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Drivers of the Tax Effort: Evidence from a Large Panel[1]

March, 2021

Victor Barros[2] Joao Tovar Jalles[3] Joaquim Miranda Sarmento[4]

Abstract

This paper extends previous literature by assessing the drivers of tax effort in a large panel of 122 countries over the period 1980 to 2017 and refining the analysis to regions, periods, income group, and economic development level. Our focus is on five blocks of determinants, namely: economic, fiscal, openness, structural, and political. We find that tax effort is influenced by all blocks, although results differ per income group. Tax effort in advanced economies is driven by all blocks of drivers, except political variables, while openness, structural, and political blocks prevail in developing economies. There is no consistency regarding the determinants across the four regions (Latin America, Africa, Europe and Asia). We also find that during the first two decades under analysis, tax effort is mainly associated with both higher levels of countries' tax revenues and the role of the agricultural sector in the economy, while from 1999 onwards the determinants are mainly driven by left-wing ruling governments and the economic and fiscal blocks of variables. Our results are robust for a battery of sensitivity and robustness tests. Taken all together, our findings suggest the existence of heterogeneous impacts, which implies that policies resulting in improvements in the level of tax effort can affect countries in different ways.

Keywords: H21; O10; O40.
JEL codes: tax effort; fiscal policy; economic development.

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1. Introduction

There is a longstanding debate regarding the drivers of tax revenues and tax effort (Gupta, 2007). Tax effort can be defined as an index of the ratio between the share of actual tax collection in gross domestic product and taxable capacity, the tax capacity being "*the predicted tax-to-gross domestic product ratio that can be estimated empirically, taking into account a country's specific macroeconomic, demographic, and institutional features, which all change through time*" (Le et al., 2012). Countries all over the world have been concerned with tax revenues and fiscal constraints (Arellano & Bai, 2017). On the one hand, a strong pressure exists regarding government spending, both for social expenditures, such as education, health, and pensions (Jimenez, 2017), and also for the need for public investments, particularly to address infrastructure gaps (Bacchiocchi et al., 2011; Sarmento & Renneboog, 2016). On the other hand, increasing attention is being paid to the sustainability of public finances, particularly in contexts of low economic growth (Afonso & Jalles, 2012). This has all led to the increasing importance for governments to raise revenues. Nevertheless, a high fiscal burden can be perceived to be an obstacle for economic development and growth (Afonso & Jalles, 2014) and accordingly, increasing tax revenues without a high level of tax effort is considered to be an essential element of fiscal policy. As a result, understanding the drivers of tax effort is of extreme relevance, particularly for policymakers.

The literature on the drivers of tax effort has been mainly focused on the economic and demographic aspects, although certain institutional issues should also be considered relevant. From the economic point-of-view, the main drivers of tax effort are the GDP growth and GDP per capita (Frank, 1959; Bird, 1964; Rivero et al., 2001; Gupta, 2007), although Gross Domestic Income is also perceived to be relevant (Lortz & Morss, 1967; Chelliah et al., 1975; Piancastelli, 2001). For both the economic and demographic cases, countries with a higher level of development tend to have higher taxation and tax effort levels. Furthermore, higher participation of agriculture in GDP tend to reduce the tax capacity (Balh, 1971; Chelliah et al., 1975; Piancastelli, 2001). Economies with a higher level of openness – i.e., with more trade – tend to have lower levels of tax efforts (Gupta, 2007; Pessino & Fenochietto, 2010; Fenochietto & Pessino, 2013). In addition, a better institutional environment, such as low corruption and better rule of law, tend to improve tax performance and reduce the tax burden (Bird et al., 2008). Unlike previous studies (Gupta, 2007; Bird et al., 2008; Fenochietto & Pessino, 2013), we include an extensive list of determinants, focus on a larger time span, including a broader sample comprising 122 countries, and refine the analysis to regions, periods, income group and economic development. The determinants are grouped into five blocks, and we assess each block's relevance, individually and collectively, in explaining cross-country variability in tax effort. Our paper

contributes to the existent literature as we show different results considering these idiosyncrasies that were not taken together to date.

Our data covers a large panel of 122 countries over the period 1980 to 2017 and is sourced from the OECD database, the World Economic Forum, the IMF World Economic Outlook (WEO), and the World Bank´s World Development Indicators (WDI). Two alternative tax effort measures are computed (the Frank and Bird indexes) for the largest available number of countries and years. The focus is on five blocks of determinants, namely: economic, fiscal, openness, structural, and political. We start to construct our baseline specification by using the standard fixed-effects model for each block of determinants and later drop any insignificant variables from the full specification with all determinants. This parsimonious process set our benchmark specification, which was narrowed down to geographical region (Latin America, Africa, Europe, and Asia), income group (advanced economies, and developing economies), and time period (1980 to 1998, and 1999 to 2017).

Overall, tax effort is influenced by all groups of determinants, although the results differ per income group. Tax effort in advanced economies is driven by all blocks of drivers, with the exception of political variables, which are not relevant. However, the three blocks for openness, structural, and political issues prevail in developing economies. Consistency is also absent for the drivers of tax effort across the four regions. Conversely, and in contrast to all other regions, Africa's tax effort is not associated with the economic, fiscal, and openness drivers. From 1980 to 1998, the level of tax effort is mainly associated with higher levels of a country’s tax revenues and the role of the agricultural sector in the GDP. Since that period, the determinants of tax effort are mainly driven by left-wing ruling governments and by the economic and fiscal blocks of determinants. The results are robust to a large number of robustness checks.

This paper contributes to the literature in several ways. First, it shows that tax effort is time sensitive and depends on the economic development of each country. Second, the income group shapes tax effort differently, and this finding was not addressed in previous studies. Bird et al. (2008) have focussed on high-income countries. Gupta (2007) split the analysis by income level, although it did not account for political variables. We demonstrate that political variables shape the tax effort differently depending on the level of economic development. Overall, the key contribution of this study comes from using a larger sample and time span than main studies in this field while including at the same time a more extensive list of determinants and also narrowing our analysis to groups (regions, periods, income group, and economic development level) that show that different idiosyncrasies matter in explaining cross-country tax effort variability.

The remainder of this paper is organised as follows. Section 2 presents the literature review. Section 3 develops the conceptual framework underlying the empirical model. Section 4 discusses the data and presents some stylised facts, and Section 5 discusses the econometric results. The last section concludes and highlights critical policy implications.

2. Literature Review

The OECD defines tax revenues as being "*the revenues collected from taxes on income and profits, social security contributions, taxes levied on goods and services, payroll taxes, taxes on the ownership and transfer of property, and other taxes. Total tax revenue as a percentage of GDP indicates the share of a country's output that is collected by the government through taxes.*". The tax burden is measured by considering total tax revenues received as a percentage of GDP (Sarmento, 2018). However, countries have different tax capacities, according to their level of GDP, income, openness to trade, and institutional quality (Gaspar et al., 2016). Tax capacity is measured as the predicted tax-to-gross GDP ratio that a country can support, considering the specific macroeconomic, demographic, and institutional characteristics (Le et al., 2012). We can assess tax effort as a derivative of tax revenues and tax capacity. Tax effort is, therefore, the ratio between tax revenues as a percentage of GDP and the tax capacity. It is important to refer that a simple comparison of tax revenues as a share of GDP can be misleading, as it ignores differences in tax capacity across the countries in question (Mertens, 2003).

The main studies on tax effort are summarised in Table A1 in the Appendix. Based on the seminal works of Frank (1959) and Bird (1964) – which were the first to define tax capacity and tax effort – studies have evolved into more complex and comprehensive studies. Most studies use a data sample of several countries for an extended period. For example, Lotz & Morss (1967) used 72 countries to assess tax capacity. For the period of 1963 to 1965, Tanzi (1968) used data from the US, Canada, and European countries. Balh (1971) used a similar period (1966-1968), but for a total of 49 low-income studies, and Chelliah et al. (1975) also used 47 low-income countries with data from 1969 to 1971. More recent studies include that of Rivero et al. (2001), which used 14 European countries, with data ranging from 1967 to 1995, and that of Mertens (2003), which analysed the ten central and eastern European countries from 1992 to 2000. Worldwide country analyses (using both developed and less developed countries) are provided by Piancastelli (2001), Gupta (2007), Bird et al. (2008), Pessino & Fenochietto (2010), and Fenochietto & Pessino (2013).

Studies on tax effort are mainly divided into two large groups: i) those which compare and evaluate tax effort across several countries, most of whom use a cross-section of data, which ignores time-variation, although some use a sample period (Pessino & Fenochietto, 2010; Fenochietto & Pessino, 2013); and ii) those that analyse the potential drivers of tax efforts. Of these, we can divide the main drivers of tax effort into tax, income, economic structure, population, and institutional environment. Table A2 in the Appendix summarises the main drivers of tax effort, authors, expected effect on tax effort, and the main findings related to each driver. Table A2 in the Appendix shows that tax effort determinants can be divided into five large blocks, namely: economic, fiscal, open economy, structural, and political.

GDP and GDP per capita are used to measure the economic drivers of tax effort, with some authors (Lotz & Morss, 1967 or Chelliah et al., 1975) using GDI (Gross Domestic Income) and GDP per capita instead. In addition, Tanzi (1968) uses personal income (total and per capita). More developed countries – measured as countries with a high GDP or GDI per capita – tend to have a higher level of taxation and tax revenues, which is primarily due to a higher level of expenditures (mainly social expenditure, i.e., on pensions, health, or education. Accordingly, greater tax revenues levels tend to lead to a higher tax effort, even when considering the above-mentioned effect of large tax capacity.

The fiscal determinants are mainly: per capita taxes, taxes as a percentage of GDP, and the total amount of tax revenues. Most authors (Frank, 1959; Bird, 1964; Tanzi, 1968 or Rivero et al., 2001) found evidence that a higher level of tax revenues and tax collection increases the pressure on taxpayers, which in turn leads to a higher tax effort. However, as more developed countries tend to have a large tax capacity due to their strong and richer economies, this effect can reduce the tax effort.

Openness of the economy is also a relevant block of tax effort. A higher level of trade tends to reduce tax effort. This is due to several factors: i) a larger volume of exports generate better profits and creates more employment, which in turn lead to greater tax revenues; ii) in most cases, imports are taxed more; iii) trade liberalisation leads to an improvement in customs procedures and also greater tax revenues (Keen & Simone, 2004; Agbeyegbe et al., 2006). Nevertheless, Baunsgaard and Keen (2010 found a weaker relationship for low-income countries, even though they discovered a positive and significant relationship between trade and revenue for high- and middle-income countries.

The economic structure of a country is also related to its capacity to collect taxes and consequently influence tax effort (Piancastelli, 2001). Studies show that countries with higher participation of agriculture in the GDP tend to have a higher tax effort (Balh, 1971; Chelliah et al., 1975; Mertens, 2003; Gupta, 2007). Agriculture tends to be rudimentary and is characterised by the predominance of

small farmers – especially in less-developed countries (Fenochietto & Pessino, 2013). This means that the majority of the economic agents involved are less prone to pay their fair share of taxes and that it is also more difficult for the tax administration to collect these revenues (Rajaraman, 2004). As a result, the other sectors share the tax burden to a large degree (Rajaraman, 2004). In less-developed countries, the agriculture share of tax revenues is lower than the percentage of GDP, and consequently, tax performance is weaker (Akitoby et al., 2020). On the contrary, mining and industry tend to reduce tax effort (Pessino & Fenochietto, 2010; Fenochietto & Pessino, 2013). In the case of mining, the high level of revenues – especially during a commodity price boom – tend to be highly taxed, which generates revenues which, in turn, enable tax authorities to reduce the tax burden on the other sectors.

Population also has a role in the level of tax effort. Balh (2004) found evidence that countries with a faster-growing population tend to have a low level of tax effort, and Bird et al. (2008) also found evidence of such an effect. Nevertheless, it is crucial to consider that countries with a growing population tend to be low-income countries, and therefore the low level of tax effort could be more related to this factor.

Finally, the institutional quality of the country is a crucial aspect of the level of tax effort. Countries with a better institutional framework – which is reflected by low corruption, a better rule of law, or better government efficiency – tend to be characterised by less tax effort (Grigorian & Davoodi, 2007; Gupta, 2007; Bird et al., 2008; Pessino & Fenochietto, 2010; Fenochietto & Pessino, 2013). Overall, these authors refer that a higher level of informal economy and tax evasion leads to a higher tax effort. The ability of a large proportion of taxpayers being able to evade their tax obligations naturally leads to the need for the tax burden to be shared by a reduced number of agents. Argentiero et al. (2020) elaborate on how corruption levels are positively related to tax evasion. Authors such as Bird et al. (2008) argue that in the case of low-income countries, improving government institutions is the best root to improve their tax collection, as such an improvement provides a better level of development than natural resources do. The authors claim that high-income countries also have the potential to enhance their tax performance through having better institutions. Despite this, some studies in the literature stress the repercussions of the lack of administrative capacity to enforce taxation in developing countries (Bird 1989, 2004).

3. Conceptual Framework and Empirical Strategy

3.1 Conceptual Framework

To implement our analysis, we compute two measures of tax effort based on the seminal works of Frank (1959) and Bird (1964). The two measures are still relevant today, despite recent attempts to define more comprehensive indexes by also including economic development and the degree of openness (Lotz and Morss, 1967), foreign trade (Bahl, 1971), the intensity of the use of specific taxes (Bahl, 1972; ACIR, 1988), and frontier production possibilities (Aigner et al., 1977). Frank (1959) proposed a measure of 'tax sacrifice', which captures the effects of differences in population and personal income. In Equation (1), the measure of tax effort starts with the tax burden in the numerator and then accounts for the ability to pay taxes:

$$Frank_{it} = \left[\left(\frac{T}{Y}\right) \div \left(\frac{Y}{P}\right) \right] \times 100 \qquad (1)$$

where, T is tax revenues, Y is the gross national product, and Y/P scales the gross national product by population (P).

Later, Bird (1964) added that the numerator in Frank's measure fails to consider the effort to produce the income. In addition, Bird (1964) also challenges Frank's inclusion of gross national product, rather than gross domestic product – which better assesses performance in open economies. Nevertheless, the formulation of Bird's index only changed the numerator part. The index proposed in this research uses disposal income to compute tax burden:

$$Bird_{it} = \left[\left(\frac{T}{Y-T}\right) \div \left(\frac{Y}{P}\right) \right] \times 100 \qquad (2)$$

3.2 Empirical Strategy

We empirically investigate the impact of different blocks of drivers on two alternative measures of tax effort computed for the largest available number of countries and years. This means that our unbalanced panel sample includes xx countries from 1980 to 2017. The analysis is further narrowed by geographical region (Latin America, Africa, Europe, and Asia), income group (AE - advanced economies, and DEV - developing economies, including EME - Emerging Market Economies, and LICS - Low-Income Countries), and time period. The following reduced-form equation is estimated, using Ordinary Least Squares (OLS) initially:

$$y_{it} = \beta_1 + \beta_2 y_{it-1} + \beta_3 eco_{it} + \beta_4 fis_{it} + \beta_5 open_{i,t} + \beta_6 stru_{i,t} + \beta_7 pol_{i,t} + \eta_i + \mu_t + \varepsilon_{i,t} \quad (3)$$

where the y_{it} dependent variable denotes tax effort (from either the Frank or Bird Index) in the country i and time t and y_{it-1} is the lagged dependent variable included in the dynamic model later on (cf. robustness section). eco_{it}, fis_{it}, $open_{it}$ $stru_{it}$, pol_{it} are the blocks of drivers that correspond respectively to the economic, fiscal, open-economy, structural, and political economy determinants of tax burden. Building on previous research (Frank, 1959; Rivero, 2001; Tanzi, 1968; Bird, 1964); Balh, 1971; Gupta, 2007; Bird et al., 2008; Pessino & Fenochietto, 2010; Fenochietto & Pessino, 2013), eco_{it} specifically includes the following variables: log of real GDP per capita; growth in real GDP, and the output gap (measured as the gap between potential and real GDP). In turn, fis_{it} includes tax revenues and the country's fiscal balance, both as a percentage of GDP. The openness of economies ($open_{i,t}$) is captured by trade openness (measured as the exports plus imports as a percentage of GDP), fiscal openness (measured by the World Bank as the commitments and implementation of fiscal transparency actions), and exchange rate stability. The block of structural drivers ($stru_{i,t}$) includes the log of population density, the share of the agricultural sector in the economy, and the Gini index. To conclude, $pol_{i,t}$ includes a variable to capture the political orientation of the government (Left), the political timing (Horizon), the degree of political fragmentation (Cohesion), and government accountability – see below for details.

These control variables enter with a one-year lag in order to minimise reverse causation issues. The η_i and μ_t coefficients denote the country-specific effects to capture time-invariant unobserved factors and the time effects controlling for common shocks (such as the global business cycle) that could affect fiscal conditions across all countries in a given year, respectively. $\varepsilon_{i,t}$ is an idiosyncratic error term which satisfies the standard assumptions of zero mean and constant variance. To account for possible heteroskedasticity, robust standard errors are clustered at the country level.

4. The Data

4.1 Tax Burden Indices

Figures 1.a and 1.b illustrate the level of tax effort worldwide, ranked from 0 to 30. While most of the advanced economics lie within the 0 to 1 range, Europe shows more variability, especially when looking at Bird's index. This measures captures the effort to produce income, and it highlights that southern European countries (Belgium, France, Italy, Portugal, Spain), Belgium and France exhibit

above average values, with the exception of the Baltic countries and a few in the Balkans. Asia shows no relevant variability in tax effort levels.

Figure 1.a Tax Burden across the World, 2017 (using Frank´s Index)

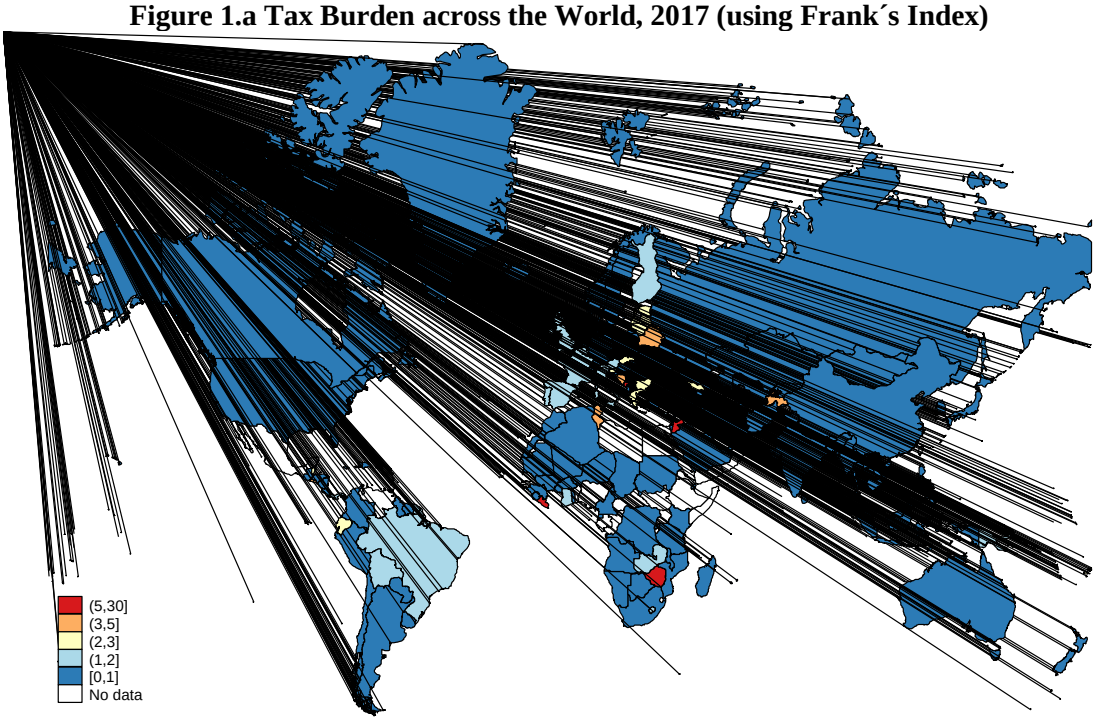


Figure 1.b Tax Burden across the World, 2017 (using Bird´s Index)

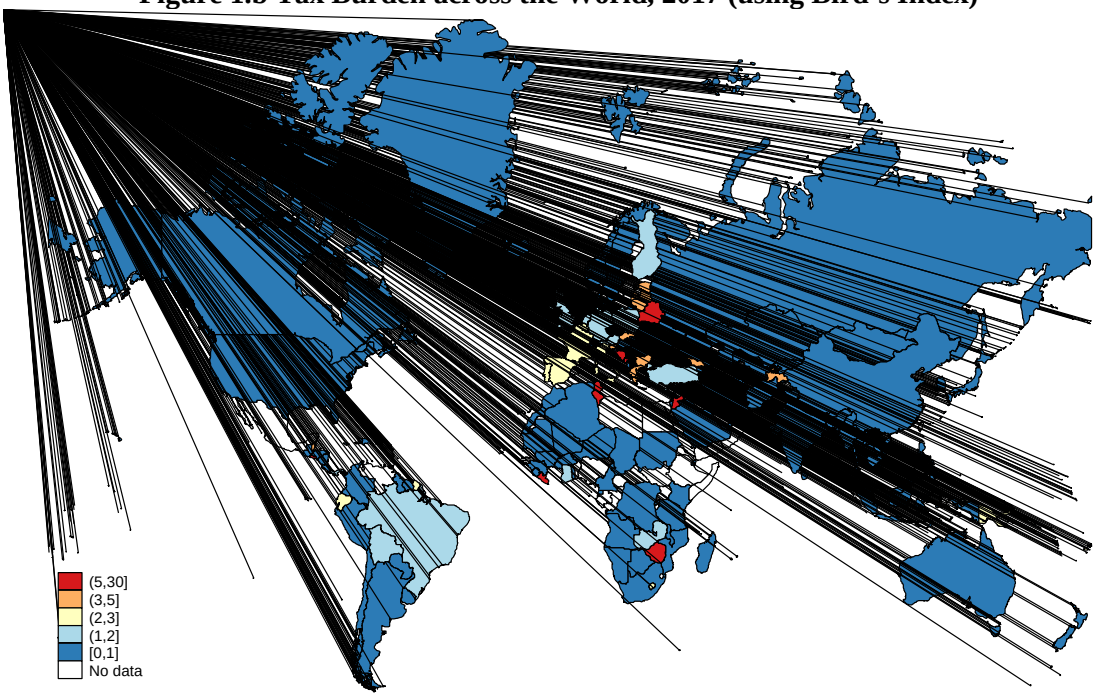
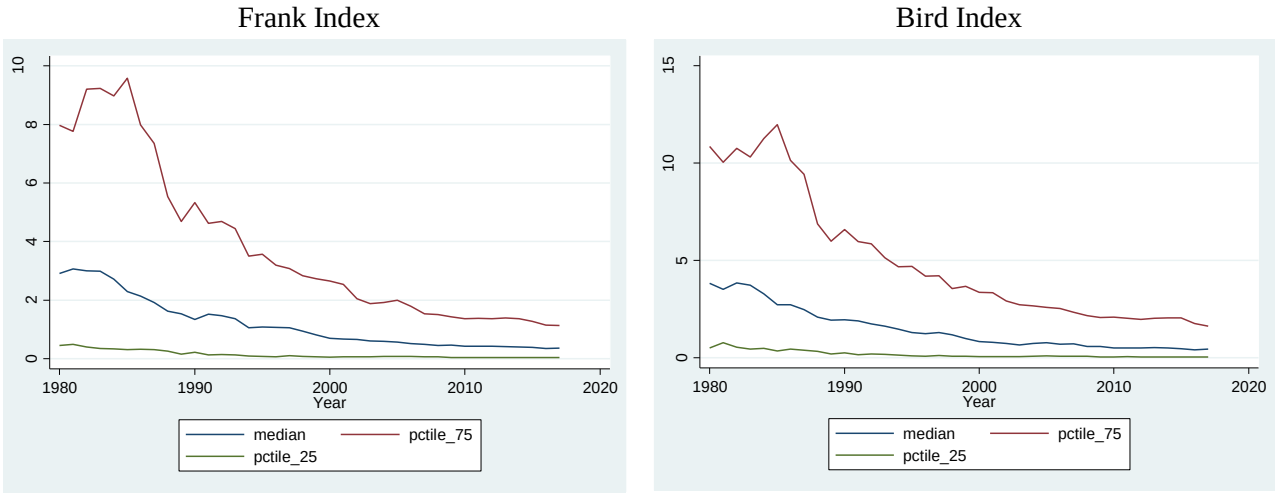


Figure 2 illustrates the evolution of both indexes since 1980. The gap decreased consistently over the years, although a visual inspection highlights the considerable drop in the interquartile range gap.

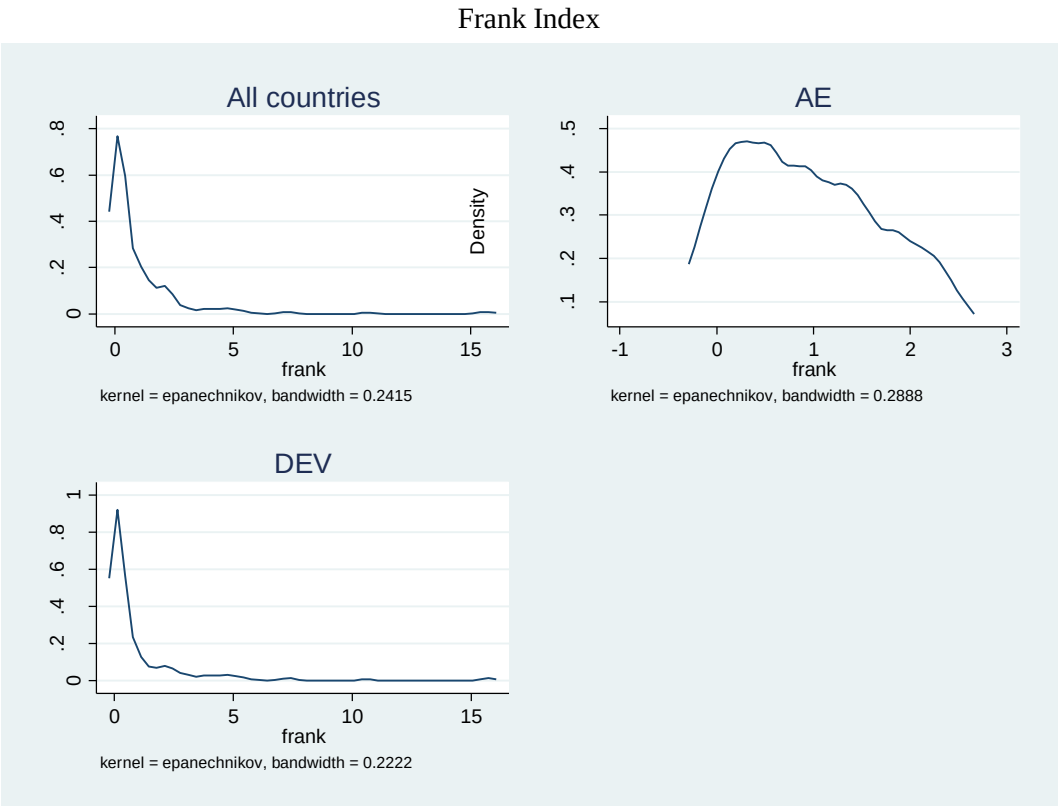
However, the gap was not similar between advanced and developing economies (see Figure A4. in the Appendix). Figures A1. to A3. in the Appendix show the evolution of Frank's and Bird's index per country. Interestingly, Japan presents an inversion of the tax effort trend within the group of advanced economies. When looking at Emerging Market Economies (EME) and Low-Income Countries (LCIS), more distinct patterns can be observed. In Figure 3, we report the distribution of the Frank and Bird indexes, which shows that the dispersion is significantly greater for developing economics.

Figure 2. Evolution of Frank and Bird indices over time, all countries

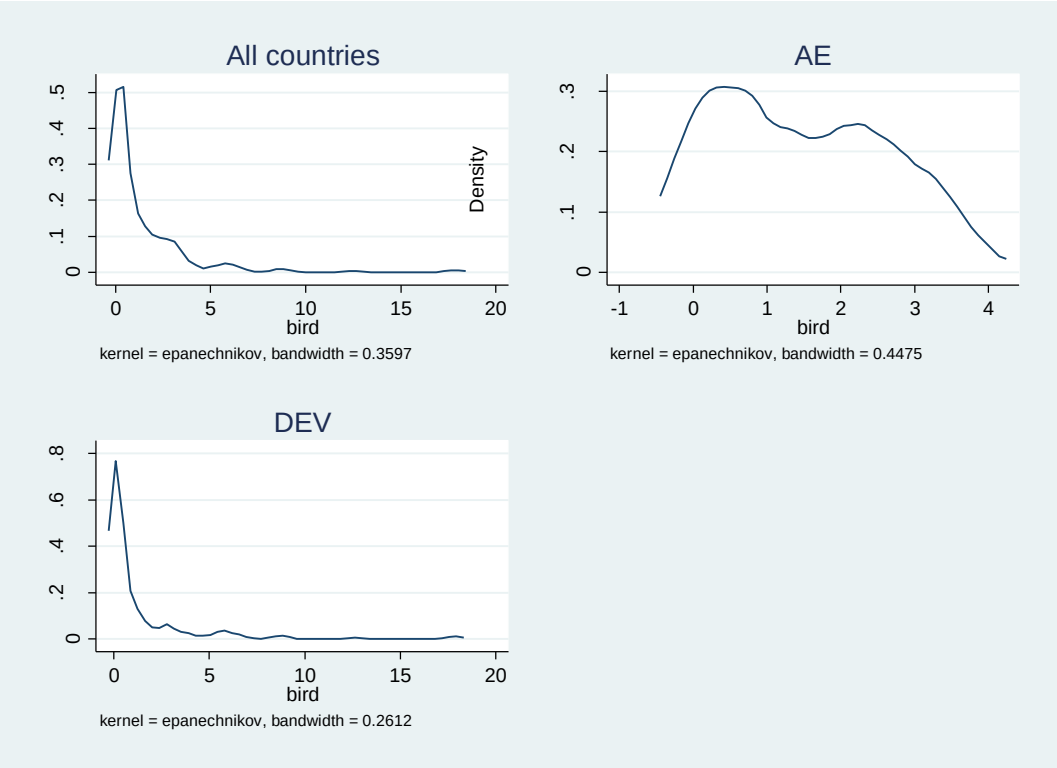


Note: interquartile range, plotting the median and first and third quartile of the respective distribution.

Figure 3. Distribution of Frank and Bird indices by income group, 2017



Bird Index



4.2 Political and Institutional Drivers

To test the role of political and institutional variables in driving the tax burden, as discussed in the previous sub-section, we propose an approach which relies on a principal component analysis (PCA), with variables grouped around three political dimensions, namely: ideology, electoral proximity, and political strength. Data on political economy variables are retrieved from Database of Political Institutions (DPI) (Cruz et al., 2018).

Ideology: this dimension captures whether a ruling government is left-wing or not. The DPI original "chief executive party orientation (execrlc)" value takes three discrete values: 1 for right-wing parties, 2 for central, and 3 for left. We define "left" as taking the value 1 if "execrlc" takes the value 3, and zero otherwise.

Electoral proximity: this dimension takes into account the time available to policy-makers before forthcoming elections. Politicians facing elections can have higher or lower incentives to implement certain tax reforms, depending on the tax area, vested interests, and constituency voting support. We use three variables to compute the proximity to elections PCA. Higher electoral proximity is associated with a longer length of time in office for the party of the chief executive, a larger number of years of the chief executive in office, and a higher number of elapsed years from

the current term. The first principal component is retained, as this factor explains 60% of the variance in the standardised data (see Table A3).

Political strength: represents a dimension which captures the number of political actors participating in fiscal decisions, which typically tend to exhibit conflicting demands. These actors could be parties in government (or in opposition), interest groups, or, more generally, veto players. Strong governments are those which operate in less fragmented political environments. We use four variables to compute the strength PCA, where more political strength is associated with a high margin of parliamentary majority, executive control of all houses, and a weak opposition which is measured by a larger number of parliamentary seats and voting share of the ruling government. Only the first principal component is retained, as it explains more than 54% of the variance in the standardised data (see Table A3).

Political Accountability: is a dimension which considers the institutional context in which fiscal policy decisions are made. Politicians tend to be more responsive to citizen's demands and more accountable to voters for the promises they make when they operate in contexts typified by more transparency, better governance, and a larger number of mechanisms designed to monitor their activities objectively. In such contexts, politicians operating in institutional contexts with more accountability are associated with greater fiscal discipline and lower promise gaps. We use four variables to compute the accountability PCA. A higher accountability index is associated with more voice and accountability, with greater regulatory quality, more government effectiveness, and less corruption. Only the first principal component is retained (see Table A3).

Table A3 in the Appendix lists the corresponding factor loadings and uniqueness for the PCAs, which, as an example, can be interpreted as follows: in the case of political strength, the resulting factor appears to mostly describe the margin of majority and control of all houses, as indicated by their lower uniqueness.

Given that PCA is based on the classical covariance matrix, which is sensitive to outliers, we take a preliminary step by basing it on a robust estimation of the covariance (correlation) matrix. A well-suited method is the Minimum Covariance Determinant (MCD), which considers all subsets containing h% of the observations and estimates the variance of the mean on the data of the subset associated with the smallest covariance matrix determinant – for which we implement Rousseeuw and Van Driessen's

(1999) algorithm. After re-computing the same indices with the MCD version, we mainly obtain similar results, which infers that outliers are not driving our factor analysis.

5. Empirical Results

5.1 Baseline

As a baseline, we estimate Equation (1) using the standard fixed-effects model and start with a specification which includes only macroeconomic variables in Column (1) of Table 1 as a point of reference. We then present parsimonious specifications with alternative blocks of drivers organised by topic and enter them independently in Specifications (2) until (6). Specification (7) includes all blocks of drivers placed together in a single regression. While these results demonstrate a relatively consistent picture, we consider the model in Column (8) - which was obtained from dropping insignificant variables from Specification (7) one at a time - as our benchmark specification.

The dependent variables in Table 1 and Table 2 are the Frank index and the Bird index, respectively. The results are very similar for the two proxies of tax effort, although with one exception. The Gini index is associated with higher tax effort for the Frank index, while it is not relevant for the Bird index. In fact, the latter differs by accounting for the effort to produce income, thus making the measure of income inequality not relevant in explaining tax effort. We observe that countries with higher taxes as a percentage of GDP and a higher fiscal balance experience higher tax effort. This result is consistent for both measures of tax effort and also with the role of tax effort in achieving fiscal consolidation.

[Insert Tables 1 and 2]

The results suggest the existence of higher tax effort for more open economies which are more sensitive to exchange rate fluctuations. The works of Lotz & Morss (1967), Balh (1971), Chelliah et al. (1975), Mertens (2003), Bird et al. (2008) all documented that openness exerts a negative effect on tax effort, although some other studies suggested that the opposite effect, which is arguably due to import taxes (Gupta, 2007; Pessino & Fenochietto, 2010; Fenochietto & Pessino, 2013). Consistent with Bird et al. (2008), tax effort increases population density, although the level of income can shape this relationship, as we discuss below.

Increasing real GDP is associated with higher tax effort. However, contrary to most empirical evidence (Frank, 1959; Gupta, 2007; Pessino & Fenochietto, 2010; Fenochietto & Pessino, 2013), real GDP per capita appears to drive down countries' tax effort. Bird et al. (2008) documented that more

developed countries have a greater tax capacity and accordingly support the need to narrow the analysis in the next section to geographical region and income group.

5.2 Sensitivity

We performed sensitivity analyses by income group (Table 3), geographical location (Table 4), and time period (Table 5). The sensitivity analysis results by income group show that there are only two consistent determinants of tax effort: real GDP per capita and population density. The results for other economic and fiscal drivers of tax effort only hold similar to the base case for advanced economies. The relevance of the agricultural sector in developing economies increases tax effort. However, this association is negative for advanced economics, which is explained by the role of the agricultural sector on output per capita. Overall, tax effort in advanced economies is driven by all blocks of drivers, except for political variables, while in developing economies, the level of tax effort is influenced by the openness, structural, and political blocks of drivers.

[Insert Table 3]

The sample is further narrowed in Table 4 to geographical location, namely: Latin America, Africa, Europe, and Asia. Overall, there is no consistency of drivers of tax effort across the four regions. Tax effort in African countries is not associated with economic, fiscal, and openness drivers. African countries show lower tax effort for a higher density of the population in the cases of countries governed by left-wing political parties and also for countries exhibiting a high weight of the agriculture sector in the economy. Latin American countries share similarities with African countries, although the Gini index, economic, and fiscal blocks of drivers need to be added to those cited above for African countries. The Gini index plays a role in the level of tax effort for regions with a concentration of more inequality countries. In fact, the Gini index is only relevant for the Latin America region. The inequality index is highly concentrated above 40 for most Latin American countries, while it is not uniform throughout the African region and is relatively lower in most countries in all other regions.

The Europe and Latin America regions share most economic drivers, although with opposing associations, namely: increase in GDP per capita, lower real GDP growth, and smaller output gap are all associated with lower tax effort in Europe, although they are higher for Latin America. The block of fiscal variables is relevant for explaining variability in tax effort in the Asia region, together with financial openness and the contribution of the agriculture sector.

[Insert Table 4]

Table 5 shows the results for two time periods – 1980 to 1999 and 1999 to 2017. During the first period, tax effort is mainly associated with higher levels of both the level of tax revenues per country and the role of the agricultural sector in the GDP. Turning to the next two decades, drivers differ significantly as countries' economic and social development evolve, whereby determinants of tax effort are now mainly driven by the economic and fiscal blocks of variables. The GDP growth is associated with higher tax effort, although it is offset by the prosperity of economies measured by per capita GDP. The relevance of left-wing ruling governments emerged in the second period – which acts as a determinant of decreasing tax effort.

[Insert Table 5]

5.3 Robustness

We began the empirical analysis with the standard fixed-effects model, which provided consistent and robust results. However, the model represented by Equation (1) is the reduced-form version, which therefore renders it impossible to make causal statements, or even quantifying the clean effects of certain drivers on the tax burden. Adding covariates partly corrects for these biases. However, endogeneity can still arise from other omitted variables (unobserved heterogeneity and selection effects), measurement errors in variables, and reverse causality (simultaneity). As causality can run in both directions, some of the right-hand-side regressors can be correlated with the error term. However, due to the potential for the existence of endogeneity and the persistence of tax burden indices, we check the sensitivity of our baseline results by estimating the static model with the Two-Stage Least Squares (2SLS) estimator. We use lagged regressors as instruments (up to two lags), which are validated by the Kleibergen-Paap and Hansen statistics.[5] Furthermore, we use the system Generalized Method of Moments (GMM) approach developed by Arellano and Bover (1995) and Blundell and Bond (1998) to estimate the dynamic version of our model – even though the GMM system approach is a very demanding estimator, especially with when using a limited number of unbalanced observations. The system GMM approach involves constructing two sets of equations, one with first differences of the endogenous and pre-determined variables instrumented by suitable lags of their own

[5] When looking at the diagnostic statistics to assess the validity of the instrumental variable strategy, the underidentification test *p*-values generally reject the null that the different equations are underidentified. In addition, the Hansen test statistics reveal that the instrument sets contain valid instruments (i.e., instruments which are uncorrelated with the error term, and those that the excluded instruments are correctly excluded from the estimated equation).

levels, and the other with the levels of the endogenous and pre-determined variables instrumented with suitable lags of their own first differences. We apply the one-step version of the GMM system estimator to ensure the robustness of the results, as the standard errors from the two-step variant of the GMM system method are known to be downward biased in small samples.

The use of all available lagged levels of the variables in the GMM estimation leads to a proliferation in the number of instruments, which reduces the efficiency of the estimator in finite samples, and can potentially lead to over-fitting. A further issue is that the use of many instruments significantly weakens the Hansen J-test of over-identifying restrictions, and therefore the detection of over-identification is harder when it is most needed. Conversely, however, restricting the instrument set too much results in a loss of information, which in turn leads to imprecisely-estimated coefficients. Accordingly, the estimation of such models involves a delicate balance between maximising the information extracted from the data on the one hand, and guarding against over-identification on the other hand. To this end, we follow the strategy suggested by Roodman (2009) to deal with the problem of weak and excessively numerous instruments. We also validate the GMM system identification assumptions by applying a second-order serial correlation test for both the residuals and the Hansen J-test for the overidentifying restrictions. The values reported for AR(1) and AR(2) in the respective tables are the p-values for first- and second-order autocorrelated disturbances in the first-differenced equation. As expected, we find evidence for high first-order autocorrelation, but no evidence for significant second-order autocorrelation. Similarly, the Hansen J-test result indicates the validity of internal instruments used in the dynamic model estimated via the GMM system approach.

Finally, we also consider the Mean Group (MG) estimator (Pesaran and Smith, 1995) and the Pooled Mean Group (PMG) estimator (Pesaran et al., 1999). Both the MG and PMG are appropriate for analysing dynamic panels which have both large time and cross-section dimensions. Furthermore, they have the advantage of accommodating both the long-run equilibrium and the possibly heterogeneous dynamic adjustment process. These estimators enable correcting for the potential bias, resulting from estimating tax buoyancy coefficients when using standard fixed-effects models in the presence of nonstationary error terms, which imposing parameter homogeneity would introduce into the estimating equation.

Results for the robustness analysis using the entire sample are presented in Table 6, which contrasts with the results in Tables 1 and 2. For The role of real GDP per capita in shaping countries' tax effort is reinforced in all estimations, as documented by Bird et al. (2008), although the results are contrary to other studies (Frank, 1959; Gupta, 2007; Pessino & Fenochietto, 2010; Pessino & Fenochietto,

2013). We also observe that fiscal balances increase countries' tax effort, as in the baseline estimation. The battery of robustness tests also yields better clarification regarding the influence of the Gini index in explaining tax effort, although it is now robust across the two dependent variables used in our study.

[Insert Table 6]

6. Conclusion and Policy Implications

In this paper, we evaluated the determinants of tax effort in a sample of 122 countries over the period of 1980 to 2017. The focus is on five groups of determinants, namely: economic, fiscal, openness, structural, and political. We begin our analysis by looking at the entire sample. Next, we narrow the analysis by geographical region (Latin America, Africa, Europe, and Asia), income group (advanced economies, and developing economies), and time period (1980 to 1998 and 1999 to 2017).

Our main findings are summarised as follows. Tax effort is influenced by all groups of determinants, although the results differ per income group. All blocks of groups of determinants explain tax effort in advanced economies – except the block of political variables – while in developing economies, the level of tax effort is mainly influenced by the open structural and political blocks of drivers. Overall, there is no consistency of drivers of tax effort across the four regions. Economic and fiscal determinants are relevant for Europe and Latin America, although in opposite directions. Conversely, none of the economic, fiscal, and openness drivers determines tax effort in Africa, with the relevant determinants for these regions being the density of population, weight of the agricultural sector, and political drivers.

Determinants of tax effort also differ in function of each of the time periods. On the one hand, tax effort is mainly associated with higher levels of countries' tax revenues and the role of the agricultural sector in the GDP during the first period (1980-1998). However, on the other hand, in the second period, relevance of left-wing ruling governments emerged as a determinant of decreasing tax effort, together with the relevance of the economic and fiscal blocks of variables.

This paper contributes to the literature in several ways. First, it shows that tax effort is time sensitive and depends on each country's economic development. Second, the income group shapes tax effort differently, and this finding was not extensively addressed in previous studies. Bird et al. (2008) have focussed on high-income countries. Gupta (2007) split the analysis by income level, although it did not account for political variables. We demonstrate that political variables shape tax effort differently

depending on the level of economic development. Overall, this study's key contribution comes from using a larger sample and time span than main studies in this field while including at the same time a more extensive list of determinants and also narrowing our analysis to groups (regions, periods, income group, and economic development level) that show that different idiosyncrasies matter in explaining cross-country tax effort variability.

Our findings have four main policy implications. First, tax effort is a relevant measure of fiscal policy, however it has limitations. It is easy to collect and provides a simple overview of tax trends over countries. However, countries with different levels of development and income should be considered with caution and the best solution is to consider the impact of each block of determinants mainly in the same income group. Second, in the case of high-level income countries, as all blocks of determinants are relevant, countries should have a holistic view of their tax system. In addition, high-income countries have the potential to improve their tax efficiency by improving their institutions. Third, if countries outside the high-level income group want to potentiate their tax revenues, then they need to consider changes in their openness and the structural aspects of their economy. Fourth, political and institutional drivers are becoming increasingly more relevant.

Future research should consider a finer decomposition of the tax burden, using Frank´s index approach by tax category (personal, corporate, goods and services). Another avenue of research could also consider the economic (and distributional) consequences of big increases in tax burden, which are defined as a binary variable that could take the value 1 if the annual change in the index was larger than each country´s time-series average plus one standard deviation. This would identify years of major country-specific tax shocks.

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Table 1. Baseline: Frank Index - OLS

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables								
Real GDP (log)	3.9552***						6.6160*	
	(0.588)						(3.641)	
Real GDP pc (log)	-8.1783***						-10.4814***	-4.6661***
	(0.787)						(3.720)	(0.496)
Real GDP growth	4.5236***						0.3803	1.9768*
	(1.431)						(1.275)	(1.133)
Inflation rate	2.1349						-0.7948	
	(1.846)						(1.733)	
Output Gap	0.0514***						0.0169	0.0411***
	(0.015)						(0.013)	(0.012)
Growth Forecast	-0.0203						0.0176	
	(0.043)						(0.029)	
Tax pc (log)		-2.8826***					-0.3541	
		(0.421)					(0.276)	
Tax (%GDP)		0.0526***					0.0338***	0.0285***
		(0.015)					(0.010)	(0.007)
Public Debt (%GDP)		-0.0193***					-0.0001	
		(0.004)					(0.002)	
Fiscal Balance (%GDP)		-0.0185					0.0288***	0.0173***
		(0.012)					(0.009)	(0.007)
Trade Openness			0.7225***				0.4351	0.3269*
			(0.204)				(0.287)	(0.198)
Terms of Trade			0.1360				-0.4027	
			(0.129)				(0.269)	
Financial Openness			-1.2281***				-0.0391	0.6297***
			(0.219)				(0.194)	(0.181)
Exchange rate stability			-1.2070***				-0.5413**	-0.3849**
			(0.208)				(0.210)	(0.151)
Monetary Independence			0.3984*				0.0842	
			(0.226)				(0.148)	
Financial Crises			-0.0385				0.0807	
			(0.191)				(0.112)	
Population density (log)				-6.0174***			2.7629	5.4213***
				(2.198)			(3.225)	(0.737)
Labor force (log)				4.5871***			-0.2166	
				(1.083)			(0.876)	
Agriculture (%GDP)				0.0863***			-0.0320	0.0752***
				(0.032)			(0.047)	(0.028)
Services (%GDP)				-0.0089			-0.0135	
				(0.022)			(0.020)	
Gini (disp.inc)				9.5888***			1.2246	4.0867**
				(2.232)			(2.127)	(1.774)
Left					-0.1010**	0.0089	-0.0699***	-0.0175
					(0.040)	(0.026)	(0.022)	(0.020)
Horizon1					-0.3027***	-0.0248	0.0645	-0.2766***
					(0.061)	(0.048)	(0.047)	(0.064)
Cohesion					0.2595	-0.1924	1.1737***	0.5741*
					(0.196)	(0.338)	(0.420)	(0.327)
Accountability						-1.2853***	-0.0842	
						(0.256)	(0.227)	
Observations	1,709	1,376	3,466	1,913	2,518	1,383	649	1,162
R-squared	0.7865	0.7735	0.6954	0.7636	0.7274	0.8813	0.9235	0.8997

Note: The dependent variable is the Frank Index. Robust standard errors in brackets. The outliers are excluded, namely the top 5% of Frank and Bird indices distributions, respectively. Country and time fixed effects are included, but are omitted for reasons of parsimony. The constant term is omitted. *, **, *** denote statistical significance at the 10, 5, and 1 percent levels, respectively.

Table 2. Baseline: Bird Index - OLS

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables								
Real GDP (log)	6.6362***						8.3178	
	(0.808)						(5.483)	
Real GDP pc (log)	-12.5423***						-14.4502***	-6.6941***
	(1.123)						(5.557)	(0.727)
Real GDP growth	5.8019***						1.2386	2.8943*
	(1.841)						(1.927)	(1.625)
Inflation rate	2.5859						-0.5998	
	(2.181)						(2.589)	
Output Gap	0.0657***						0.0313	0.0594***
	(0.020)						(0.021)	(0.017)
Growth Forecast	-0.0061						0.0133	
	(0.052)						(0.045)	
Tax pc (log)		-3.8572***					-0.2698	
		(0.573)					(0.418)	
Tax (%GDP)		0.0897***					0.0516***	0.0458***
		(0.023)					(0.015)	(0.010)
Public Debt (%GDP)		-0.0242***					0.0000	
		(0.005)					(0.003)	
Fiscal Balance (%GDP)		-0.0253					0.0456***	0.0298***
		(0.016)					(0.014)	(0.009)
Trade Openness			0.8051***				0.5977	0.4753*
			(0.255)				(0.433)	(0.289)
Terms of Trade			0.0851				-0.5569	
			(0.143)				(0.416)	
Financial Openness			-1.7570***				-0.1332	0.7644***
			(0.282)				(0.294)	(0.245)
Exchange rate stability			-1.5190***				-0.7912**	-0.6843***
			(0.260)				(0.317)	(0.209)
Monetary Independence			0.5640*				0.1196	
			(0.299)				(0.225)	
Financial Crises			-0.0640				0.0783	
			(0.243)				(0.166)	
Population density (log)				-6.1792**			4.7866	8.1081***
				(2.956)			(4.856)	(1.067)
Labor force (log)				5.8131***			-0.0638	
				(1.460)			(1.328)	
Agriculture (%GDP)				0.0967**			-0.0720	0.0714*
				(0.040)			(0.072)	(0.038)
Services (%GDP)				-0.0185			-0.0165	
				(0.029)			(0.030)	
Gini (disp.inc)				10.4189***			0.1712	3.7901
				(3.047)			(3.306)	(2.492)
Left					-0.1333**	0.0247	-0.0962***	-0.0208
					(0.053)	(0.036)	(0.034)	(0.028)
Horizon1					-0.3925***	-0.0242	0.0787	-0.3501***
					(0.081)	(0.064)	(0.071)	(0.082)
Cohesion					0.3604	-0.1537	1.7809***	0.9297**
					(0.248)	(0.429)	(0.647)	(0.472)
Accountability						-1.7098***	-0.0465	
						(0.347)	(0.332)	
Observations	1,709	1,376	3,466	1,913	2,518	1,383	649	1,162
R-squared	0.8077	0.7639	0.6871	0.7525	0.7108	0.8679	0.9116	0.8968

Note: The dependent variable is the Bird Index. Robust standard errors are in brackets. The outliers are excluded, namely the top 5% of Frank and Bird indices distributions, respectively. Country and time fixed effects are included, but are omitted for reasons of parsimony. The constant term is omitted. *, **, *** denote statistical significance at the 10, 5, and 1 percent levels, respectively.

Table 3. Sensitivity: Frank and Bird Index – OLS by income group

Specification	(1)	(2)	(3)	(4)
Dependent Variable	Frank	Frank	Bird	Bird
Income group	AE	DEV	AE	DEV
Variables				
Real GDP pc (log)	-7.0596***	-2.4031***	-10.3648***	-3.2610***
	(0.605)	(0.557)	(0.910)	(0.727)
Real GDP growth	3.9041***	-0.2315	5.0267***	0.0003
	(1.051)	(1.818)	(1.620)	(2.512)
Output Gap	0.0598***	-0.0039	0.0874***	-0.0004
	(0.013)	(0.015)	(0.020)	(0.020)
Tax (%GDP)	0.0386***	0.0065	0.0612***	0.0197
	(0.007)	(0.027)	(0.010)	(0.034)
Fiscal Balance (%GDP)	0.0364***	0.0041	0.0570***	0.0115
	(0.007)	(0.016)	(0.010)	(0.022)
Trade Openness	1.1718***	-0.4094	1.7528***	-0.5588
	(0.224)	(0.349)	(0.338)	(0.480)
Financial Openness	-0.0304	1.4028***	0.0239	1.5797***
	(0.124)	(0.318)	(0.201)	(0.422)
Exchange rate stability	-0.5887***	-0.0788	-1.0110***	-0.1445
	(0.153)	(0.246)	(0.232)	(0.332)
Population density (log)	7.6925***	4.7012***	11.4558***	6.2270***
	(0.664)	(1.198)	(0.993)	(1.681)
Agriculture (%GDP)	-0.1077**	0.0947***	-0.1969***	0.1138***
	(0.046)	(0.030)	(0.070)	(0.041)
Gini (disp.inc)	-0.0867	2.9377	-1.2200	2.2388
	(1.606)	(2.176)	(2.550)	(2.995)
Left	-0.0052	0.0048	-0.0085	0.0154
	(0.018)	(0.048)	(0.028)	(0.061)
Horizon1	0.0260	-0.5319***	0.0401	-0.6789***
	(0.035)	(0.094)	(0.054)	(0.119)
Cohesion	0.5232	1.2183**	0.9799*	1.6006**
	(0.373)	(0.562)	(0.577)	(0.759)
Observations	688	474	688	474
R-squared	0.9256	0.9259	0.9230	0.9219

Note: The dependent variable is the either the Frank or the Bird Index. The robust standard errors are in brackets. The outliers are excluded, namely the top 5% of Frank and Bird indices distributions, respectively. Country and time fixed effects are included, but are omitted for reasons of parsimony. The constant term omitted. *, **, *** denote statistical significance at the 10, 5, and 1 percent levels, respectively.

Table 4. Sensitivity: Frank and Bird Index – OLS by geographical region

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Frank	Frank	Frank	Frank	Bird	Bird	Bird	Bird
Region	Latin America	Africa	Europe	Asia	Latin America	Africa	Europe	Asia
Variables								
Real GDP pc (log)	0.8971**	2.0296	-7.3616***	-0.2055	1.2520**	3.5767*	-11.0858***	-0.1753
	(0.396)	(1.237)	(0.673)	(0.189)	(0.528)	(1.955)	(1.004)	(0.260)
Real GDP growth	-2.7187*	-2.1839	3.4479***	-0.4214	-3.7043*	-3.9181	4.5904**	-0.5763
	(1.394)	(2.829)	(1.223)	(0.470)	(1.955)	(4.438)	(1.864)	(0.676)
Output Gap	-0.0366***	-0.0155	0.0629***	-0.0036	-0.0528***	-0.0303	0.0946***	-0.0028
	(0.014)	(0.029)	(0.014)	(0.007)	(0.019)	(0.044)	(0.021)	(0.010)
Tax (%GDP)	0.0824***	-0.0139	0.0330***	-0.0192**	0.1436***	-0.0208	0.0515***	-0.0297**
	(0.032)	(0.015)	(0.007)	(0.008)	(0.046)	(0.023)	(0.011)	(0.012)
Fiscal Balance (%GDP)	-0.0114	0.0044	0.0347***	0.0135***	-0.0144	0.0102	0.0546***	0.0245***
	(0.013)	(0.012)	(0.009)	(0.004)	(0.018)	(0.018)	(0.013)	(0.007)
Trade Openness	-0.0925	0.2009	1.1795***	-0.0577	-0.1484	0.2324	1.6575***	-0.0559
	(0.246)	(0.268)	(0.320)	(0.063)	(0.341)	(0.424)	(0.483)	(0.094)
Financial Openness	-0.3195	0.0242	0.1257	0.4145***	-0.5258*	-0.1025	0.2434	0.5576***
	(0.230)	(0.310)	(0.152)	(0.151)	(0.316)	(0.494)	(0.238)	(0.211)
Exchange rate stability	0.2835	-0.4221	-0.8098***	0.0110	0.3740	-0.7343	-1.2901***	0.0005
	(0.232)	(0.398)	(0.150)	(0.069)	(0.316)	(0.647)	(0.225)	(0.109)
Population density (log)	-2.2734***	-5.9368***	8.0483***	-0.3829	-2.7240**	-7.1459**	11.5598***	-0.5931
	(0.790)	(1.622)	(1.011)	(0.308)	(1.114)	(2.587)	(1.518)	(0.439)
Agriculture (%GDP)	-0.0563***	-0.0581*	-0.0196	0.0199***	-0.0790***	-0.0914*	-0.0721	0.0237**
	(0.019)	(0.032)	(0.057)	(0.007)	(0.027)	(0.050)	(0.089)	(0.010)
Gini (disp.inc)	12.2224***	4.4996	2.0634	0.0876	15.1202***	6.9319	1.5744	-0.0852
	(2.109)	(3.023)	(2.125)	(0.949)	(2.894)	(4.939)	(3.380)	(1.398)
Left	-0.0491*	-4.7953**	-0.0400*	0.0029	-0.0448	-5.4869*	-0.0555	0.0078
	(0.026)	(1.680)	(0.023)	(0.017)	(0.034)	(2.688)	(0.036)	(0.025)
Horizon1	0.0312	-0.2162**	0.0251	-0.0168	0.0444	-0.3675**	0.0279	-0.0168
	(0.057)	(0.091)	(0.045)	(0.014)	(0.078)	(0.146)	(0.068)	(0.021)
Cohesion	0.4228	2.7674*	1.1379**	-0.2556*	0.5929	4.5485*	1.7111**	-0.3516*
	(0.344)	(1.481)	(0.451)	(0.134)	(0.475)	(2.366)	(0.690)	(0.193)
Observations	206	49	571	136	206	49	571	136
R-squared	0.9753	0.9984	0.9228	0.9681	0.9682	0.9980	0.9188	0.9665

Note: The dependent variable is the either the Frank or the Bird Index. The robust standard errors are in brackets. The outliers are excluded, namely the top 5% of Frank and Bird indices distributions, respectively. Country and time fixed effects are included, but are omitted for reasons of parsimony. The constant term is omitted. *, **, *** denote statistical significance at the 10, 5, and 1 percent levels, respectively.

Table 5. Sensitivity: Frank and Bird Index – OLS by time period

Specification	(1)	(2)	(3)	(4)
Dependent Variable	Frank	Frank	Bird	Bird
Time period	1980-1998	1999-2017	1980-1998	1999-2017
Variables				
Real GDP pc (log)	0.0246	-3.9766***	0.3646	-5.6642***
	(1.408)	(0.530)	(1.970)	(0.769)
Real GDP growth	-2.3432	2.6107***	-3.5873	3.6983***
	(1.710)	(0.859)	(2.373)	(1.197)
Output Gap	-0.0355*	0.0218**	-0.0571**	0.0326**
	(0.021)	(0.011)	(0.028)	(0.015)
Tax (%GDP)	0.0400***	0.0086	0.0569***	0.0180*
	(0.015)	(0.007)	(0.020)	(0.010)
Fiscal Balance (%GDP)	-0.0088	0.0108**	-0.0117	0.0203***
	(0.014)	(0.005)	(0.019)	(0.007)
Trade Openness	0.7552	-0.1248	0.7493	-0.1305
	(0.558)	(0.200)	(0.728)	(0.300)
Financial Openness	0.0950	0.0179	0.1789	-0.0788
	(0.223)	(0.166)	(0.324)	(0.238)
Exchange rate stability	-0.2105	-0.1652	-0.4142	-0.2968
	(0.202)	(0.161)	(0.287)	(0.227)
Population density (log)	-4.0539	6.1490***	-5.5306	8.8226***
	(2.878)	(0.842)	(3.832)	(1.218)
Agriculture (%GDP)	0.3023***	0.0239	0.3491***	0.0076
	(0.063)	(0.018)	(0.082)	(0.025)
Gini (disp.inc)	3.1376	1.9428	4.1789	1.1211
	(3.408)	(1.675)	(4.562)	(2.402)
Left	0.0228	-0.0473***	0.0146	-0.0632**
	(0.035)	(0.017)	(0.054)	(0.025)
Horizon1	-0.1370*	-0.0591	-0.1582	-0.0730
	(0.083)	(0.049)	(0.112)	(0.068)
Cohesion	-0.5606	0.9931***	-0.5085	1.4063***
	(0.454)	(0.326)	(0.671)	(0.467)
Observations	249	913	249	913
R-squared	0.9870	0.9308	0.9864	0.9253

Note: The dependent variable is the either the Frank or the Bird Index. The robust standard errors are in brackets. The outliers are excluded, namely the top 5% of Frank and Bird indices distributions, respectively. Country and time fixed effects are included, but ae omitted for reasons of parsimony. The constant term is omitted. *, **, *** denote statistical significance at the 10, 5, and 1 percent levels, respectively.

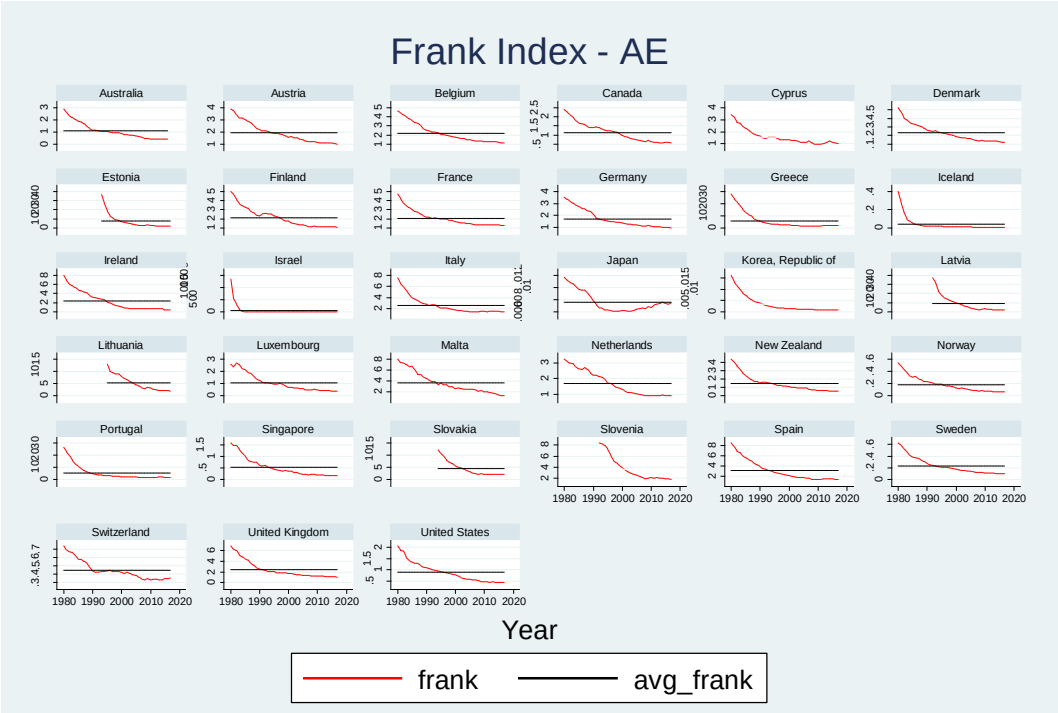
Table 6. Robustness: Frank and Bird Index – alternative estimators, all countries

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent Variable	Frank	Frank	Frank	Frank	Frank	Bird	Bird	Bird	Bird	Bird
Estimator	TSLS	Diff-GMM	Sys-GMM	MG	PMG	TSLS	Diff-GMM	Sys-GMM	MG	PMG
Variables										
Real GDP pc (log)	-4.5922***	-2.9200**	-0.5595***	-2.6130***	-1.2872**	-6.7203***	-4.4252***	-0.8230***	-3.7618**	-2.0038**
	(0.185)	(1.119)	(0.084)	(0.973)	(0.559)	(0.262)	(1.615)	(0.121)	(1.815)	(0.939)
Real GDP growth	3.1778***	1.4969	3.1020	1.1317	0.3646	4.7780***	2.0097	4.5113	1.4531	0.3780
	(0.674)	(1.744)	(2.432)	(0.872)	(0.296)	(0.955)	(2.483)	(3.394)	(1.361)	(0.553)
Output Gap	0.0344***	0.0325	0.0418	0.0162*	-0.0064	0.0505***	0.0432	0.0648	0.0266*	-0.0183
	(0.007)	(0.022)	(0.029)	(0.009)	(0.010)	(0.011)	(0.033)	(0.042)	(0.014)	(0.017)
Tax (%GDP)	0.0215***	0.0067	-0.0017	0.0310**	0.0356	0.0340***	0.0224	-0.0074	0.0503**	0.0630*
	(0.006)	(0.022)	(0.029)	(0.013)	(0.023)	(0.009)	(0.032)	(0.043)	(0.022)	(0.037)
Fiscal Balance (%GDP)	0.0141**	-0.0130	-0.0272	0.0115**	0.0121	0.0241***	-0.0135	-0.0368	0.0230***	0.0365*
	(0.007)	(0.014)	(0.031)	(0.005)	(0.012)	(0.009)	(0.021)	(0.043)	(0.008)	(0.022)
Trade Openness	-0.0165	-0.7702*	-1.0264***	0.1544	0.3066	-0.0271	-1.1078*	-1.6181***	0.1953	0.5036
	(0.145)	(0.437)	(0.381)	(0.159)	(0.272)	(0.205)	(0.644)	(0.528)	(0.250)	(0.498)
Financial Openness	0.5020***	-0.4786	-1.2144**	-0.7123**	-0.2169*	0.5546***	-0.6730	-1.8303**	-0.9221	-0.4030*
	(0.115)	(0.417)	(0.549)	(0.357)	(0.134)	(0.163)	(0.570)	(0.787)	(0.609)	(0.245)
Exchange rate stability	-0.3210***	0.0324	-0.2422	0.0596	0.3058**	-0.6291***	-0.0354	-0.2958	0.0489	0.4787**
	(0.109)	(0.196)	(0.542)	(0.071)	(0.142)	(0.155)	(0.312)	(0.777)	(0.113)	(0.214)
Population density (log)	4.4313***	1.0192	0.1535	-4.6124	-0.3347	6.5138***	2.8126	0.2675	-6.5249	0.0140
	(0.368)	(3.352)	(0.118)	(2.968)	(0.754)	(0.521)	(4.477)	(0.176)	(5.146)	(1.177)
Agriculture (%GDP)	0.0498***	0.1240**	0.0555	0.0058	0.0346	0.0379*	0.1852**	0.0740	0.0139	0.0721
	(0.015)	(0.053)	(0.065)	(0.016)	(0.036)	(0.021)	(0.081)	(0.093)	(0.028)	(0.064)
Gini (disp.inc)	4.1043***	10.6360**	-2.0022	-1.4397	-0.6764	3.5108**	16.5095**	5.4346*	-2.4869	-0.8501
	(1.235)	(4.731)	(2.135)	(1.120)	(0.430)	(1.749)	(6.929)	(3.177)	(1.877)	(0.698)
Left	0.0072	0.0278	0.1241	-0.0122	-0.0206	0.0190	0.0339	0.1608	-0.0285	-0.0320
	(0.031)	(0.109)	(0.140)	(0.013)	(0.024)	(0.044)	(0.150)	(0.199)	(0.025)	(0.041)
Horizon1	-0.3810***	-0.0190	0.1572	0.1335	-0.0650**	-0.4878***	-0.0347	0.2296	0.2003	-0.1284**
	(0.065)	(0.123)	(0.144)	(0.117)	(0.033)	(0.093)	(0.176)	(0.212)	(0.165)	(0.063)
Cohesion	1.0367**	0.2150	-0.5532	0.0098	-0.3329	1.6446***	0.2324	-0.8186	0.0253	-0.6222
	(0.432)	(0.505)	(1.192)	(0.340)	(0.352)	(0.611)	(0.739)	(1.632)	(0.598)	(0.611)
Observations	1,129	1,100	1,184	901	901	1,129	1,100	1,184	901	901
R-squared	0.5559					0.5684				

Note: The dependent variable is the either the Frank or the Bird Index. The robust standard errors are in brackets. The outliers are excluded, namely the top 5% of Frank and Bird indices distributions, respectively. Country and time fixed effects are included, but are omitted for reasons of parsimony. The constant term is omitted. *, **, *** denote statistical significance at the 10, 5, and 1 percent levels, respectively.

APPENDIX

Figure A1. Country-time evolution of Frank´s and Bird´s Index, Advanced Economies



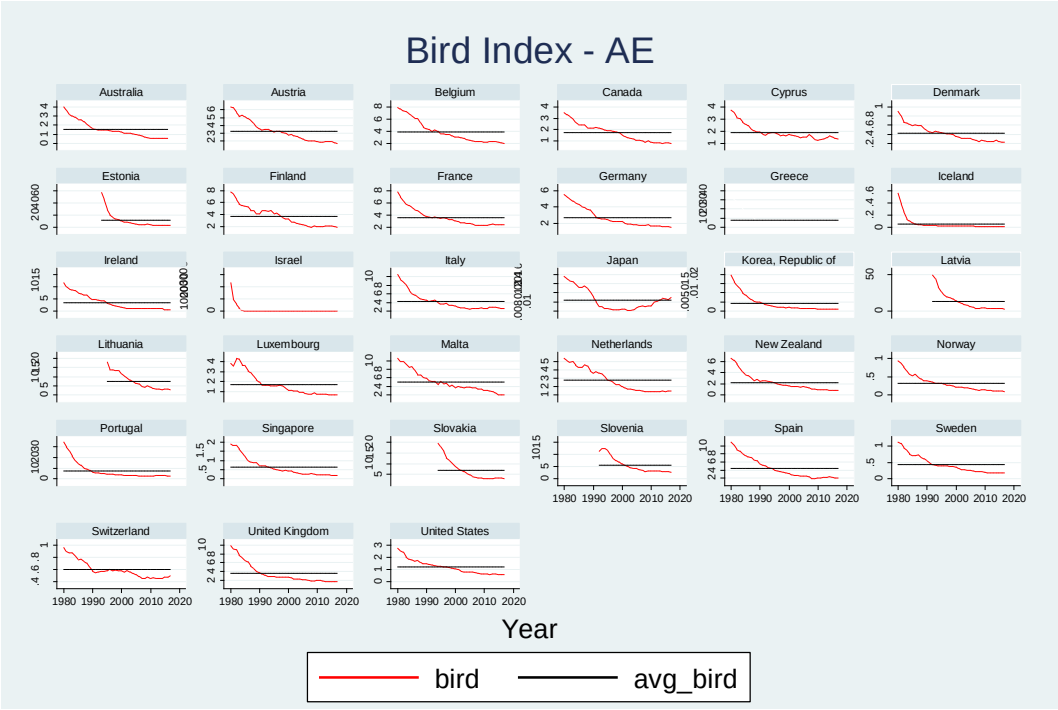
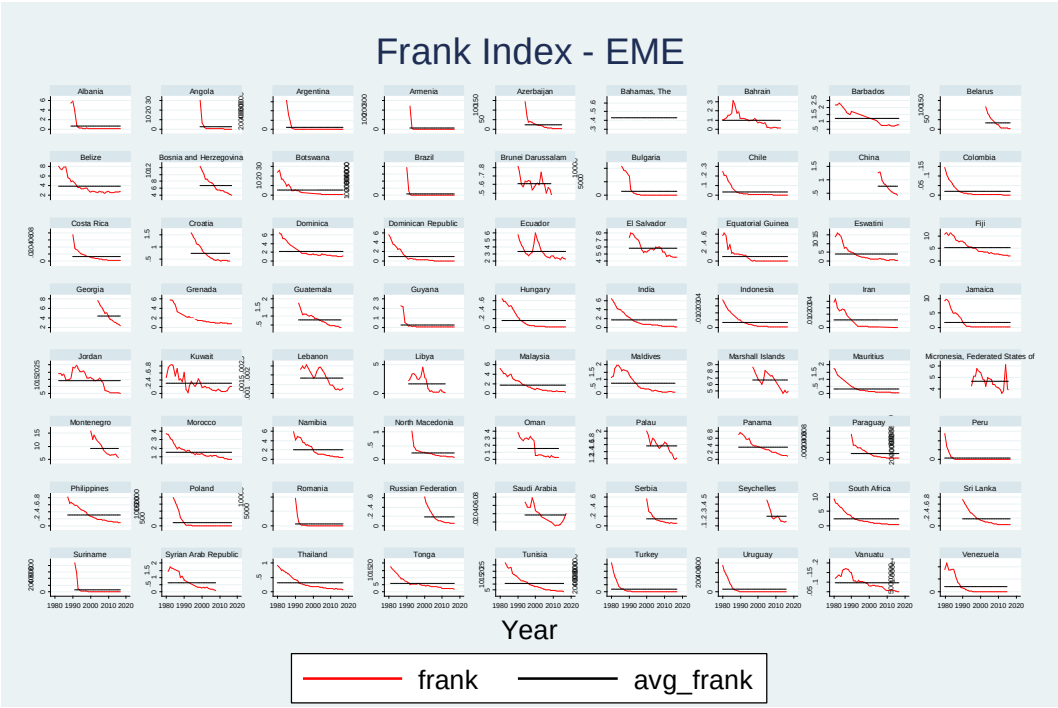


Figure A2. Country-time evolution of Frank´s and Bird´s Index, Emerging Market Economies



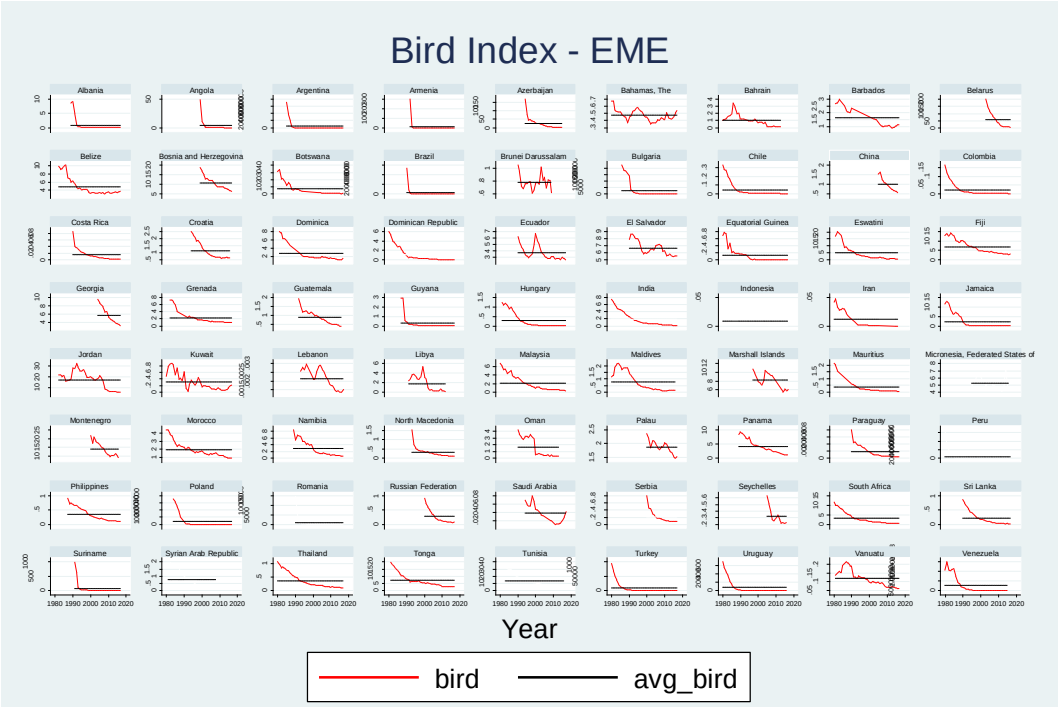
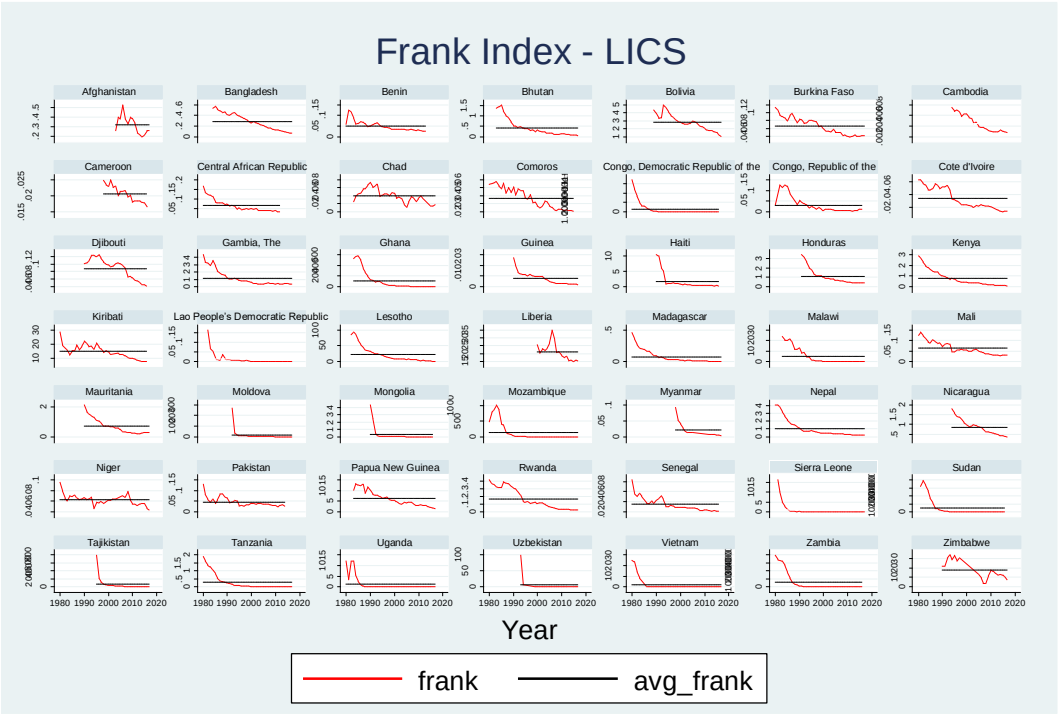


Figure A3. Country-time evolution of Frank´s and Bird´s Index, Low Income Countries



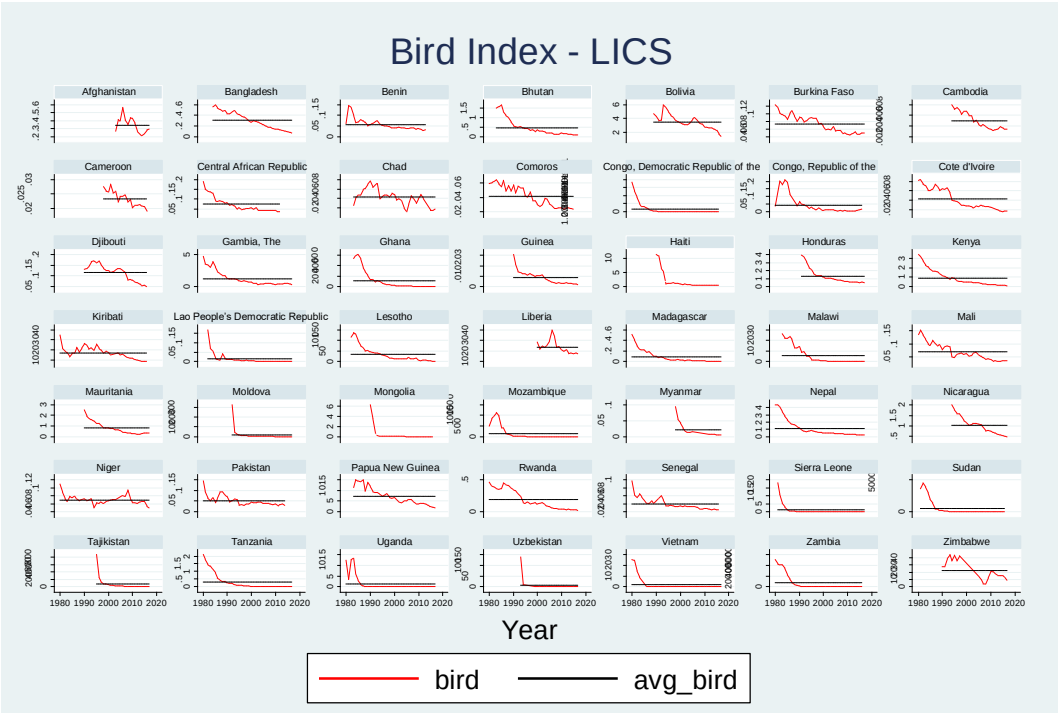
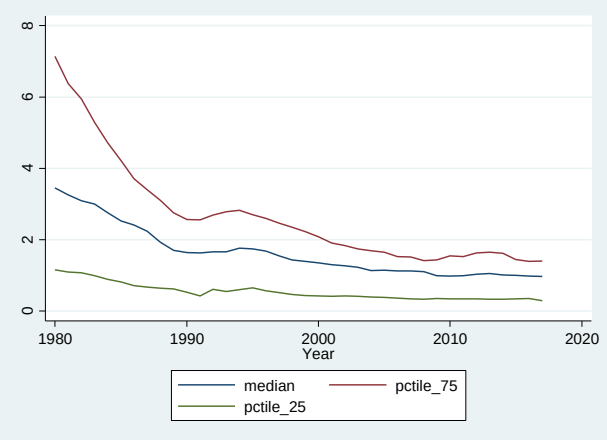
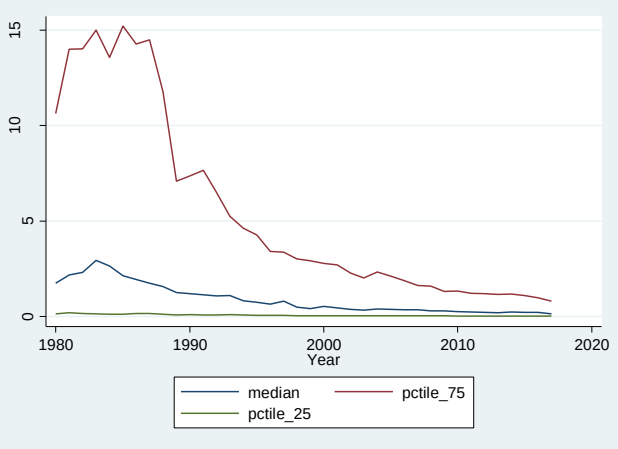


Figure A4. Evolution of Frank and Bird Indices over time, by income group

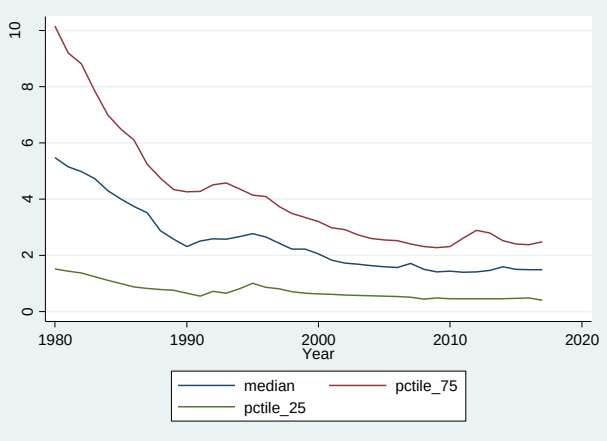
Frank Index
Advanced Economies



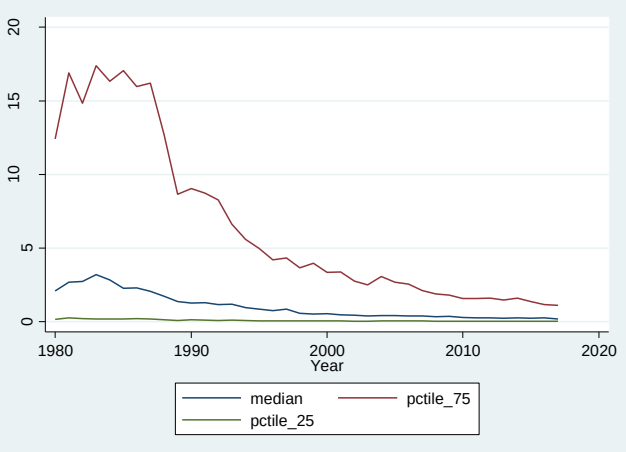
Frank Index
Developing Economies



Bird Index
Advanced Economies



Bird Index
Developing Economies



Note: Interquartile range, plotting the median and first and third quartile of the respective distribution.

Table A1 Literature review

This table presents the main literature on tax efforts. In the tax effort calculations: T stands for taxes, and Y stands for GDP. IT is total income tax revenue.
GDI stands for Gross Domestic Income. GDP stands for Gross Domestic Product. Openness economy is calculated as the sum of exports and imports divided by tGDP. Corruption is an index measured by the World Bank (ranging from 0 – worst, to 100 – best). Voice and Accountability is an index which is measured by the World Bank, which considers perception of democracy, freedom of expression, association, and media (ranging from 0 – worst, to 100 – best).

Author	Country/Region	Period	Methodology	Dependent variables	Explanatory variables	Main conclusions
Frank (1959)	US	1953-1957	Frank index	Frank index (tax effort)	▪ Per capita taxes ▪ Tax as % of GDP ▪ Tax revenues ▪ GDP ▪ GDP per capita	▪ Methodology used to understand the main determinants of tax effort ▪ Compares tax effort across different States
Bird (1964)	US, Canada, Europe and Latin America	1962	Bird index	Bird index (tax effort)	▪ Tax revenues ▪ GDP per capita ▪ GDI	▪ Low-income countries tend to have higher tax effort ▪ More robust results than the Frank index, by using GDI instead of GDP
Lotz & Morss (1967)	72 countries		Lotz-Morss equation	Tax capacity	▪ GDI ▪ GDI per capita ▪ Economy openness	▪ Low-income countries tend to have higher tax effort ▪ Tax capacity limits tax revenue in low income countries
Tanzi (1968)	US, Canada and Europe	1963-1965	Tanzi equation	Tax effort $(\frac{IT}{Y'} = f(Y''))$	▪ Tax revenue ▪ Personal income (Y') ▪ Personal income per capita (Y'')	▪ Compares the tax effort of other countries with the US
Bahl (1971)	49 low-income countries	1966-1968	OLS	Tax effort $(\frac{T}{Y})$	▪ Agriculture and mining as % of GDP ▪ Exports/Imports ▪ GDP	▪ A greater share of agriculture in GDP reduces tax capacity, as opposed to mining
Chelliah et al. (1975)	47 low-income countries	1969-1971	Linear regressions	Tax effort	▪ GDI per capita ▪ Economy openness ▪ Agriculture and mining as % of GDP	▪ Despite the general increase in tax ratios in developing countries, the average level of taxation is still lower than that in developed countries ▪ The differences between developing and developed countries are more significant if total taxes are defined with the inclusion of social security contributions.

Berry & Fording (1997)	US (State level)	1960-1991	Time series regressions	Tax effort index: $\frac{T}{T_{potential}}$	▪ GDI ▪ GDI per capita	▪ A change in the index over time indicates a difference in the State tax effort in relation to the national effort
Rivero et al. (2001)	14 EU countries	1967-1995	Convergence of tax effort in EU	Tax effort (β convergence): $[\beta = \frac{1}{T} \log(\frac{\beta_t}{\beta_0})]$	▪ Tax revenues as % of GDP ▪ Population ▪ GDP	▪ Considerable convergence in the EU between 1967-1974, but lower convergence between 1984-1995 (with a divergence between 1974-1984) ▪ This tax convergence contributed to better monetary integration
Piancastelli (2001)	75 countries	1985-1995	Stochastic model	Tax effort $(\frac{T}{Y})$ Also uses Lotz-Morss and Tanzi equations	▪ GDI per capita ▪ Economy openness ▪ Industry as % GDP ▪ Agriculture and mining as % of GDP ▪ Degree of literacy	▪ Both GDP per capita and trade increase tax effort ▪ Agriculture share increases tax effort in medium and low-income countries
Mertens (2003)	10 Central and Eastern European (CEE)	1992-2000	OLS	Tax effort $(\frac{T}{Y})$ Also uses Lotz-Morss and Tanzi equations	▪ Industry as % GDP ▪ Agriculture and mining as % of GDP ▪ Imports as % of GDP	▪ Substantial variations in tax effort among CEE countries ▪ Agriculture share increases tax effort
Gupta (2007)	105 countries	1980-2004	OLS fixed effects and endogeneity models	Tax revenues as a % of GDP	▪ GDP per capita ▪ Economy openness ▪ Foreign aid ▪ Corruption ▪ Agriculture and mining as % of GDP	▪ Several factors increase revenues: GDP growth, the share of agriculture in GDP, and trade openness along with foreign aid. ▪ Several institutional factors decrease revenues potential: more corruption and political instability. ▪ Countries that depend on taxing goods and services as their primary source of tax revenue tend to have poorer revenue performance. ▪ Countries perform better which place greater emphasis on taxing income, profits, and capital gains
Bird et al. (2008)	121 countries	1998-2000	OLS 2SLS	Tax share as % of GDP	▪ GDP per capita ▪ Population growth ▪ Economy openness ▪ Corruption ▪ Voice and accountability ▪ Agriculture and mining as % of GDP	▪ Better institutions improve tax performance ▪ Tax effort is determine to a significant extent by extending the conventional model of tax effort by showing that not only do supply factors matter, but also that demand factors such as corruption, voice and accountability are also important

Fenochietto & Pessino (2013)	96 countries	1991-2006	Stochastic Frontier Models	Ratio between actual revenue and tax capacity	▪ GDP per capita ▪ Economy openness ▪ Income distribution ▪ Inflation ▪ Levels of education ▪ Corruption ▪ Agriculture and mining as % of GDP	▪ Countries should analyse the efficiency of their tax effort before implementing new taxes or increasing the rate of the existing ones ▪ A positive and significant relationship exists between tax revenue as a percentage of GDP and the level of development (per capita GDP), trade (imports and exports as percentage of GDP), and education (public expenditure on education as a percent of GDP). ▪ A negative relationship exists between tax revenue as a percentage of GDP and inflation (CPI), income distribution (GINI coefficient), the ease of tax collection (agricultural sector value-added as a percentage of GDP), and corruption.

Table A2 Main drivers of tax effort

This table presents the main drivers of tax effort in the literature. In the results on tax effort, the "+"signal indicates that the variable increases the tax effort, the "-" signal shows that the variable reduces the tax effort, "n.s" means that the variable is not significant, and "n.a" indicates that the variable was used to calculate the tax effort, but no specific result regarding the variable was obtained.

Main driver	Authors	Results on tax effort (+/-; n.s; n.a)	Main findings
Economic determinants			
GDP	Frank (1959)	+	▪ More developed countries have higher tax revenues, mainly due to large expenditures on social functions ▪ More developed countries tend to have a higher tax effort Nevertheless, more-developed countries also have more tax capacity than less-developed ones, which can reduce the effect on tax effort
	Balh (1971)	+	
	Rivero (2001)	n.a	
GDP per capita	Frank (1959)	+	
	Bird (1964)	+	
	Gupta (2007)	+	
	Bird et al. (2008)	-	
	Fenochietto & Pessino (2013)	+	
GDI	Bird (1959)	+	
	Lotz & Morss (1967)	+	
	Berry & Fording (1997)	n.a	
GDI per capita	Lotz & Morss (1967)	+	
	Chelliah et al. (1975)	+	
	Berry & Fording (1997)	n.a	
	Piancastelli (2001)	+	
Personal income (total & per capita)	Tanzi (1968)	n.a	
Fiscal determinants			
Per capita tax	Frank (1959)	+	A higher level of tax revenues naturally leads to an increase in tax effort, although tax capacity can mitigate tax effect
Tax % GDP	Frank (1959)	+	
	Rivero (2001)	n.a	
Tax revenues	Frank (1959)	+	
	Bird (1964)	+	
	Tanzi (1968)	n.a	
Other determinants (open economy, structural and political)			
Openness economy	Lotz & Morss (1967)	-	A more-open economy (i.e., more exports and imports as a % of GDP) tends to have less tax effort. However, some studies show the opposite effect, mainly due to taxes on imports
	Balh (1971)	-	
	Chelliah et al. (1975)	-	
	Piancastelli (2001)	+	
	Mertens (2003)	-	
	Gupta (2007)	+	
	Bird et al. (2008)	-	
	Fenochietto & Pessino (2013)	+	
Agriculture as % GDP	Balh (1971)	+	Studies are consensual that countries with a higher share of agriculture in GDP tend to have more tax effort This is mainly the effect of agriculture activities – particularly in less-developed countries – which tend to be more difficult to tax, leading to more tax effort in the other sectors
	Chelliah et al. (1975)	+	
	Piancastelli (2001)	+	
	Mertens (2003)	+	
	Gupta (2007)	+	
	Bird et al. (2008)	+	
	Fenochietto & Pessino (2013)	+	
Institutional environment	Gupta (2007)	-	A better institutional environment – with low corruption and a better rule of law – tends to reduce tax evasion, which leads to less tax effort
	Bird et al. (2008)	-	
	Fenochietto & Pessino (2013)	-	

Table A3: Factor Loadings and Uniqueness

Variables	Factors			Uniqueness
	proximity	strength	accountability	
Longer length of time of party in office	0.84			0.28
Higher number of years available for the Chief Executive in office	0.84			0.29
Years left in the current term	0.02			0.48
Margin of majority		0.88		0.21
Executive control of all houses		0.86		0.25
Government voting share		0.32		0.89
government number of seats		0.71		0.49
Voice and accountability			0.95	0.08
Regulatory quality			0.97	0.07
Government effectiveness			0.96	0.09
Control of corruption			0.87	0.24
% explained	**0.60**	**0.53**	**0.88**	