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Measuring tax effort:

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I. Introduction

In this paper we attempt to take a fresh look at the classical question of the determinants of tax effort. Our goal is to better understand the fundamental economic logic of the different approaches that have been used in the previous literature, consider alternative measurements which may provide a more direct intuition of what the concept of tax effort attempts to measure, and to compare quantitatively the rankings of tax effort produced by all these different approaches. As we see it, the fundamental issue is how to move forward toward a definition of tax effort that has a higher relevance to the developmental needs and budgetary ambitions of a country and as an indicator of potential tax reform needs. Fundamentally, all tax effort indicators are calculated by comparing actual collection performance against a measure of potential collections. This definitional choice lays out several dimensions for the conduct of tax policy in a country. These include the need for reform to raise revenues with reference to some potential, the desirable timing and urgency of those reforms, and the extent of the gains in national welfare that are achievable with these reforms. While the first two dimensions have been examined in different ways in the previous literature, in this paper, for the first time in this literature, we will examine how much the two different approaches to estimation of tax effort matter as compared to those conventionally used. In addition, and also for the first time in this literature, in this paper we argue for the need to explicitly link the adequacy of tax effort with the specific expenditure goals of government and their associated gains in national welfare.

Developing countries have often clearly defined service delivery and development outcome gaps. A number of international reports highlight who is lagging behind global trends and by how much.[1] These comparative statistics are often used to serve as motivations for focusing attention on the development needs in different countries, to spur action on specific reforms or to gather support for particular programs. These discussions very often correctly point out the gaps in development needs. But much less often the discussions clearly identify how much financing is available to a country to bridge the existing budget gaps. In developing countries, foreign aid and national tax effort together bring the resources up to cover budgetary needs. The national tax effort is something the countries can change through tax reform but without referring to development needs or 'desirable revenue potential'; by how much and within what time frame

[1] For example, to name two of the most influential sources of this information: UNDP Human Development Reports annualized since 1990; World Bank's World Development Reports annualized series since 1978.

the tax effort should be changed is often left unclear. A number of considerations are relevant to these key questions. These include whether tax effort is an outcome of the structural features of the economy largely outside the immediate control of the government or is it simply a result of administrative inputs much more under control of government; whether taxation levels indicate collective preferences for public goods or they are hampered by endemic corruption which seeps away resources; or whether institutional features of the country matter more than anything else. All these issues have been debated in the literature for several decades. The vibrant debate on the determinants of tax effort indicates not only its critical importance to development but also the complex nature of the issue.

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. In this paper, we develop this discussion by comparing three different ways to estimate tax potential, and therefore tax effort. Each case has certain strengths and weaknesses. Through this discussion we aim to extend the literature by organizing the search for a tax potential estimate in an integrated manner. We also make a mention of some additional ways in which tax potential, and thus tax effort, could be estimated.

This paper contributes to the discussion on tax effort in two other relatively less significant but noteworthy ways. First, one of the approaches we examine in depth is the stochastic frontier analysis model. This econometric tool generates a measure of tax capacity which is specific to each country while the performance benchmark arises out of the experience with general tax effort across countries. Using a wider range of explanatory variables our analysis provides improved estimates vis-à-vis the previous literature. Second, the model allows estimation of time-varying inefficiency in tax effort. In our analysis we attempt to estimate the effects of various institutional factors on this inefficiency thus delineating a clearer agenda for comprehensive tax reforms.

The rest of the paper is organized as follows. First, we briefly recount in Section 2 the importance of calculating tax effort, not only accurately but cogently, to tax policy and reform discussions. In Section 3, we discuss three ways in which tax effort can be calculated for different countries using different benchmarks for tax capacity or desirable levels of revenue.

Then in Section 4, we recount the methodology for estimating tax effort using the traditional and stochastic frontier analysis approaches. In addition, we also identify several other ways in which tax capacity and effort could be calculated. Section 5 contains a discussion of the estimation results. In Section 6, we provide an explanation of a new measure of tax potential and therefore tax effort and draw a comparison between tax efforts calculated by using three different methods. Section 7 concludes the discussion laying out directions for further work.

II. The Importance of Calculating Tax Effort Correctly

How much tax revenue needs to be raised in any particular country is fundamentally the result of a collective choice decision on the desired level of public expenditures. Collective preferences for public goods and services, desired level of social protection and insurance and economic wealth, in turn, are the main determinants of the desired level of public expenditures. There is, therefore, no normative theory of desired revenues applicable to all countries. Among developed countries it is perfectly anticipated to find marked differences in the share of GDP that is collected in taxes (for example, Sweden and the United States). On the other hand, there is a commonly accepted stand that lagging economic development can be interpreted as an almost obvious need for more public revenues. Developing countries with lagging indicators in health, education, public infrastructure and regulatory services are commonly perceived to be in need of higher public spending to meet short term population needs as well as to put the country on a longer term development trajectory. The recent UNDP rankings for Human Development Index show that some countries lag behind others by a magnitude of 3 fold in health and education outcomes.[2] Finding sustainable financing is a key to bridging these gaps and harnessing the human potential in these societies. This brings up tax effort as a central concern for policy.

Tax effort, the ratio between actual tax collection and potential tax or revenue, serves as an effective indicator and point of departure for tax reforms and as an enduring indicator of the sufficiency of government revenues. From this perspective tax effort is a useful tool to motivate policy discussions on how much additional endeavor a country needs to make for meeting its development objectives. Only when governments are raising sufficient revenue can they pursue

[2] UNDP's 2011 Human Development Report shows that Democratic Republic of Congo has achieved a human development index of 0.286 while Norway has ranked a high 0.943.

enhancing access and quality of services for the people. Within the development policy, poverty reduction is a key objective that has shaped many developing country plans in the past decades (Pirttilä and Tuomala, 2004). In addition, donor policies in many countries have required poverty reduction strategies to be developed and adopted as formal statements and serve as devices to monitor progress. All these policy options lay down expenditure levels, which, in turn require commensurate revenue.[3] On the other hand, growth promotion policies also consider tax effort as an important indicator but from a different perspective. How much income should be left for private allocation is often at the center of growth and development policies together with what type of taxes should be used to collect revenue (Arnold et al., 2011). High taxation means less income for private consumption and investment. More importantly, a bad tax system is likely to stifle growth (Bird, 2010) and be accompanied by some negative effects on local economic activity and job creation.[4] Of course, the level of taxation and even the types of taxes used in a country are linked to the level of development (Bahl and Bird, 2008). However, while this relationship is apparent, it is noteworthy that it is less clearly understood how they affect each other.

The manner in which tax effort is calculated, however, becomes as important as the reported ratio itself. A country with high preference for public goods, and therefore public expenditure, may need a higher level of revenues. Social norms may influence tax collection as well as level of taxes (Konrad and Qari, 2012).[5] The quality of public expenditure also influences citizens' choices.[6] Inefficiency in converting public expenditure inputs into consumption would intuitively lower the value of such expenditure in the eyes of the citizens.[7] On the other hand an inverse comparator may have a very low preference for public goods where the people dictate choices of

[3] This discussion is often captured by fiscal response models tracing the effects of foreign aid on tax effort (for examples,Franco-Rodriguez,2000 and McGillivray and Ouattara,2003) or by linking foreign aid with poverty reduction targets as an autonomous source of revenue (Agenor, Bayraktar and Aynaoui, 2008).

[4] In the U.S. context, Wasylenko (1997) points out that some studies report negative tax elasticity estimates which means that the states with higher tax rates will lose economic activity to other regions and may also have a slower job creation.

[5] Martinez-Vazquez and Torgler (2009) modeling the case of Spain show that when political change leads to social norms change this can result in an overall increase in the level of taxation.

[6] Barone and Moceti (2011) arguing that the efficiency of public expenditures contributes to tax morale show that the quality of public expenditures can be seen as another factor that will in turn determine how much will be collected in taxes.

[7] The notion of this inefficiency and how it may affect GDP estimates is discussed in Grigoli and Ley (2012).

low public expenditures.[8] Consequently, in such a country the required level of revenue will be lower. This notion demands that tax effort measures should take into account the collective preference for public goods and the interdependence of preferences for public expenditures and taxes.[9] If democratically expressed collective preferences for a certain level of public expenditure result in a certain level of tax effort there is not much point in generating a policy debate about increasing efforts to collect additional revenues. It is this intimate connection between country specific development objectives and the measures of potential tax revenue and actual collections that forms the main basis for the discussion of tax effort measures.

It can be argued that the collective preference for public goods in a country should have a mirror image in the level of taxation. It is intuitively appealing to argue that a country decides to provide a certain level of public goods and then goes about raising a matching level of revenue. In practice, that true reflection of collective preference for public expenditure seen through the revenue effort may be hobbled by political factors in a country. There are cases where tax effort in a country has stagnated over time (for example, Martinez-Vazquez, 2001 for the case of Mexico; Martinez-Vazquez, 2007 in the case of Pakistan). This could be a combination of tax policy and administration settling into some sort of an equilibrium which is quite divorced from what appears to be the collectively preferred level of public expenditures. In addition, the quality of political institutions is reflected in the level of tax effort with interest groups vying with each other for influencing public policy in general and tax policy in particular. The level of taxation therefore must be seen as a direct outcome of highly contested political and rent-seeking processes, with notions of equitable access to services, allocative efficiency, and size of government impinging upon the final outcomes.

Political choices in a country materialize in the shape and level of taxation but those may not be the only forces at play. Tax administration, its functionality and effectiveness are also determined by politics. What may not be achievable by tax policy transparently is sometimes possible through tax administration opaquely. Thus political redistribution may be achieved through differential application of administration (Esteller-Moré, 2012). Tax policy may treat

[8] For example Neustadt and Zweifel (2010) report differences in willingness to pay and size of the Swiss welfare state resulting in pressures on the latter.
[9] See Bierbrauer and Sahm (2010) for theoretical discussion of this issue.

different groups according to notions of equity. But tax administration may favor some groups by paying less attention to them. In Pakistan, for example, small traders comprise a formidable political group. Tax policy levies a sales tax on retail business transactions but lack of enforcement allows small businesses to evade the tax. This is an apparent loophole in the tax system. Governments in the last two decades have struggled periodically to enforce documentation of retail transactions and to follow through with collection. However, each time public protests were launched by small businesses forcing the governments to abandon efforts and allowing the status quo to continue. In other words, to provide a dispensation which, although not legislated in tax policy, is de facto provided through tax administration.

Between the traditional approach to estimating tax effort focused on the presence of tax handles starting with the work of Lotz and Morss (1970) and Bahl (1971) and the later work like Bird, Martinez-Vazquez and Torgler (2008), there has been an attempt to unravel the largely subliminal political agreements, organizational culture and social features of tax systems. Estimating tax effort by taking into account the political and institutional dimensions of a country starts to cater to less visible constraints on tax systems. We now clearly understand that the political equilibrium in a society affects the level of taxation.[10] This is important from several perspectives. First of all, tax gaps generated by comparing country collections with international average may serve as a good entry point for discussions on tax policy but they may not provide a plan for reform. Deeper understanding of local tax systems is required to create tax reform packages with specific country relevance. Second, tax reform may seek to reset the political balance achieved between competing interests in the past. If this plays out on the sidelines of reform implementation, it may affect the reform outcomes without the main issues ever coming into proper focus. If this threat is recognized and discussed in the reform process, its adverse effects may be curtailed. Third, tax reform that suits a particular context has higher probability of success. The standard tax advice must be tailored to address particular situations, keeping in view the feasibility of reform actions. Fourth, institutional characteristics in a country may be of two types. First, some social or cultural characteristics are hard to change in the short run. These must be recognized so to adopt mitigation strategies for enhancing the success of reforms.

[10] See, for example, Ehrhart (2011) who finds a positive relationship between democracy and tax collection in a panel of 66 developing countries for the period 1990-2005.

Second, organizational characteristics and tax morale, on the other hand, are not set in stone. Reforms that aim to address the contextual variables that define the environment in which taxes are levied, paid and collected are again likely to be more successful than those which pay scant attention to them.

The quality of governance is also likely to affect tax effort. This is based on the assumption that if corruption is rife and trust in public authority is low then citizens would not support higher levels of taxation. An inefficient public expenditure system converts taxes into public services at higher costs. Often, the failure of the state to provide adequate public services leads to citizens opting for privately provided service substitutes. When this happens, citizens are likely to support even lower levels of taxation.

III. Three Approaches to Calculating Tax Effort

Several approaches can be used to determine tax effort for individual countries, and they differ fundamentally by the way in which the key variable of potential tax revenue is calculated.

In the first approach, which for lack of a better name we will call the traditional regression approach, tax effort is measured by comparing actual tax collection as a percentage of potential tax revenues. That revenue potential is generated from the predicted values based on regression analysis. Some early contributions to this discussion were Bahl (1971) and Lotz and Morss (1970). Later on, Leuthold (1991), Tanzi (1992), Stotsky and WoldeMariam (1997), Ghura (1998), Piancastelli (2001), Eltony (2002), and Gupta (2007) have contributed empirical studies using this approach. The advantage of this approach lies in its simplicity. Data on the dependent variables are easily available and the estimation models do not impose much structure on the estimation parameters. By adding various economic features related to the tax bases and their relative accessibility to the tax administration authorities, this approach takes into consideration structural economic features that are likely to affect tax effort. In an international cross country setting, this approach to calculating tax effort serves a useful purpose of providing comparisons on the size of government revenue across countries conditional on economic structure and other determinants of taxable bases.

For policy advice, tax effort determined in this manner serves a useful but limited purpose. The traditional approach yields an indicator that is clear but that generally has important limitations to inform policy reform.. An exception to this may be when the introduction or not of a particular tax instrument can be used to explain variations in tax effort. [11]

From a specific country perspective, the traditional regression approach does not provide a yardstick of expected revenues but generates a notional value of revenue potential if a number of estimated parameters were to follow the same pattern in that particular country. In particular, the standard estimated equation characterized by tax handles representing structural features of the economy does not provide much guidance to governments eager to increase their revenue. The structural features are often not amenable to change over the short run as a result of government policy measures.[12] For instance, if an economy has a large agrarian base and this shows up as a major determinant of low tax effort, it only indicates that tax effort may not change for many years to come thus diminishing government's enthusiasm for reform.

As an extension of the traditional approach, the role of institutions can be added to the list of determinants of tax effort. (Bird, Martinez-Vazquez and Torgler, 2008). Beyond the traditional tax handles, the level of revenue a government is able to collect may be constrained (facilitated) by the quality of public services, governance and state institutions. [13] Whereas the first two contribute to tax morale, the quality of institutions may have both a direct and an indirect effect on tax collections. Institutions may lack capacity to collect revenue. Where outdated systems form the bedrock of tax administration, it is hard to collect higher revenue as documentation may be insufficient, records may not be up to date or disaggregated record keeping may result in loss of information. The cost of administration is high and this may result in *ab initio* high expenditures on reform measures to raise more revenue. For tax reform purposes, this choice sets up a tradeoff between current consumption, which is politically insistent, and future tax revenues to be realized over time (Cárdenas and Tuzemen, 2011). Fiscally constrained governments may

[11] Keen and Lockwood (2010) use VAT as an explanatory variable in the tax effort equation to determine its impact on changes in revenue mobilization.

[12] Features of industrial organization in a country may also be deemed to affect tax collections (Kleven, Kreiner and Saez, 2009) but they may be equally hard to change, especially in the short run.

[13] There is a wide range of other institutional variables that have been examined for their potential to affect tax collection levels. Aizenman and Jinjarak (2012) derive results to show that inequality has a negative effect on tax base in a country; Elgin et al., (2012) argue that religion influences private charitable donations as a substitute to taxes.

not be able to adopt long term costly options. Indirectly, the quality of institutions again affects tax morale and creates opportunities of collusion between tax collectors and tax payers. The additional analytic dimensions of the traditional approach can provide more relevant guidance to governments aiming to enhance their tax effort since it offers some entry points for policy reform in the short run.

More recently several papers have used stochastic frontier analysis to compute tax effort and for taking a stab at formally identifying the determinants of inefficiency in tax collections (Alfirman, 2003; and Pessino and Fenochietto, 2010). The analysis is conducted into two stages. In the first stage, stochastic frontier analysis is used to model tax effort while in the second stage, factors influencing the time-varying inefficiency in tax effort are identified. This approach has the advantage of identifying weak areas of administration and institutional environment. These sources of time-varying inefficiency are generally important to tax reform and typically are more amenable to reform measures than structural variables over shorter spans of time.

The sources of inefficiency in tax effort have been discussed in a number of papers (Pitt and Lee, 1981; Battese, 1992; and Battese and Coelli, 1992). Corruption is seen as an important factor that decreases tax collection and can add rents to formally paid taxes.[14] More generally, corruption may vitiate efforts at increasing taxes in two ways. First, corruption is an unobserved charge on tax payments resulting in a higher effective tax on taxpayers than what is estimable from the public accounts. Attempts at increases in taxes are likely to be met with more resistance and higher evasion. Second, corruption payments do not contribute to the financing of public goods and services. They are rents siphoned away for private consumption. If higher taxes lead to higher rates of corruption, taxpayers will attempt to evade even more. Third, corruption is a result of the bargaining position granted to tax collectors by tax policy decisions. Higher tax rates increase tax collectors' bargaining position allowing them to collect higher rents from taxpayers.

Tax gaps result from both tax policy decisions and administration and compliance implementation. Exemptions and other elements of the tax structure are part of the first component of the gaps, whereas corruption and evasion are part of the second component.

[14] Corruption may lower the burden of corporate taxes (Goodspeed, Martinez-Vazquez and Zhang, 2011); on the other hand, it is sometimes argued to be a marginal tax for businesses (Olken and Pande, 2011).

While recognizing the dual sources of gaps, the revenue losses from tax exemptions and the like are much more difficult to account for in cross-country analysis.

For ascertaining the value of the traditional and stochastic frontier approaches of calculating tax effort to tax policy discussion it is useful to focus on the creation of the counterfactual revenue or tax potential measure. The traditional regression approach creates a counterfactual for the measure of tax potential that is the predicted value for each country from the estimated equation for entire sample of countries. In other words, the measure of tax capacity for each country is generated by using parameters based on cross-country data but allowing for individual country characteristics as given by the level of the variables used in the estimation equation.

The stochastic frontier analysis develops a function that expresses the maximum amount of revenue that countries could collect from given bundles of determinant characteristics of revenues, and allows us to estimate technical inefficiency in a country's revenue collection and then investigate factors determining technical inefficiency in the country's tax system. The possibility frontier of taxation is the highest level of taxation feasible under the given country conditions. It estimates a measure of tax capacity in the country given its economic, institutional, social and population features. It takes into account the national income, tax handles, tax administration and preference for public goods. There are some advantages to estimating tax effort and collection inefficiency as a two-step process. The first step clearly lays out a model where the production possibility frontier of taxation is clearly established. The second step provides a measure of time varying inefficiency in tax collections. This is a function of both tax policy and administration. As a second step, different institutional and administrative variables can be analyzed as determinants of the measure of inefficiency.

As we discuss below, the estimated tax effort from the traditional approach and the stochastic frontier analysis are highly correlated. This result indicates that the two methods are quite substitutable. Thus, the advantage of the stochastic frontier approach may simply lie in having a more transparent interpretation of specific institutional constraints to tax effort in a country.

On the other hand, both the traditional and stochastic frontier approaches are limited in that they do not generate country specific measures of tax potential that are cogent to national policy. Using data from other countries to estimate tax potential introduces noise through unobserved

factors not the least of which are the collective preferences for public goods and services and general cultural attitudes toward the role of the public sector.[15] An alternative approach to estimating tax effort is to look at the deviations between what a country would like to raise in tax revenues – as revealed by the persistent (or structural) choice of the level of public expenditures—and its actual tax collections. Invoking Ricardian equivalence it should be possible to argue that taxpayers see the current deficit as future taxes. Therefore, the deficit is a measure of the discrepancy between the desired level of taxation (or preferred level of public expenditures) and the current level of taxation for each particular country. This approach has the advantage of assessing tax effort while accommodating preferences for size of government in a country. Under this approach therefore we would use the actual level of public expenditures (or some moving average of that variable) as an indicator of desired level of taxation in a country, revealed through the political process.[16] This method is closely related to the revenue adequacy approach which relates the overall balance between expenditures and revenues (Martinez-Vazquez and McNab, 2000) and it is consistent with the empirical evidence that changes in expenditures appear to lead to changes in tax levels (Baicker and Skinner, 2011). As we indicate, developing this approach is a veritable research agenda and something we highlight to be important for generating a higher relevance for tax policy discussions for policy makers.

Selecting the (persistent or structural) level of expenditures observed in a country as a benchmark for the desired level of taxation suggests that there are several other possibilities for the selection of the benchmark. For example, one such benchmark for revenue effort could be the average expenditure levels (adjusted for population and so on) of other countries in the region of similar income levels. This approach would seem to be the one implicitly used in public expenditure reviews by the World Bank and other multilateral finance institutions when they compare the performance in education, health, infrastructure and so on of a country to those in other similar countries in the region. A similar benchmark could be constructed by deriving the level of expenditures required in a country to achieve the Millennium Development Goals (MDG). In the empirical work in the next section we will only consider the (persistent or

[15] In the empirical section below we address some of these issues by using fixed effects estimation.

[16] Mahdavi (2008) alludes to actual tax to GDP ratio as a function of the desired level of tax ratio but does not develop the concept further. The empirical analysis focuses on the standard determinants of tax level, and public debt and foreign aid and other control variables. Due to substitution, the desired level of tax ratio drops out of the model.

structural) level of expenditures observed in a country as a benchmark for the desired level of taxation as the alternative to the tax effort measures derived from the traditional approach and stochastic frontier approach.

IV. Alternative Estimations of Revenue Effort

To estimate revenue effort under the different methodologies discussed in the previous section we employ a panel data set comprising a sample of 94 countries over the period 1970-2009. Our main goal in this section is to compare the performance of the three approaches discussed in the previous section, and in particular determine to what extent the different approaches deliver different scores for tax effort.

We start with the so-called traditional regression approach for which the benchmark for potential revenues in the tax effort ratio is derived from the predicted revenues based on a fixed effects model, which has been traditionally used in the literature. The traditional method is augmented by including institutional factors that can potentially affect tax effort.

Our second approach is known as the stochastic frontier approach, which develops in the first stage a function that expresses the maximum amount of revenues that countries could collect given several bundles of determinant characteristics of revenues. In a second stage, this analysis also allows us to investigate what factors may be responsible for explaining the observed technical inefficiency in a country's tax collection system. For the third approach, we calculate countries' revenue effort based on their expenditures.

Finally, we will compare three estimates of revenue effort and analyze the correlation between them. Note that in all the estimations we will use total revenues in place of tax revenues for reasons of definitional simplicity in our data. We are led by the assumption that most so-called non-tax revenues could be easily transformed via legal definitions in tax revenues. Under this approach we also avoid the noise introduced in the tax revenue data by how different countries decide to tax or collect other types of revenues from natural resources. We assume therefore that this is a reasonable proxy for tax effort.[17]

[17] Only a few papers on tax effort discuss this issue. For example, Mahadavi (2008) uses non-tax revenue as a determinant of tax revenue, arguing that it works as a substitute to tax collections. Other papers have shown that

Predicting Potential Revenues

A. The Traditional (Fixed Effects) Regression Approach

As we explained above, we firstly apply the traditional regression approach for predicting countries' potential revenues. In this case we estimate the function $q_i = f(z_i, \beta)$ using the traditional fixed effects method. The basic model can be expressed as

$$q_{ji} = \sum_{j=1}^{k} \gamma_j z_{ji} + \alpha_i + \mu_t + \varepsilon_{ji} \quad (1)$$

α_i is the unknown intercept for each country which is time-invariant, while μ_t changes over time but not across countries. z_{ji} is a matrix of variables that we consider as important factors affecting countries' potential revenue collection. We discuss the determinants of potential revenues below. A significant difference between the traditional approach and the stochastic frontier approach is the assumption made about the random error, ε_{ji}. In the case of the traditional approach this is a two-sided normally distributed error while in the case of the stochastic frontier model the error is assumed to be one-sided. Thus in the case of the stochastic frontier approach a country can only deviate from the optimal by underperforming in its tax administration while in the case of the traditional approach a country can deviate from the expected average by both overperforming or underperforming.

B. Stochastic Frontier Analysis

We now move to the Stochastic Frontier Analysis. Stochastic frontier models became a popular subfield in econometrics after they were first introduced by Aigner, Lovell, and Schmidt (1977) and Meeusen and van den Broeck (1977).

In a world where there is no inefficiency, tax administration in country i collects tax revenues $q_i = f(z_i, \beta)$. Stochastic frontier analysis, however, assumes that tax administration potentially collects less revenue than it might due to a degree of inefficiency, that is

$$q_i = f(z_i, \beta)\xi_i$$

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higher non-tax revenue in developing countries (for example, from natural resources) is correlated with lower tax revenue. This issue is related to the study of revenue structure or mix.

where $\xi_i = (0,1]$ is the level of inefficiency in its revenue collection. If $\xi_i = 1$, the tax administration is collecting the optimal amount of tax revenues, using the available inputs z_i defining the tax bases, and the production function $f(z_i, \beta)$. When $\xi_i < 1$, the tax administration is not making the most of the available inputs z_i. Since tax collection q_i is assumed to be strictly positive $(q_i > 0)$, the degree of technical inefficiency is also assumed to be strictly positive $(\xi_i > 0)$.

Tax revenue collection q_i is also assumed to be subject to random shocks, implying that

$$q_i = f(z_i, \beta)\xi_i \exp(\upsilon_i) \quad (2)$$

Taking the natural log of equation (1) yields

$$ln(q_i) = ln[f(z_i, \beta)] + ln(\xi_i) + \upsilon_i \quad (3)$$

Assuming that function $f(z_i, \beta)$ is linear in logs, that there are k inputs defining the country's tax bases, and defining $u_i = -ln(\xi_i)$ yields

$$ln(q_{ji}) = \beta_0 + \sum_{j=1}^{k} \beta_j \, ln(z_{ji}) + \upsilon_{ji} - u_{ji} \quad (4)$$

where q_i represents a ratio of total revenues (sum of tax and non-tax revenues) to GDP, while z_{ji} represents a matrix of variables affecting the country's potential revenues. Moreover, to account for countries' fixed effects, we include a set of country and year dummies.

We assume that the idiosyncratic error component, υ_i, is independently $N(0, \sigma_\upsilon)$ distributed over the observations. Since $\xi_i = (0,1]$, it implies that $ln(\xi_i) \leq 0$ and, therefore, $u_i \geq 0$. In other words, the inefficiency effect u_i lowers the tax collection from its potential level. We assume two alternative specifications of the inefficiency term, u_i. In the first one, the u_i is independently half-normally $N^+(0, \sigma_u^2)$ distributed, and in the second one, the u_i is independently exponentially distributed with variance, σ_u^2.

Revenue potential variables

When identifying determinants of countries' revenue potential that can be derived from the stochastic frontier regression analysis, we are led by the hypothesis that a country's revenue capacity depends on economic, demographic and institutional factors. As economic factors we

include GDP per capita, openness, shares of hard-to-tax sectors in GDP (agriculture, services, and construction), inflation rate, income inequality, capital investments, foreign grants, and crude petrol production. Among demographic variables we identify age dependency, population density, and level of education. Finally, to account for the country's institutional setting, we include corruption level as an additional determinant.

Economic Factors

GDP per capita is one of the variables that are most commonly used in the tax effort literature as a proxy for economic development. One would expect a positive relationship between GDP per capital and revenue collection because of higher ability to pay in a society with higher income (Bahl, 1971; Fox and Gurley, 2005).

As a measure of trade flows serving as a tax handle, *Openness* is measured by the KOF's Globalization Index, which incorporates three major dimensions of globalization; namely, economic, social and political globalization.[18] The effect of globalization on revenue mobilization is ambiguous. On the one hand, greater mobility of goods and factors of production largely represents increased mobility of the tax base, and hence, potentially reduces revenues (Keen and Mansour, 2010). On the other hand, since imports and exports take place at specific locations generally few in numbers in a country, they are relatively easy to tax, leading to larger revenues (Alonso and Garcimartin, 2011).

Similarly, the effect of *inflation* on the tax revenues is ambiguous. On the one hand, due to the Oliveira-Tanzi effect (Oliveira, 1967; Tanzi, 1977), hyperinflation decreases real value of tax revenues due to the lags between tax liabilities and the actual collection of the taxes. Moreover, certain types of taxes, such as excise duties, that are levied at specific rates may not be properly indexed, in which case high inflation leads to a reduction in their real value (Easterly and Schmidt-Hebbe, 1991). On the other hand, inflation may increase revenues in progressive tax systems if the tax rates are indexed with a significant lag (Alonso and Garcimartin (2011).

[18] The reason that we use this measure of globalization rather than the ratio of trade (sum of exports and imports) and GDP is that the latter does not take into account other important factors affecting trade openness, such as trade policy and country's economic, social, and political characteristics, which the KOF's index does take into account.

Another important determinant of a country's ability to collect taxes is the sectoral structure of the economy. Certain sectors in the economy have been traditionally hard to tax, such as *agriculture, services, and construction*. Because of that and other reasons (equity and political economy issues), many countries exempt agriculture from taxes. A similar case can be made for many services. The construction section in most countries has a high percentage of output produced informally and therefore hard to reach by tax administrations (Jewell et al., 2005). Therefore, the larger the share of these sectors in GDP, the more difficult it will be for tax administrations to collect revenues.

The *income inequality* variable is measured by the Gini coefficient, which represents the extent to which the distribution of individual income or consumption within a country deviates from an equal distribution. Income distribution has been rarely used as a determinant of revenue effort, with the exception of just a few studies such as Bird et al. (2004), Gupta (2007), Pessino and Fenochietto (2010), and Alonso and Garcimartin (2011). All these studies find that income inequality has a negative effect on revenue collections. It is considered that increasing income inequality reduces the tax base through more than one channel. For example, in a more unequal society, the administration mostly depends on the higher income groups for revenue collection, which reduces the tax base. Gupta (2007) uses tax structure (direct versus indirect taxes) as a proxy for income distribution and argues that since indirect taxes tend to be regressive, they increase income inequality and reduce the tax base. Similarly, as Alonso and Garcimartin (2011) point out, higher income inequality may lead to a larger informal sector which hinders tax collection. Furthermore, a political economy argument can be made that income inequality also represents concentrated but powerful interests in society which may not be easily amenable to paying higher taxes.

Capital investment, measured by the gross fixed capital formation, is expected to have a positive effect on government revenues through the potential expansion of economic activity and tax bases. On the other hand, resource-rich countries may exert lower tax effort than their resource-scarce counterparts because of either incentives caused by the wealth from natural resources, or because of the lack of capacity to fully utilize their revenue potential (Ndikumana and Abderrahim, 2010). We employ *domestic crude petrol production* as a proxy for a country's

natural resource endowment. Similarly, *grants* received from foreign governments and international organizations may give governments an incentive to reduce their tax effort (Gupta et al., 2003).

Demographic Factors

Demographics can also play a significant role in determining a country's tax base and effort. *Age dependency*, measured as the ratio of dependents (the population under age 15 and above age 65) to the working-age population (those aged 15-64), is expected to have a negative effect on the tax base (Minh Le et al., 2008). Another demographic component is *population density*, whose effect on the revenue potential and revenue effort is ambiguous. On the one hand, a higher concentration of people should make taxation easier. On the other hand, larger population density may also encourage informal activities that are difficult to tax (Mkandawire, 2010). Because people live closer to each other, information transactions become more feasible which in turn tends to reduce revenue collection (Kau and Rubin, 1981).

The level of *education*, measured by the UN's Education Index, has been frequently used as another important demographic component of a country's revenue capacity. The effect of education is also ambiguous. On the one hand, the more educated people are the better they can understand the relationship between public goods provision and the importance of paying taxes to finance them (Pessino and Fenochietto, 2010). On the other side, the more educated people are the more knowledgeable they become regarding how to avoid paying taxes, in which case we would expect a negative effect of education on revenue collection.

Institutional Factors

The previous empirical evidence shows that a high level of *corruption* reduces revenues collection (Abed and Gupta, 2002). Bird et al. (2008) have also found that taxpayers who deal with rampant corruption are less willing to pay taxes. Corruption also discourages foreign investment, which negatively affects economic activity and the tax base. We measure corruption with the ICRG's assessment of corruption in the political system. The index ranges from 1 to 6, where a higher number means a lower risk of corruption.

Finally, given that our dependent variable is preferably observed at the general government level whenever possible, and at the central government level when the data at the general government level are not available, we include a dummy that equals 1 if the revenues are observed at the general government level, and zero otherwise. This allows us to cater to the effects of budget classification in our empirical results.

Explaining Technical Inefficiency

As we mentioned above, the stochastic frontier analysis allows us to estimate the level of technical inefficiency and its determinants in countries' revenue collection systems.

Basically, after estimating equation (4)

$$ln(q_{ji}) = \beta_0 + \sum_{j=1}^{k} \beta_j \, ln(z_{ji}) + \upsilon_{ji} - \, u_{ji}$$

we predict the technical inefficiency term, $\widehat{u_{ji}}$, and then we estimate the following equation

$$\widehat{u_{ji}} = \sum_{j=1}^{k} \theta_j \, w_{ji} + \alpha_i + \mu_t + \varepsilon_{ji} \quad (5)$$

where w_{ji} represents a set of variables that may explain technical inefficiency in revenue collection, including corruption, complexity of the tax system, tax morale, years in office of the chief executive, political fractionalization, population growth, government debt level, and changes in the monetary base. α_i is the unobserved individual country effect, while μ_t is the time effect.

It is not clear whether *corruption* is only an input variable determining potential revenue collection by reducing the tax base, or it is also the determinant of technical inefficiency. That is why we also include corruption in the inefficiency equation. Corruption may increase technical inefficiency in the tax system by introducing permanent instability in the political system. Since our variable represents the risk of corruption, with larger values meaning lower risk, we expect a negative relationship between this variable and technical inefficiency.

After Wagner's (1976) findings strongly supported the hypothesis that the *complexity of the tax system* affects public expenditures and revenues, there were many studies that tested this hypothesis and found positive effects [19]or no effect.[20] This hypothesis states that the simpler the tax system, the easier it is for the taxpayers (and voters) to perceive the real cost of government, and it is more likely that the government would have smaller expenditures and, therefore, smaller revenues. In other words, more complex tax systems lead to larger government, greater expenditures and, therefore, greater revenues for their financing, and in turn, more efficiency in revenue collection. We measure tax complexity by the Herfindahl Index of a country's revenue system,[21] but we acknowledge that it is far from being a perfect measure of tax complexity given that it assumes that all taxes have the same level of progressivity and equally affect taxpayers' incentives.

Tax morale, measured by the percentage of the population who declare cheating on taxes as never justifiable, is another variable for which it is not very clear whether it should be an input to the collection process or, instead, a determinant of technical inefficiency. Since higher tax morale makes it easier for the government to collect taxes, it could be interpreted to be an input contributing to the larger tax base. However, in high-tax-morale societies, tax administration may be more relaxed in collecting taxes and have lower audit rates (and therefore, all other things equal, be relatively more inefficient in extracting revenue for a given tax base), which may give way to higher tax evasion. We try to estimate equation (4) by including tax morale as another explanatory variable, but due to a relatively small number of observations, our sample is reduced 50 percent of its size and allows us to predict potential revenues for just a few countries. Therefore, we include tax morale only in the technical inefficiency equation while its sign may depend upon the mechanism through which it affects tax effort.

Democracies tend to have more efficient tax systems (Aizenman and Noy, 2004) and greater *fractionalization in the government* is interpreted to mean better representation of citizens and more efficient provision of services. Moreover, fractionalized governments might contribute to

[19] See for example Pommerehne and Schneider (1978), Baker (1983), Breeden and Hunter (1985), Cullis and Jones (1987), and Heyndels and Smolders (1995).
[20] See for example Clotfelter (1976), Munley and Greene (1978), Misiolek and Elder (1988), and Henrekson (1988).
[21] We use different types of taxes to compute the Herfindahl Index. See the Appendix for details.

political stability by being less able to make comprehensive reforms (Bjornskov et al., 2006). The variable *political fractionalization* represents the probability that two deputies from among the government parties picked at random would be of different parties.

Population growth rate is associated with higher inefficiency in the tax system because it is difficult to administer a rapidly rising populations of taxpayers (Minh Le et al. 2008). On the other hand, while higher levels of *government debt* [22]may have a positive effect on government efficiency in collecting taxes because it will need to repay the debt in the future (Barro, 1974), *seignorage revenues*, proxied by increases in the monetary base, may discourage governments from collecting taxes (Cukierman et al., 1992). To account for a lag in the effect of debt on efficiency in collecting revenues, we use the previous year value of government debt.[23]

Finally, we include a dummy for general government to distinguish between inefficiency measured at the general government level from the one measured only at the central government level, and we also include a dummy for the OECD countries, allowing for a structural shift between developed and developing countries.

V. Empirical Results

A. Fixed Effects

We start the discussion with the results obtained from the estimation of equation (1) using the fixed effects model. Table 1 presents alternative specifications for estimating potential revenues by using this methodology. As can be observed, unlike Stochastic Frontier Analysis where in the first stage we include only those variables potentially affecting the tax base, in the traditional approach we also include the institutional variables. In addition to a different estimation method, in this case we do not log- transform any of the variables in the model. As we can see in Table 1, the estimated coefficients mostly have the expected signs and are statistically significant.

[22] Government debt refers to the gross general government debt, whenever data are available. However, when general government data were not available, only central government debt was observed. See the Appendix for a full description of the variable and data sources.

[23] We experiment with different lags of government debt and observe no significant difference in the results. Therefore, we observe only its one year lagged value.

Table 1. Determinants of Potential Revenues, Fixed Effects

	(1)	(2)	(3)	(4)	(5)
Income Inequality	-0.279***	-0.288***	-0.291***	-0.254***	-0.284***
	(0.037)	(0.038)	(0.035)	(0.040)	(0.038)
Globalization	0.108***	0.098***	0.079***	0.113***	0.106***
	(0.032)	(0.033)	(0.030)	(0.035)	(0.033)
Age Dependency	0.022	0.023	-0.079***	0.021	0.048
	(0.027)	(0.028)	(0.025)	(0.030)	(0.032)
Agriculture	-0.297***	-0.296***	0.077	-0.289***	-0.292***
	(0.049)	(0.051)	(0.053)	(0.053)	(0.051)
Services	-0.147***	-0.142***	0.022	-0.145***	-0.142***
	(0.034)	(0.034)	(0.034)	(0.037)	(0.034)
Construction	-0.848***	-0.895***	-0.243*	-0.923***	-0.894***
	(0.139)	(0.141)	(0.130)	(0.148)	(0.141)
Population Density	-0.001	-0.001	-0.025	-0.003	0.001
	(0.004)	(0.004)	(0.016)	(0.005)	(0.004)
GDP per capita	0.002***	0.001***	0.001**	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Education	0.100***	0.107***	0.140***	0.125***	0.108***
	(0.023)	(0.023)	(0.025)	(0.025)	(0.023)
Inflation	-0.062***	-0.061***	-0.026*	-0.060***	-0.059***
	(0.017)	(0.017)	(0.016)	(0.018)	(0.017)
Capital Formation	0.176***	0.202***	0.074	0.210***	0.211***
	(0.051)	(0.052)	(0.050)	(0.054)	(0.052)
Grants	-0.620***	-0.667***	-1.159***	-0.759***	-0.681***
	(0.151)	(0.154)	(0.134)	(0.164)	(0.154)
Crude Petrol	-0.008***	-0.009***	-0.000	-0.008***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Government $Debt_{-1}$	0.027***	0.027***	0.035***	0.031***	0.027***
	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)
Corruption	0.015***				
	(0.002)				
$Corruption_{-1}$		0.015***	0.008***	0.016***	0.014***
		(0.002)	(0.002)	(0.002)	(0.002)
Complexity of Tax System			2.386***		
			(0.160)		
Government Fractionalization				-0.009	
				(0.008)	
Population Growth					-0.573*
					(0.341)
General Government	0.034***	0.036***	0.031***	0.034***	0.036***
	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)
Constant	0.280***	0.212***	0.153***	0.217***	0.201***
	(0.053)	(0.055)	(0.052)	(0.059)	(0.055)
Observations	1,079	1,039	814	976	1,039
R-squared	0.843	0.845	0.910	0.844	0.846

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Dependent variable: Total Revenues; All explanatory variables are in levels. All specifications include regional and period dummies.

Table 2. Determinants of Potential Revenues, Stochastic Frontier Analysis

	Half-Normal			Exponential		
	(1)	(2)	(3)	(4)	(5)	(6)
Income Inequality	-0.307***	-0.224***	-0.185***	-0.340***	-0.267***	-0.228***
	(0.042)	(0.048)	(0.050)	(0.041)	(0.046)	(0.049)
Globalization	0.313***	0.199***	0.225***	0.320***	0.211***	0.237***
	(0.049)	(0.059)	(0.059)	(0.049)	(0.058)	(0.059)
Age Dependency	-0.048	-0.119*	-0.109	-0.076	-0.177***	-0.172**
	(0.063)	(0.067)	(0.069)	(0.061)	(0.066)	(0.067)
Agriculture	-0.035**	-0.050**	-0.033*	-0.046***	-0.067***	-0.051***
	(0.017)	(0.020)	(0.020)	(0.017)	(0.019)	(0.019)
Service	0.042	-0.089	-0.060	0.033	-0.140**	-0.111
	(0.058)	(0.069)	(0.071)	(0.058)	(0.068)	(0.070)
Construction	-0.131***	-0.103***	-0.109***	-0.142***	-0.122***	-0.128***
	(0.027)	(0.030)	(0.030)	(0.027)	(0.030)	(0.030)
Population Density	-0.034***	-0.054***	-0.052***	-0.037***	-0.055***	-0.053***
	(0.007)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)
GDP Per Capita	0.137***	0.141***	0.145***	0.106***	0.100***	0.105***
	(0.023)	(0.024)	(0.024)	(0.023)	(0.024)	(0.024)
Education	0.238***	0.194***	0.197***	0.274***	0.230***	0.233***
	(0.034)	(0.035)	(0.035)	(0.034)	(0.035)	(0.035)
Inflation	-8.737	-12.685**	-9.953	-5.566	-10.084	-7.183
	(5.765)	(6.281)	(6.427)	(5.765)	(6.316)	(6.490)
Capital Formation	0.171***	0.093**	0.125***	0.183***	0.106**	0.138***
	(0.038)	(0.044)	(0.044)	(0.038)	(0.043)	(0.043)
Grants	-0.010***	-0.012***	-0.012***	-0.010***	-0.013***	-0.012***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Crude Petrol	-0.004*	-0.007**	-0.005**	-0.003	-0.005*	-0.004
	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
Corruption		0.130***			0.133***	
		(0.024)			(0.023)	
$Corruption_{-1}$			0.053***			0.053***
			(0.008)			(0.007)
Gen. Government	0.163***	0.124***	0.133***	0.154***	0.114***	0.123***
	(0.022)	(0.024)	(0.024)	(0.021)	(0.023)	(0.024)
Constant	-2.061***	-2.273***	-2.180***	-2.083***	-2.361***	-2.270***
	(0.141)	(0.154)	(0.156)	(0.136)	(0.148)	(0.150)
Observations	1,334	1,094	1,064	1,334	1,094	1,064
Lambda	1.117	`1.228	1.234	0.748	0.814	0.813
	(0.036)	(0.032)	(0.032)	(0.017)	(0.015)	(0.016)
Sigma (u)	0.210	0.212	0.213	0.051	0.135	0.135
	(0.027)	(0.231)	(0.235)	(0.002)	(0.011)	(0.011)
Log-Likelihood	89.63	133.12	127.45	102.30	148.61	142.30

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Dependent variable: Log(total revenues); All explanatory variables, except Gen. Government Dummy are in logs; All specifications include regional and period dummies.

B. Stochastic Frontier Analysis

As we explained above, in our analysis with the stochastic frontier model we assume two alternative specifications of the inefficiency term, u_i. In the first one, the inefficiency term has

half-normal distribution and in the second one it has an exponential distribution.[24] In addition, we estimate three specifications for each distribution of the inefficiency term. In the first one, we consider corruption as a component of the technical inefficiency so we do not include it in the stochastic frontier model; while in the second specification we include corruption as an input. Finally, in the third specification, we employ one-year lagged value of corruption rather than the current value, to account for the potential reverse causality between revenues and corruption. We acknowledge that lagged values may not be the best instrument to resolve the reverse causality problem, but until we find a better instrument, we will have to rely on this one.

Table 2 presents the results from estimating equation (4) and assuming the two alternative distributions of the inefficiency term. As the table shows, results are robust to changes in the distribution of the inefficiency term and to changes in the specification. Moreover, the coefficients do not even change significantly in magnitude. All the coefficients have the expected signs and are mostly statistically significant.

In general, the results in Table 2 support those obtained by the traditional approach with most of the coefficients being within a close range of the magnitude. This is comforting in the sense that the different econometric estimation strategies do not seem to lead to different interpretations of the role played by the determinants of tax performance.

In the two models, the lambda parameter, $\lambda_i = \sigma_{ui}/\sigma_{vi}$, is statistically significant and the log-likelihood ratio test allows us to reject the null hypothesis that there is no technical inefficiency in the model.

C. Explaining Inefficiency in the Tax System

As we have already mentioned above, the stochastic frontier analysis allows us to predict technical inefficiency in revenue collection and then investigate its determinants. Table 3 presents the results obtained by estimating equation (5) when half-normal distribution of

[24] We also try to estimate the model by assuming truncated-normal distribution of the inefficiency term, but we fail to do so since the estimation fails to converge.

u_{ji}assumed, and Table 4 presents a corresponding model in the case of the exponential distribution of u_{ji}. Columns 1-4 in Table 3 present the results obtained by estimating the model where the dependent variable $\widehat{u_{ji}}$ is obtained as a predicted value from the model in column 1 in Table 2, while in columns 5-8 in Table 3 the dependent variable is the predicted value from the model in column 2 in Table 2. Similarly, the dependent variable in the specifications presented in columns 1-4 and 5-8 in Table 4 is obtained from column 4 and 5 in Table 2, respectively. In other words, when corruption is included in the frontier model, we do not include it in the inefficiency equation, and when it is not, we do include it.

As Table 3 shows, the results are quite robust to inclusion/exclusion of corruption, even though its estimated coefficient shows the expected sign and it is statistically significant. We also find that complexity of the tax system (measured by the Herfindahl index) and government debt are especially important components contributing to higher efficiency in the tax system. In the words of numbers – one percentage point increase in the complexity of the tax system reduces inefficiency by 3.3-4 percentage points. Similarly, one percentage point increase in the previous year level of government debt to GDP reduces inefficiency by 3.8-5.3 percentage points. Political fractionalization also seems to be a significant factor for tax efficiency – one percentage point increase in the probability of two deputies from the government being from different parties reduces inefficiency by 1.3-1.5 percentage points. In addition, tax morale seems to have a statistically significant effect, even though it is not as large in the magnitude. A surprising result is the negative sign on population growth rate which is the opposite from what we expected. A possible explanation for this result could be that a rapidly growing population generates pressure on the government for meeting their increasing needs for public goods and encourages it to collect more revenues to finance them.

VI. Comparing the Conventional Tax Effort Indicators and the Expenditure-Revenue Gap.

Finally, we turn to calculating countries' tax effort indicators and to comparing them to the expenditure-revenue gap. Table 5 presents estimates of the tax effort using the stochastic frontier method (columns 5-10), the traditional fixed effects model (columns 11-13), and the ratio of total

Table 3. Explaining Inefficiency in the Tax System.
Dependent variable: Predicted Inefficiency from the Model Assuming Half-Normal Distribution of Ui

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Corruption	-0.502***	-0.105	-0.512***	-0.526***				
	(0.192)	(0.218)	(0.191)	(0.190)				
Complexity of Tax System	-3.541***	-3.297***	-3.434***	-3.438***	-3.996***	-3.629***	-3.851***	-3.861***
	(0.445)	(0.427)	(0.447)	(0.446)	(0.514)	(0.505)	(0.515)	(0.514)
Tax Morale	0.089***	0.159***	0.098***	0.097***	0.078***	0.150***	0.089***	0.088***
	(0.025)	(0.025)	(0.025)	(0.025)	(0.028)	(0.029)	(0.029)	(0.029)
Political Fractionalization	-1.438**	-1.525**	-1.485**	-1.522**	-1.325*	-1.349*	-1.395*	-1.453*
	(0.661)	(0.670)	(0.659)	(0.656)	(0.761)	(0.787)	(0.758)	(0.754)
Government $Debt_{-1}$	-4.096***	-3.824***	-4.477***	-4.331***	-4.825***	-4.891***	-5.342***	-5.129***
	(0.857)	(0.805)	(0.876)	(0.851)	(0.988)	(0.955)	(1.008)	(0.976)
OECD	-0.283	-1.214*	-0.494		-0.386	-1.155	-0.680	
	(0.690)	(0.641)	(0.696)		(0.794)	(0.755)	(0.800)	
General Government	-2.492	-2.015	-1.991	-1.772	-4.423*	-3.937*	-3.739	-3.439
	(2.180)	(1.969)	(2.187)	(2.164)	(2.525)	(2.347)	(2.528)	(2.503)
Broad Money		1.630				-1.920		
		(1.513)				(1.694)		
Pop. Growth			-0.802*	-0.756*			-1.102**	-1.036**
			(0.418)	(0.412)			(0.483)	(0.476)
Constant	44.162***	30.934***	42.989***	42.382***	47.627***	38.872***	45.947***	45.000***
	(4.735)	(4.902)	(4.757)	(4.676)	(5.364)	(5.664)	(5.383)	(5.265)
Observations	435	354	435	435	435	354	435	435
R-squared	0.856	0.889	0.857	0.857	0.843	0.871	0.845	0.845

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Columns 1-4: Dependent variable is technical inefficiency predicted from regression in Column 1, Table 1. Columns 5-8: Dependent variable is technical inefficiency predicted from regression in Column 2, Table 1

Table 4. Explaining Inefficiency in the Tax System.
Dependent variable: Predicted Inefficiency from the Model Assuming Exponential Distribution of Ui

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Corruption	-0.610***	-0.179	-0.622***	-0.636***				
	(0.207)	(0.211)	(0.206)	(0.204)				
Complexity of Tax System	-3.298***	-2.814***	-3.162***	-3.166***	-3.666***	-3.035***	-3.498***	-3.505***
	(0.479)	(0.414)	(0.480)	(0.479)	(0.550)	(0.487)	(0.550)	(0.549)
Tax Morale	0.065**	0.153***	0.076***	0.075***	0.042	0.134***	0.055*	0.055*
	(0.026)	(0.024)	(0.027)	(0.027)	(0.030)	(0.028)	(0.031)	(0.031)
Political Fractionalization	-1.546**	-1.381**	-1.606**	-1.643**	-1.624**	-1.369*	-1.705**	-1.748**
	(0.711)	(0.650)	(0.708)	(0.705)	(0.814)	(0.758)	(0.809)	(0.805)
Government $Debt_{-1}$	-3.763***	-3.366***	-4.246***	-4.102***	-4.290***	-4.259***	-4.892***	-4.734***
	(0.922)	(0.781)	(0.941)	(0.914)	(1.057)	(0.920)	(1.077)	(1.042)
OECD	-0.218	-1.312**	-0.486		-0.161	-1.093	-0.503	
	(0.742)	(0.621)	(0.748)		(0.850)	(0.728)	(0.855)	
General Government	-2.959	-2.230	-2.324	-2.109	-4.559*	-3.770*	-3.763	-3.541
	(2.346)	(1.909)	(2.350)	(2.324)	(2.701)	(2.263)	(2.701)	(2.672)
Broad Money		1.100				-1.845		
		(1.467)				(1.633)		
Pop. Growth			-1.017**	-0.971**			-1.282**	-1.233**
			(0.449)	(0.443)			(0.516)	(0.508)
Constant	41.193***	24.941***	39.705***	39.108***	43.649***	31.505***	41.695***	40.995***
	(5.098)	(4.752)	(5.111)	(5.024)	(5.737)	(5.461)	(5.751)	(5.621)
Observations	435	354	435	435	435	354	435	435
R-squared	0.817	0.877	0.819	0.819	0.797	0.854	0.801	0.801

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Columns 1-4: Dependent variable is technical inefficiency predicted from regression in Column 4, Table 1. Columns 5-8: Dependent variable is technical inefficiency predicted from regression in Column 5, Table 1

Table 5. Estimated Tax Effort by Country

No.	Country	Period	GG Level	Fixed Effects			Stochastic Frontier Analysis						Total Revenues / Total Expenditures
							Half-Normal			Exponential			
				Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3	
1	Albania	2002 - 2004	1	0.78	0.88	0.89	0.68	0.73	0.73	0.68	0.73	0.73	N.A.
2	Algeria	1994 - 1995	0	1.28	1.31	1.33	0.95	0.90	0.92	0.95	0.90	0.92	N.A.
3	Argentina	2005 - 2006	1	0.99	1.04	1.05	0.86	0.88	0.88	0.86	0.88	0.88	0.90
4	Armenia	1996 - 1998	1	0.71			0.73			0.73			0.97
5	Australia	2002 - 2004	1	0.91	0.93	0.92	0.69	0.65	0.66	0.69	0.65	0.66	1.03
6	Austria	2004 - 2006	1	1.00	0.99	0.99	0.87	0.83	0.83	0.87	0.83	0.83	0.94
7	Bangladesh	2003 - 2005	0	0.95	1.02	1.08	0.73	0.76	0.76	0.73	0.76	0.76	0.83
8	Belgium	2003 - 2005	1	1.03	1.04	1.04	0.90	0.90	0.93	0.90	0.90	0.93	0.98
9	Benin	2003	0	0.79			0.79			0.79			N.A.
10	Bhutan	2006 - 2007	0	1.69			0.56			0.56			0.48
11	Bolivia	2000 - 2002	1	0.85	0.82	0.80	0.72	0.71	0.70	0.72	0.71	0.70	0.61
12	Brazil	2003 - 2005	1	1.75	1.69	1.70	1.29	1.24	1.23	1.29	1.24	1.23	N.A.
13	Bulgaria	2003 - 2005	1	1.03	1.09	1.10	0.88	0.94	0.95	0.88	0.94	0.95	1.01
14	Burkina Faso	2001 - 2003	0	0.64	0.68	0.69	0.68	0.71	0.72	0.68	0.71	0.72	N.A.
15	Burundi	1996 - 1998	0	1.55			1.44			1.44			0.76
16	Cambodia	2005 - 2007	0	1.04			0.68			0.68			N.A.
17	Cameroon	1999 - 2001	0	0.80	0.84	0.83	0.87	0.99	0.99	0.87	0.99	0.99	N.A.
18	Canada	1998 - 2000	1	1.07	1.04	1.04	1.03	0.99	0.96	1.03	0.99	0.96	1.04
19	Central African Republic	1992	0	1.38			0.74			0.74			N.A.
20	Chile	1998 - 2000	1	1.01	0.99	1.00	0.90	0.89	0.88	0.90	0.89	0.88	0.96
21	China	2001 - 2003	0	0.51	0.56	0.58	0.47	0.51	0.50	0.47	0.51	0.50	0.64
22	Colombia	2002 - 2004	1	0.98	0.91	0.94	0.86	0.85	0.86	0.86	0.85	0.86	0.99
23	Costa Rica	2004 - 2006	0	1.11	1.15	1.13	1.01	1.02	1.01	1.01	1.02	1.01	0.97
24	Cote d'Ivoire	2000 - 2002	0	0.83	0.81	0.86	0.76	0.72	0.75	0.76	0.72	0.75	0.96

Table 5. Estimated Tax Effort by Country (continued)

No.	Country	Period	GG Level	Fixed Effects			Stochastic Frontier Analysis						Total Revenues / Total Expenditures
							Half-Normal			Exponential			
				Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3	
25	Croatia	1996 - 1998	1	1.19			1.06			1.06			N.A.
26	Cyprus	2003 - 2005	1	1.02	1.04	1.04	0.95	0.96	0.97	0.95	0.96	0.97	0.67
27	Denmark	2003 - 2005	1	1.17	1.13	1.13	1.09	1.07	1.05	1.09	1.07	1.05	1.04
28	Dominican Republic	2004 - 2006	0	0.98	0.97	0.99	0.87	0.88	0.90	0.87	0.88	0.90	0.95
29	Ecuador	2006	0	0.90	0.85	0.87	0.80	0.76	0.76	0.80	0.76	0.76	0.83
30	Egypt	2002 - 2004	1	0.79	0.83	0.83	0.69	0.76	0.75	0.69	0.76	0.75	0.92
31	El Salvador	2002 - 2004	0	0.75	0.71	0.70	0.73	0.73	0.73	0.73	0.73	0.73	0.84
32	Estonia	1996 - 1998	1	0.99			0.86			0.86			0.98
33	Ethiopia	1998 - 2000	0	0.72	0.94	0.95	0.78	0.87	0.90	0.78	0.87	0.90	0.55
34	Finland	2004 - 2006	1	1.11	1.04	1.05	0.93	0.82	0.81	0.93	0.82	0.81	1.06
35	France	2004 - 2006	1	1.05	1.10	1.10	0.92	0.94	0.98	0.92	0.94	0.98	0.91
36	Germany	1997 - 1999	1	1.01	1.00	0.99	0.89	0.89	0.88	0.89	0.89	0.88	0.96
37	Guatemala	2002 - 2004	0	0.84	0.87	0.80	0.74	0.78	0.75	0.74	0.78	0.75	0.82
38	Honduras	2004 - 2006	0	0.90	0.93	0.91	0.84	0.86	0.85	0.84	0.86	0.85	0.75
39	Hungary	2004 - 2006	1	0.90	0.93	0.95	0.73	0.78	0.80	0.73	0.78	0.80	0.84
40	Iceland	2004 - 2006	1	1.34	1.31	1.33	1.10	1.04	1.03	1.10	1.04	1.03	0.99
41	India	2003 - 2005	0	1.32	1.34	1.42	1.06	1.06	1.07	1.06	1.06	1.07	1.17
42	Indonesia	2002 - 2004	0	1.03	1.09	1.13	0.89	0.92	0.90	0.89	0.92	0.90	0.96
43	Iran	2003 - 2005	1	1.11	1.13	1.14	0.85	0.89	0.88	0.85	0.89	0.88	0.94
44	Ireland	2003 - 2005	1	0.75	0.79	0.79	0.72	0.70	0.72	0.72	0.70	0.72	0.91
45	Italy	2003 - 2005	1	1.04	1.09	1.09	0.96	1.00	1.03	0.96	1.00	1.03	0.90
46	Jamaica	2003 - 2004	0	1.56	1.81	1.79	1.49	1.67	1.64	1.49	1.67	1.64	0.88
47	Japan	2006 - 2008	1	0.96	0.99	0.99	0.74	0.74	0.74	0.74	0.74	0.74	0.75
48	Jordan	2001 - 2003	0	0.83	0.85	0.86	0.70	0.71	0.73	0.70	0.71	0.73	0.80

Table 5. Estimated Tax Effort by Country (continued)

No.	Country	Period	GG Level	Fixed Effects			Stochastic Frontier Analysis						Total Revenues / Total Expenditures
							Half-Normal			Exponential			
				Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3	
49	Korea, Rep.	2006 - 2008	1	1.01	1.06	1.06	0.92	0.94	0.94	0.92	0.94	0.94	0.96
50	Lao PDR	2006 - 2008	0	0.84			0.69			0.69			N.A.
51	Latvia	1996 - 1998	1	1.12			0.96			0.96			0.91
52	Lithuania	1996 - 1998	1	0.86			0.78			0.78			N.A.
53	Luxembourg	2005 - 2006	1	0.75	0.77	0.77	0.66	0.63	0.64	0.66	0.63	0.64	1.01
54	Madagascar	2000 - 2001	0	0.54	0.50	0.50	0.52	0.55	0.54	0.52	0.55	0.54	0.89
55	Malaysia	2006 - 2008	0	0.85	0.81	0.84	0.79	0.75	0.75	0.79	0.75	0.75	N.A.
56	Maldives	2002 - 2004	1	1.49			1.35			1.35			0.85
57	Mali	1999 - 2001	0	0.71	0.84	0.86	0.72	0.75	0.77	0.72	0.75	0.77	N.A.
58	Mexico	2003 - 2005	0	0.86	0.86	0.85	0.78	0.78	0.79	0.78	0.78	0.79	0.95
59	Moldova	1998	1	1.17			1.21			1.21			N.A.
60	Mongolia	2006 - 2008	1	1.29	1.30	1.28	1.02	0.97	0.96	1.02	0.97	0.96	1.00
61	Morocco	1997 - 1999	0	1.06	1.08	1.10	1.02	1.04	1.05	1.02	1.04	1.05	0.94
62	Namibia	1993	0	1.50	1.31	1.44	0.96	0.95	0.95	0.96	0.95	0.95	N.A.
63	Nepal	2002 - 2004	0	2.42			1.01			1.01			0.78
64	Netherlands	2004 - 2006	1	0.93	0.92	0.92	0.85	0.84	0.83	0.85	0.84	0.83	0.98
65	New Zealand	2002 - 2004	1	1.04	0.98	0.99	0.96	0.93	0.91	0.96	0.93	0.91	1.09
66	Nicaragua	2003 - 2005	0	1.41	1.39	1.40	1.25	1.23	1.23	1.25	1.23	1.23	0.73
67	Norway	2004 - 2006	1	1.18	1.15	1.15	0.92	0.82	0.82	0.92	0.82	0.82	1.09
68	Pakistan	1997 - 1999	0	0.97	0.91	0.95	0.88	0.88	0.90	0.88	0.88	0.90	0.67
69	Panama	1998 - 2000	0	0.83	0.99	1.00	0.69	0.75	0.76	0.69	0.75	0.76	0.74
70	Paraguay	2003 - 2005	0	0.93	1.15	1.16	0.69	0.74	0.71	0.69	0.74	0.71	0.71
71	Peru	2003 - 2005	0	0.82	0.80	0.82	0.75	0.74	0.76	0.75	0.74	0.76	0.94
72	Philippines	2001 - 2003	0	0.79	0.80	0.80	0.74	0.75	0.74	0.74	0.75	0.74	0.78

Table 5. Estimated Tax Effort by Country (continued)

No.	Country	Period	GG Level	Fixed Effects			Stochastic Frontier Analysis						Total Revenues / Total Expenditures
							Half-Normal			Exponential			
				Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3	
73	Poland	2003 - 2005	1	0.95	1.01	1.03	0.82	0.86	0.89	0.82	0.86	0.89	0.86
74	Portugal	2003 - 2005	1	0.98	1.00	1.01	0.88	0.86	0.87	0.88	0.86	0.87	0.81
75	Romania	2004 - 2006	1	0.88	0.90	0.92	0.78	0.79	0.80	0.78	0.79	0.80	0.99
76	Rwanda	2000	0	0.42			0.43			0.43			N.A.
77	Singapore	1997 - 1999	1	0.91	0.97	0.98	0.78	0.82	0.83	0.78	0.82	0.83	1.07
78	Slovak Republic	1996 - 1997	1	0.98	1.03	1.02	0.85	0.94	0.94	0.85	0.94	0.94	0.86
79	Slovenia	1996 - 1998	1	0.98			0.76			0.76			0.95
80	South Africa	1985 - 1987	1	0.93	0.84	0.83	0.79	0.84	0.80	0.79	0.84	0.80	0.94
81	Spain	2003 - 2005	1	0.92	0.95	0.95	0.81	0.79	0.80	0.81	0.79	0.80	0.97
82	Sri Lanka	2000 - 2002	0	0.93	0.84	0.83	0.76	0.70	0.69	0.76	0.70	0.69	0.59
83	Sweden	2003 - 2005	1	1.12	1.09	1.08	0.90	0.83	0.83	0.90	0.83	0.83	1.01
84	Switzerland	2000 - 2002	1	0.72	0.73	0.72	0.65	0.64	0.64	0.65	0.64	0.64	0.94
85	Thailand	2000 - 2002	1	0.66	0.67	0.66	0.56	0.58	0.57	0.56	0.58	0.57	0.85
86	Tunisia	1998 - 2000	0	1.02	1.08	1.09	0.85	0.89	0.89	0.85	0.89	0.89	0.92
87	Turkey	1987 - 1989	0	0.65	0.68	0.68	0.55	0.55	0.56	0.55	0.55	0.56	0.92
88	Uganda	2000 - 2002	0	1.23	1.44	1.46	1.22	1.36	1.38	1.22	1.36	1.38	0.82
89	United Kingdom	2003 - 2005	1	0.92	0.91	0.91	0.85	0.80	0.82	0.85	0.80	0.82	0.92
90	United States	2002 - 2004	1	1.00	1.02	1.04	0.91	0.87	0.89	0.91	0.87	0.89	0.89
91	Uruguay	1996 - 1998	0	1.09	1.17	1.18	1.04	1.04	1.07	1.04	1.04	1.07	0.85
92	Venezuela, RB	2003 - 2005	0	0.79	0.81	0.83	0.72	0.71	0.72	0.72	0.71	0.72	0.54
93	Vietnam	2006 - 2008	1	1.55	1.46	1.51	1.49	1.43	1.45	1.49	1.43	1.45	N.A.
94	Zambia	2002 - 2004	0	0.61	0.72	0.75	0.55	0.62	0.62	0.55	0.62	0.62	0.55

Table 6. Correlation Coefficients b/w Tax Effort Estimates

			Stochastic						Traditional			Budget Balance
			Half-Normal			Exponential			Fixed Effects			
			Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3	TR/TE
Stochastic	Half-Normal	Spec 1	1.00									
		Spec 2	0.96	1.00								
		Spec 3	0.96	0.99	1.00							
	Exponential	Spec 1	1.00	0.96	0.96	1.00						
		Spec 2	0.96	1.00	0.99	0.96	1.00					
		Spec 3	0.96	0.99	1.00	0.96	0.99	1.00				
Traditional	Fixed Effects	Spec 1	0.94	0.87	0.86	0.94	0.87	0.86	1.00			
		Spec 2	0.90	0.90	0.90	0.90	0.90	0.90	0.94	1.00		
		Spec 3	0.89	0.89	0.90	0.89	0.89	0.90	0.93	0.99	1.00	
Budget Balance		TR/TE	0.35	0.26	0.26	0.35	0.26	0.26	0.42	0.31	0.31	1.00

revenues and total expenditures (columns 14). The tax effort ratios for the first two methodologies are obtained by dividing the actual tax and non-tax collections by the potential revenue capacity as defined earlier in each case. As we can see, in most cases tax effort estimates from the stochastic frontier method are slightly smaller than those from the traditional fixed effects model. We can also see that in most OECD countries the stochastic frontier estimate is about 10 percentage points lower than the one from the fixed effects. In part this reflects the fact that the benchmark for revenue performance under the stochastic frontier method is the best performance in the sample while the benchmark in the traditional approach is the fitted average in the sample.

There are alternative ways to further discuss the results. One revealing approach is to focus on the different rankings obtained for selected countries.

An interesting case is Australia with only 69 percent estimated tax effort by frontier analysis, which is significantly lower than the estimate from the fixed effects model (about 90 percent) and the ratio between total revenues and total expenditures (103 percent). According to these numbers we could infer that even though Australia has a much larger capacity to raise revenues than in does, it actually raises only the amount that it needs for financing its desired expenditure needs. Another interesting example is Burundi for which the estimated tax effort from the traditional econometric analysis is between 140 and 150 percent, but they manage to cover only 76 percent of their expenditure needs from their own revenues.

However, to have a better understanding of these results, it may be more desirable to make comparisons between more similar countries. For example, among the industrial nations, when we compare Australia with Canada we can conclude that both countries collect enough revenues to finance their expenditures, but we estimate that revenue collection in Canada is much closer to its potential than it is in Australia. This may be the result of larger expenditure needs in Canada than in Australia and, thus, the need for higher collection of revenues. Similarly, we estimate that revenue collection in Burundi and Uganda, which are among the poorest countries in the world, is well above its potential, but at the same time they are not high enough to finance their expenditure needs. On the other hand, Bangladesh and Pakistan are two countries that are so

similar but in many ways, including revenue collection, so different. While in both countries the level of revenue collection is below their potential and they are below the level needed to fully finance their expenditures, the revenue effort measure is much higher in Pakistan than in Bangladesh.

These numbers would suggest that for countries like Burundi and Uganda it would be necessary to increase their tax capacity through economic and institutional development efforts. Moreover, high dependence on foreign aid for financing government spending has a negative effect on potential revenue collections. As our results suggest, 1 percent increase in grants from foreign governments and international organizations (i.e. foreign aid) leads to a 1 – 1.3 percent reduction in potential revenue collections. Countries like Burundi, with relatively low ratios of total revenues (tax and non-tax revenues) to GDP of 15.7 percent and relatively high average dependence ratios of foreign grants to GDP of 4.8 percent, have space for higher tax effort. Note that according to the latest Transparency International (2011) report, the corruption perception index in Burundi is 1.9 (10 being the lowest and 0 the highest risk). In addition, it is quite clear from our numbers that countries like Pakistan and Bangladesh have space (and need) to increase their revenue collections through improved tax administration and enforcement.

For a more general comparison, Table 6 presents the correlation coefficients between the three estimates of tax effort. We can see that estimates obtained by the stochastic frontier model and the fixed effects traditional model exhibit a high positive correlation indicating that, whereas the differences in magnitude may be important, the two methods yield estimates within a close neighborhood of each other. The table also shows that each of the estimates from the traditional method and the stochastic frontier analysis has a much lower correlation with the tax effort measure generated by using total expenditures as a benchmark for potential revenue requirements. This result could mean that the tax effort measures generated by different econometric methods may not measure up very closely with the revenue requirements in a country, especially if the desired development levels achieved by a country or pursued by its policies are better approximated by its level of public expenditures. Connecting this with the question of how much revenue it needs to raise, given its preferred level of public goods, provides a more tractable avenue for tax policy discussions. The low correlation between the tax effort measures calculated by econometric methods and our third method also point toward a

need to carry out further work in developing cogent measures of revenue requirements. Such measures could either be built as sustainability requirements for the current level of development or serve as lights on the path to achieving higher levels of development. As we mentioned earlier in Section 2, despite some good beginnings, much work remains to be accomplished in this area.

In general, according to our results, for most countries in our sample, actual revenue collections do not match their revenue potential. There are different reasons for such a result. Some countries (e.g. Australia) do not tax up to their full capacity because they do not need to, while some others (e.g. Burundi) tax much over the capacity but still have to rely on foreign aid and grants to finance much of their expenditure needs.

VII. Conclusion

Calculating tax effort accurately for tax policy purposes and motivating discussion on the scope of tax reforms remains an important endeavor. In such efforts, the tax collections are known with relative accuracy. A plausible measure of tax capacity that appeals to the policy sense of decision makers is a harder task but still key to defining the potential tax gap for any country. The traditional approach to measuring tax effort develops a measure of tax capacity that arises out of the tax levels attained in other countries and the effects of tax handles and other determinants on those tax levels prevailing in the international experience. Adding institutional determinants refines this measure but it does not change in any substantial way.

Similarly, the stochastic frontier approach modifies the measure of tax capacity and parses out the production frontier and the implied time varying inefficiency. This provides an additional dimension for policy discussions by identifying determinants of and factors influencing inefficiency. The tax capacity measure produced with either approach, however, does not provide a tangible revenue target specifically applicable to a country. In either case, a weakness persists in that the tax gap does not have a close correspondence to the revenue needs given the development level to be sustained or achieved. In this paper we have argued that the public expenditure level revealed as a political choice in a country may serve as an additional informative measure to quantify tax effort. It serves as a readily visible preference for the desired level of public goods and service provision in a country. Observed over time, it shows what a

country wishes to spend on public goods. This is a useful and politically cogent fiscal indicator to assess the adequacy of the level of taxation in a country.

Linking tax collection to a country's expenditure profile has the advantage of bringing the politics of financing public goods to the foreground of policy discussions. A country may be able to sustain high levels of public expenditure with low tax collections in the short to medium term. In individual country cases, this could be made possible either due to international aid policies or country specific ability to borrow. Over the long run, however, the question of raising revenues that correspond with the desired level of expenditures cannot be skirted by policy makers. The traditional approaches to measuring tax effort have some technical advantages including the fact that country cases are related to the international trends in taxation. However, even when these are considered, the political forces may not be moved by them. On the other hand, when tax and expenditure choices are seen as linked together and policy makers face the choice of either scaling down expenditures (politically unpopular) or increasing taxes (politically unpalatable), the tradeoffs for development become much more apparent and may motivate appropriate decisions toward timely tax reform.

It is within this ambit that the search for a counterfactual measure of tax capacity should pay attention to regional comparators. Compared with relatively opaque international averages, regional comparisons may evoke more intuitive responses. In this regard, additional measures of public expenditure could be developed to serve as indicators of either desired or recommended revenue requirements for a country, such as those in the Millennium Development Goals . Regional expenditures per capita on basic services like education, health and water and sanitation can provide a measure which indicates critical revenue requirements for keeping a country on the path of development. These critical expenditures may be low in a country, due to political priorities or high, due to inefficient expenditure management and service production systems. Using regional averages will help diminish such effects via some form of benchmarking competition. Another approach could be to develop regionally applicable measures of efficient expenditures to provide a set of basic services. Such measures will compare the cost of delivering services in comparable circumstances and may present convincing targets for enhancing tax effort.

Finally, a look at the development commitments may provide another measure of revenue requirement or desired fiscal capacity. Under several international commitments like health commitments and Millennium Development Goals, developing countries bind themselves to pursuing specific outcomes. The financial implications of these commitments are easy to work out. This could be done in absolute terms per country to find out the fiscal cost of reaching a particular development indicator or in comparative terms by alluding to regional comparators and referring to the levels of public expenditure reached to achieve particular development ends. Tax effort could then be defined with reference to committed public expenditures and used per se to provide specific policy guidance for tax reform. We aim to use such data and refined measures of tax effort, with a higher cogency for development, as future work.

Appendix Table A.1. Variables, Description, and Sources

Total Revenues	= Tax Revenues + Non-Tax Revenues	IMF GFS Database, OECD Revenues Database, CEPAL
Age Dependency	Age dependency ratio (% of working-age population)	WDI
Agriculture	Agriculture, hunting, forestry, fishing (GDP Value Added in current Prices, %)	United Nations Statistics Division
Broad Money	Broad money (% of GDP)	WDI
Capital Formation	Gross fixed capital formation (including Acquisitions less disposals of valuables)(GDP Value Added in current Prices, %)	United Nations Statistics Division
Complexity of Tax System	= Personal Income Tax^2+Corporate Income Tax^2+General Tax on Goods and Services^2+Excises^2+Customs Duties^2	IMF GFS Database, OECD Revenues Database, CEPAL
Construction	Construction (GDP Value Added in current Prices, %)	United Nations Statistics Division
Corruption	Assessment of Corruption within the political system (max. points 6)	ICRG
Crude Petrol	Production of Crude Oil, NGPL, and Other Liquids (Thousand Barrels Per Day)	US Energy Information Administration
Education	Education index	UNDP Human Development Report
GDP Per Capita	GDP per capita, PPP (constant 2005 international $)	WDI
General Government	=1 if revenue data at the general government level	
Globalization	Globalization index	Dreher, Axel (2006). Does Globalization Affect Growth? Evidence from a new Index of Globalization, Applied Economics 38, 10: 1091-1110. and Dreher, Axel, Noel Gaston and Pim Martens (2008), Measuring Globalisation – Gauging its Consequences (New York: Springer).
Grants	Grants from foreign government and international organizations, % of GDP	IMF GFS Database
Income Inequality	Gini coefficient	UNWIDER
Inflation	Inflation, consumer prices (annual %)	WDI
OECD	=1 if OECD member country	
Political Fractionalization	Fractionalization Index	Thorsten Beck, George Clarke, Alberto Groff, Philip Keefer, and Patrick Walsh, 2001. "New tools in comparative

		political economy: The Database of Political Institutions." 15:1, 165-176 (September), World Bank Economic Review.
Pop. Growth	Population growth (annual %)	WDI
Population Density	Population density (people per sq. km of land area)	WDI
Government $Debt_{-1}$	General Government debt (% of nominal GDP). It does not include debt of public corporations	Historical Public Debt Database 2011
Service	Services, etc., value added (% of GDP)	WDI
Tax Morale	Percent of population declaring cheating on taxes as never justifiable	World Value Survey
Years in Office	Chief Executive Years in Office	Thorsten Beck, George Clarke, Alberto Groff, Philip Keefer, and Patrick Walsh, 2001. "New tools in comparative political economy: The Database of Political Institutions." 15:1, 165-176 (September), World Bank Economic Review.

Appendix Table A.2. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Age Dependency	6211	0.70	0.20	0.17	1.20
Agriculture	5793	0.18	0.15	0.00	0.81
Broad Money	4743	0.44	0.34	0.04	3.24
Capital Formation	5834	0.22	0.08	0.01	0.68
Complexity of the Tax System	2670	1.08	1.15	0.01	8.29
Construction	5834	0.06	0.03	0.00	0.28
Corruption	2760	3.17	1.39	0.00	6.17
Crude Petrol	4472	0.34	1.10	0.00	10.64
Education	3243	0.75	0.21	0.09	0.99
GDP per capita	4434	10.59	12.40	0.25	123.26
Globalization	5479	0.47	0.18	0.10	0.93
Government Debt	4895	0.56	0.52	0.00	20.93
Grants	3736	0.01	0.03	0.00	0.30
Income Inequality	2646	0.38	0.10	0.18	0.74
Inflation	5289	0.11	0.14	-0.29	1.00
Political Fractionalization	4059	0.21	0.28	0.00	1.00
Population Density	6272	0.26	1.22	0.00	19.43
Services	4925	0.52	0.14	0.07	0.93
Tax Morale	957	0.60	0.13	0.26	0.95
Total Revenues	3737	0.26	0.13	0.01	0.61
Years in Office	4892	7.05	7.25	1.00	46.00

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