The tax burden has a positive impact with the coefficient 0.865, while the square of tax burden has a negative impact with the coefficient -0.026 and are respectively significant at 1% and 5%. The tax threshold associated with this model is 16.42% of GDP. On the other hand, the result of column 3 including the regulation of political participation as an indicator of political stability shows that the optimal tax burden is 15.28% of GDP. The regulation of political participation has a significant and long-term negative effect on economic growth, but this effect is statistically null in the short term. This model is also valid ($ec = -1.054$; $pvalue = 0.000$). The tax burden has a positive effect with the coefficient 0.724 while the square of tax burden has a negative effect with the coefficient -0.024 and they are both significant at 1%.

Second, we test the sensitivity of the model with respect to quality of institutions[12] (column 4), according to Ajaz and Ahmad (2010) who found that developing countries face a number of institutional problems in revenue mobilization. The robustness check shows that institutional quality has no significant statistical impact on short and long term growth. Indeed, considering the validity of the model ($ec = -1.086$; $pvalue = 0.000$) and the expected signs of the tax variables (the coefficients of tax burden is 0.868; the square of tax burden coefficient is -0.022) the optimal tax rate estimated for this model is 20.06% of GDP.

Given the results from the two different models estimated, our study conclude that the optimal tax rate that would maximize economic growth is between 14.5% and 20.1% of GDP in the WAEMU Member States.

We also address in this paper the homogeneity issue of the tax thresholds obtained. Indeed, papers that estimate optimal tax rates for panel groups are not asked about the homogeneity of these optimal tax rates. In fact, the optimal tax rate may vary from one country to another depending on the characteristics of each country. In the case of our study, the WAEMU countries present some differences in terms of

[12] Quality of institutions is the arithmetic mean of ICRG indices of Bureaucracy quality, Law and order, and Control of corruption. These data are not available for Benin, and therefore estimates were made for the other 7 countries of the Union.

geographical location, some being coastal countries while others are Sahelian, as well as different levels of political stability and industrialization. These parameters may cause the optimal tax rate to differ from one country to another. To overcome this criticism, it seemed important for us to check whether the optimal rates of taxation are homogeneous or not. But contrary to that, the estimation method we used, especially the Pooled Mean Group (PMG) does not allow us to remove this concern, because it assumes that the long-term effects are forced to be equal for all individuals or special groups and only the short-term coefficients are allowed to differ. Therefore, given that our paper focuses on the long-run relationship between taxation and growth, we felt that it was not necessary to report these results on short-term relationships, since they are the only ones that are supposed to differ between countries or panel groups. Nevertheless, the results are available upon request from the authors. Similarly, the level of the optimal tax rate may differ depending on the nature of the tax in question. Since the WAEMU countries have a rather particular fiscal structure, it would be interesting to break down the tax burden variable into its various components such as corporation tax, personal income tax, VAT and customs duties to quantify the different tax margins associated with each type of tax.

Table 7: Empirical estimation of the Quadratic model

Δ(GDP per capita growth)	Estimated Model	Robustness with respect to: Political Stability		Robustness with respect to: Quality of institutions
LR				
Tax burden	0.520***	0.865***	0.742***	0.868***
	(0.002)	(0.001)	(0.000)	(0.001)
Tax burden square	-0.014**	-0.026**	-0.024***	-0.022*
	(0.023)	(0.012)	(0.002)	(0.053)
Population growth	0.072	-0.367	-1.638**	-1.510**
	(0.457)	(0.617)	(0.025)	(0.048)
Terms of trade growth rate	-0.020***	-0.007	-0.003	-0.008
	(0.000)	(0.293)	(0.639)	(0.226)
Shadow economy	0.040***	-0.032	-0.110***	-0.073*
	(0.010)	(0.401)	(0.001)	(0.078)
Investment	0.107***	0.066*	0.083**	0.043
	(0.000)	(0.054)	(0.011)	(0.185)
Deficit	-0.035	-0.171	-0.429***	-0.153
	(0.149)	(0.167)	(0.001)	(0.290)
Openness	-0.023***	0.029	0.054**	0.021
	(0.000)	(0.319)	(0.043)	(0.479)
Share of agriculture	0.035***	0.025	0.061	-0.019
	(0.000)	(0.612)	(0.225)	(0.720)
Initial per capita GDP	-0.006***			
	(0.000)			
Durability of political regime		0.014		
		(0.601)		
Regulation of political participation			-0.803***	
			(0.005)	
Quality of institutions				0.252
				(0.151)
SR				
Error correction term (ec)	-2.103**	-1.008***	-1.054***	-1.086***
	(0.042)	(0.000)	(0.000)	(0.000)
Δ(Tax burden)	-0.328	0.015	5.137	0.364
	(0.728)	(0.988)	(0.314)	(0.701)
Δ(Tax burden square)	0.017	0.014	-0.160	-0.006
	(0.625)	(0.675)	(0.324)	(0.813)
Δ(Population growth)	-10.775***	5.985	9.688	5.632
	(0.001)	(0.470)	(0.306)	(0.675)
Δ(Terms of trade growth rate)	-0.003	-0.017*	-0.021	-0.015
	(0.852)	(0.086)	(0.101)	(0.215)
Δ(Shadow economy)	-0.967***	-0.831***	-0.680***	-0.875***
	(0.000)	(0.000)	(0.002)	(0.000)
Δ(Investment)	-0.019	0.062	0.030	0.044
	(0.737)	(0.264)	(0.612)	(0.474)
Δ(Deficit)	0.269	0.244	0.382	0.240
	(0.319)	(0.245)	(0.111)	(0.262)
Δ(Openness)	-0.101	-0.121**	-0.119**	-0.136*
	(0.134)	(0.016)	(0.020)	(0.060)
Δ(Share of agriculture)	-0.007	-0.015	0.012	-0.025
	(0.969)	(0.897)	(0.931)	(0.877)
Δ(Initial per capita GDP)	0.136			
	(0.355)			
Δ(Durability of political regime)		-0.025		
		(0.898)		
Δ(Regulation of political participation)			0.344	
			(0.141)	
Δ(Quality of institutions)				-0.022
				(0.935)
Constant	-6.089	-6.344***	1.698**	0.556
	(0.199)	(0.000)	(0.019)	(0.510)
No. of Observations	192	192	171	168
No. of Countries	8	8	8	7
Efficient estimator	PMG	PMG	PMG	PMG
Optimal tax rate	18.88	16.42	15.28	20.06

Note: Pvalues in parentheses. *,**, and *** denote significance levels at 10%, 5%, and 1%, respectively. The first Panel (LR) shows long-run effects while the second panel reports both short-run effects (SR) and the speed of adjustment (ec).

5 Conclusion and policy implications

This paper shows the existence of a fiscal space within the WAEMU zone through an optimal taxation approach. In fact we examine the optimality of tax yield within the WAEMU area for $1980 - 2017$, using the Scully and quadratic models. The results confirm the evidence of an inverted U-shaped tax-growth relationship. The optimal tax rate to maximize growth for 8 WAEMU countries is around 20% of GDP.

The analysis reveals a structurally low level of taxation throughout the study period. The average tax revenue for all 8 countries over the period $1980 - 2017$ is 12.6% of GDP and then the level of tax revenue likely to maximize the rate of economic growth is about 7.5 percentage points higher than the current level. These results illustrate the inability of WAEMU countries to mobilize tax revenues up to the required tax threshold. This low level of taxation causes countries to lose substantial revenue and thus reduce their budget space. These countries thus find themselves in a situation characterized by a limited margin of public finances with relatively high debt ratios leading to brake the economic growth. Thus, within WAEMU there would be a substantial fiscal margin that would allow governments to allocate additional resources to pursue priority objectives without compromising economic stability. The underlying economic analysis of these results is that the levels of real GDP and economic growth still achieved by the economies of the WAEMU countries have remained below their potential.

However, in order to exploit this existing fiscal space, states have to face many structural difficulties in mobilizing tax revenues. These obstacles stem from the predominance of tax incivility resulting in fraud and tax evasion, the existence of an agricultural sector based on subsistence agriculture and an important informal sector, corruption and lack of serious controls of taxpayers' declarations by the tax and customs authorities. These statements are related to studies on the factors of low revenue mobilization. Auriol and Warlters (2005) argues that the existence of the informal sector that is difficult to tax is a major problem in developing countries. For most of these countries, the informal sector accounts for 60% of GDP while the average is about 40% (Schneider et al., 2010). Nevertheless, we can notice that small businesses end up in the informal sector because of their incomes below the threshold required to be subject to tax. The most obvious frauds are committed by qualified professionals not by small businesses. Rather, it is a matter of fiscal incivility (see Kanbur, 2009 and Kanbur & Keen, 2014). Other structural factors that hinder tax collection have also been highlighted in the literature, including weak tax administrations, demoralization of taxpayers and poor governance. For example, (Attila et al., 2009) found a significant relationship between low tax revenue mobilization and governance indicators, including corruption. But the analysis of the relationship between tax and governance indicators also raises the question of causal interactions. In addition, governance issues are not typical of tax collection administrations, but are much more general in developing countries. But as taxation being a great playing an importance rule in the execution of the government functions (Musgrave, 1959), it seems obvious that particular attention should be paid to governance issues in terms of tax revenue mobilization. Furthermore, the low tax revenue mobilization could also be due to the introduction of investment incentive schemes based on exemptions and derogations granted to different categories of economic operators. This is related to Gupta and Tareq (2008) who consider that incentives reduce the tax base and complicate tax administration, which constitutes a major source of revenue loss and leakage to the economy. But investment decisions depend on many other factors that often weigh more heavily than tax incentives. Rather, countries should improve the business climate by ensuring that tax measures remain as neutral as possible for investors.

The major economic implication of this study is that the WAEMU members States have a fiscal margins to increase its level of taxation in order to produce positive externalities induced by the tax levy. This increase in tax revenues will make it possible to finance investment expenditures and thus stimulate the level of economic activity by making less use of indebtedness.

In this respect, it is not a question of governments multiplying taxes or increasing existing ones. On the contrary, they should consider promoting fiscal citizenship, broadening the tax base and strengthening tax and customs administrations while having a more specific view on taxpayer reporting controls. However, it is essential for governments to be more transparent and cooperative in managing public finances in order to improve the efficiency and traceability of public spending, and reduce sources of waste. This will strengthen taxpayer confidence on which fiscal citizenship is based.

References

Abdullaev, B., Konya, L., et al. (2014). Growth-maximizing tax rate for uzbekistan. *Applied Econometrics and International Development*, *14*(1), 59–72.

Aizenman, J., & Jinjarak, Y. (2005, August). *The Collection Efficiency of the Value Added Tax: Theory and International Evidence* (NBER Working Papers). National Bureau of Economic Research, Inc.

Ajaz, T., & Ahmad, E. (2010). The effect of corruption and governance on tax revenues. *The Pakistan Development Review*, 405–417.

Amedanou, Y. M. I. (2019). *Optimal taxation and economic growth in togo: Empirical investigation in time series* (Tech. Rep.).

Amgain, J. (2017). Estimating optimal level of taxation for growth maximization in asia. *Applied Economics and Finance*, *4*(3), 47–55.

Attila, G., Chambas, G., & Combes, J.-L. (2009). Corruption et mobilisation des recettes publiques : une analyse économétrique. *Louvain Economic Review*, *75*(2), 229–268.

Auriol, E., & Warlters, M. (2005). Taxation base in developing countries. *Journal of Public Economics*, *89*(4), 625–646.

Aydin, C., Esen, Ã.-m., et al. (2019). Optimal tax revenues and economic growth in transition economies: a threshold regression approach. *Global Business and Economics Review*, *21*(2), 246–265.

Barro, R. J. (1990). Government spending in a simple model of endogeneous growth. *Journal of political economy*, *98*(5, Part 2), S103–S125.

Branson, J., & Lovell, C. K. (2001). A growth maximising tax structure for new zealand. *International Tax and Public Finance*, *8*(2), 129–146.

CAPES. (2014). Evaluation of the performance of tax revenue collection in burkina faso. , 5–13.

Chao, J. C., & Grubel, H. (1998). Optimal levels of spending and taxation in canada. *How to use the fiscal surplus: what is the optimal size of government*, 53–68.

Chapple, S. (1997). One for the x-files: A critical assessment of professor scully's 'taxation and economic growth in new zealand'. report to the periodic report group. wellington: New zealand institute of economic research. *Wellington, November*.

Choi, I. (2001). Unit root tests for panel data. *Journal of international money and Finance*, *20*(2), 249–272.

Culpeper, R., & Bhushan, A. (2010). *Domestic resource mobilization in africa: An overview. the north-south institute.*

Davidsson, M. (2012). Optimal growth taxation. *Research in World economy*, *3*(1), 35–44.

Dollar, D., & Kraay, A. (2002). Growth is good for the poor. *Journal of economic growth*, *7*(3), 195–225.

Dupuit, J. (1844). On the measurement of the utility of public works. *International Economic Papers*, *2*(1952), 83–110.

Easton, B. (1999). *The whimpering of the state: Policy after mmp.* Auckland University Press.

Eaton, J. (1981). Fiscal policy, inflation and the accumulation of risky capital. *The Review of Economic Studies*, *48*(3), 435–445.

Engen, E. M., & Skinner, J. (1992). *Fiscal policy and economic growth* (Tech. Rep.). National Bureau of Economic Research.

Fisher, R. (1932). Statistical methods for research workers. edinburgh: Oliver and boyd, 1925. *Google Scholar*.

Gupta, S., & Tareq, S. (2008). Mobilizing revenue. *Finance and Development*, *45*(3), 44–7.

Hill, B. C. (2008). Agglomerations and strategic tax competition. *Public Finance Review*, *36*(6), 651–677.

Hurlin, C., & Mignon, V. (2005). Une synthèse des tests de racine unitaire sur données de panel. *Economie prevision*(3), 253–294.

Husnain, M. I., Haider, A., Salman, A., & Shaheen, F. (2015). Determining the optimal level of taxes in south asia: An unbalanced budget approach.

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of econometrics*, *115*(1), 53–74.

Kanbur, R. (2009). Conceptualising informality: regulation and enforcement.

Kanbur, R., & Keen, M. (2014, Aug 01). Thresholds, informality, and partitions of compliance. *International Tax and Public Finance*, *21*(4), 536–559.

Keho, Y. (2010). Estimating the growth-maximizing tax rate for cote divoire: Evidence and implications. *Journal of Economics and International Finance*, *2*(9), 164–174.

Kennedy, P. E. (2000). On measuring the growth-maximizing tax rate. *Pacific Economic Review*, *5*(1), 89–91.

Laffer, A. B. (1981). Supply-side economics. *Financial Analysts Journal*, *37*(5), 29-43. Retrieved from https://doi.org/10.2469/faj.v37.n5.29 doi: https://doi.org/10.2469/faj.v37.n5.29

Leibfritz, W., Thornton, J., & Bibbee, A. (1997). Taxation and economic performance.

Levin, A., Lin, C.-F., & Chu, C.-S. J. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of econometrics*, *108*(1), 1–24.

Maddala, G. S., & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and statistics*, *61*(S1), 631–652.

Motloja, L., Makhoana, T., Kassoma, R., Houdman, R., & Phiri, A. (2016). Changes in the optimal tax rate in south africa prior and subsequent to the global recession period. , 2–17.

Musgrave, R. A. (1959). Theory of public finance; a study in public economy. *New York, N.Y.: McGraw-Hill*.

Myles, G. D. (2000). Taxation and economic growth. *Fiscal Studies*, *21*(1), 141–168. Retrieved from http://www.jstor.org/stable/24437591

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and statistics*, *61*(S1), 653–670.

Pesaran, M. H., Shin, Y., & Smith, R. P. (1997). Pooled estimation of long-run relationships in dynamic heterogenous panels. *DAE working papers amalgamated Series*, *9721*.

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, *94*(446), 621–634.

Pesaran, M. H., & Smith, R. (1995). Estimating long-run relationships from dynamic heterogeneous panels. *Journal of econometrics*, *68*(1), 79–113.

Phillips, P. C., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*, *75*(2), 335–346.

Plosser, C. I., et al. (1992). The search for growth. In *A symposium sponsored by the federal reserve bank of kansas city, policies for long-run economic growth* (pp. 57–86).

Saibu, O. M., et al. (2015). Optimal tax rate and economic growth. evidence from nigeria and south africa. *Euro Economica*, *34*(1), 41–50.

Schneider, F., Buehn, A., & Montenegro, C. E. (2010). New estimates for the shadow economies all over the world. *International Economic Journal*, *24*(4), 443–461.

Scully, G. W. (1991). *Tax rates, tax revenues and economic growth.* National Center for Policy Analysis.

Scully, G. W. (1996). Taxation and economic growth in new zealand. *Pacific Economic Review*, *1*(2), 169–177.

Scully, G. W. (1998). Measuring the burden of high taxes. *Policy Report*, *215*.

Scully, G. W. (2000). The growth-maximizing tax rate. *Pacific Economic Review*, *5*(1), 93–96.

Scully, G. W. (2003). Optimal taxation, economic growth and income inequality. *Public choice*, *115*(3-4), 299–312.

Scully, G. W. (2006). Taxes and economic growth. *NCPA Policy Report*, *292*.

Sieper, E. (1996). *Review by e. sieper of gerald w. scully,'taxation and economic growth in new zealand.'* (Tech. Rep.). Revised IRD working paper.

Skinner, J. S. (1987). *Taxation and output growth: Evidence from african countries.* National Bureau of Economic Research Cambridge, Mass., USA.

Smith, A. (1776). 1776, the wealth of nations. *Oxford University Press, Oxford*.

WAEMU, C. (2018). Semi-annual implementation report of multilateral surveillance. , 13–16. https://bit.ly/2XQjGs1.

Westerlund, J., & Edgerton, D. L. (2007). A panel bootstrap cointegration test. *Economics letters*, *97*(3), 185–190.

A Appendix

Box: This box describes the model to determine the growth-maximizing tax rate. Let consider the following production function in the Cobb-Douglas form:

$$Y_{i,t} = \delta(G_{i,t})^{\alpha}[(1-\tau)Y_{i,t-1}]^{\gamma} \tag{6}$$

Y is national output or GDP, G government spending to finance the production of public goods, the tax rate (τ) in year (t) of countries (i). δ, α and γ are the parameters. We postulate that the government budget is balanced. Hence, the government budget constraint is written as follow:

$$G_{i,t} = \tau Y_{i,t} \tag{7}$$

Where (τ) is the ratio of tax revenues to GDP called tax burden. From equations (6) and (7), equation (6) can be re-written as follows:

$$Y_{i,t} = \delta(\tau Y_{i,t-1})^{\alpha}[(1-\tau)Y_{i,t-1}]^{\gamma} \tag{8}$$

However, the growth rate is defined by:

$$\frac{Y_{i,t}}{Y_{i,t-1}} = 1 + g$$

Hence, we divide each side of equation (8) by $Y_{i,t-1}$:

$$\frac{Y_{i,t}}{Y_{i,t-1}} = \delta(\tau)^{\alpha}(1-\tau)^{\gamma}[Y_{i,t-1}]^{\alpha+\gamma-1}$$

However, we obtain:

$$1 + g = \delta(\tau)^{\alpha}(1-\tau)^{\gamma}[Y_{i,t-1}]^{\alpha+\gamma-1} \tag{9}$$

The optimal tax rate τ^*_{opm} which maximizes the level of economic growth, is obtained by the first-order condition which consists in canceling the first derivative of equation (9) with respect to (τ) i.e. diff(g,τ)=0

$$\frac{\partial\, g}{\partial \tau} = \delta[Y_{i,t-1}]^{\alpha+\gamma-1}[\alpha(\tau)^{\alpha-1}(1-\tau)^{\gamma} - \gamma(\tau)^{\alpha}(1-\tau)^{\gamma-1}] = 0$$

$$\Rightarrow \alpha(\tau)^{\alpha-1}(1-\tau)^{\gamma} = \gamma(\tau)^{\alpha}(1-\tau)^{\gamma-1}$$

$$\frac{\alpha}{\tau} = \frac{\gamma}{(1-\tau)}$$

Hence, the optimal tax rate is obtained by the expression:

$$\tau^*_{opm} = \frac{\alpha}{(\alpha+\gamma)} \tag{10}$$

We postulate that the Cobb-Douglas type production function used has constant returns to scale. Thus, $\alpha + \gamma = 1$ i.e. γ, α <1. However, according to (10), the optimal tax rate is: $\tau^*_{opm} = \alpha$.

To estimate the parameters of the model, we write (9) under the hypothesis of constant returns:

$$1 + g = \delta(\tau)^{\alpha}(1-\tau)^{\gamma}[Y_{i,t-1}]^{\alpha+\gamma-1}$$

Since $\alpha + \gamma = 1$, then we obtain:

$$1 + g = \delta(\tau)^{\alpha}(1-\tau)^{\gamma}$$

Or $\gamma = 1 - \alpha$

$$1 + g = \delta(\tau)^{\alpha}(1-\tau)^{1-\alpha}$$

$$\frac{1+g}{1-\tau} = \delta(\frac{\tau}{1-\tau})^{\alpha}$$

Applying the linear log on each side of the equation, we obtain:

$$\log\left[\frac{1+g}{1-\tau}\right] = \lambda_i + \theta_t + \log\delta + \alpha\log\left[\frac{\tau}{1-\tau}\right] + \epsilon_{i,t} \tag{11}$$

To obtain the optimal tax rate that maximizes economic growth, we estimate (11) by a Pooled Mean Group (PMG) regression and obtain the value of the coefficient α.

Table 8: Hausman test of Quadratic model

Δ(Dependant variable)	Pooled Mean-Goup Estimator (Pesaran et al., 1997, 1999)	Mean-Group Estimator (Pesaran & Smith, 1995)
LR		
Initial per capita GDP	-0.009***	-0.022**
	(0.000)	(0.036)
Tax burden	1.166***	1.431
	(0.000)	(0.385)
Tax burden square	-0.034***	0.002
	(0.001)	(0.981)
SR		
Error correction term (ec)	-1.235**	-1.966***
	(0.010)	(0.000)
Δ(Initial per capita GDP)	0.092	0.158***
	(0.195)	(0.000)
Δ(Tax burden)	3.813**	3.500**
	(0.018)	(0.038)
Δ(Tax burden square)	-0.147**	-0.153*
	(0.040)	(0.092)
Constant	-4.025**	-1.334
	(0.030)	(0.878)
No. of Observations	279	279
No. of Countries	8	8
Efficient estimator	Yes	No
Optimal tax rate	17.15	N/A
Hausman test/ Ho: difference in coefficients not systematic		
Statistic	Chi2(1) = 1.88	
Pvalue	Prob>Chi2 = 0.5986	

Note: Pvalues in parentheses. *,**, and *** denote significance levels at 10%, 5%, and 1%, respectively. The first Panel (LR) shows long-run effects while the second panel reports both short-run effects (SR) and the speed of adjustment (ec). Hausman test reveals that PMG is consistent and efficient.

Fig. 8: GDP per capita growth rate in WAEMU Member States

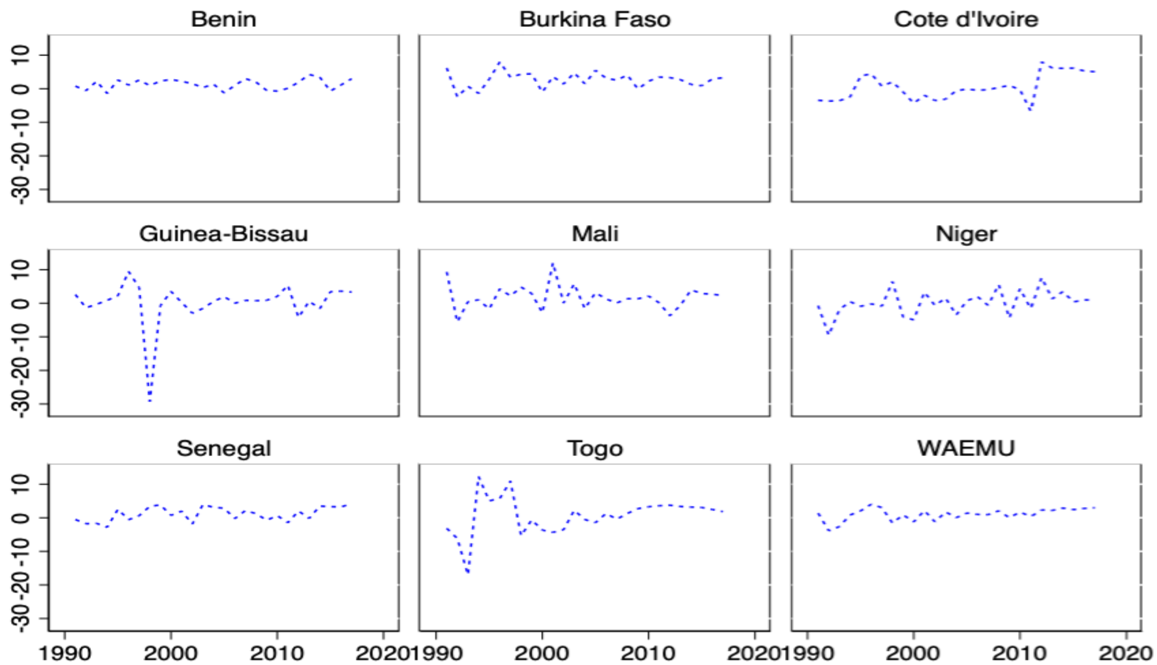


Fig. 9: Trends of tax rates in WAEMU Member States

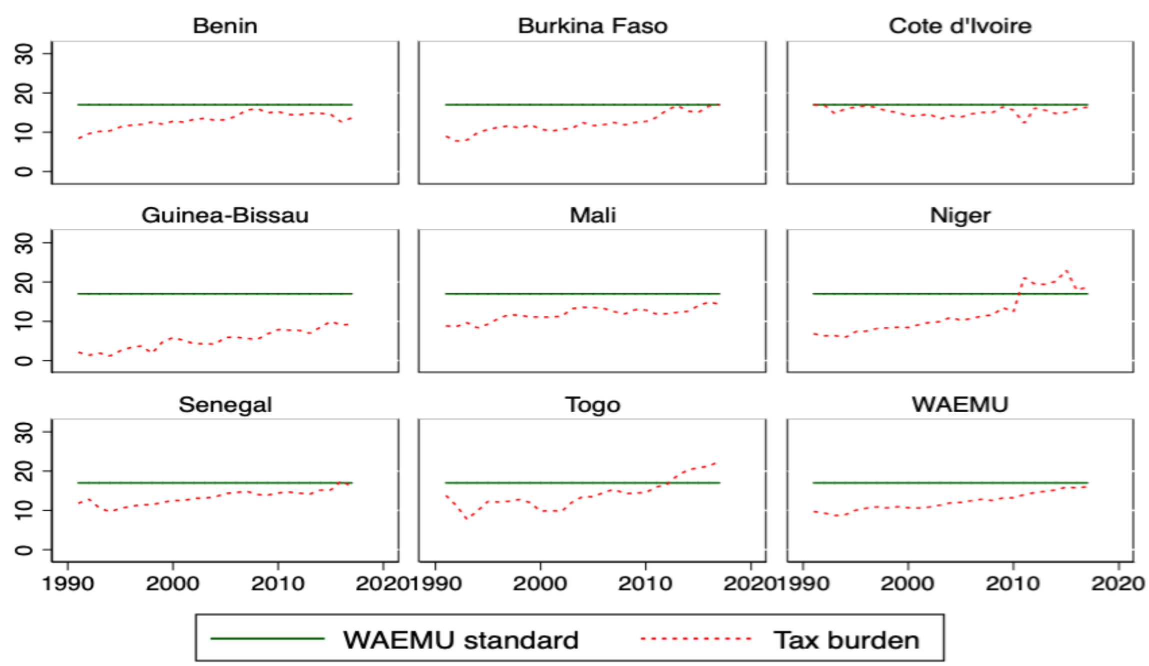


Table 9: Summary of empirical review

Researchers	Sampling country and period	Methods	Results
Abdullaev and Konya (2014)	Uzbekistan (1996 – 2011)	Scully model	22 and 31.2% of GDP over two differents periods
Amedanou (2019)	Togo (1960 – 2016)	Quadratic and Scully models	22.6% of GDP
Amgain (2017)	Panel of 32 Asian countries (1991-2012)	Quadratic and Scully models	18 % of GDP
Aydin and Esen (2019)	Panel of 11 Central and South-eastern European and Baltic countries (1995 and 2014)	Hansen model	18% of GDP for full transition economies 18.5% of GDP for developing economies 23% of GDP for developed economies.
Chao and Grubel (1998)	Canada (1926 – 1996)	Scully model	34% of GDP
Center for Analysis of Economic and Social Policies (2014)	Burkina Faso (1960 – 2012)	Scully model	29.1% 0f GDP
Davidson (2012)	Panel of 12 countries (1982 – 2012)	Scully model	11.1% of GDP
Husnain, Haider and Salman (2015)	4 South Asia countries (1975 – 2012)	Scully model	13.7% of GDP
Keho (2010)	Cote d'Ivoire (1960 – 2006)	Quadratic and Scully models	21.1 – 22.3% of GDP
Motloja and al. (2016)	South Africa, Quarterly data (1994:Q1 – 2009:Q2) and (2009:Q2 – 2016:Q2)	Scully model	22% of GDP
Saibu (2015)	South Africa (1964 - 2012) Nigeria (1970 - 2012)	Quadratic and Scully models	15% of GDP for South Africa 30% of GDP for Nigeria
Scully (1991)	103 countries (1960 –1980)	Quadratic model	19.3% of GDP
Scully (1995)	USA (1949 – 1989)	Scully model	21.5 – 22.9% of GNP
Scully (1999, 2000)	New Zealand (1927 – 1994)	Scully model	19.7– 20.02% of GDP
Scully (2003)	USA (1960 – 1990)	Scully and Barro models	19.3 – 25.1% of GDP
Scully (2006)	USA (1929 – 2004)	Scully model	23% of GDP
Terzi and al. (2017)	Tunisia (1966 – 2015)	Quadratic and Scully models	15.2 - 19.6% of GDP

Table 10: Definitions of variables and sources

Variables	Description	Sources
Per capita GDP growth	Growth rate of GDP per capita	World Development Indicators (WDI)
Population	Population growth rate	
Openness	Share of foreign trade in GDP (Imports + Exports, % of GDP)	
Terms of trade growth rate	Annual growth in the terms of trade index	Calculation based on WDI data
Initial per capita GDP growth	Initial GDP per capita is obtained by the lag of one year of GDP per capita	
Investment	Proportion of total investment in GDP (Gross Fixe Capital Formation, total % of GDP)	World Economic Outlook (WEO)
Tax burden	Ratio of total tax revenue as a percentage of GDP	Calculation based on data taken from Central Bank of West African States (CBWAS)
Deficit	Revenue minus total expenditure, expressed as a percentage of GDP.	
Share of agriculture	Agriculture share of GDP: value added (percent of GDP). Agriculture corresponds to ISIC divisions 1-5 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production.	World Development Indicators (WDI)
Shadow economy	The shadow economy includes all economic activities which are hidden from official authorities for monetary, regulatory, and institutional reasons. Monetary reasons include avoiding paying taxes and all social security contributions, regulatory reasons include avoiding governmental bureaucracy or the burden of regulatory framework, while institutional reasons include corruption law, the quality of political institutions and weak rule of law. It's expressed as a percent of GDP.	Estimate of L. Medina and F. Schneider (2018)
Regulation of political participation	Participation is regulated to the extent that there are binding rules on when, whether, and how political preferences are expressed. One-party states and Western democracies both regulate participation, but they do so in different ways, the former by channeling participation through a single party structure, with sharp limits on diversity of opinion; the latter by allowing relatively stable and enduring groups to complete non-violently for political influence. The index ranges from 1 "unregulated" to 5 "regulated".	Integrated Network for Societal Conflict Research (INSCR)
Durability of political regime	The number of years since the most recent regime change (defined by a three-point change in the POLITY score over a period of three years or less) or the end of a transition period defined by the lack of stable political institutions (denoted by a standardized authority score).	
Quality of Institutions	Synthetic index of institutional quality is the arithmetic mean of ICRG indices of Bureaucracy quality, Law and order, and Control of corruption. The higher the index, the higher the institutional quality.	Authors' calculations based on International Country Risk Guide (ICRG, 2009) data.