Tax Revenue Potential and Effort in Ethiopia: Evidence from Stochastic Frontier Analysis

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Abstract

This study aims to estimate the actual tax effort and tax revenue potential of the country, measuring the gap between realized performance and the stochastic tax frontier, as well as between income and consumption using utility maximization function. The results from the stochastic tax frontier model have been compared with the utility maximization function as a robustness check. Very close values for tax effort, tax potential, and tax gap are recorded under each model. The estimated tax potential, effort, and gap from the two methods are found to be 22.89 percent, 23.69 percent, 36 percent, 34 percent 14.37 percent, and 15.58 percent, respectively. The empirical results revealed that Ethiopia is characterized by a huge tax gap and low tax effort, mainly resulting from the country's policy choice and enforcement mechanisms.

Key words: tax potential; tax effort; utility maximization; stochastic frontier; inefficiency
JEL Classification: H21, H25, H26

1. Introduction

Multilateral and bilateral donor organizations have increasingly acknowledged the importance of taxation in guaranteeing sustainability and ownership, particularly, in the development process (Mascagni & Mengistu, 2016). Countries have undertaken various reforms by prioritizing this issue: for example, African governments and pan-African institutions have undertaken several significant

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reforms in the last decade, elevating taxation to a higher priority on the policy agenda; the African Tax Administration Forum, established in 2008 (Mascagni & Mengistu, 2016). Tax revenue mobilization has piqued the curiosity of many experts, notably in the fields of economics and political science (Fjeldstad, 2013; Fjeldstad & Brun, 2014). The essential question here is why, after decades of living in the shadows of other, ostensibly more serious issues, taxation has recently (re-)established itself as a priority issue in the international debate? Mascagni (2016) raised five broad issues in his policy development study to help answer this question: the potential benefits of taxation on state-building; long-term independence from foreign assistance and the shifting aid paradigm; trade liberalization; the increased prominence of fiscal issues in the West due to the financial and debt crisis; and developing countries continued acute financial needs.

Given the aforementioned initiatives, developing countries urgently require additional financial resources to address important development challenges such as poverty, malnutrition, natural disaster vulnerability, and disease prevention. Developing countries raise significantly less revenue than advanced economies, as evidenced by tax to GDP ratios ranging from 10% to 20%; whereas, OECD economies range from 30% to 40%, indicating a significant tax gap that must be filled from the enormous tax potential in these countries, of which Ethiopia is a member (Mascagni & Mengistu, 2016; Richardson, 2006; Torgler & Schneider, 2009). This pattern suggests that more work remains to be done to increase tax revenue mobilization in low-income and Sub-Saharan African (SSA) countries (Addison & Levin, n.d.; Agbeyegbe et al., 2006; Fjeldstad & Brun, 2014; Moore, 2013). To boost their revenue mobilization, low-income countries (LICs) must increase their tax-to-GDP ratios by roughly 2-4 percentage points, substantiating requirements for poverty alleviation and infrastructure improvement.

A growing body of theoretical and empirical work suggests that developing countries' revenue-raising challenges are two-fold: first, they typically have a low taxable capacity (a small tax base) and a significant share of economic activity in the informal (40-60 percent) and difficult-to-tax sectors, and second, their tax regimes may be littered with a slew of tax relief measures. IMF (2018) goes on to say that weak administration, informality, taxing mobile capital, high compliance costs, a lack of data, bad governance and corruption, and methodological flaws limit estimates of tax revenue losses from evasion and avoidance in developing countries. Furthermore, these countries use excessive incentives to entice investment, and they suffer from profit shifting through transfer pricing, a lack of integrated tax structures in terms of horizontal and vertical tax equality, and political and economic instability.

In line with the developmental state model, Ethiopia's government established the Growth and Transformation Plan (GTP I, 2010-2015) and significantly increased its infrastructure development activities. As a result, income mobilization through taxes is thought to be the most realistic and practicable method of financing Ethiopia's development. The GTP I had expected a nominal growth in tax collection of roughly 25 percent per year by 2015, resulting in a tax-to-GDP ratio of 15 percent. However, according to World Bank data, Ethiopia's tax share was around 9 percent of GDP at the start of the GTP I, which is an ambitious goal. This trend has been supported by empirical studies, out of 85 countries analysed in a cross-country study by Langford and Oldenburg (2015), Ethiopia was found to have the worst performance, with a tax-to-GDP ratio of 8.6 percent. Apart from revenue deficits, the country's tax-to-GDP ratio remains below 15 percent, which is considered a good benchmark for ensuring government operation (Mascagni, 2016b). Ethiopia's national bank (NBE) announced a tax-to-GDP ratio of 11.55 percent for the 2018/2019 fiscal year, down from an average of 11.70 percent for the previous two decades (Mascagni, 2016b). Moreover, despite many tax reforms since 2002, literature suggests serious and impartial research by highly skilled experts and institutions to address why Ethiopia's tax to GDP ratio has been substantially lower than the Sub-Saharan African average of 15 percent for the past two decades (Mascagni & Mengistu, 2016).

The focus of prior studies in the country was on tax compliance of regional taxpayers and corporations, which is inconclusive to the nation. To his knowledge, the researcher has never come across a single study on the current tax potential and effort of the country. To fill this gap, the study aims to estimate the actual tax effort and tax potential of the country, measuring the gap between realized performance and the stochastic tax frontier, as well as between income and consumption using utility maximization function for robustness checks. The major aim of this research, from a tax policy standpoint, is to provide a quantitative indication of the country's potential for greater domestic revenue mobilization.

The rest of the article is organized as follows: Section 2 presents the review of related literature; section 3 specifies research methodology and data; section 4 presents results and discussions, and section 5 concludes the article.

2. Theoretical Reviews

In the economics literature concentrating on public finance and taxation, many taxation models have been highlighted as the subject of discussion. Until recently, the allocation theory of taxation, the theory of public expenditure, normative tax theory, and the distributional theory of taxation are some of the most important ones. Tax allocational theory has been analysing welfare losses induced by tax distortions since the beginning of public sector economics. Many-person economies have seen the most substantial progress in understanding the trade-offs between equality and efficiency. As a result, tax and government spending theories are becoming increasingly interwoven (Tresch, 2014, 2015; Alan et al., 2013).

Logically, public expenditure theory which defines the legitimate areas of public concern as well as the permissible forms that policy may take, should come before theory of taxation. Moreover, public expenditure theory often contains its own theory of taxation in the sense that the expenditure decision rules define a set of taxes and transfers necessary to guide the market system to an optimum. In these instances, taxes contribute to the pursuit of efficiency and equity. Public expenditure theory addresses two fundamental questions: in what area of economic activity can the government legitimately become involved and what decision rules should the government follow in each area? Taxation theory becomes relevant in and of itself only when the expenditure decision criteria signal the need for certain government expenditures without also articulating how those expenditures will be funded. When this occurs, the same criteria that drive the analysis of public expenditures also regulate the collection of tax income. Taxes should advance the microeconomic goals of allocational efficiency and distributional equality in society (Tresch, 2015).

According to the classic theory of optimum taxation, a tax system should be chosen to maximize a social welfare function within a set of restrictions. The social planner is often treated as a utilitarian in the literature on optimal taxation: that is, the social welfare function is based on the individual utility of society members (Ramsey, 1927; Besley & Persson, 2013). However, there is a natural conflict between tax policy and the goal of allocational efficiency. Most taxes cause market distortions by requiring producers and demanders to compete on different pricing. These distortions cause resource misallocation, resulting in allocational inefficiencies. Of course, resource misallocation is undesirable, but it is an unavoidable consequence of raising tax collections. For any given amount of money to be collected, one goal of normative tax theory is to design taxes that minimize these distortions. Alternatively, if the government relies on one of two or three types of taxes to produce money, normative tax theory should determine which of these taxes causes the least degree of inefficiency. The guiding premise in both the allocational theory of taxation and the allocational theory of public expenditure is Pareto optimality. According to the Pareto criterion, the government should collect a certain amount of money such that it would not be able to generate the same amount of revenue with an alternative set of taxes that would improve the welfare of at least one consumer without lowering the welfare of any other consumer. If such Pareto improvements are not achievable, then, tax policy satisfies the Pareto requirement of allocational efficiency, even if it causes inefficiencies in comparison to a no-tax condition. In the context of a finite set of different groups, Pareto efficient tax structures maximize the utility of one individual (group) given the utility of others and given the budget balance and informational constraints on the government (Stieglitz, 2018; Dagobert, 1990).

Apart from a natural conflict between tax policy and the goal of allocational efficiency, the other inescapable effect of taxes is that they lower the purchasing power of taxpayers, forcing them to participate in the government's redistribution program. Naturally, the government wants its taxes to help society achieve its distributional goals, but there are two obstacles. The first is that the redistribution theory of taxation suffers from all of re-distributional theory's indeterminacies in general. While public sector economists usually agree on normative tax policy in terms of society's allocational aims, there is significant disagreement about what constitutes appropriate tax policy in terms of distribution. The second issue is the trade-off that exists in taxation between equity and efficiency. In general, higher tax rates on the rich are required to achieve greater redistribution, but higher tax rates tend to increase inefficiency. Furthermore, taxing a certain product may be desirable in terms of societal distributional aims but highly undesirable in terms of efficiency, or vice versa. Understanding the nature of these kinds of equity–efficiency trade-offs has always been one of normative tax theory's main goals (Pedone, 2009; Tresch, 2015).

The expanding specialization and refinement of theoretical and empirical research of numerous areas of taxation economics, as well as continual changes in an increasingly complex economic and social reality, make communication between tax theorists and tax practitioners challenging. Furthermore, analytical models and econometric estimations, like other fields of theoretical and applied economic study, produce ambiguous findings and mixed results; whereas, tax practitioners want unequivocal and realistic propositions (Pedone, 2009; Ramsey, 1927; Tresch, 2015).

The level and optimal structure of tax rates is the subject of taxation theory, given that tax bases are clearly defined, accurately measured, and easily and uniformly assessable. In actuality, the impacts produced in terms of efficiency, equality, and other major economic variables are nearly always different from the effects anticipated based on the theoretical model when shifting from theoretical models to the concrete application of any kind of taxation regarded optimal. The bigger the difference between theoretical and practical consequences, the more those particular constraints vary and are subject to change from how they are described in the theoretical model (Pedone, 2009). These constraints have been grouped into five namely: the prevailing social and economic structure, the degree of international integration, institutional set-ups, how the tax administration is organized, and the attitudes and behaviours of taxpayers. Depending on the availability of data and experiences to draw on, their relative importance in different circumstances, and the way they interact, these constraints may be approximated by a set of indicators that are more or less representative. However, these constraints are often ignored or inadequately considered in many current studies, which assume the existence of well-defined and consistent, and uniformly measurable and assessable tax bases, thus, focusing research efforts on optimal tax-rate schedules. As a result, tax-related studies and proposals that ignore these aspects and rely entirely on data drawn from necessarily aggregated and simplified theoretical models can be deceptive (Pedone, 2009; Tresch, 2018).

In general, the difference between tax theory and practice could be traced back to variances in ideal taxation (tax design), legally imposed taxation (tax law), the effective impact of taxation (tax impact), the effective incidence of taxation (tax incidence), and perceived taxation (tax perception). It is possible to obtain an understanding of the extent to which theoretical indications and pragmatic applications of a certain system of taxation coincide or diverge by identifying the challenges highlighted by each of these phases and the relationships between them. It's also possible to compare the effects predicted by the theoretical model with those observed in a particular country's economic and institutional structure over time.

The concept of tax effort is subjective and difficult to quantify because it is not directly observable. The most frequently accepted trend in the literature is the ratio of a country's real tax income to its potential tax revenue or tax capacity. A jurisdiction's tax capacity refers to the amount of tax revenue that a government can collect by fully utilizing and properly managing its regulatory power over the taxes within its jurisdiction (legal tax capacity). As a result, the denominator measurement's quality will decide how accurate the tax effort indicator is (or tax capacity). However, the most popular strategy is to use an economic approach, which predicts a country's maximum tax revenue based on its economic, social, institutional, and demographic characteristics (economic tax capacity). Thus, the econometric method has become the most popular for empirical investigations of tax capacity. This is a method for assessing tax capacity that relies on regressions of reported tax income against objective, non-manipulable parameters that serve as proxies for tax bases (Brun & Diakite, 2016; Langford, 2015; Zárate-marco & Vallés-giménez, 2019).

This study is led by the idea that a country's revenue capacity is validly dependent on two sets of factors: economic and institutional, based on the aforementioned taxation theories (Brun & Diakite, 2016; Alamirew et al., 2020; Mebratu & Fentaw, 2020; Castro & Ramírez, 2014; Langford, 2015). GDP per capita, shares of hard to tax sectors/ productive specialisation or structural (manufacturing and service value added, all scaled by GDP), trade openness/ trade volume, and external debt are among economic factors. Corruption level is included to account for country’s institutional setting. It is through these factors that one can assure the validity of both supply and demand side factors which could affect the tax potential and effort of a country (Langford & Ohlenburg, 2015; Alamirew et al., 2020).

The dependent variable is the tax ratio computed as tax revenue as Percent of GDP or simply tax-to GDP ratio. As a proxy for development, GDP per capita is one of the variables that are most commonly used in the tax effort literature. Because of higher ability to pay in a society with higher income, one would expect a positive relationship between GDP per capital and revenue collection (Cyan, Martinez-Vazquez & Vulovic, 2016). As a higher level of income typically correlates with a greater demand for public goods and services, and higher income increases the overall ability to pay in a society, one should expect higher tax payment and collection (Bahl, 1971; Fox *et al*., 2005). Richer countries tend to collect more revenues, and similarly, countries tend to collect more revenues as they become more affluent, as a country expands the level of development, the formal sector of the economy increases in relative terms (Le, Moreno-Dodson & Rojchaichaninthorn, 2008).

Tax potential might also depend on the ease of tax collection, that is, Productive Specialisation or Structural factors such as agricultural, manufacturing and service value added. Due to its inherent difficulty to collect the tax, especially, in developing countries where production tends to be organized on small-scale basis or due to equity and political reasons, most developing countries exempt from taxes a large share of agricultural activities.

Manufacturing value added, measured as a fraction of GDP, is the net output of the manufacturing sector after adding up all outputs and subtracting intermediate inputs. Specialization on industry as a percentage of the economy can have positive effects on taxation as industrial enterprises are typically easier to tax and manufacturing can generate larger taxable than agriculture **(**Castro & Camarillo, 2014**).** A larger tax base makes for more tax potential, and indeed industrialisation, in the form of a high manufacturing share of output, is associated with a rise in tax potential (Langford & Ohlenburg, 2015). Authors such as Cyan, Martinez-Vazquez and Vulovic, (2016), argued that certain sectors in the economy such as agriculture, services, and construction have been traditionally hard to tax, and because of that and other reasons (equity and political economy issues), many countries exempt agriculture from taxes. They conclude similar case to be made for many services.

Trade openness is an aggregated level of export and import calculated as a fraction of GDP. It is expected to have a positive relationship between trade openness and taxable capacity due to the taxes applied on imports, and as trade expands, the formalisation and the competitiveness of the economy increases; therefore, more possibilities to collect taxes. However, globalization and international competition have gradually led countries to reduce their reliance on trade taxes, the strength of this correlation should be gradually decreased (Le, Moreno-Dodson & Rojchaichaninthorn, 2008). On the other hand, an open economy reduces tariffs and trade barriers and this fact can have negative effects on tax collection (Baunsgaard & Keen, 2010). Taxes from trade are an important source of revenue that is relatively easier to tax even with a weak tax administration. Hence, trade openness is a variable which is expected to have a positive coefficient in the regression (Khwaja & Iyer, 2014).

The International Country Risk Guide (ICRG) provides alternatives for gauging the quality of the institutional setting of a country, particularly, the corruption index. Corruption is measured by the corruption index developed by International Country Risk Guide (ICRG's) assessment of corruption in the political system through assigning a numerical value to a country. The index ranges from 0 to 6; close to 6 means a lower risk of corruption and vice-versa. Literature argues a high level of corruption reduces revenues collection (Abed & Gupta, 2002; Le, Moreno-Dodson & Rojchaichaninthorn, 2008); taxpayers who deal with rampant corruption are less willing to pay taxes (Bird et al., 2008; Cyan, Martinez-Vazquez & Vulovic, 2016). Corruption also discourages foreign investment, which negatively affects economic activity and the tax base.

The degree of external indebtedness of a country may affect revenue performance as well. To generate the necessary foreign exchange and service the debt, a country may choose to reduce imports. In such a scenario, import taxes will be lower. Alternatively, the country may choose to increase import tariffs or other taxes with a view to generate a primary budget surplus to service the debt (Alamirew et al., 2020; Javid & Arif, 2012; Sen Gupta, 2007).

3. Empirical Studies

A number of empirical studies attempted to investigate the effect of economic and institutional variables on economies' overall tax potential and tax effort (Alamirew et al., 2020; Bird et al., 2008; J.-F. Brun & Diakite, 2016; Langford, 2015; Fenochietto & Pessino, 2013; Grigorian & Davoodi, 2007; Khwaja & Iyer, 2014; Le et al., 2012; Mascagni, 2016b; Mascagni & Mengistu, 2016; Mebratu & Fentaw, 2020).

Using different specifications of the stochastic frontier panel data (the Battese-Coelli half normal and truncated normal models) and the Mundlak version of the Random Effects Model, Brun and Diakite (2016) and Fenochietto and Pessino (2013) find a positive and significant relationship between tax revenue as scaled by GDP and per capita GDP (indicates country's level of development and the capacity to tax) and trade openness. The studies also demonstrate a negative relationship between tax revenue as a Percent of GDP and corruption. In a cross-country study by Langford (2015), corruption-reflecting the political and administrative components of taxation-is found to be significant determinants of tax effort.

In a similar cross-country study, Sen Gupta (2007) finds strongly significant relationship between revenue performance and several structural factors such as per capita GDP, share of agriculture in GDP and trade openness are statistically significant. These variables judged by the author as strong determinants of revenue performance. As to the impact of foreign aid and foreign debt on revenue mobilization, he finds that although foreign aid improves revenue performance significantly, debt does not. On the other hand, the result revealed the negative and significant effect of corruption on revenue performance. Findings further revealed that countries that depend on taxing goods and services, as their primary source of tax revenue, tend to have poorer revenue performance than countries that put greater emphasis on taxing income, profits and capital gains.

Le and Moreno-dodson (2012) examined determinants of countries' taxable capacity and tax effort covering a sample of 110 developing and developed countries during 1994–2009. Among the economic variables, GDP per capita and trade openness are found to be positive and statistically significant determinants of tax potential and effort, while the effect of corruption index is found negative and significant. Bird et al. (2008) studied the impact of corruption, voice and accountability on low-income and high-income countries' tax effort. The estimation result of 2SLS techniques shows negative and significant effect of GDP per capita on developing countries tax effort, while the effects of corruption is found to be positive and statistically significant for both low- and high-income countries.

By employing a robust stochastic frontier estimation technique (Brun & Diakite, 2016; Fjeldstad & Brun, 2014) studied factors affecting Tax Potential and Tax Effort for a large sample of developing countries over the period 1980-2014. Findings revealed the positive and significant effect of GDP per capita and trade openness, and suggested that inefficiency in taxation depends more on policy decisions than on tax administration performance. Employing a fixed effect estimation technique (Grigorian & Davoodi, 2007) conducted a cross country study on determinants of tax potential versus tax Effort, and points out positive and significant effect of GDP per capita and institutional quality on tax potential and then effort.

Alamirew et al. (2020) conducted a comprehensive assessment of the tax revenue potential and effort of 23 Sub-Saharan African nations from 2000 to 2018. On average, almost all sample countries' tax effort is found lower than the global average index. These show that Sub-Saharan African countries collect taxes below what could be collected due to reasons attributed to nation's economic, demographic, policy and institutional factors.

Thus, for country level studies are rare in the tax effort literature, studies are largely dominated by cross-country studies that are useful in identifying broad trends but that also suffer from problems related to countries and factors heterogeneity. Cross-country studies do not provide fully conclusive evidence on whether the effect of economic, institutional and demographic factors on tax effort is positive or negative. On top of that, countries' tax potential and thereby their efforts tend to be under or overestimated due to methodological dynamics and their sensitivity to the set of countries, and the period of analysis (Mascagni, 2016b). Thus, this article aims to better investigate the determinants of tax revenue potential and then effort in Ethiopia using appropriate methodologies detailed in the next section.

4. Empirical Model of the Study

4.1 The Cobb-Douglas Production Function

The production function is one of the key concepts of mainstream neoclassical theories since almost all economic theories presuppose a production function, either on the firm level or the aggregate level. In both microeconomics and macroeconomics, the production functions are positive non-constant functions that specify the output of a firm, an industry, or an entire economy for all combinations of inputs. A famous two factor production function was first introduced in 1928 by Cobb and Douglas, nowadays called Cobb-Douglas production function, in order to describe the distribution of the national income (Belotti et al., 2013). This function reflects the relationships between its inputs (physical capital and labour) and the amount of output produced. It is a means for calculating the impact of changes in the inputs, the relevant efficiencies, and the yields of a production activity.

The basic form of two factor Cobb-Douglas production function is given by:

$$Y = bL^{k}C^{21-k}, \qquad (1)$$

Where Y denotes the total production, L the labor input, C is the capital input, and b is the total factor productivity (TFP). Besides production, this function has also been applied to many other issues. The generalized form of the function is written as:

$$F\ (x1, \ldots\ldots xn) = Ax1^{\alpha 1 \cdots\cdots} xn^{\alpha n}, \qquad (2)$$

Where $xi > 0\,(i = 1, \ldots, n), A$ is a positive constant, and $\alpha 1, \ldots, \alpha n,$ are nonzero constants.

In theory, because of similarities between firms' problems in producing output and governments' problems in generating taxes, where both types of institutions are concerned with the unused production or tax potential, generally interpreted as inefficiency, the application of the stochastic frontier should work well in tax frontier estimation. However, for the stochastic frontier technique to work, it requires some conditions, such as the negative third moment of the OLS residuals. Another main difference is in the interpretation, the difference between current tax ratio and tax frontier cannot purely represent the level of inefficiency like that of the production frontier, rather the difference be interpreted only as the level of unused tax potential which may be caused by at least two factors (i) policy issue; differences in tax legislation, for instance, in the level of tax rates (Pessino & Fenochietto, 2010), the low tax ratio may be chosen intentionally following local people's preferences of low provision of public goods and services, and/or (ii) the existence of technical inefficiencies, inefficiency of local governments.

In the case of production function, the determinants of outputs are very clear that output is produced by some inputs, such as: labour, capital, and some other factors. This situation becomes less clear when it comes to the tax frontier estimation, that is because output, in this case the tax ratio, is the output of some combination of inputs, such as tax bases and tax rates. Therefore, the empirical study of tax ratio is reduced to tax bases and the standard proxies normally used for estimating tax bases are output or income, among others. Thus, finding of the right combination of tax ratio determinants to find the tax frontier is the main issue of concern for such a research, otherwise, the stochastic frontier approach will not work well (Langford, 2015).

4.2 Model Specification and Estimation Issues

The theme of this study is to answer the question of how much tax revenue Ethiopia as a country *could, (*the theoretical liability), rise by giving a quantitative suggestion of the scope for additional domestic revenue mobilisation. Clearly, the way tax effort is calculated is affected by the choice of the measure of revenue potential, the denominator of any tax effort indicator. Thus, one way to research the tax effort concept is to see how the revenue potential benchmark or desired tax capacity is estimated.

4.2.1 Stochastic frontier analysis (SFA)

This article models tax potential using the stochastic frontier analysis (SFA), adopted from the production function, and first pioneered by (Aigner & Schmidt, 1977). Stochastic frontier analysis technique is found to be advantageous as compared to the traditional regression approach of OLS based cross-section and panel data techniques, which are more akin to an average level achieved for a given set of determinants rather than an indication of true maximum potential. SFA provides measure of the extent to which a country may be able to raise additional revenue. Besides, SFA technique supports a more intuitive and potentially more policy-relevant measure of tax potential and effort, and can be used to generate a stochastic tax frontier (Tsionas, 2012; Belotti *et al.*, 2013; Fenochietto & Pessino, 2013; Brun & Diakite, 2016; Langford, 2015; Alamirew & Leykun, 2020; Mebratu & Fentaw, 2020). Hence, in this study, the researcher builds on advances in the stochastic frontier literature by applying time-series data techniques to the estimation of overall tax potential and effort**.**

The most likely explanation is that the stochastic frontier approach combines elements from both the standard regression analysis and an incomplete utility maximization process (Dalamagas et al., 2019)**.** The tax stochastic frontier model, which measures time-varying inefficiency, has two disturbances. The first disturbance is the usual mean zero statistical error term and the second one is the estimate of technical inefficiency. The SFA model separates the overall tax effort into a constant tax effort resulting from policy economic decisions and a time-varying tax effort resulting from tax administration efficiency (Alamirew et al., 2020; Brun & Diakité, n.d., 2016; Fenochietto, 2014; Fenochietto & Pessino, n.d.; Langford, 2015; Le et al., 2012; Pessino & Fenochietto, 2010; Yohou, 2017;

Zárate-marco & Vallés-giménez, 2019). The general specification of these models is as follows:

$$\log Y_t = \alpha + f(\log X_t;\ \beta) + \epsilon_t \qquad \textbf{(3)}$$

$$\epsilon_t = v_t - u_t \qquad \textbf{(3.1)}$$

Where, $\mathbf{Y_t}$ represents Log of tax to GDP ratio for the country, $\mathbf{u_t > 0}$, represents the error in obtaining the maximum amount of revenue for given inputs or tax bases (inefficiency in tax collection) and would be the function of variables $\boldsymbol{zt}$, which may vary over time and would include observed heterogeneity, $\mathbf{v_t}$ denots random error term that captures omitted variable bias and measurement errors, β denotes vector of unknown parameters and X_t represents vector of economic and institutional variables that affect tax capacity in the country (GDP per capita, trade openness, manufacturing value added, service value added, external debt and corruption, all scaled by GDP except corruption index retrieved from ICRG). However, agricultural value added and shadow economy have been dropped from the model due to colinearity issues, see correlation matrix in the appendix.

Another element of the tax stochastic frontier model is that, while some of the inputs needed to produce the output, such as economic inputs, are well-known, others, such as institutions, are not. The value of the stochastic frontier tax function may simply lay in having a more obvious interpretation of specific institutional restrictions to tax effort, as the SFA is an extension of the traditional regression model.

For tax potential analysis, this study employs Battese (1995) and Battese and Tessema (1993) time-varying cross-sectional model with observable heterogeneity. Observable heterogeneity refers to variables that do not directly affect the tax capacity of a country but could affect efficiency through other variables determining tax effort, say ze. The cross-sectional specifications for time-varying cross-sections are as follows:

$$y_t = f\,(X_t\,;\beta).\,\xi_t.\,e^{vi} \qquad \textbf{(3.2)}$$

$$Y_t = \alpha + \beta'\,X_t + v_t - u_t \qquad (\mathbf{3.3})$$

where $u_t = -\ln(\xi_t)$

$$v_t \sim N(0, \sigma^2 v) \tag{3.3a}$$

$$u_t \sim N^+(\mu_t, \sigma_u^2), \mu_t = \delta_e z_{t,e} \tag{3.3b}$$

Where, ξ is tax effort, and is restricted to being between 0 and 1, the final term e^{vi} represents random shocks to reflect factors such as one-off windfalls, measurement errors and model misspecification.

Assumptions for Maximum Likelihood (ML) Estimators

Testing the underlined assumption is required prior to estimating the ML in order to produce efficient and consistent results.

Table 1: Assumptions, tests and expected results

Assumptions	Tests	Expected results
Residual's skewness	OLS residual test to check for the validity of the SFA specification	For a production-type stochastic frontier model with the composed error, $v_t - u_t, u_t \geq 0$ and vt distributed symmetrically around zero, (i.e., negative Skewness).
Parametric Distributional Assumptions for the inefficiency term u_t	a normal distribution on v_i and a half-normal distribution on u_i is represented as the following: $\ln y_t = \ln yt^* - u_t,$ $\ln y_t{}^* = f(x_t; \beta) + v_t$ u_t ~i. i. d. $N^+(0, \sigma2ut)$, u_t ~i. i. d. $N(0, \sigma2v_t)$, truncated-normal distribution of u_t ; $\ln y_t = \ln y_t{}^* - u_t, u_t \geq 0$ $\ln y *_t = f(x_t; \beta) + v$ $u_t \sim N^+(\mu, \sigma^2 u)$ $v_t \sim N(0, \sigma^2 v)$	Zero-mean normal distribution forv_t. The efficiency term can be either half-normal distribution (assumes that the mode in the distribution is zero) or truncated normal distributed (assumes the ui distribution to have nonzero mode).
A Likelihood Ratio Test of technical Inefficiency u_t	A likelihood ratio test statistics computed as the difference between the estimated restricted model (Cobb- Douglas) and the estimated unrestricted model (SFA), $-2 * (\text{restricted value} - \text{unrestricted value})$.	The null hypothesis of stochastic frontier model is not appropriate or no technical inefficiency- to test the existence of the one-sided error for the model. For a half-normal model, the LR tests the hypothesis that $\sigma^2 u = 0$.

Heteroscedasticity in v and u	Heteroscedasticity can be parameterized by a vector of observable variables and associated parameters; the exponential function is used to ensure a positive estimate of the variance parameter. $$\sigma^2 u_{,t} = \exp(z'_{u,i} w_u)$$ $$\sigma^2 v_{,t} = \exp(z'_{v,i} w_v)$$ Where $z_{u,i}$ is a mX_1 vector of variables including a constant of 1, and wu is the mx1 corresponding parameter vector.	The Aigner et al. (1977) original half-normal model assumes that vi and the pre-truncated u_i are homoscedastic, that is, both $\sigma^2 v$ and $\sigma^2 u$ parameters are constants.
Exogenous Determinants of Inefficiency	In the maximum likelihood method, the single-step truncated normal approach predicts the parameters of the relationship between ui and z- t, as well as all other model parameters.	The variance of the ui is assumed to be a function of z variables, which they call inefficiency explanatory variables; Note that, given $u_t \sim N^+ (0, \sigma^2 u)$, the mean of $u_i$is a function of$\sigma^2 u$ (instead of 0) because of the truncation.
Endogeneity and omitted variable bias	Though the slow-moving nature of structural determinants precludes a substantial contemporaneous influence from tax revenues, observed endogeneity can be captured by integrating corruption and external debt stock, while unobserved heterogeneity is not a problem for a country-specific analysis.	By using what if analysis and robustness checks with different estimation model specifications, the output is maintained to be consistent and efficient.

Source: Author's computation

4.2.2 Utility maximization function (UMF)

Cross-country or country-level investigations of the factors that might explain changes in tax effort over time would necessitate more advanced theoretical and econometric analytical approaches. Economic, institutional, and demographic factors, among others, have been discussed in the literature as potential drivers of a country's tax capacity, and then, as direct inputs as determinants of tax effort index and indirect inputs to the tax base as environmental variables (Dalamagas et al., 2019; Albouy, n.d.; Misch et al., n.d.). Furthermore, these variables, as well as unobserved or non-economic factors (political, institutional, demographic, geographical, ethical and legal indices, cultural, and so on) and remaining factors used by previous researchers, are already embodied by assumption- there is no adequate priori justification for an ad hoc use of variables selected as measures of taxable capacity, whereas, data, particularly on non-economic factors, is unreliable, and regression results are not reliable, suffering from Hetroskedasticity, contemporaneously correlated and auto regression.

Throughout, however, some structural macroeconomic variables are well established both theoretically and methodologically, while other existing, but not yet well-developed latent data as ad hoc regressors in tax equations are extremely difficult to specify in the regression model. As a result, Dalamagas et al. (2019) propose a new optimization technique for evaluating tax effort based solely on observable macroeconomic factors, ignoring other existing but less well-established latent data as ad hoc regressors in tax equations.

According to Dalamagas et al. (2019), no meaningful attempts to provide a theoretical underpinning to tax effort econometric estimations have been made till now. The most likely explanation is that the stochastic frontier method incorporates aspects of both traditional regression analysis and an incomplete utility maximizing technique. Regardless of the differences in estimated tax effort values, the major problem with all previous tax-effort methods is that they do not lead to a Pareto optimal outcome. Therefore, the natural question about Pareto efficiency is whether a distortionary tax system could lead to Pareto optimal tax revenue. In most cases, an optimal outcome would be achieved if the government could maximize social welfare through a combination of direct (equitable but inefficient) and indirect (inequitable and inefficient) taxes, subject to the constraint that sufficient revenue is generated to finance the provision of public goods (Albouy, n.d.; Griffith et al., 2010; Mankiw et al., 2009; Arrow & Debreu, 1954; Stieglitz, 2018).

In comparison to the tax frontier regression model, SFA, used, this study has tested the new measure of tax effort proposed by Dalamagas et al. (2019), who suggested that in the context of an Arrow-Debreu economy with fixed labor supply and no savings, a utility function with two arguments (income and government spending) is maximized with respect to direct and indirect tax rates. Thus, regardless of the prevailing economic, institutional, political, and other variables in any country, the ideal level of tax revenue is calculated through utility maximization procedure and demonstrated to be equal to the gap between income (Y) and consumption (C). The first-order conditions are then, manipulated to provide the optimal tax revenue as the difference between income and consumption ($T^* = Y - C$).

The most often used definition of tax effort, namely the ratio of actual to optimal tax revenue (T/T^*), is used to evaluate whether the economy is overtaxed ($T/T^* > 1$) or undertaxed ($T/T^* < 1$). All of the previous researches of both economic and non-economic aspects are considered to have been included into private and public agents' priorities for labor effort and consumer preferences. As a result, three important macroeconomic variables are required in this new model to compute the variable in the above formula: GDP, Tax revenue (direct and indirect), and Consumption (Private consumption net of indirect tax) (Dalamagas et al., 2019: Griffith, 2010; Arrow & Debreu, 1954).

5. Results and Discussion

5.1 Data Description

Table 2 displays descriptive statistics for government revenue indicators from 1981 to 2018. Ethiopian government revenue accounts for about 8 percent of the country's GDP on average. The low standard deviation indicates that there are little differences over time, implying that the tax-to-GDP ratio in the country has been stable for over three decades. In the years 1988 and 1997, the lowest and highest levels of government revenues were recorded. As shown in the table, the average per capita GDP is $921.5, with a large standard deviation, indicating greater differences over time (1981-2018). The lowest and highest level of per capita income was reported in 1981 and 2018, respectively, indicating a steady increase over time. The trade openness as a percentage of GDP can be explained in the same way. It provides 33 percent of GDP on average, with a high standard deviation that shows huge fluctuations over time, with the highest amount in 2004 and the lowest in 1993.

Table 2: Summary of statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Actual tax (% GDP)	38	8.113	1.760	.500	11.262
GDP per capita	38	921.5	476.91	421.36	2103.5
Trade openness (% GDP)	38	33.16	10.592	18.3	51.086
Manufacturing value added (% GDP)	38	4.731	.904	3.113	7.301
Service value added (%GDP)	38	35.93	4.043	26.82	42.75
Corruption (ICRG index)	38	.3476	.026	.25	.396
External debt stocks (%GNI)	38	60.56	36.891	10.50	147.18

Source: Author's own computation

As shown in Table 2, the hard-to-tax sectors of the country's economy, manufacturing and service value added, contribute on average 5 percent and 36 percent of the country's total output, respectively. With relatively small standard deviations, both the service and industrial sectors show less volatility over time. ICRG includes a corruption component in its political risk index that goes from 0 to 6, with 0 corresponding to the highest conceivable level of corruption and 6 corresponding to the lowest possible level of corruption. Ethiopia's ICRG corruption index, on average, is nearer to zero (i.e., 0.35), suggesting that the country has the highest level of corruption. On average, the country's external debt as a proportion of gross national income reveals a massive debt burden with a large standard deviation, showing considerable changes over time, with minimum and maximum values recorded in 2008 and 1994, respectively.

5.2 Estimation Methods: Assumptions and Maximum Likelihood Estimators

A Skewness Test on OLS Residuals

As a requirement for justifying the appropriateness of the SFA, a skewness test on the distribution of OLS residuals ensures the left (negative skewness). As a result, the OLS residuals for estimated 'inefficiency' (that is, lack of tax effort) have a negative skewness (-4.5), which is consistent with a production frontier specification (Kumbhakar et al., 2015; Skolrud, 2005). The Table is not included simply to save space. This finding has been complemented by a *sktes*t, which presents a skewness-based normality test and a kurtosis-based normality test, then, combines the two tests into an overall test statistic. The null hypothesis of no skewness is safely rejected when the test produces a p-value of less than 0.01. As a result, we uncovered evidence for a left-skewed error distribution with statistically significant skewness. As a result, we may be quite confident that we do not need to re-examine the model's specification at this time and can move on to the next step of estimating the stochastic frontier model. As a result of finding support for the model's stochastic frontier specification, we can proceed to estimate it using parametric distributional assumptions on v_t & u_t.

Parametric Distributional Assumption

The two common statistics are relevant for diagnostic checks for the distribution of technical inefficiency term (u_i): variance of the inefficiency term and likelihood ratio test statistics.

a) Variance of the inefficiency term (u_i)

Compute the total variance of the error term, $\sigma = \sigma ut^2 + \sigma vt^2$ and then make sure that the ratio of the variance coming from the technical inefficiency term (u_t) to the total variance closes to 1. That is, $y = \sigma ut^2/(\sigma ut^2 + \sigma vt^2) \approx 1$

Table 3: Summary of technical inefficiency variance

Variances	SD	Variance
Var_u	7.003711	49.05197
Var_v	1.49E-07	2.22E-14
Total variance		4.91E+01
Variance of technical inefficiency		1.00E+00

Source: Author's own computation

This statistics is found greater than 0.8 (close to 1) showing that most of the variances are coming from the technical inefficiency, not from the stochastic error term, suggests the SFA as appropriate model.

b) Likelihood ratio test statistics

However, according to Kumbhakar, Wand and Horncastio (2015), the above statistics (technical inefficiency variance) is not really advisable in order to check the appropriateness of SFA for analysis, and hence, they suggest to conduct a likelihood ratio test statistics computed as the difference between the estimated restricted model (Cobb- Douglas) and the estimated unrestricted model (SFA), $-2 * (restricted\ value - unrestricted\ value)$. Then, compare this value with the critical values at 1% level of significance with 1 degree of freedom developed by (Kodde & Polm, 1987).

Table 4: Summary of Likelihood ratio test statistics

Likelihood ratio computation, Kumbhakar et al. (2015)	
Unrestricted	19.809
Restricted	-22.080
likelihood ratio	83.781

Source: STATA output

Critical value at 1% significant level is 5.412, since 83.783 is much greater than 5.412, reject the null hypothesis of stochastic frontier model is not appropriate or no technical inefficiency. Hence, the two test statistics confirms the appropriateness of the stochastic frontier model and the existence of technical inefficiency.

6. Empirical Results and Discussion

The usages of two-step and one-step techniques, as well as the distribution of the technical inefficiency component, are all important considerations when estimating SFA (Ui). In the first of two steps, we must first estimate the SFA and then, construct levels of technical inefficiency on environmental factors, which are normally observable at the time decisions are taken. Then, in the second stage, such degrees of technical inefficiency are employed as a dependent variable, and other exogenous variables are included as independent variables in the model $ui = f\ (z)$. The literature implies, however, that if we use the two-step technique, we may end up with system-biased results. To overcome this bias, this study adopted a one-step approach in which the SFA is simply estimated and variables affecting technical inefficiency are factored in.

A functional form of the production possibility frontier is another important consideration. The Cobb-Douglas production function and the Translog are the two most often used functional forms; the Translog is more versatile than the Cobb-Douglas, while the Cobb-Douglas is more limiting. This study follows the best practice that is to estimate both functional forms and perform a likelihood ratio test to see which one is more appropriate.

The Half-normal distribution, exponential normal, and truncated normal are among the distributional assumptions accessible for ui (Aigner et al., 1977). The first two are single parameter distributions that are simple to estimate, although they are less flexible. Literature suggests that a more flexible distribution, such as the truncated normal, used in this study, can help to relieve rigidity.

The stochastic frontier model (SFA) seems to fit very well (Table 5) in that all of the coefficients of the frontier determinants are statistically significant and have signs as expected across the three alternative models. The result is consistent with prior empirical studies (Alamirew et al., 2020; Brun & Diakite, 2016; Fenochietto & Pessino, 2013; Langford, 2015; Le et al., 2008; Rao et al., 2018; Zárate-marco & Vallés-giménez, 2019). The exception is that in some regression specifications, an institutional variable (corruption) and an economic variable (external debt) are included as determinants of inefficiency (column 5). The value of lambda over each model indicates that lack of tax effort accounts for a large proportion of the composite error. For example, the variance components are $(1 - 2/\pi)\,\sigma\,\hat{}2u = 0.183$ and $\sigma\,\hat{}2v = 0.104$, so about 64 percent of the total variance ε is accounted for the variance of inefficiency u under half normal distribution. Same calculation can be applied for the rest of the distribution, truncated normal and Truncated normal heterogeneous in Mean and Decay Inefficiency. In other words, relatively huge value for lambda indicates much of the variations in the total variance coming from the inefficiency term u.

More interestingly, the result supports theories and practices in the country for variables included as hard to tax sectors (manufacturing and service value added), though agricultural value added is dropped due to multicollinearity issue. The argument for the former is that industrialisation, in the form of a high manufacturing share of output, is associated with a rise in tax potential Langford, (2015), specialization on industry as a percentage of the economy can have positive effects on taxation as industrial enterprises are typically easier to tax and manufacturing can generate larger taxable than agriculture (Castro & Camarillo, 2014). For the latter, authors such as Cyan et al. (2016) argued that certain sectors in the economy have been traditionally hard to tax, such as agriculture, services, and construction, and because of that and other reasons (equity and political economy issues), many countries exempt these sectors from taxes.

Table 5: Summary results of SFA estimation: Maximum Likelihood Method

	Models					
Variables	**Half normal**		**Truncated normal**		**Truncated normal heterogeneous in Mean and Decay Inefficiency**	
	Coeff.	**Pv**	**Coeff.**	**Pv**	**Coeff.**	**Pv**
Log of GDP per capita	5.447	0.000	6.271	0.000	.323	0.000
The square of Log of GDP per capita	-.400	0.000	-.463	0.000	-4.456	0.000
Log of trade openness	.154	0.000	.128	0.000	.122	0.000
Log of manufacturing value added (%GDP)	.162	0.000	.128	0.002	.195	0.000
Log of service value added (%GDP)	-.390	0.000	-.257	0.000	-.477	0.000
Inefficiency (MU):						
Corruption					-13.155	0.126
External debt					-.021	0.564
Wald chi2	4.15e+	0.000	3.85e+10	0.000	3.63e+07	0.000
sigma_u	.504	0.000	7.692	0.510	1.253	0.000
sigma_v	6.18e-06	0.977	1.47e-07	0.988	.000329	0.740
Lambda (λ = σu / σv)	81635	0.000	5.23e+07	0.000	3809	0.000
No. of obs		38		38		38

Source: STATA output

Manufacturing companies are less difficult to tax than agricultural companies since their owners keep better records of obligations and facts. Green manufacturing can generate significant surpluses, affecting the tax effort. According to global economic.com (2020), Ethiopia's value-added in the agricultural, industrial, and service sectors was 35.45 percent, 23.11 percent, and 36.81 percent, respectively, as a percentage of GDP. In 2020, the global average, based on 168 countries, was 10.86 percent. When we look at these numbers, we can see that the share of the economy that is difficult to tax (35.45% & 36.81%)

is substantially higher than the share of the economy that is simpler to tax (23.11%). Apart from tax management issues, this reduces the country's tax base.

For a variety of reasons, including fairness and political-economic system issues, many nations exempt agriculture from taxes. Several service groups can be established to make a similar case. As a result, the higher the proportion of these industries in GDP, the more difficult it will be for tax administrations to collect money (Jewell et al., n.d.). This result is bolstered by the fact that, during the GTP (2010-2015), Ethiopia saw outstanding economic growth of 9.97 percent on average over a decade, but the tax-to-GDP ratio remained stable at 8 percent on average, demonstrating the absence of a trend. The IMF (2011) verified that tax collections in developing countries, particularly in LICs and SSA, had been static for 30 years. The tax base that is fundamental to increasing tax-to-GDP ratios in a sustained manner is formal sector employment and earnings (the income tax base) and private sector spending (the indirect tax base). It will be difficult to enhance the tax-to-GDP ratio if these bases do not rise at the same rate as GDP (IMF, 2011). Tax ratios are supposed to rise in lockstep with GDP, based on the assumption that tax collection efficiency improves with development, although there is little evidence to support this hypothesis.

In the Mean and Decay Inefficiency model, the other two variables (corruption and foreign debt) are considered independent predictors of tax inefficiency (Table 5, last column). The signs of both coefficients are as expected, even if they are statistically insignificant. The degree of corruption, which ranges from 0 to 6, has a negative sign, indicating that a high level of this variable, that is, less corruption, is linked to a lower level of inefficiency and a higher level of efficiency. In the same way, the negative sign for external debt indicates that it has a negative impact on inefficiency while having a favourable impact on tax collection efficiency. Literature argues that a high level of corruption reduces revenues collection (Le et al., 2012; Le & Moreno-dodson, 2008); taxpayers who deal with rampant corruption are less willing to pay taxes (Bird et al., n.d., 2008; Cyan et al., 2016). Corruption also discourages foreign investment, which negatively affects economic activity and the tax base.

Higher amounts of government debt, on the other hand, may have a positive influence on government efficiency in collecting taxes because the debt must be repaid in the future. This finding supports the idea that a large public debt necessitates government income increases in order to service the debt, particularly, when interest on the debt exceeds net borrowing plus non-interest spending reductions. The country is suffering from the high stock of external debt, debt distress increased from moderate to high (UNDP, 2018), public external debt reached $24.2 billion, showing 12 percent annual growth. The central government's share of the debt was 56 percent, while public enterprises share the remaining 44 percent (52% of which is government-guaranteed). In the same year, the external debt to GDP ratio was 30 percent, and the annual debt service to exports ratio was 11.9 percent. On top of that, according to IMF/WB debt sustainability analysis (DSA) 2017, Ethiopia's risk of debt distress increased from moderate to high, and the country's trade deficit in the first six months of 2017/2018 was $6.6 Billion. These, among others, make it unquestionable that revenue mobilization through taxation is the most realistic and practical way of financing Ethiopia's development through broadening the country's tax bases.

Table 6 summarizes the actual tax ratio, tax potential, tax effort, and tax gap estimated using half normal, Truncated normal, and Truncated normal heterogeneous models. Across each model, the tax potential, effort, and gap all have very similar values. Using alternate estimation methodologies, tax effort determined to be almost identical for the given two-digit values. However, as we extend its decimal to three and above digits, these values become significantly different; the figures shown here are rounded to conserve space. Over a three-decade, from 1981 to 2018, the country's real tax to GDP ratio averaged 8.27 percent. The average tax potential values among other models for the same period show no substantial variance (see column 3, 4, 5). Each model (see columns 6, 7, and 8) finds the same average tax effort index of 36 percent, whereas, the average value for the tax gap is over 14 percent (see column 9, 10, and 11).

As seen in Table 6, the country has a high tax gap, which can be read as inefficiency in the case of a production frontier function. However, the interpretation of the tax frontier function is quite different, and this figure cannot be wholly attributed to technical inefficiencies. Because tax effort reflects two essential aspects: policy choices defined in terms of tax rates, tax bases, and any exemptions, and technical inefficiency in policy enforcement that encompasses issues of tax administration and taxpayer compliance, as well as the interconnections between these two. As a result, this figure represents the issues of policy choice and enforcement in the country's tax policy (see Le, Moreno-Dodson & Rojchaichaninthorn, 2008; Pessino & Fenochietto, 2010, 2013; Le, Moreno-Dodson & Bayraktar, 2012; Cyan, Martinez-Vazquez & Vulovic, 2016; Langford & Ohlenburg, 2015). Tax literature suggests that the primary causes of tax collecting inefficiencies include: corruption, inadequate tax administrations, government ineffectiveness, and low enforcement (Alamirew et al., 2020; Mebratu & Fellow, 2020; Pessino & Fenochietto, 2010).

In Ethiopia, inefficient tax collection is mostly caused by policy choices and enforcement. As the realities on the ground, the country is currently plagued by corruption, poor tax administration, a patchwork of tax laws, and on-going political upheaval. Corruption, among other things, exacerbates tax collection inefficiencies, inhibits foreign investment, and erodes Ethiopia's revenue bases. It is worth noting that this variable encompasses both policy selection and enforcement. The country's corruption is so pervasive that the tax system is bound by politically connected tax officers and taxpayers. Furthermore, the country's constitution's Article 200(2) limits on tax power, as well as the country's dispersed tax laws, very expensive tax exemptions, and biased policy enforcement, all contribute to systemic corruption.

In spite of the fact that Ethiopian revenue and customs authority (ERCA) is not the only government agency involved in tax administration in the country, other government agencies are also involved. For example, the Federal Investment Agency, the Ministry of Mines and Energy, the Ministry of Tourism and Culture, and the National Bank of Ethiopia (NBE) are all involved in tax administration in some capacity (proclamation no.280/2002). As a result, while the distribution of tax administration across various government agencies in the country was unavoidable, it had unintended consequences (Gemechu, 2013; Alamirew et al., 2020)). Despite a slew of recent changes aimed at combining the authorities directly involved in tax administration, there are still a slew of government agencies participating (at least indirectly) in tax administration, raising worries about miscoordination and jurisdictional disputes. Most tax legislations repeat certain elements as if they were not already provided for in other tax legislations as a result of the country's uncoordinated tax laws, suffering from short-term duplication of tax regulations meant to treat a certain public or political group. When it comes to codifying tax legislation, the country has no track record. As a result, the country's tax legislation field remained chaotic, fragmented, uncoordinated, and worse, making it impossible for the common taxpayers to understand their responsibilities under the different tax laws in effect. Furthermore, Ethiopia's public finances are in shambles due to pervasive corruption involving tax fraud, illegitimate tax credits, and theft of government tax income (Gemechu, 2013; Alamirew et al., 2020; Mascagni & Mengistu, 2016).

Table 6: Summary of Tax revenue potential and tax revenue effort index computed

Year	Actual tax ratio (%GDP)	Tax potential			Tax effort			Tax gap		
		Battese Coelli Half Normal	Battese Coelli Truncated normal	Truncated normal heterogeneous in Mean and Decay Inefficiency	Battese Coelli Half Normal	Battese Coelli Truncated normal	Truncated normal heterogeneous in Mean and Decay Inefficiency	Battese Coelli Half normal	Battese Coelli Truncated normal	Truncated normal heterogeneous in Mean and Decay Inefficiency
1981	6.50	21.18	21.01	21.33	0.30	0.30	0.30	14.68	14.51	14.83
1982	7.00	21.04	20.97	21.12	0.33	0.33	0.33	14.04	13.97	14.12
1983	7.80	21.46	21.42	21.52	0.36	0.36	0.36	13.66	13.62	13.72
1984	8.00	20.79	20.79	20.86	0.38	0.38	0.38	12.79	12.79	12.86
1985	8.50	21.40	21.45	21.41	0.39	0.39	0.39	12.90	12.95	12.91
1986	7.45	21.45	21.51	21.47	0.34	0.34	0.34	14.00	14.06	14.02
1987	8.60	21.78	21.82	21.83	0.39	0.39	0.39	13.18	13.22	13.23
1988	7.50	21.57	21.68	21.59	0.34	0.34	0.34	14.07	14.18	14.09
1989	8.63	21.56	21.70	21.57	0.40	0.39	0.40	12.92	13.06	12.94
1990	7.45	22.55	22.79	22.56	0.33	0.32	0.33	15.10	15.34	15.11
1991	5.60	22.53	22.63	22.57	0.24	0.24	0.24	16.93	17.03	16.97
1992	5.91	22.50	22.47	22.62	0.26	0.26	0.26	16.59	16.56	16.71
1993	7.67	22.84	22.83	22.98	0.33	0.33	0.33	15.16	15.16	15.31
1994	8.42	23.07	23.13	22.94	0.36	0.36	0.36	14.64	14.70	14.52
1995	8.95	23.52	23.49	23.44	0.38	0.38	0.38	14.56	14.54	14.49
1996	10.52	23.53	23.53	23.54	0.44	0.44	0.44	13.01	13.01	13.02

1997	11.26	24.96	24.57	25.23	0.45	0.45	0.44	13.70	13.31	13.97
1998	10.88	23.97	23.87	23.88	0.45	0.45	0.45	13.09	12.98	13.00
1999	9.48	23.78	23.77	23.65	0.39	0.39	0.40	14.29	14.28	14.17
2000	8.08	23.61	23.67	23.45	0.34	0.34	0.34	15.53	15.58	15.37
2001	9.70	23.77	23.83	23.58	0.40	0.40	0.41	14.06	14.12	13.88
2002	9.11	23.52	23.67	23.25	0.38	0.38	0.39	14.41	14.55	14.14
2003	9.68	23.53	23.68	23.17	0.41	0.40	0.41	13.85	14.00	13.49
2004	8.72	23.93	23.99	23.61	0.36	0.36	0.36	15.20	15.26	14.89
2005	8.26	23.91	23.95	23.61	0.34	0.34	0.34	15.64	15.69	15.35
2006	7.81	23.71	23.76	23.50	0.32	0.32	0.33	15.90	15.95	15.69
2007	7.81	23.50	23.56	23.35	0.33	0.33	0.33	15.68	15.74	15.54
2008	6.58	23.24	23.27	23.16	0.28	0.28	0.28	16.66	16.69	16.58
2009	8.16	23.23	23.23	23.11	0.35	0.35	0.35	15.06	15.07	14.95
2010	9.20	22.80	22.83	22.72	0.40	0.40	0.40	13.59	13.62	13.52
2011	9.37	22.38	22.38	22.39	0.41	0.41	0.41	13.00	13.00	13.02
2012	8.76	22.20	22.11	22.35	0.39	0.39	0.39	13.44	13.35	13.59
2013	8.81	21.90	21.76	22.15	0.40	0.40	0.39	13.09	12.94	13.34
2014	8.35	21.64	21.41	22.02	0.38	0.39	0.37	13.29	13.06	13.67
2015	8.08	21.26	20.95	21.85	0.38	0.38	0.36	13.18	12.86	13.77
2016	7.60	21.53	20.97	22.39	0.35	0.36	0.33	13.92	13.36	14.79
2017	7.60	21.46	20.75	22.42	0.35	0.36	0.33	13.85	13.14	14.82
2018	6.50	21.17	20.41	22.18	0.30	0.31	0.29	14.67	13.91	15.68
Average	**8.27**	**22.57**	**22.51**	**21.33**	**0.36**	**0.36**	**0.36**	**14.30**	**14.34**	**14.37**

Source: Author's own computation

Regarding policy choice, the country has been losing a significant amount of revenue as a result of poorly designed tax exemptions, which include costly tax holidays and incentives and a wide range of tax rates (from 0% to 150%) that fail to attract investment while also narrowing the tax base. Absence of codified tax laws, complex tax system with unlimited number of rates, weak information management system, traditional registration and management of filling obligations, and lack of risk based and targeted audit programs, among other factors, reduce tax compliance and bring inefficiency to the country's tax administration.

7. Robustness Checks

Alternative model specifications and estimation approaches are often used to assess the consistency and efficiency of estimated outcomes from any model. Following the publication of Dalamagas et al. (2019) recent work on a new method to tax effort, this is the first research to compare tax effort estimation findings using the utility maximization function and the SFA, as shown in Table 7.

To compare summarised results with the Utility maximization function, truncated normal heterogeneous in Mean and Decay Inefficiency is utilized among the different models estimated in Table 6. Only 20 years (1999-2018) are considered due to real data availability limitations when computing tax potential using the Utility maximization function (UMF).

Table 7 shows that the average tax potential calculated using UMF is extremely close to the average value predicted using the SFA, at 23.69 percent and 22.89 percent, respectively. The tax effort calculated from the former (34%) is on average smaller than the average value estimated from the later (36%). In terms of the tax gap, the two models have relatively similar average values of 15.58 percent for UMF and 14.37 percent for SFA. These findings support the argument in the literature that tax potential calculated using the UMF is likely to be exaggerated when compared to SFA results (Dalamagas et al., 2019; Arrow & Debreu, 1954)). The reason for this is that in the case of the UMF, real revenue is compared to a theoretically optimal tax level that takes only three macroeconomic variables into account (GDP, tax revenue, consumption). In this scenario, the optimal level of tax revenue is determined using a utility maximization procedure and is proven to be equal to the difference between income and consumption, regardless of the country's economic, institutional, political, or other variables. The SFA, on the other hand, compares actual revenue to a notional capacity estimate based on economic, demographic, and institutional characteristics linked to tax revenue drivers (Arrow & Debreu, 1954; Dalamagas et al., 2019).

Table 7: Robustness checks using utility maximization function

Period (Year)	**Actual tax ratio (%GDP)**	**Tax potential**		**Tax effort**		**Tax gap**	
		Utility maximization function	Truncated normal heterogeneous in Mean and Decay Inefficiency	Utility maximization function	Truncated normal heterogeneous in Mean and Decay Inefficiency	Utility maximization function	Truncated normal heterogeneous in Mean and Decay Inefficiency
1999	9.48	30.87	23.65	0.30	0.40	21.39	14.17
2000	8.08	28.75	23.45	0.28	0.34	20.67	15.37
2001	9.70	25.15	23.58	0.38	0.41	15.44	13.88
2002	9.11	21.92	23.25	0.41	0.39	12.80	14.14
2003	9.68	29.06	23.17	0.33	0.41	19.37	13.49
2004	8.72	22.73	23.61	0.38	0.36	14.01	14.89
2005	8.26	21.32	23.61	0.38	0.34	13.06	15.35
2006	7.81	23.58	23.50	0.33	0.33	15.77	15.69
2007	7.81	19.67	23.35	0.39	0.33	11.86	15.54
2008	6.58	19.29	23.16	0.34	0.28	12.70	16.58
2009	8.16	18.46	23.11	0.44	0.35	10.30	14.95
2010	9.20	27.56	22.72	0.33	0.40	18.35	13.52
2011	9.37	27.53	22.39	0.34	0.41	18.15	13.02
2012	8.76	26.53	22.35	0.33	0.39	17.76	13.59
2013	8.81	29.77	22.15	0.29	0.39	20.96	13.34
2014	8.35	19.69	22.02	0.42	0.37	11.34	13.67
2015	8.08	22.23	21.85	0.36	0.36	14.15	13.77
2016	7.60	33.16	22.39	0.22	0.33	25.56	14.79
2017	7.60	21.39	22.42	0.35	0.33	13.79	14.82
2018	6.50	5.18	22.18	1.42	0.29	-2.21	15.68
Average	**8.43**	**23.69**	**22.89**	**0.34**	**0.36**	**15.58**	**14.37**

Source: Author’s own computation

In conclusion, the comparison of SFA and UMF shows that there are no significant differences between the two types of estimations, at least at the average level. The most important finding is that the optimal overall tax potential is equal to the difference between GDP and private consumption. According to this criterion, Ethiopia's actual tax burden is lower than its optimal level, implying that the country is undertaxed with low tax effort and high tax potential. A country's tax effort index could be any value between zero and one, regardless of its level of economic growth. The difference between actual tax income and the tax frontier can only be read as the amount of uncollected tax or the tax gap, not as a rigorous measure of inefficiency. This uncollected tax may be due to two factors: people's choices for low-cost public goods and services, resulting in low tax income, and government inefficiencies in tax collection. Because Ethiopia is a developing country with a high need for public financing in order to meet its millennium development goals (MDGs) and to place the country in the middle-income group by 2025, the Ethiopian people seek a high level of public goods and services. As a result, policy choices such as tax exemptions and inefficiencies in policy enforcement are linked to low tax effort and a large tax gap.

8. Conclusions and Recommendations

This research examines Ethiopia's tax potential and effort using the two alternative models of SFA and UMF. The methodology and the results enable for a precise assessment of the country's tax potential, effort, and gap. The central economic and institutional factors that affect tax capacity in the two alternative models are determined in this study: GDP per capita, trade, manufacturing value-added, service value-added, external debt, and corruption in the former, and GDP, tax revenue, and private consumption net of indirect tax in the latter. Results from the UMF confirm the consistency of findings from SFA with no substantial differences between the two, at least at the average level. Of most importance of these findings is that the optimal level of total taxation is equal to the difference between GDP and private consumption.

This research contributes to the field by combining the UMF and the SFA as a new measure of tax effort. The empirical findings revealed that Ethiopia's economy is still undertaxed. The real tax to GDP ratio is significantly lower than the SSA average, and a significant tax gap exists as compared to the country's tax capacity, owing to policy difficulties such as policy choice and enforcement. To maximize the country's tax potential, broaden the tax base and enhance tax collection efficiency in the economy, this study proposes two policy recommendations: 1) emphasize tax policy choice, and 2) focus on enforcement (tax administration). In terms of the former, the government should concentrate on structural changes that push the economy away from hard-to-tax sectors such as agriculture and services and toward easy-to-tax sectors such as manufacturing in order to expand the revenue base and reduce tax administration costs. The government should also reform the discretionary award of comprehensive tax exemptions by various authorities, such as the MoFED, which leads to corruption. Regarding the latter, the effectiveness of tax administration is influenced by the enforcement of tax laws. To that end, the government should codify the country's current scattered laws to maximize the benefits of accessibility and intelligibility, eliminate duplication of definitions and administrative provisions in individual pieces of legislation, avoid conflicting interpretations, and rationalize the tax system's overall structure towards encouraging voluntary compliance, detecting and penalizing non-compliance and rendering quality taxpayer service, and thereby, assure efficient tax collection practices. Future research could concentrate on investigating the impact of policy choice and enforcement on a country's tax revenue collection.

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Appendix

Table A: Summary of variables, description and classification

Variables	Description	Source	Classification	dd/ss	location in model specification	
					X	**Ze**
Tax_GDP	Tax revenue as percentage of GDP	WDI/NBE/ICTD	Eco	Ss		
GDPPC	GDP per capita, PPP (constant 2017 international $)	WDI	Eco	Ss	x	
Trade	Imports plus exports as percentage of GDP	WDI	Eco	Ss	x	
AGVA	Share of agriculture to GDP	WDI	Eco	Ss	x	
MAVA	share of manufacture to GDP	WDI	Eco	Ss	x	
SVA	Share of Service industry to GDP	WDI	Eco	Ss	x	
Imports	Imports of goods and services (% of GDP)	WDI	Eco	Ss	x	
Export	Exports of goods and services (% of GDP)	WDI	Eco	Ss	x	
EXD	External debt stocks (% of GNI).	WDI	Eco	Ss		X
CORR	Corruption index (ranges from 0-6, where 0 corresponds to the highest possible level of corruption and 6 – to the lowest.)	ICRG	Inst	dd		x

Where, eco denotes economic factors, dd/ss denotes demand or supply side factors, x denotes tax frontier determinants, and ze as determinants of tax effort.

Table B: Correlation Matrix

	Tax to GDP ratio	GDP per capita	trade openness	Agri. Value added	Mfg. value added	Service value added	Corruption	Imports	Exports	External debt	Shadow eco.
	1.000										
GDP per capita	0.205	1.000									
trade openness	0.396	0.610	1.000								
Agri. Value added*	-0.278	-0.623	-0.801*	1.000							
Mfg. value added	0.410	-0.305	0.136	-0.241	1.000						
Service value added	0.184	0.592	0.785	-0.948	0.052	1.000					
Corruption	-0.357	-0.695	-0.729	0.559	-0.017	-0.540	1.000				
imports	0.551	0.207	0.327	-0.201	0.356	0.112	-0.443	1.000			
exports	0.166	0.124	0.149	-0.067	-0.087	0.169	-0.081	0.334	1.000		
External debt	0.244	-0.471	-0.343	0.432	0.424	-0.495	0.154	0.492	0.010	1.00	
Shadow eco.*	-0.181	-0.975*	-0.569	0.530	0.354	-0.512	0.694	-0.189	-0.125	0.42	1.00

*Dropped from SFA model due to multicollinearity issue.