WORLD BANK GROUP

FISCAL POLICY

ESTIMATING TAX POTENTIAL: METHODS & INTERPRETATION

Dr. Kyle McNabb
Global Fiscal Policy Unit (EMFTX)
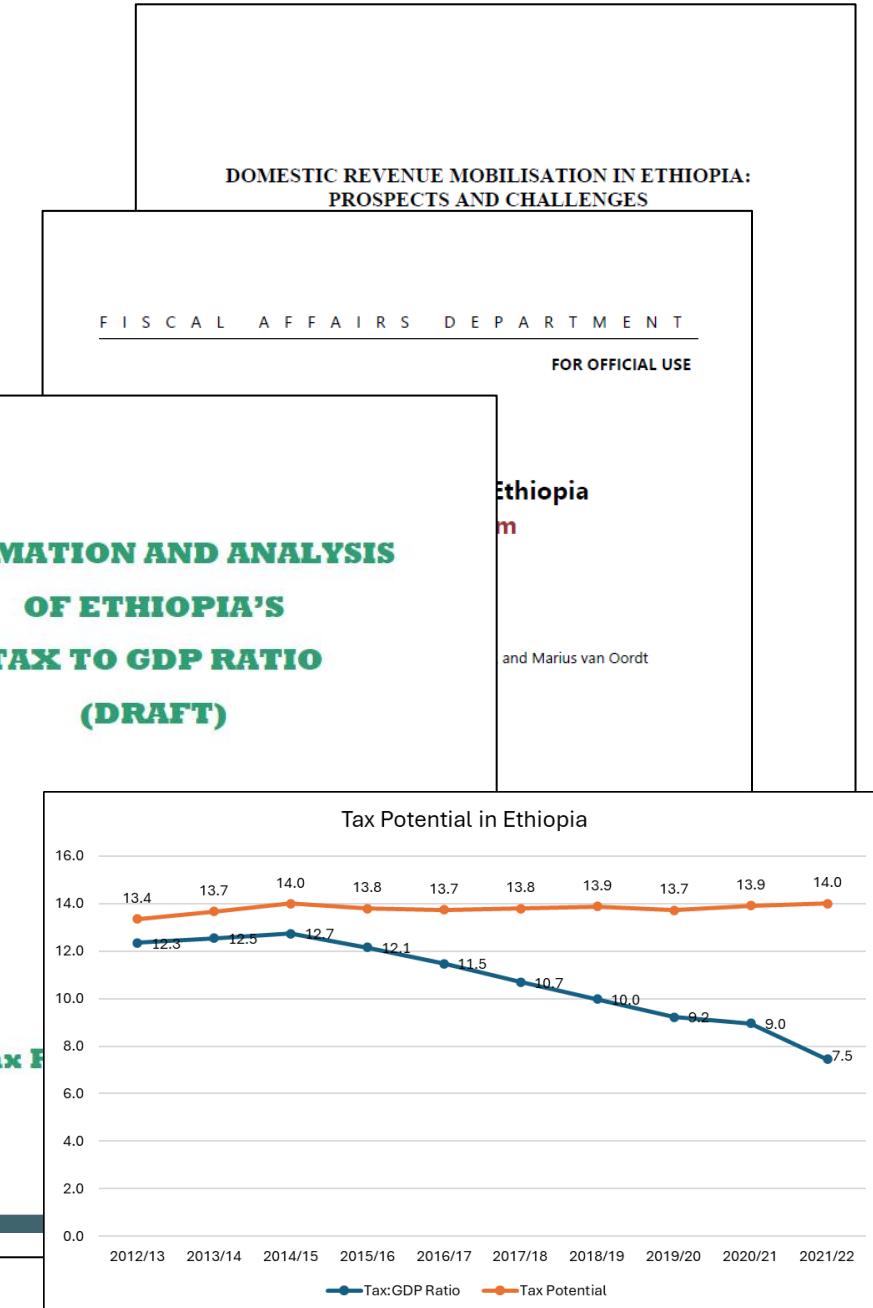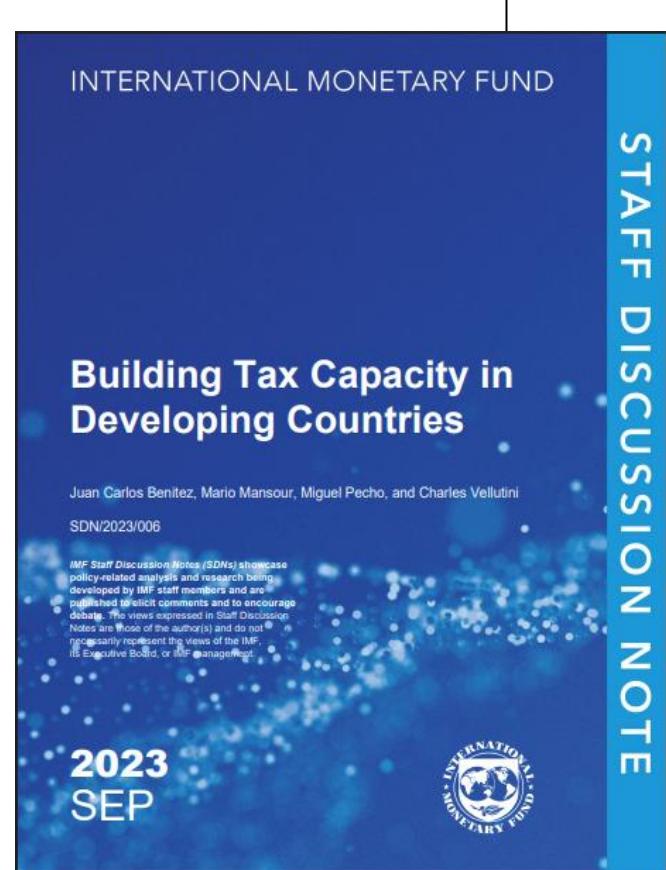April 2025

CONTENTS

- Introduction
  - Overview – recent studies

- Measuring Tax Effort (Potential)
  - Methods
  - Concepts and Terminology
  - Interpretation, Limitations

- Results and discussion of recent studies
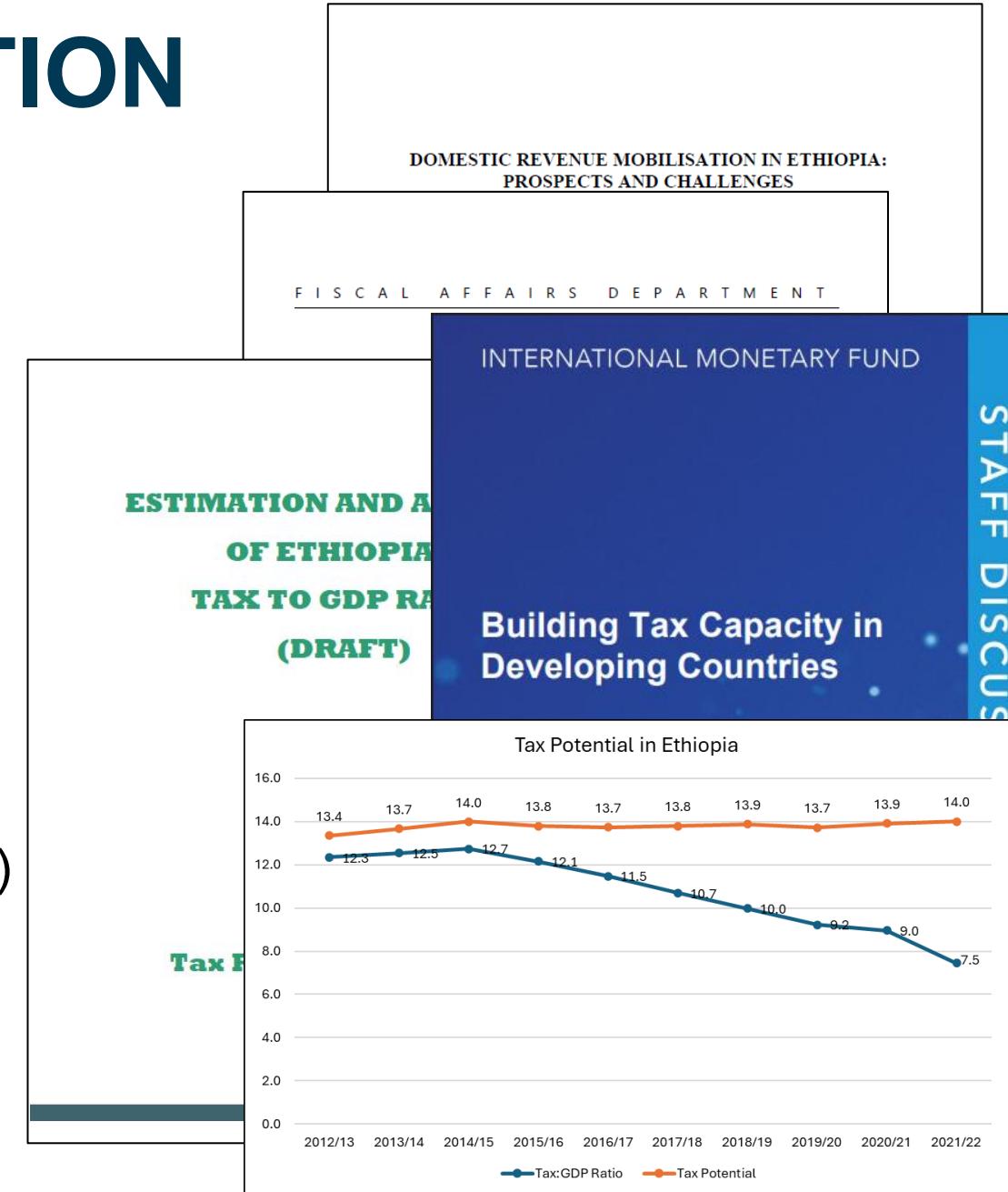
OVERVIEW / INTRODUCTION

- A number of recent studies project or estimate potential tax-to-GDP for Ethiopia…

OVERVIEW / INTRODUCTION

- Recent studies or projections of tax potential in Ethiopia

- Each provides different estimates…

- 2017: study: 20.9% of GDP (2022-23)(Gap of 14.6%)
- 2019: IMF: 19.9% of GDP (2018-19) (Gap of 9.6%)
- 2023: IMF: 11% of GDP (Gap of 3.7%)
- 2025: MoF/Taxdev: 11% of GDP (2022-23) (Gap of 3.5%)
- 2025: World Bank: 14% of GDP (2021/22) (Gap of 6.5%)

DOMESTIC REVENUE MOBILISATION IN ETHIOPIA:
PROSPECTS AND CHALLENGES

FISCAL AFFAIRS DEPARTMENT

ESTIMATION AND A...
OF ETHIOPIA...
TAX TO GDP RA...
(DRAFT)

Tax P...

INTERNATIONAL MONETARY FUND

STAFF DISCUS...

Building Tax Capacity in Developing Countries

Tax Potential in Ethiopia

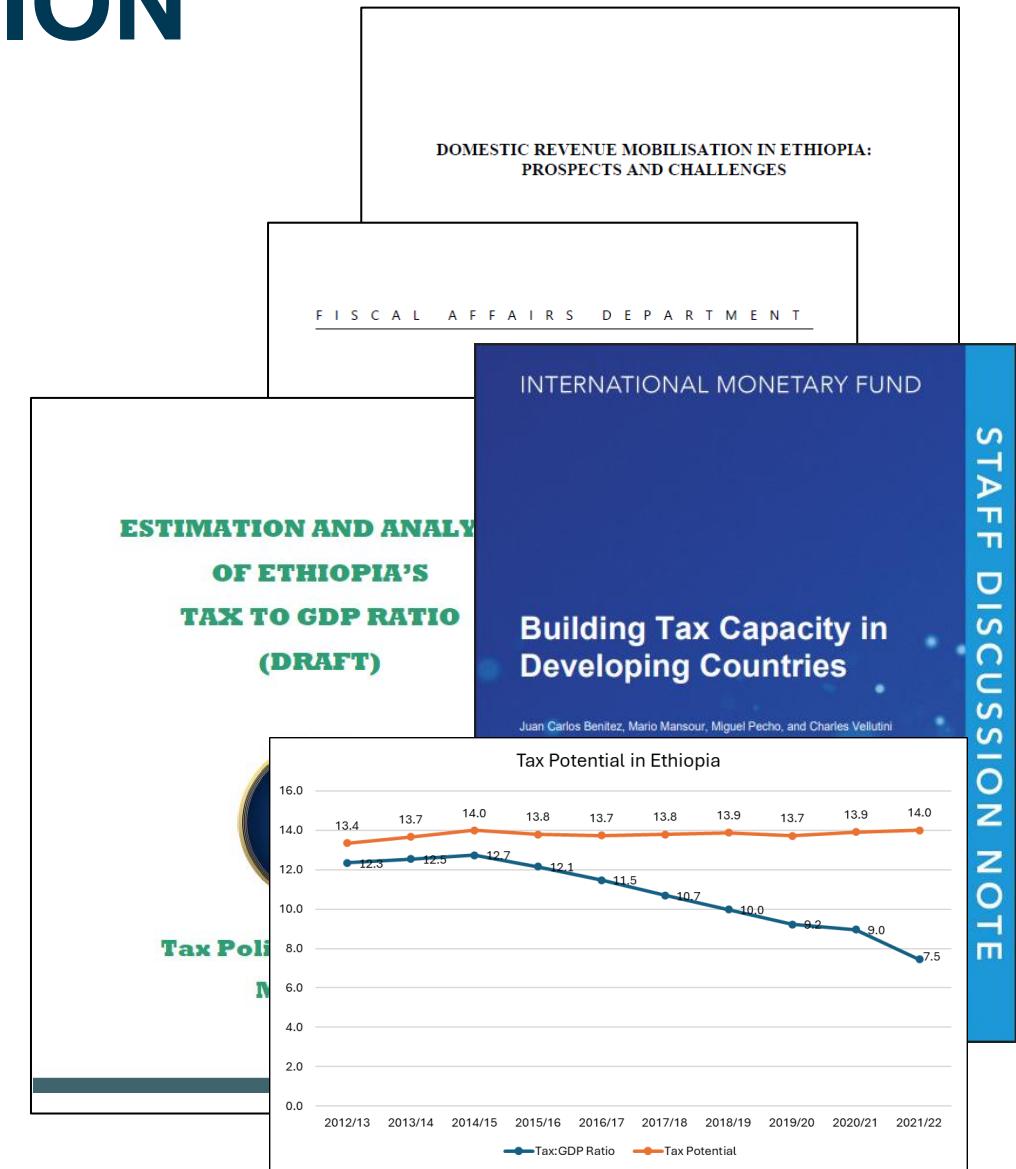| Year	Tax:GDP Ratio	Tax Potential
2012/13	12.3	13.4
2013/14	12.5	13.7
2014/15	12.7	14.0
2015/16	12.1	13.8
2016/17	11.5	13.7
2017/18	10.7	13.8
2018/19	10.0	13.9
2019/20	9.2	13.7
2020/21	9.0	13.9
2021/22	7.5	14.0

SO, WHICH ESTIMATE IS CORRECT?

OVERVIEW / INTRODUCTION

- It's important to consider… (e.g.),

- Different methodologies
  - ARMA time-series forecasting, Stochastic Frontier Analysis, Random-Forest modelling

- Different times
  - *A lot has changed since 2017*. Ethiopia's tax:GDP ratio has fallen and thus, the basis on which projections are made is different (later studies more conservative…)

  - In addition, in the past, there were very different beliefs about how revenue collection would evolve in Ethiopia – e.g., from the IMF's WEO…

DOMESTIC REVENUE MOBILISATION IN ETHIOPIA: PROSPECTS AND CHALLENGES

FISCAL AFFAIRS DEPARTMENT

INTERNATIONAL MONETARY FUND

ESTIMATION AND ANALY OF ETHIOPIA'S TAX TO GDP RATIO (DRAFT)

Building Tax Capacity in Developing Countries

Juan Carlos Benitez, Mario Mansour, Miguel Pecho, and Charles Vellutini

STAFF DISCUSSION NOTE

Tax Poli

Tax Potential in Ethiopia

	Tax:GDP Ratio	Tax Potential
2012/13	12.3	13.4
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REVENUE FORECASTS / PREDICTIONS FROM IMF SINCE 2012

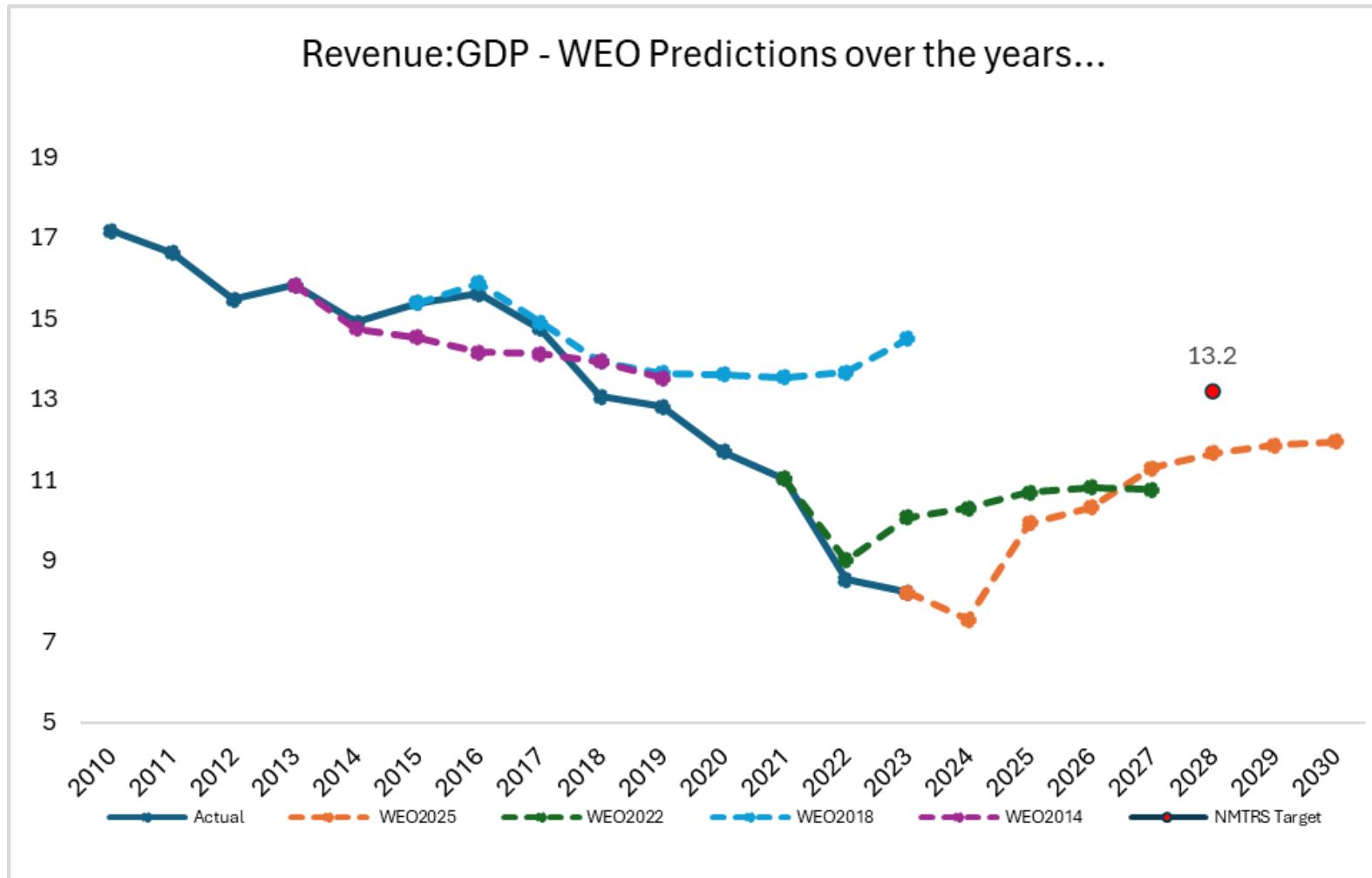
Revenue:GDP - WEO Predictions over the years...
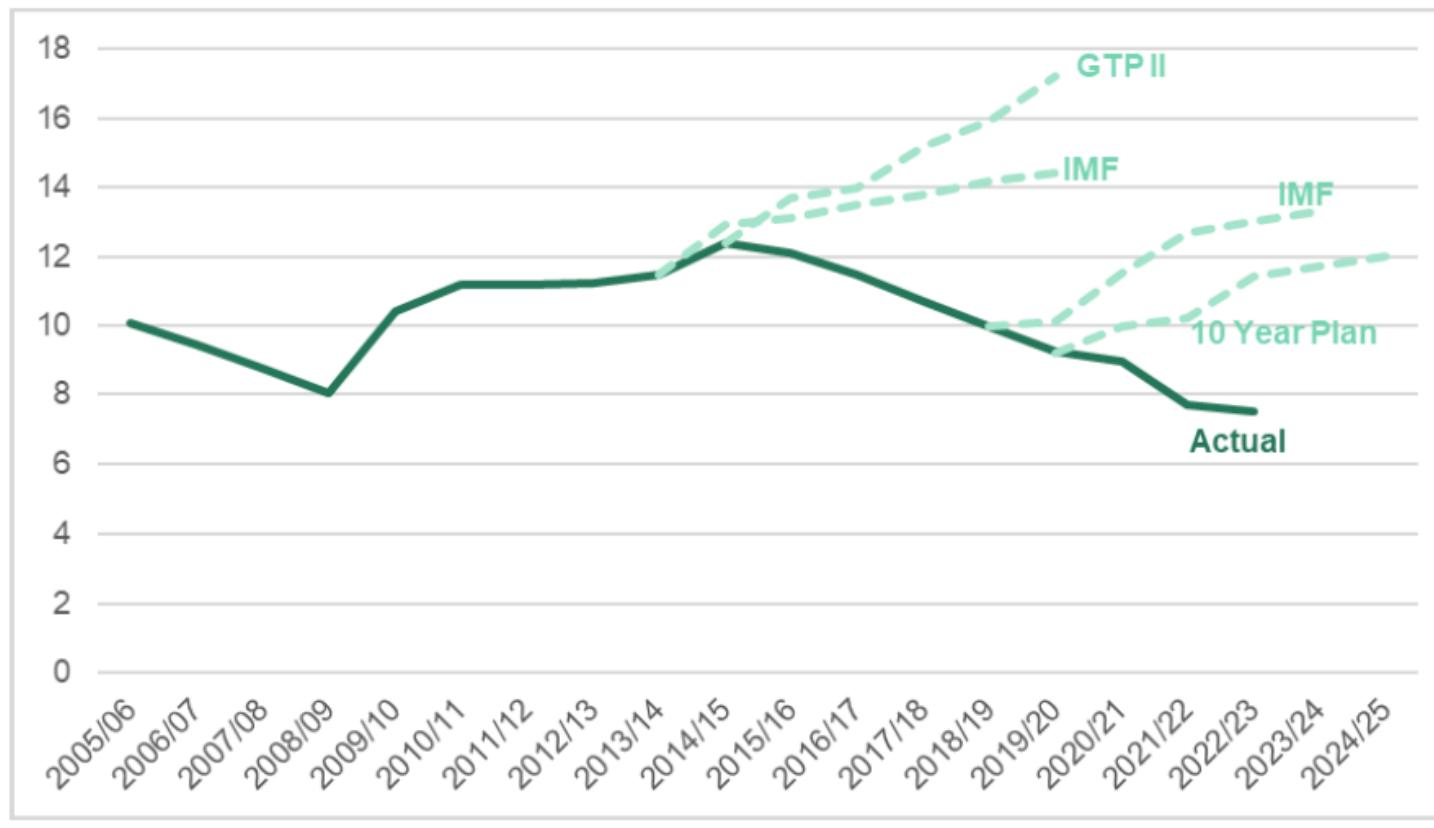
Chart shows Total Revenue to GDP (so includes Nontax)

Forecasts of future revenues rarely align with what happens in reality

NMTRS target of 13.2% of GDP by 2027/28 is ambitious, but importantly, it is backed by estimations of reforms to policy and administration.

We have seen similar predictions of tax:GDP…

REVENUE FORECASTS / PREDICTIONS FROM IMF SINCE 2012

Figure 1.1. The tax-to-GDP ratio and predictions in Ethiopia

Source: MoF & TaxDev report

We have seen similar predictions of **tax:GDP**

← From the MoF & TaxDev report

FROM PROJECTIONS TO REALITY

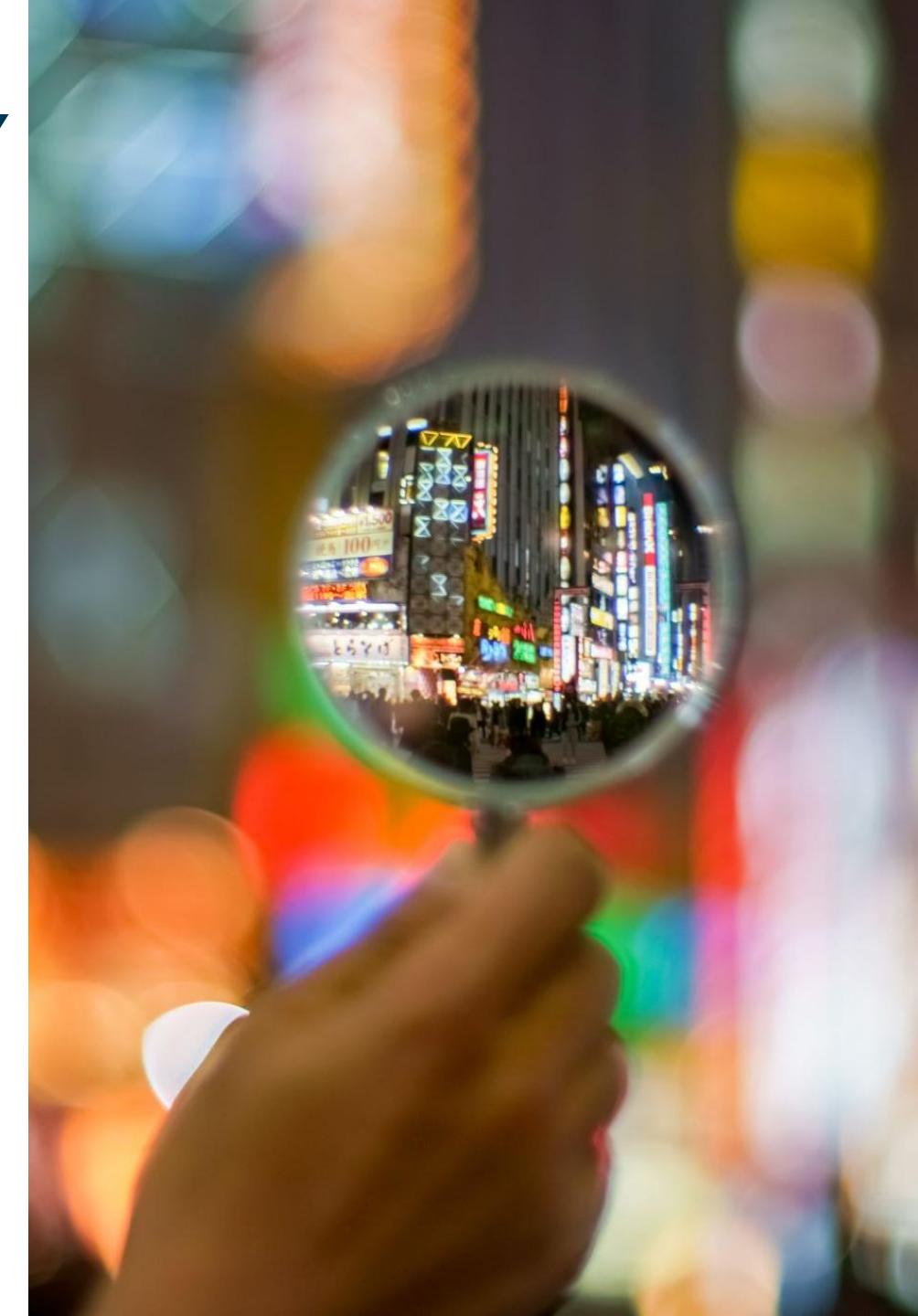Actual revenue performance often deviates from estimates or forecasts.

Forecasts (e.g., IMF) are often based on assumptions over
- How the economy will evolve in future (growth, inflation, etc.)

- Which tax policy and admin measures will be implemented.

Typically, forecasts do not (cannot!) account for shocks (pandemics, conflict, political etc.) which can affect tax collections.

Models of tax potential are typically backward looking and don't provide many clues regarding *how* to close the tax gap.
- This is where more in-depth study is vital

MEASURING TAX EFFORT: METHODS

CONCEPTS

Tax *Potential* Potential tax collections (% GDP), typically estimated as a function of a country's characteristics (economic, social, governance etc.)

Tax *Gap* Difference between current collections and tax potential (% GDP)

Tax *Effort* Current tax collection, as % of tax potential

Tax *Ratio* Current tax collection, as % of GDP

Consider an example:
The tax *gap* is 5%; tax *potential* is 20%; tax *effort* is 0.75; and tax *ratio* is 15%.

CONCEPTS

Consider an example:
The tax *gap* is 5%; tax *potential* is 20%; tax *effort* is 0.75; and tax *ratio* is 15%.

How are these concepts related?

$$\frac{\text{Tax } \textit{Ratio}}{\text{Tax } \textit{Effort}} = \text{Tax } \textit{Potential}$$

$$\frac{15\%}{0.75} = 20\%$$

CONCEPTS

Consider an example:
The tax *gap* is 5%; tax *potential* is 20%; tax *effort* is 0.75; and tax *ratio* is 15%.

How are these concepts related?

Tax *Gap* = Tax *Potential* - Tax *Ratio*

5% = 20% - 15%

CONCEPTS

Consider an example:
The tax *gap* is 5%; tax *potential* is 20%; tax *effort* is 0.75; and tax *ratio* is 15%.

How are these concepts related?

Tax *Gap* = Tax *Potential* - Tax *Ratio*

5% = 20% - 15%

But estimation of Tax *Effort* is often a key first step before the other concepts

Tax Potential is a function of tax effort, so we will focus on understanding estimation of tax effort

MEASURING TAX POTENTIAL / EFFORT: METHODS

- Economists have been trying to do this since at least the 1950s (Oshima, 1957)

- Gained a lot of momentum in the 1970s at IMF (IMF 1971, 1975, 1979)

- By 1980s, the determinants of the tax ratio were often estimated as a function of economic variables like **GDP per capita**, **trade openness**, **size of the agriculture sector (or structure of the economy).**

- Typically, this was estimated by, for example, OLS regression. E.g.,
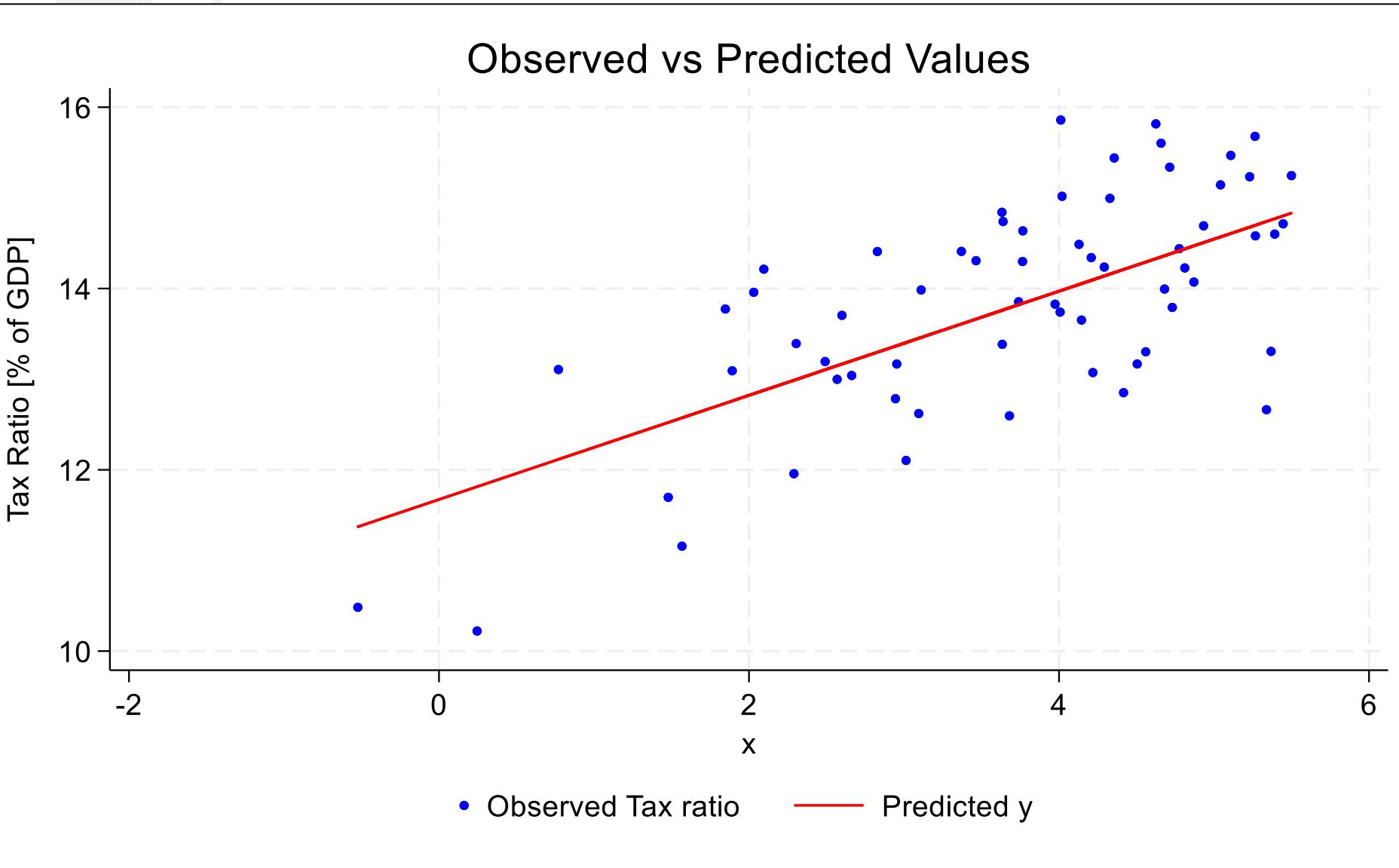
$$Y \; = \; a + \beta X + \varepsilon$$

- Where **Y** = Tax/GDP ratio; **X** is a vector of explanatory factors (GDP, trade, economic structure etc.)

MEASURING TAX POTENTIAL / EFFORT: METHODS

- The OLS approach merely showed *which* factors were statistically significant determinants of tax-to-GDP.

- However, important results emerged: from this literature we observed the statistical relationships between GDP and tax collection, economic structure (agriculture) etc. **These important stylized facts still hold true today.**

- Later, researchers began to estimate tax effort by studying the predicted values of the tax ratio, following the OLS regression

- This is the "traditional regression approach"

MEASURING TAX EFFORT: METHODS

Observed vs Predicted Values

- Typical plot of predicted (fitted) values following an OLS regression

- Each point represents a country, the line represents prediction of tax:GDP

- Zoom in to see how this was/is used to estimate tax effort and potential
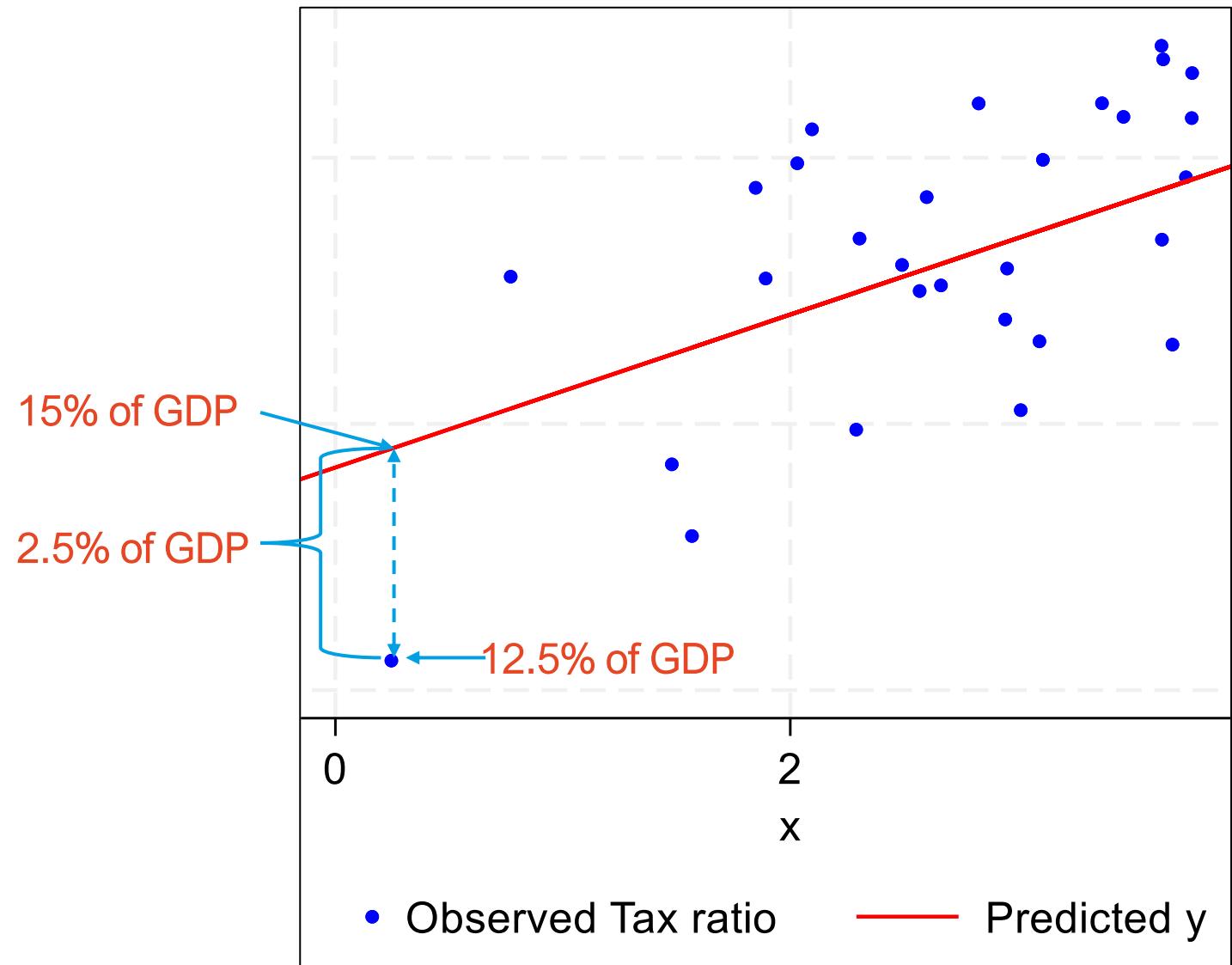
MEASURING TAX EFFORT: METHODS

Let's add some numbers…

So, tax effort would be:

(Tax Ratio / Tax Potential)

(12.5% / 15%) = 0.83

The 'tax gap' is equal to the residual from the regression

However, there are some limitations with the 'traditional' OLS approach

15% of GDP

2.5% of GDP

12.5% of GDP

0

2

x

• Observed Tax ratio ⎯⎯ Predicted y

However, there are some limitations with the 'traditional' OLS approach
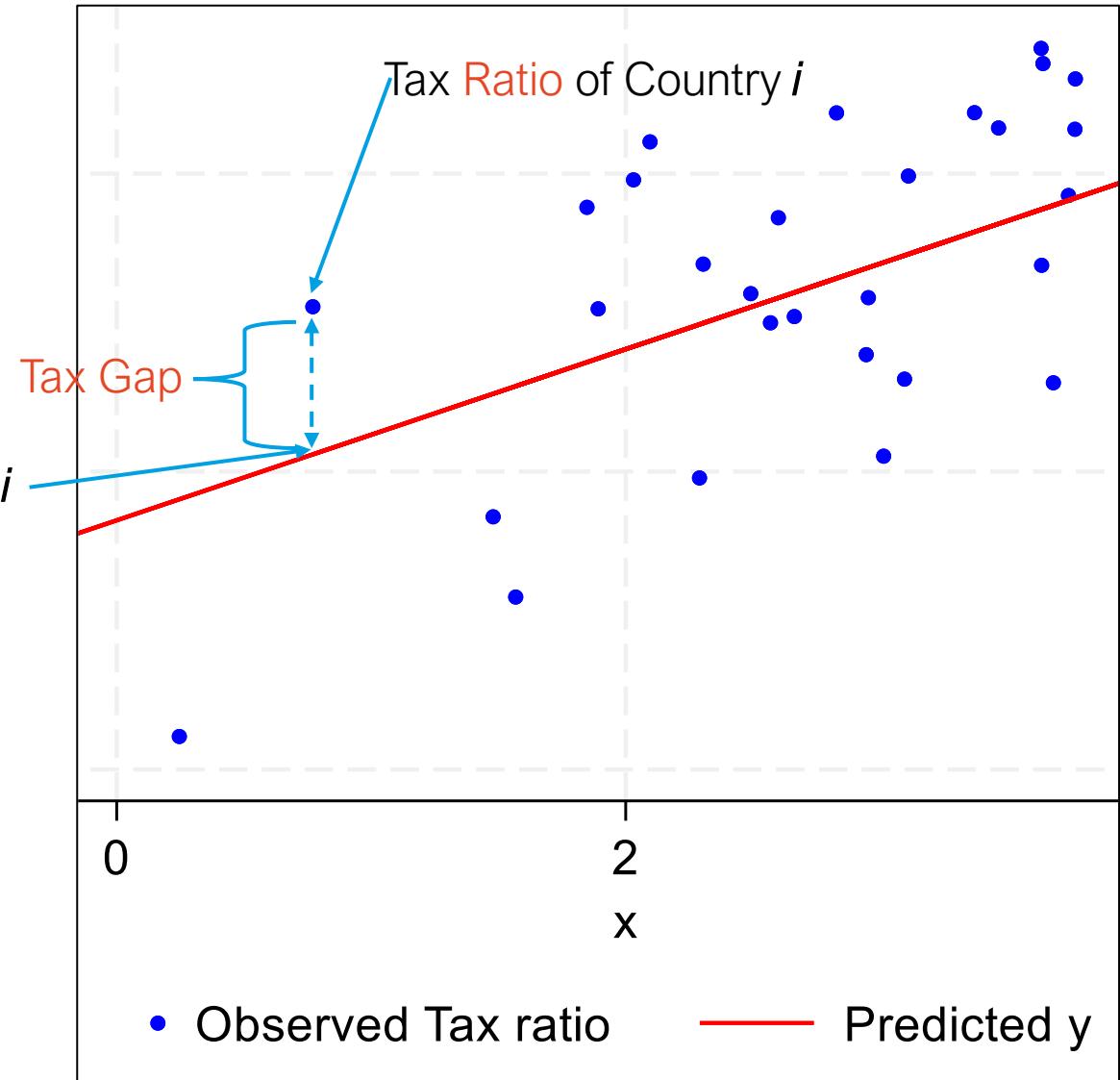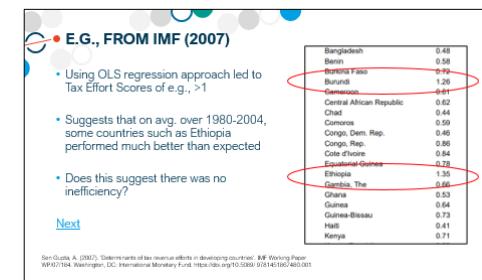
Many observations (countries) in the sample will have a tax potential below their actual collections.

Tax effort will be >1

Question: is it useful to say that your tax effort is 1.3? Or 1.8?

Ranking & looking for outliers can be insightful…

But focus on absolute values is of limited use

E.G., FROM IMF (2007)

- Using OLS regression approach led to Tax Effort Scores of e.g., >1

- Suggests that on avg. over 1980-2004, some countries such as Ethiopia performed much better than expected

- Does this suggest there was no inefficiency?

Next

Bangladesh	0.48
Benin	0.58
Burkina Faso	0.72
Burundi	1.26
Cameroon	0.61
Central African Republic	0.62
Chad	0.44
Comoros	0.59
Congo, Dem. Rep.	0.46
Congo, Rep.	0.86
Cote d'Ivoire	0.84
Equatorial Guinea	0.78
Ethiopia	1.35
Gambia, The	0.66
Ghana	0.53
Guinea	0.64
Guinea-Bissau	0.73
Haiti	0.41
Kenya	0.71

Sen Gupta, A. (2007). 'Determinants of tax revenue efforts in developing countries'. IMF Working Paper WP/07/184. Washington, DC: International Monetary Fund. https://doi.org/10.5089/9781451867460.001

Tax Ratio of Country *i*

Tax Gap

Tax Potential of Country *i*

0   2

x

• Observed Tax ratio   ——— Predicted y

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MEASURING TAX EFFORT: METHODS

- Limitations such as this have led researchers to seek other methods to estimate tax effort.

- More recently (since around 2010), research has turned to estimate tax effort via 'Stochastic Frontier Analysis' (SFA)

- The estimated 'frontier' represents the *highest possible tax collection you can achieve from a given set of inputs*.

- In our context: given a country's economic/social/government factors, what is the 'best' or highest amount of tax it could collect?
    - E.g., two countries (A&B) are identical, size, economy, tax system etc. Tax:GDP in country A is 15%; in country B it is 20%. The difference is inefficiency in tax collection

MEASURING TAX EFFORT: METHODS

- Stochastic Frontier Analysis (equation):

$$Y_{it} = \alpha_i + \beta' X_{it} + \varepsilon_{it}$$

$$\varepsilon_{it} = v_{it} - u_{it}$$

Similar to the OLS regression equation, except the error term ε_{it} can be split into two components:
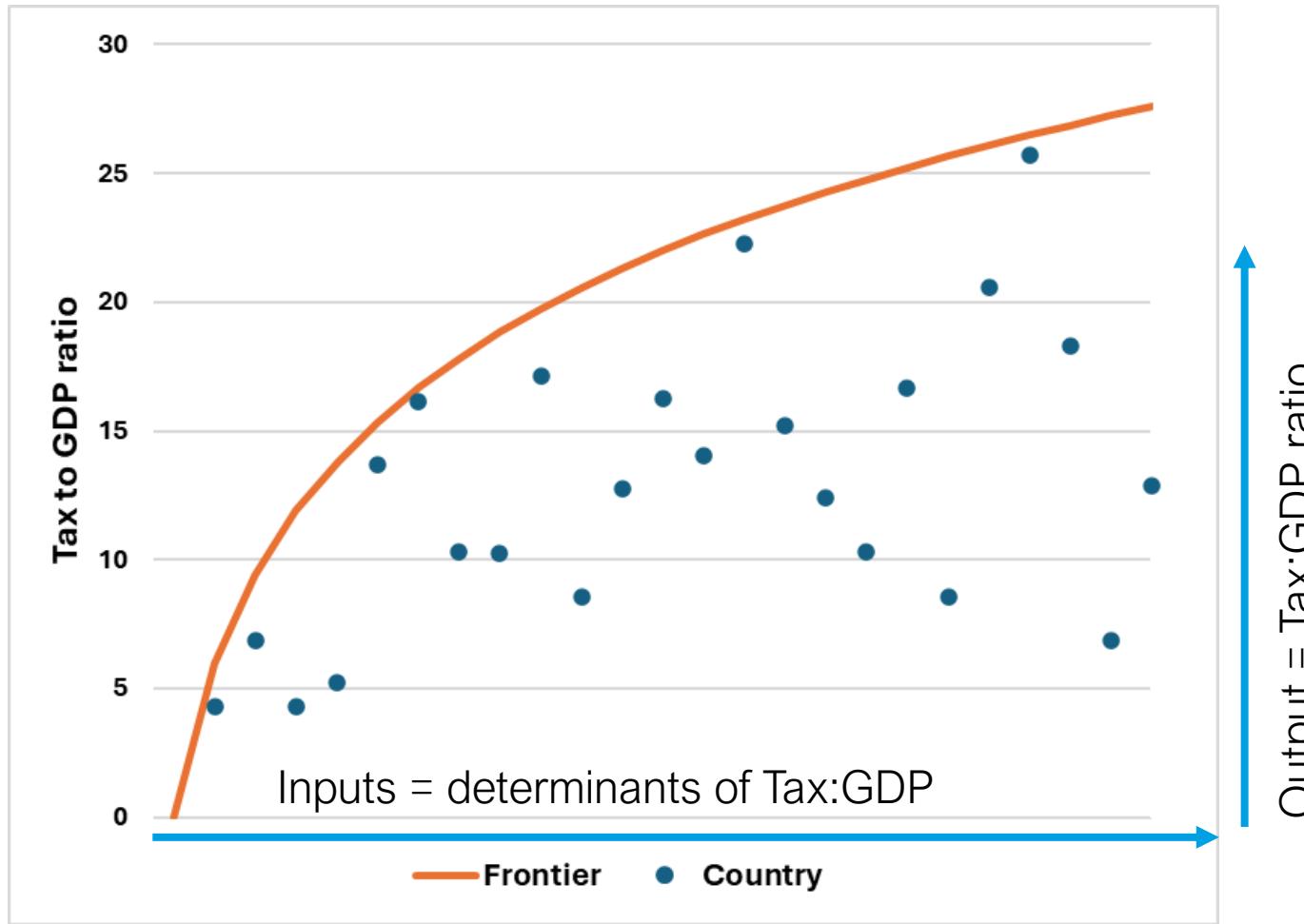
v_{it} is random error
u_{it} is inefficiency component.

SFA allows us to separately identify these – this is a key improvement over traditional / OLS methods. Utilized by recent World Bank, IMF studies.

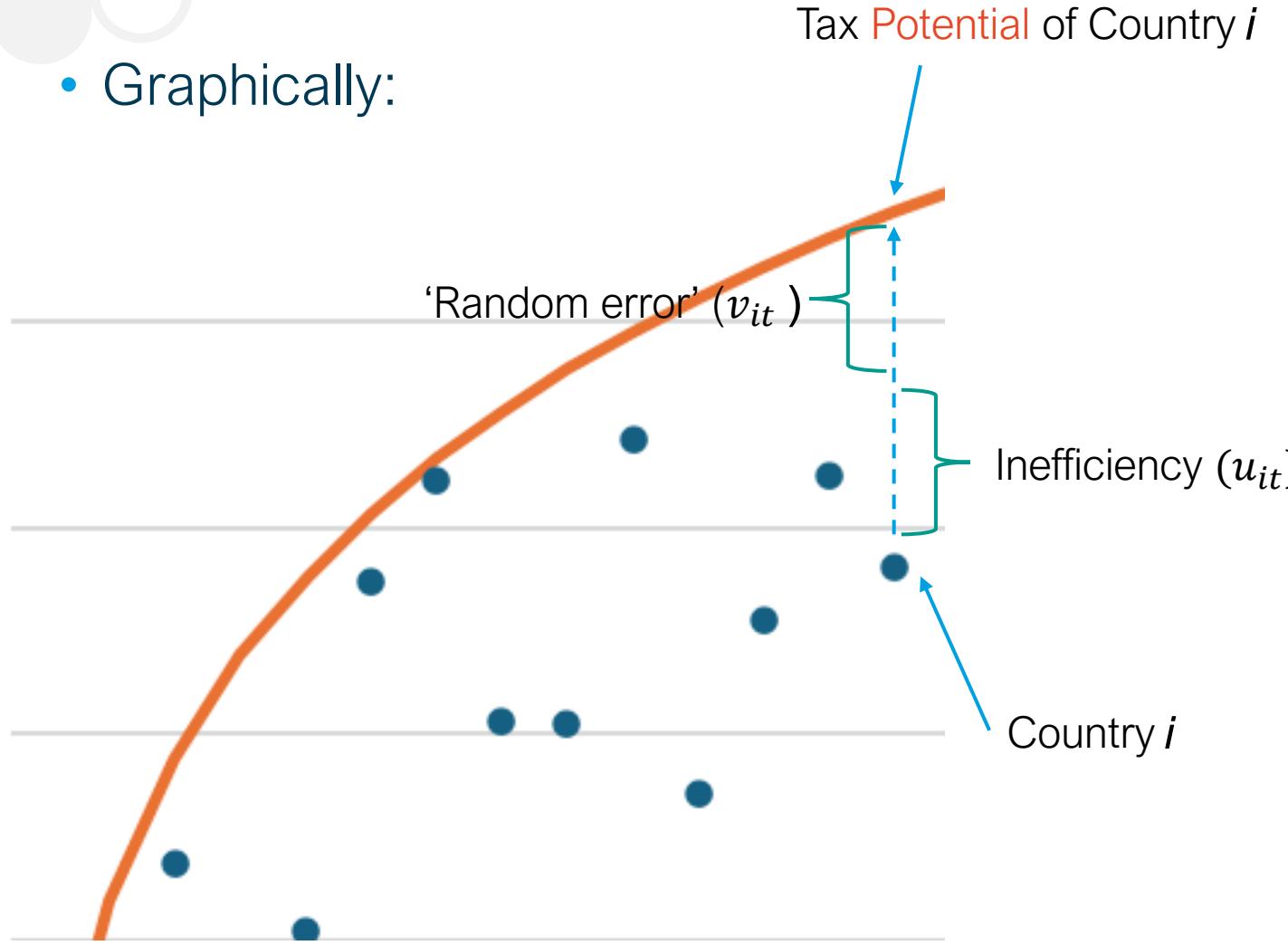# MEASURING TAX EFFORT: METHODS

- Graphically:

Let's zoom in again…

- Graphically:

Tax Potential of Country i

'Random error' (v_{it})

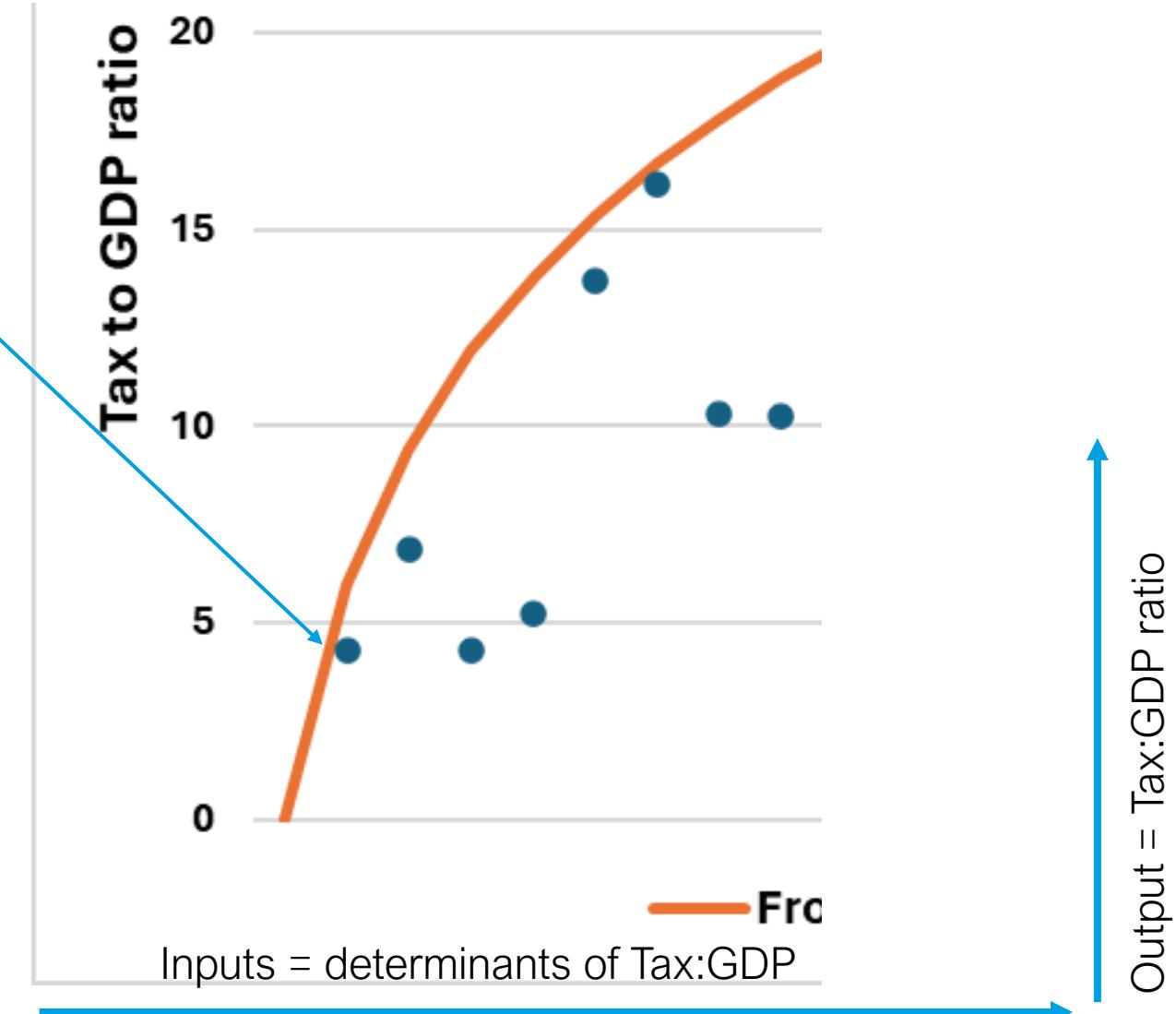Inefficiency (u_{it})

Country i

We are only interested in the size of the 'inefficiency' component, not the random noise

Regular regression models assume that residuals are random noise; but some of this is due to inefficiency.

Crucially, the SFA allows us to separate the error into the random noise component and the 'technical inefficiency', u_{it}

MEASURING TAX EFFORT: METHODS

- Graphically:

- It's possible to have a low tax-to-GDP ratio, but a high tax effort

- E.g., this country has 'low' input values (x-axis) but, *given these low input values*, it is collecting almost as much tax as it can (i.e., it's close to the frontier)

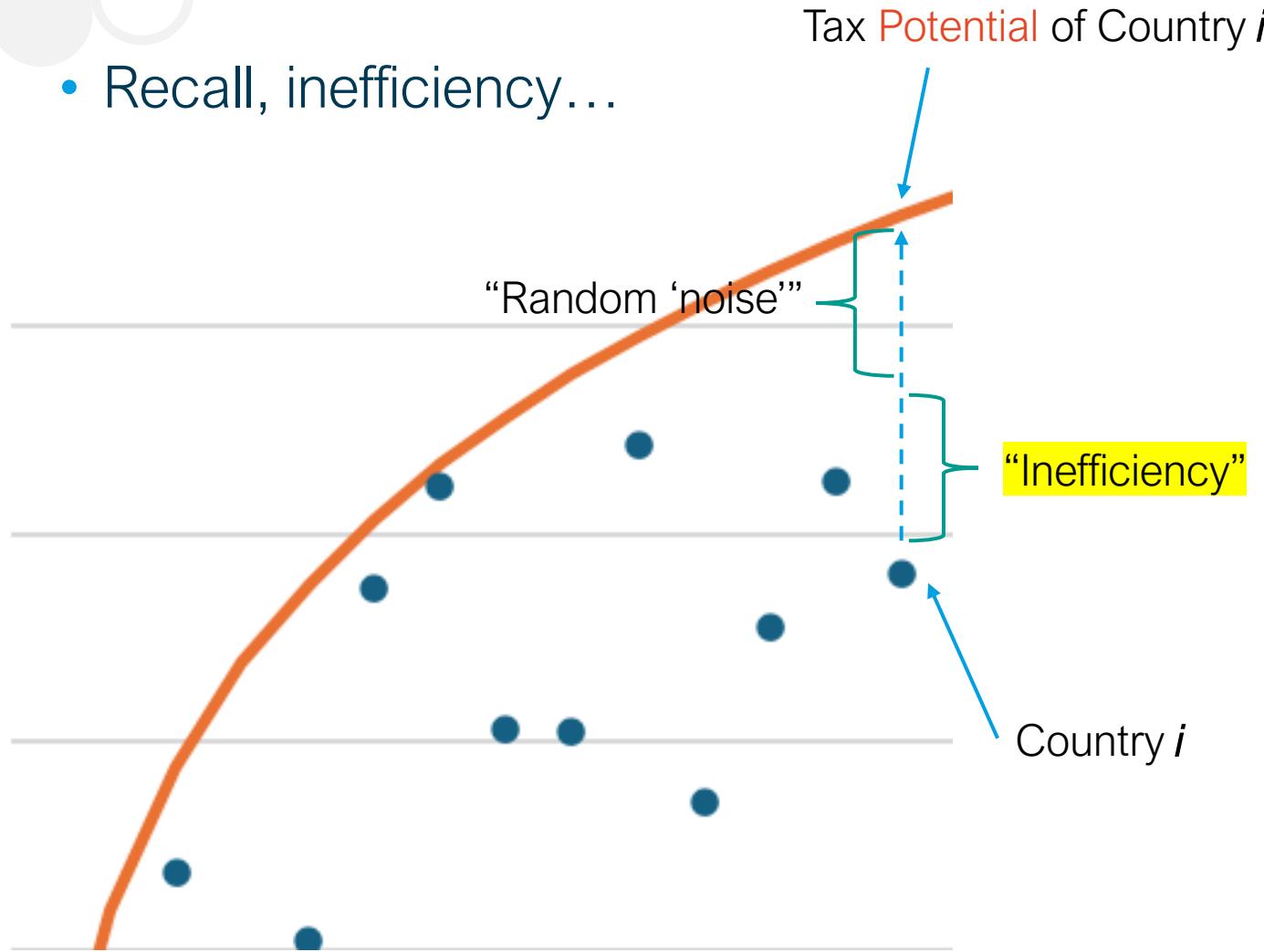- So, you might find a largely agrarian, LIC, with quite a high tax effort score.

Inputs = determinants of Tax:GDP

Output = Tax:GDP ratio

LIMITATIONS & ALTERNATIVES

LIMITATIONS OF TAX EFFORT

- Recall, inefficiency…

Tax Potential of Country i

"Random 'noise'"

"Inefficiency"

Country i

The SFA can isolate inefficiency from random variation, however…

- There could be two potential sources of inefficiency

(i) 'Pure' inefficiency -> where the tax system does not collect as much revenue from the tax base as it 'should'. Probably fair to interpret this as policy and admin weaknesses.

(ii) Omitted variables -> some other factors that we can't include in the model may influence the size of the error in the model: the lack of data on the policy and admin environment is key here.

LIMITATIONS OF TAX EFFORT

- *Omitted variables* represents a major limitation of tax effort / tax potential models.

- It's very difficult to control for what tax policy or administration environment looks like in a given country, *over time*.
  - Is there one indicator, since 2000, that is consistently reported on?
  - One option (tax policy) is to control for statutory tax rates, but as we know, effective tax rates often differ substantially - allowances, deductions, tax expenditures etc.

- Other omitted variables play an important role – e.g., difficult to control, across countries, for e.g., corruption, quality of governance, etc.
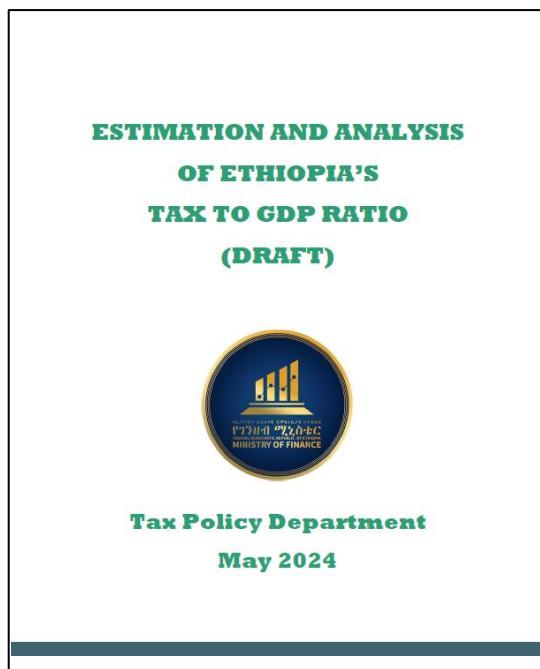
LIMITATIONS OF TAX EFFORT

- Tax effort estimates are backward-looking.
  - It's an estimate of how much a country *could have collected* at that point in time *given its structural features*.

- Doesn't normally incorporate social contributions
  - Countries have differing mixes of tax on labor between social contributions (SSCs) and personal income taxes (PITs)
  - Tax effort models incorporate tax-to-GDP excluding social contributions.

- A poor guide for resource-dependent countries
  - Tax-to-GDP ratio might be low in these jurisdictions, but governments collect a lot of revenue from license fees and royalties (non-tax revenues). So, a low tax effort is of little concern (and even expected).

MEASURING TAX EFFORT: OTHER METHODS

- *Random Forest?*

ESTIMATION AND ANALYSIS
OF ETHIOPIA'S
TAX TO GDP RATIO
(DRAFT)

Tax Policy Department
May 2024

MEASURING TAX EFFORT: OTHER METHODS

- *Random Forest?*

- Takes an aggregate of multiple 'decision-trees', randomly selected from the data

- These are like flowcharts; and each predicts tax-to-GDP by splitting the sample into small, similar groups, based on observable characteristics. Example of a tree…
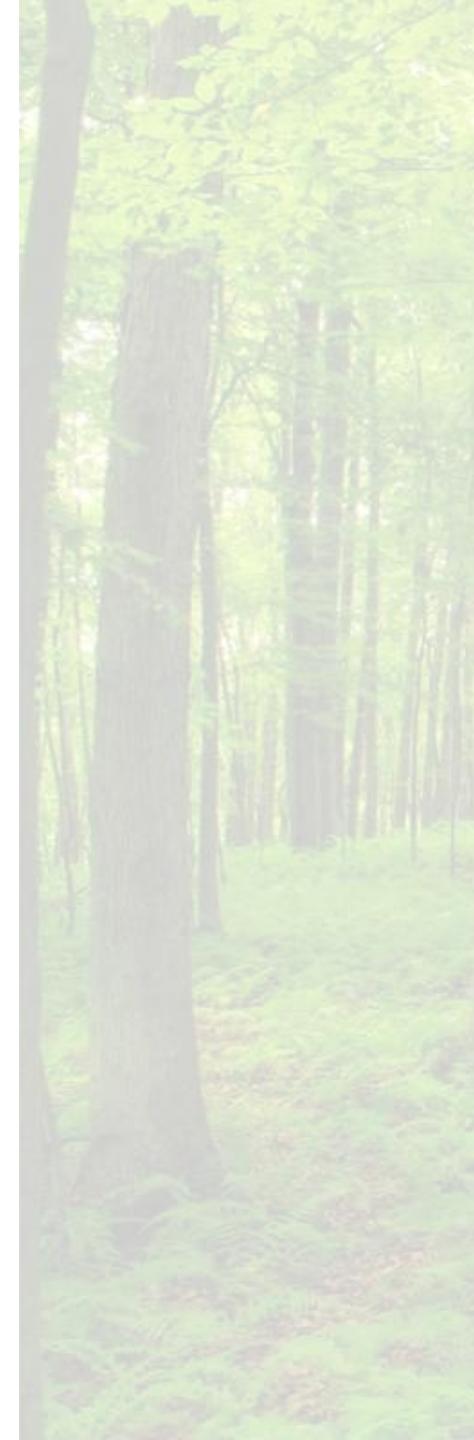
Is GDP per capita > 12,000?
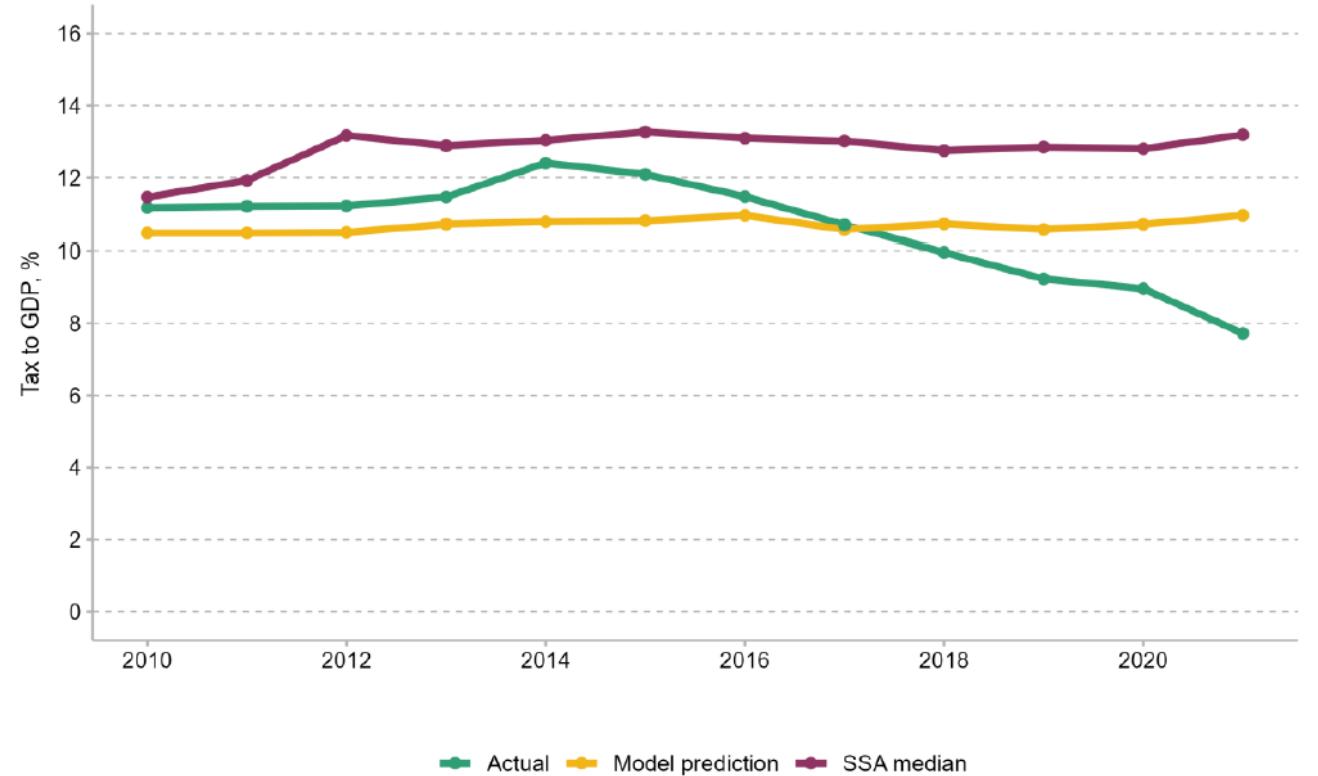
MEASURING TAX EFFORT: OTHER METHODS

- *Random Forest?*

- Takes an aggregate of multiple, randomly selected, 'decision-trees'.

- These are like flowcharts; and each predicts tax-to-GDP by splitting the sample into small, similar groups, based on observable characteristics. Example of a tree…

- The 'random forest' makes *1000's* of paths like this (with random starting values) and then aggregates the results.

- The MoF – TaxDev study used this method…

MEASURING TAX EFFORT: OTHER METHODS

- *MoF-TaxDev* study using this method predicts that tax:GDP should be around 11% in 2021/22. (So, a tax gap of around 3% of GDP)

- Agrees with other studies that **do not predict falling tax:GDP ratios for Ethiopia.**

Figure 2.2. Predicted tax as a % of GDP for Ethiopia

Tax to GDP, %
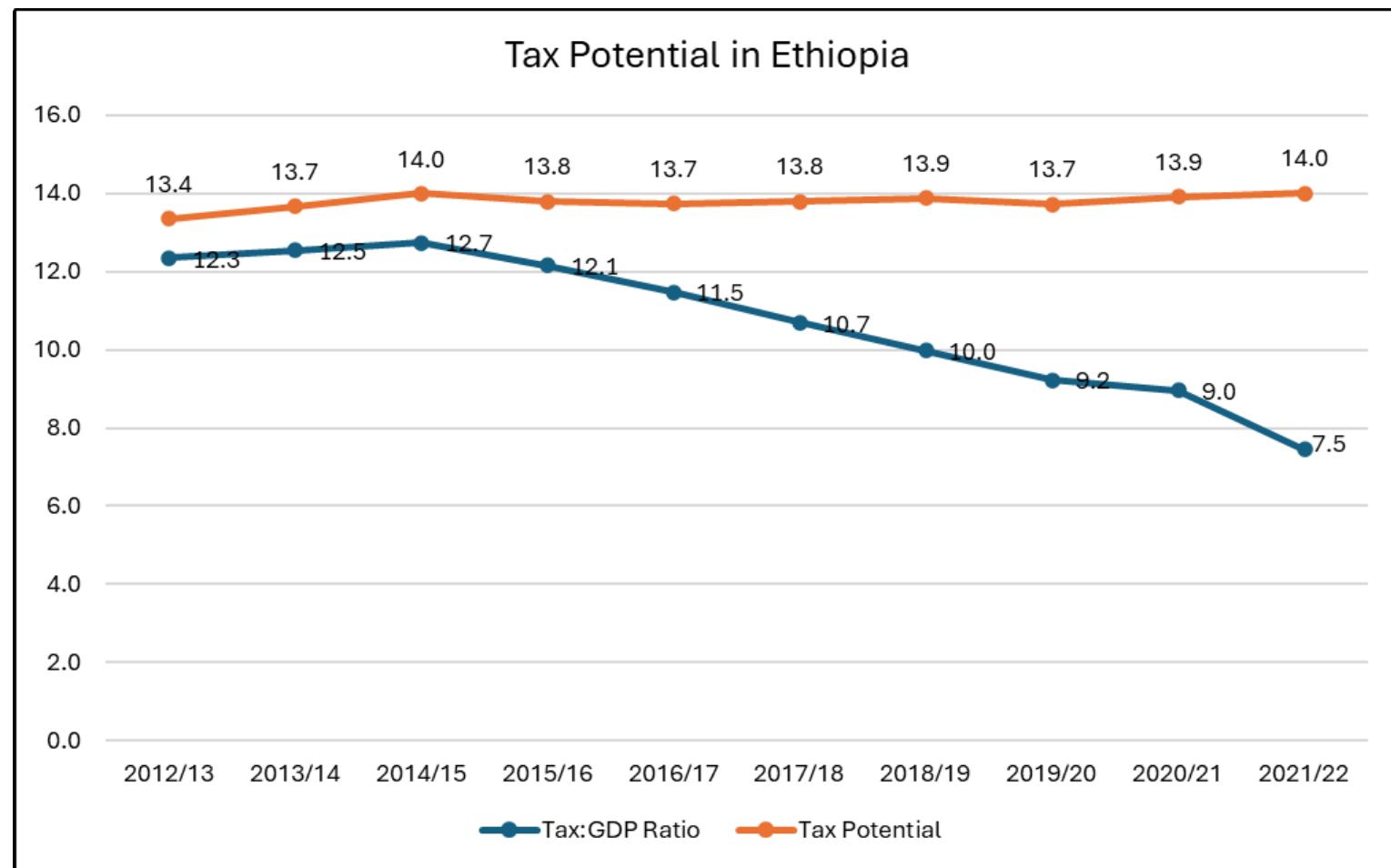
Legend: Actual — Model prediction — SSA median

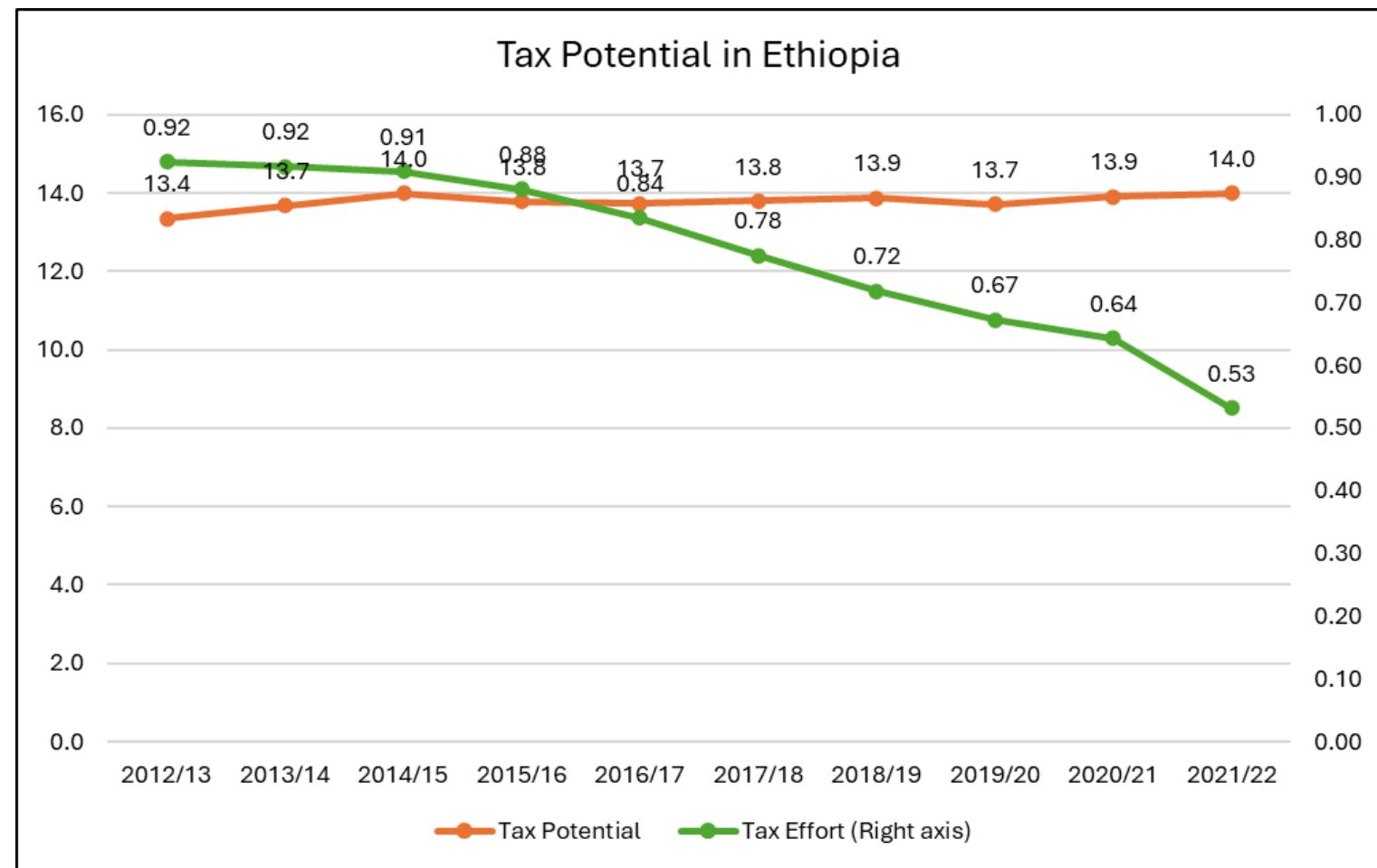# MEASURING TAX EFFORT: INTERPRETING RESULTS

MEASURING TAX EFFORT: RESULTS

- **World Bank** recently estimated tax effort (and potential) according to the SFA approach

  - Results for Ethiopia

  - Tax:GDP declining, but tax potential increasing

  - Increasing tax gap…

  - "Tax effort" has been declining…

Tax Potential in Ethiopia

Tax Potential: 13.4, 13.7, 14.0, 13.8, 13.7, 13.8, 13.9, 13.7, 13.9, 14.0

Tax:GDP Ratio: 12.3, 12.5, 12.7, 12.1, 11.5, 10.7, 10.0, 9.2, 9.0, 7.5

Years: 2012/13, 2013/14, 2014/15, 2015/16, 2016/17, 2017/18, 2018/19, 2019/20, 2020/21, 2021/22

Legend: Tax:GDP Ratio, Tax Potential
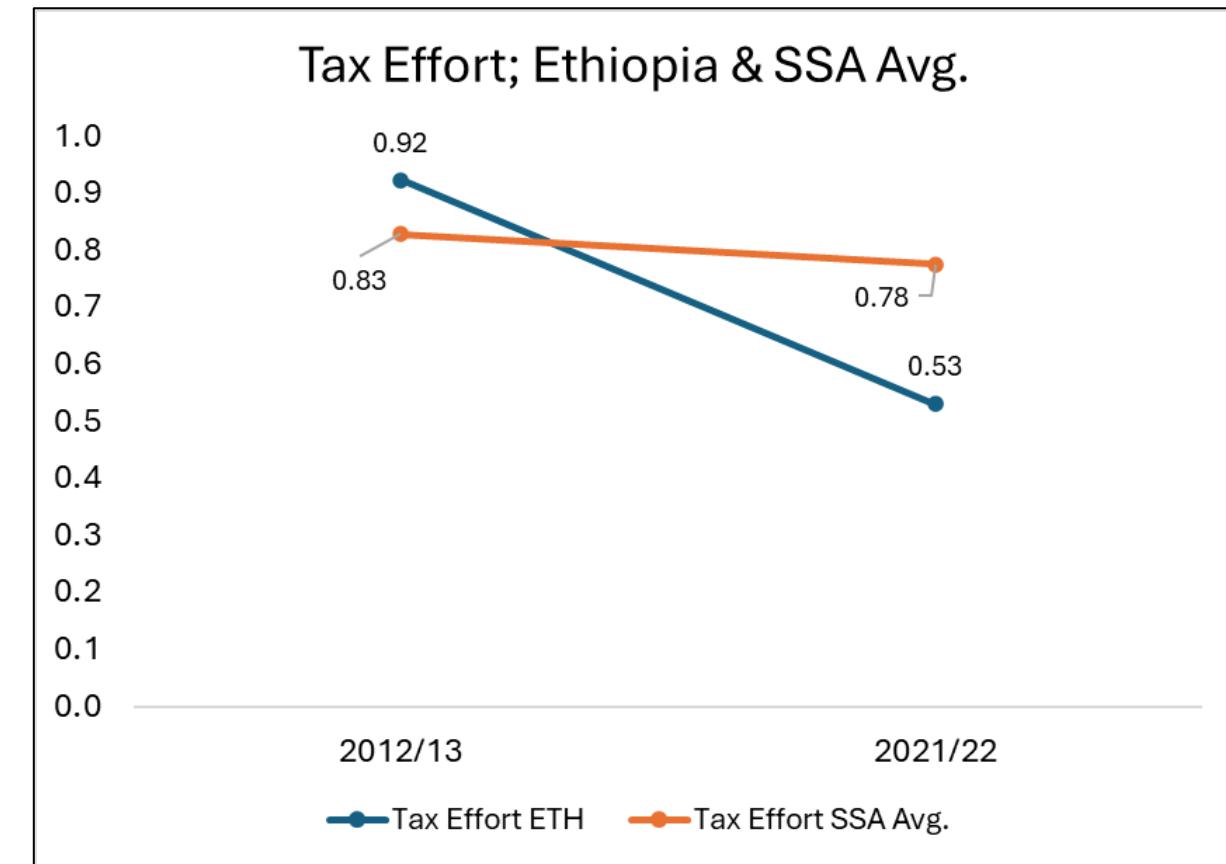
MEASURING TAX EFFORT: RESULTS

- "Tax effort" has been declining

Tax Potential in Ethiopia

Data labels: 0.92, 0.92, 0.91, 0.88, 0.84, 0.78, 0.72, 0.67, 0.64, 0.53 (Tax Effort)
13.4, 13.7, 14.0, 13.8, 13.7, 13.8, 13.9, 13.7, 13.9, 14.0 (Tax Potential)

Years: 2012/13, 2013/14, 2014/15, 2015/16, 2016/17, 2017/18, 2018/19, 2019/20, 2020/21, 2021/22

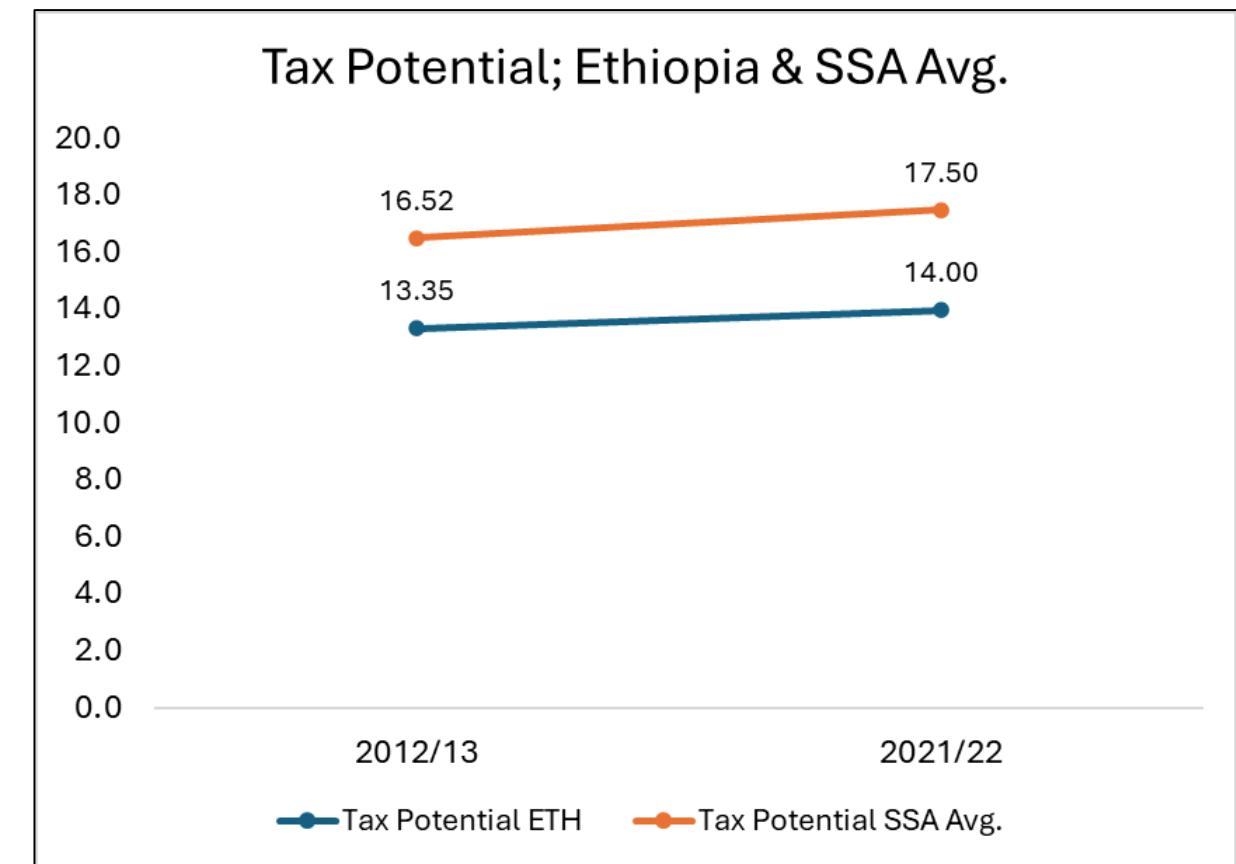Legend: Tax Potential — Tax Effort (Right axis)

MEASURING TAX EFFORT: RESULTS

- In comparison with Sub-Saharan Africa:

- Tax Effort in Ethiopia was previously above regional average; now lies well below

Tax Effort; Ethiopia & SSA Avg.

0.92

0.83

0.78

0.53

2012/13   2021/22

Tax Effort ETH   Tax Effort SSA Avg.

MEASURING TAX EFFORT: RESULTS

- In comparison with Sub-Saharan Africa:

- Tax *potential* is below SSA average and has remained there

Tax Potential; Ethiopia & SSA Avg.

INTERPRETING TAX EFFORT (POTENTIAL) RESULTS

- Tax potential is not a tax target
  - Most countries do not reach the 'frontier'; and no country has a tax effort =1
    - UK: 0.86
    - Norway: 0.85
    - Finland 0.79

- A focus on the absolute values of tax effort (potential) is not a particularly good basis for informing policy
  - As stated previously, it doesn't tell us much about how to *increase* tax effort (reach potential)

- However, there are two areas where tax effort can be quite insightful
  - Trends over time
  - Comparisons with peers

- No matter the method employed, these comparisons can be useful

INTERPRETING TAX EFFORT

- Given Ethiopia's economic structure (and other variables), actual tax performance falls short of what is predicted = **falling and low "tax effort"**

- What does this tell us?

- Some level of inefficiency is expected. Almost no country is performing "at the frontier".

- Compared to its peers, Ethiopia's Tax Effort was previously performing above average (given its structure) but is now well below.

- This tells us that inefficiency has crept into tax policy/admin within the past decade… but not "why"

INTERPRETING TAX EFFORT

- Explaining tax performance in Ethiopia today, is not our (main) focus

- Forthcoming World Bank **Public Finance Review** goes into much more depth.
  - Recent IFS/TaxDev study also v. insightful

- Tax Effort / Tax Potential estimates are saying, *based on the factors that we control for*, *what level of tax collection does the model predict a country could be collecting?*

- **But we can't control for every factor** across countries and over time that would influence the tax ratio

MOF – TAXDEV STUDY

- Prediction model ('random forest') is quite new for estimating tax potential
  - Very powerful model
  - Similar findings to others
  - Looks to be a good approach to explore in other countries

- Study presents a comprehensive understanding the drivers of the low and falling tax:GDP ratio.

- Looks at each tax type to understand where performance is good / poor

- Examines at reasons for the fall in Tax to GDP

ESTIMATION AND ANALYSIS
OF ETHIOPIA'S
TAX TO GDP RATIO
(DRAFT)

MINISTRY OF FINANCE

Tax Policy Department
May 2024

MOF – TAXDEV STUDY

- Very important recommendations!

- Maintaining quality of data – this is a vital step
  - Use of microdata from different taxpayers can reveal a lot about taxpayer behavior

- Importantly, this report lays the ground for the NMTRS.
  - This is a key study to focus on right now…

ESTIMATION AND ANALYSIS OF ETHIOPIA'S TAX TO GDP RATIO

(DRAFT)

Tax Policy Department

May 2024

CONCLUDING REMARKS

- Tax effort and tax potential estimates have been around for many decades
  - We have learnt a lot but there are many limitations

- Tax Potential estimates are, on their own, a poor guide for policymaking

- Tax Potential estimates help us identify good/poor performance both vs. peers and over time
  - Where performance is deteriorating, or trailing behind peers, then this might indicate attention required!

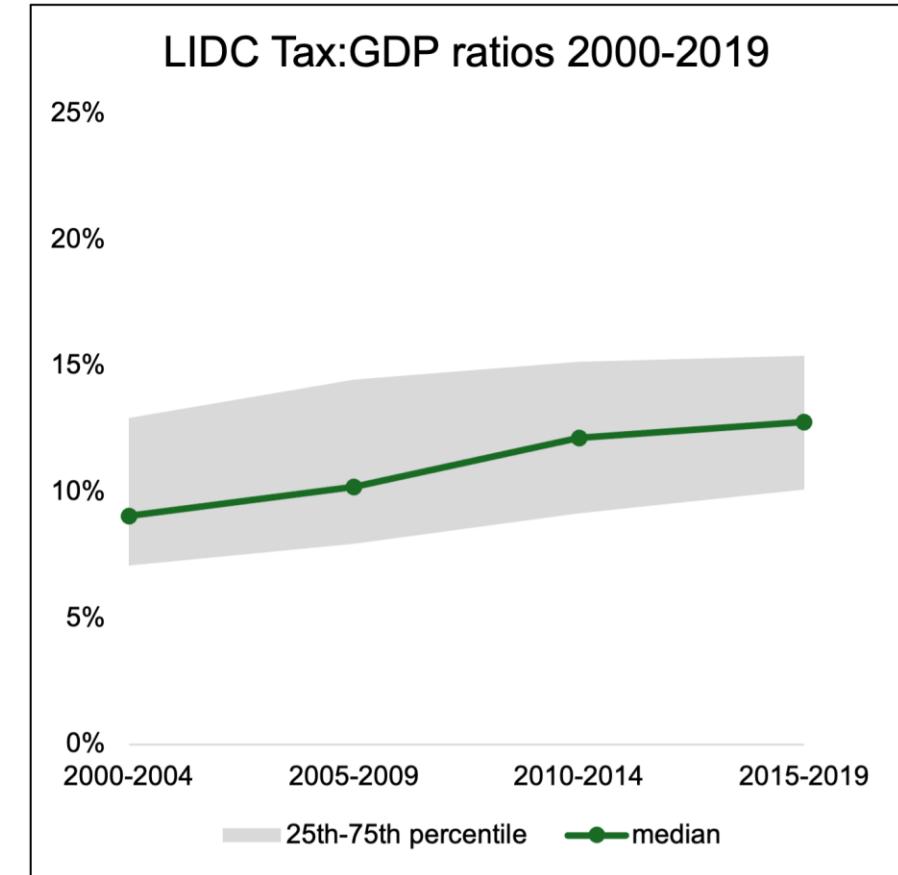# CONCLUDING REMARKS

- Other important work that can support our understanding of how to improve tax effort:

- Tax Expenditure reporting
  - Assigns estimates of foregone revenue *to each policy choice*
    - Supports a better understanding of 'how' to close some tax gaps.

- Tax Gap Analysis
  - Bottom-up (using admin data) or Top-down (national accounts data)
    - Can highlight which tax types (though not which policies) are performing well / poorly

- TADAT assessment
  - Diagnostic assessment of strengths and weaknesses of various elements of tax administration

CONCLUDING REMARKS

- There has been some noise about Tax Potential recently:
  - E.g., IMF in 2023 suggested that in LIDCs, 'a 9 percentage-point increase in the tax-to-GDP ratio is feasible'

- This was based partly on SFA analysis of tax potential and some other assumptions.

- But which LIDCs have increased tax:GDP by 9% pts recently...?

- History shows us that progress is slow. But that doesn't mean we can't, or won't, make progress.
  - Digitization, AI etc. – many new technologies can support faster growth in tax revenues.
  - **In depth diagnostic work can provide answers that tax effort studies cannot.**

Source: ODI Global (McNabb et al 2024)

CONCLUDING REMARKS

Tax Potential estimates show you the destination

NMTRS, and other in-depth research, tells you *how to get there*

REFERENCES

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