The Government Revenue and Development Estimations (the GRADE)

(last updated 12th June 2024)

Introduction

Introduction

Studies have shown that governments spend more on public services such as schools and hospitals when they have more revenue. The Government Revenue and Development Estimations (GRADE) allows the user to '**translate'** the impact of an increase or decrease in government revenue on access to several Sustainable Development Goals (SDG) indicators in an individual country.

The research underpinning GRADE modelled the effect of government revenue on several SDG indicators, including basic and safe water, basic and safe sanitation, child school years, school attendance, number of teachers, child, and maternal survival, selected for their importance because they are **fundamental rights.**[1] Governance indicators strongly affect the relationship between government revenues and SDG targets. Additional revenue has a much greater impact on well-governed countries (see Figure 1).
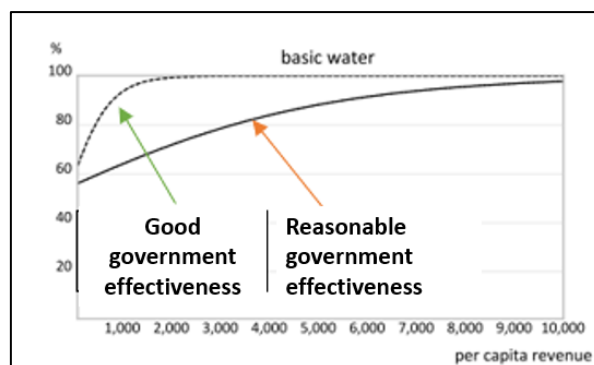

Figure 1 The effect of governance on the effectiveness of government spending

GRADE employed unbalanced panel data modelling for 217 countries between 1960-2000 and expressed SDG indicators as percentages ranging from 0 to 100. A linear relationship between revenue and these variables

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[1] The Impact of Government Revenue on the Achievement of the Sustainable Development Goals and the Amplification Potential of Good Governance. *Cent Eur J Econ Model Econom* 2022; **14**: 109–29. https://econpapers.repec.org/article/pscjournl/v_3a14_3ay_3a2022_3ai_3a2_3ap_3a109-129.htm

would not be appropriate as this would not respect these boundaries. We employ a logistic function as the correct specification for the model. In contrast, a standard panel logistic function would impose the same shape 'S curve for all countries, which is inappropriate. **We augmented the logistic function parameters with measures of governance quality, which allowed each country to have a different 'S' shape as its government's quality varied**. Additional revenue has a much more significant impact in lower-income countries than in high- or upper-middle-income (higher-income) countries, and as per capita revenue increases, possible gains decline rapidly.

However, governance indicators also respond to increased government revenue. We used two contrasting econometric methodologies to quantify the effects of an increase in government revenue per capita on indicators of governance quality [2]. The results show that increasing government revenue significantly affects governance indicators, yielding a remarkably consistent picture over a ten-year horizon.

This effect was incorporated into the model and online visualisation (see Figure 2). The critical insight gained is that there is important feedback from government revenue to governance, and from governance to government revenue.

Over time, as governance improves, there will be further increases in government revenue which further improves governance, forming a critical virtuous cycle.
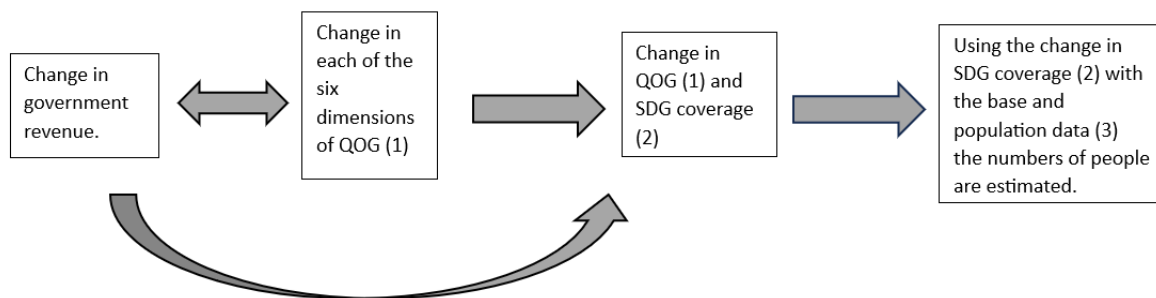

Figure 2 Schematic diagram showing how changes in government revenue and governance impact SDG indicators in the GRADE online model.

(The numbers in parenthesis refer to the three databases which underpin the online model)

Frequently Asked Questions about the GRADE

Why do we use the government revenue per capita?

The GRADE uses government revenue per capita rather than, say, health spending per capita for two reasons.

1. A better understanding of the relationship between government revenue per capita and SDG indicators is helpful because the policies and practices of other governments, multinational organisations, corporations, and banks may influence government revenue. By contrast, international actors are less likely to influence government spending, except for the International Monetary Fund (IMF) and donors in highly aid-dependent countries.

2. The government revenue per capita also reflects the ability of governments to spend across all sectors. Many studies have concentrated on only one aspect of social spending, often health. However, sectors

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[2] A Model to Explain the Impact of Government Revenue on the Quality of Governance and the SDGs
https://www.mdpi.com/2227-7099/11/4/108

outside the health sector account for much of the increased survival rate in all countries. For example, spending on education increases maternal literacy, which is known to improve children's survival.

Does GRADE assume that governments spend additional revenue in specific sectors?

No. All governments allocate resources according to their national priority. GRADE models the relationship between government revenue and SDG indicators and, therefore, assumes that governments will spend the same amount of additional revenue as in recent years. Additionally, health benefits and reductions in mortality are likely to result from increased spending across multiple sectors.

Do all countries benefit the same when revenue increases?

No. A given amount of additional revenue does not increase access to SDG indicators or reduce survival rates in different countries by the same amount. Governance indicators strongly affect the relationship between government revenues and SDG indicators. Additional revenue has a much greater impact on well-governed countries (see Figure 1).

There is considerable scope for reducing survival rates and saving lives in countries with low per capita revenue.

The reasons for this are as follows:

1. In wealthy and high-income countries, the average government revenue per person is more than a hundred times larger than that in low-income countries. Therefore, additional income in low-income countries is relatively more significant. For example, in 2016, the average government revenue per person was $80 in low-income countries, $380 in lower-middle-income countries, $1250 in upper-middle-income countries and $12,750 in high-income countries. Thus, an additional 200 million in revenue in a low-income country with a population of 10 million will increase government revenue per capita by $20–an increase of 25%. In comparison, in a high-income country, the average increase is 0.16 %. Thus, extra revenue will go much further regarding access to services that contribute to health, and ultimately save lives.

2. The gains are smaller at different stages of a country's developmental trajectory. The reason for this is that reducing high child mortality rates, for example, from 150 to 75 per 1000 live births, involves reducing more easily preventable deaths by, for example, ensuring that more people have access to clean water, sanitation, and primary healthcare. On the other hand, reducing child survival rates from 20 to 10 per 1000 live births involves reducing fewer preventable deaths and requires more advanced healthcare services.

Which Government Revenue per capita data does GRADE use?

For the GRADE modelling, we used the Government Revenue (GR) data from the UNU WIDER Government Revenue Dataset (GRD)[3], the most recent update (August 2023). The UNU WIDER GRD dataset includes general and central government revenue, and we used the former because the latter underestimates the total revenue in fiscally decentralised states. In addition, data which include and exclude grants are available, and we used the total general government revenue, excluding grants, as this variable best reflects the capacity of domestic revenue. For the same reason, we used data that included social contributions. When there were missing data for government revenue per capita, we used linear interpolation with two known data points. Where there were data in the GRD on revenue (but not excluding grants and including social contributions), we used the annual changes to guide interpolation if two data points were available.

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[3] UNU WIDER Government Revenue Dataset (GRD)

Which source is used for Gross Domestic Product?

The GRD expresses all data as a percentage of GDP in LCU, which we express as % GDP in constant 2015 USD, taken from the World Development Indicators (last updated 29th June 2023), to produce a GR per capita in constant 2015 USD.

Which currency does the GRADE use?

The model used a constant 2015 USD; therefore, if inputting additional revenue, convert this to 2015 values. There is a tool on the website which allows deflation, adapted from FRED [4].

Which source is used for the SDGs?

These data were obtained from the World Development Indicators[5]. (See Appendix:

Definitions for the SDGs used in GRADE

Except for the pupil–teacher ratios, all estimates were presented as percentages or proportions. The change in percentage or proportion coverage is then multiplied by the population data to provide the number of people, women, or children who gain access to one of the SDG indicators or fundamental rights.

Water and sanitation were recorded as percentages, ranging from 0 to 100%.

School attendance – Here, we use UNESCO[6] estimates of out-of-school rates for primary, lower, and upper secondary schools to model the impact of government revenue and governance on in-school rates or school attendance. To estimate the number of children who would benefit from an increase in government revenue, we used the percentage change at each level of education and multiplied this by the school-age population by gender for that level [7]. We believe that this is a good estimate to use because it is divided into three school levels, and the school population data used is available by gender. [8]

What sources are used as governance indicators?

GRADE uses the Worldwide Governance Indicators

After an increase in revenue, when do benefits accrue?

There is a lag period after an increase in revenue plus increased government revenue significantly affects the governance indicators, yielding a remarkably consistent picture over a ten-year horizon[9]. This effect was incorporated into the model and online visualisation.

Where can the data used in the models be obtained?

At the bottom of the visualisation, select' **advanced,** there is a button to download the data.

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[4] https://fred.stlouisfed.org/series/GDP/
[5] World Development Indicators
[6] UNESCO Out of School rates https://education-estimates.org/out-of-school/data/
[7] UIS School age population http://data.uis.unesco.org/index.aspx?queryid=3847
[8] A model of the impact of government revenue and quality of governance on schooling .
[9] A Model to Explain the Impact of Government Revenue on the Quality of Governance and the SDGs
https://www.mdpi.com/2227-7099/11/4/108

Why do these estimates fluctuate over time?

Government revenue per capita and the quality of governance vary between years; therefore, the estimates may fluctuate over time.

What is the 'best' estimate for each SDG indicator?

Either

1. The final value reached over the projection period selected, as this will incorporate the maximum impact of the improvement in governance.
2. It is also reasonable to present the maximum number of people impacted, which is often the same as the final value.
3. If a single year is studied, there will be only one estimate.

Where can I find the code used to drive the Web tool?

The source code is freely available on GitHub at https://github.com/stuwilmur/GRADE-DOH.

How can I use the model in my own software or calculations?

The current webtool does not expose an API, and the code which drives it is not specifically designed for repurposing. To overcome this, a new version of the model has been developed which is designed to be freely reused by developers and those wishing to perform calculations. It is freely available as a pair of npm packages:

- grade-doh-model: packages the model calculations: https://www.npmjs.com/package/grade-doh-model;
- grade-doh-data: bundles the base data: https://www.npmjs.com/package/grade-doh-data.

Note that this new version of the model may produce results which differ slightly from the current webtool, owing to differences in the precision of the model equation constants used. The GitHub repositories for both packages are publicly available at https://github.com/stuwilmur/GRADE-DOH-model and https://github.com/stuwilmur/GRADE-DOH-data.

See the following resources to begin with the model:

- JSFiddle example, showing the model and data being imported from a CDN: https://jsfiddle.net/5732nc8y/3/;
- Grade-doh-model user guide on Observable: https://observablehq.com/@grade/model-user-guide;
- a simple example Notebook in Observable, to show the package being used to perform largely the same tasks as the webtool, with relative ease: https://observablehq.com/@grade/calculator-tool.

Who funded the research underpinning the GRADE?

The GRADE project was supported by the Scottish Funding Council, the Global Challenges Research Fund, the Scottish Funding Council, the Medical Research Council, and the Professor Sonia Buist Global Child Health Research Fund.

Using the GRADE Model – a step-by-step guide

On the GRADE homepage[10], select the tab, called the GRADE Model. Click on the map to use the model. This model can be used for single- and multiple-country analyses. Here, we describe these separately using panels on the left-hand side of the screen.
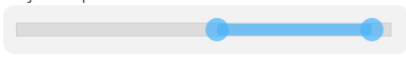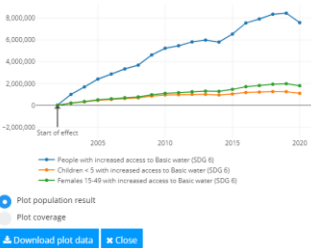
For most users the following four panels will be used

1. **country**
2. **revenue**
3. **year(s) of interest**
4. **outcome of interest**

Single country analysis

Country Select from the list or click the map (Click oceans to reset the view) All countries	**Select the country of interest from the drop-down list.**
Revenue Absolute additional revenue Millions (M) USD Additional Revenue (USD): $0M 0 Deflator tool	Estimates of additional revenue can be entered from the drop down in any of the following ways. GRADE uses constant 2015 USD. (see below) 1. Absolute additional revenue in USD, Millions of USD, or Billions of 2015 USD 2. Additional revenue per capita in 2015 USD 3. Increase as a percentage of government revenue per capita. (Note: if projecting over several years this is the preferred estimate of additional revenue as government revenue will change over time). (Note - the upload as a CSV file is most useful if carrying out a multiple-country analysis, see below).
Deflator tool	If your estimates are in current USD, convert to constant 2015 USD using the deflator tool on the site or another deflator tool.

1. If estimates are available for several years, convert these to 2015 USD, express as a percentage of government revenue (see next panel) and use the average.
2. If estimates are only available for one year, but the losses/gains in government revenue are likely to take place over many years, for example tax abuse, convert this into a percentage of government revenue and project this over several years. The reason for projected over several years is to allow the impact of the increase in revenue on governance indicators and therefore on development indicators to be visualised.
3. If the losses/gains only took place in one year or they vary a lot between years (for example debt service) it is better to analyse for one year only, in which case the impact of additional government revenue on the governance indicators will not be incorporated.
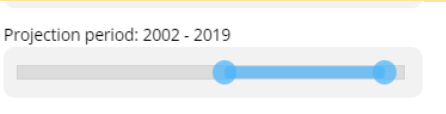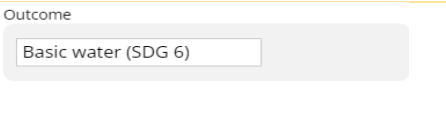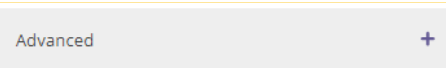
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[10] GRADE https://medicine.st-andrews.ac.uk/grade/

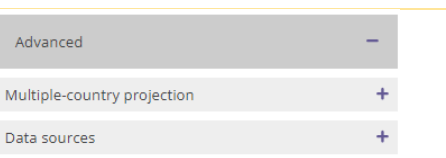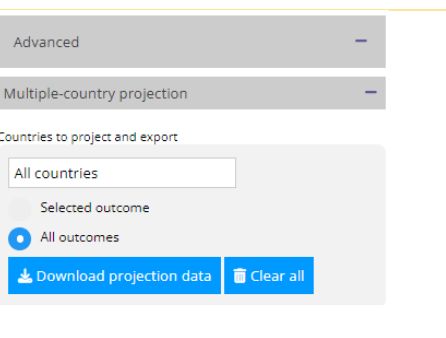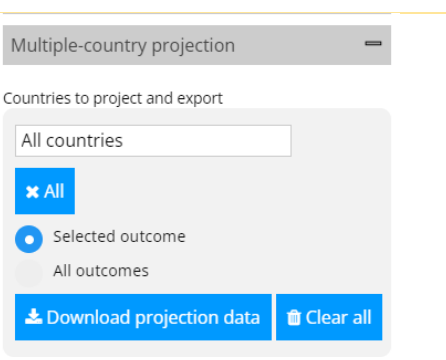|	
Afghanistan Projection for 2010 - 2020 2010 Current Gov. rev. per capita: $59.14 New Gov. rev. per capita: $62.57 Increase in Gov. rev. per capita: 5.79%	The tool can be used to calculate the percentage increase in government revenue per capita by inputting the absolute amount and selecting the year when there was this increase – the panel will show this as a percentage.
Projection period: 2002 - 2019	**Projection period:** Adjust the start and end slider buttons to ensure the longest time possible (may be limited due to data availability, currently there is data 2002-2020.
Outcome Basic water (SDG 6)	**Select the outcome or SDG indicator of interest.**
Projection for Afghanistan: Basic water (SDG 6) _(line chart)_ Plot population result Plot coverage Download plot data Close	**The projection:** This appears on the panel on the right and can be plotted as the population numbers or as percentage coverage. The plot can be **downloaded** as a PNG file, or the data can be downloaded as an excel file. Use the radio button to toggle the plot between the population results and the coverage in percent.

Multiple-country analyses

Country Select from the list or click the map (Click oceans to reset the view) All countries	**Country panel: select All countries from the drop-down list.**
Revenue Use CSV file Upload revenue CSV My revenue data is specified as: Absolute additional revenue	Revenue panel: select 'Use CSV file' and select the blue upload button. Indicate how the revenue is specified: This can be absolute additional revenue in 2015 USD, additional revenue per capita in 2015 USD or (recommended if projecting over many years) increased revenue as a percentage of government revenue.
REVENUE,ISO,Year 3.26,ABW,2002 0.00,SSD,2002 0.07,LSO,2002 0.09,BFA,2002 0.21,STP,2002	Upload data for multiple countries as a CSV file in the format shown. Column 1 'REVENUE' (indicating in step 2 above, if the additional revenue is absolute additional revenue in 2015 USD, additional revenue per capita in 2015 USD or increase in percentage of government revenue as shown here. Column 2 "ISO" detailing the country's ISO-3 code. Column 3 "YEAR" listing the year in which the increase in revenue began. Generally, select the earliest and latest years where data is available.

1.   If estimates are available for several years, convert these to 2015 USD, express as a percentage of government revenue (see next panel) and use the average.

2.   If estimates are only available for one year, but the losses/gains in government revenue are likely to take place over many years, for example tax abuse, convert this into a percentage of government revenue and project this over several years. The reason for projected over several years is to allow the impact of the increase in revenue on governance indicators and therefore on development indicators to be visualised.

3.   If the losses/gains only took place in one year or they vary a lot between years (for example debt service) it is better to analyse for one year only, in which case the impact of additional government revenue on the governance indicators will not be incorporated.

Afghanistan Projection for 2010 - 2020 2010 Current Gov. rev. per capita: $59.14 New Gov. rev. per capita: $62.57 Increase in Gov. rev. per capita: 5.79%	The tool can be used to calculate the percentage increase in government revenue per capita by inputting the absolute amount and selecting the year when there was this increase – the panel will show this as a percentage.
Projection period: 2002 - 2019	Projection period: Adjust the start and end slider buttons to coincide with the CSV file.
Outcome Basic water (SDG 6)	Select the outcome or SDG indicator of interest.
Advanced +	Select the **advanced button**
Advanced – Multiple-country projection + Data sources +	Select the 'Multiple country projection' option.
Advanced – Multiple-country projection + Data sources +	Other options in Advanced Data sources: The population data and government revenue data used in GRADE can be downloaded here).
Advanced – Multiple-country projection – Countries to project and export All countries Selected outcome ◉ All outcomes ⬇ Download projection data 🗑 Clear all	Under advanced, select one country or all countries. Note, if all countries selected, the download will include all countries in the world including those which did not have additional revenue.
Multiple-country projection ▬ Countries to project and export All countries ✖ All ◉ Selected outcome All outcomes ⬇ Download projection data 🗑 Clear all	Select the 'selected outcomes' which were selected in the outcomes panel OR choose 'all outcomes', in which case the downloaded projection data contains all current coverage and the improved coverage with additional revenue and the numbers of people, women and children impacted. Note in the downloaded spread sheet, projections on the percentage of those who currently do not have access can be calculated using - (improved coverage – current coverage)/ (100 – current coverage)

Appendix:

Definitions for the SDGs used in GRADE [11]

Basic drinking water services – the percentage of the population drinking water from an improved source, provided collection time is not more than 30 minutes for a round trip. This indicator encompasses both people using basic drinking water and those using safely managed drinking water. Improved water sources include piped water, boreholes or tube wells, protected dug wells, protected springs, and packaged or delivered water.
Safely managed drinking water services – the percentage of the population using drinking water from an improved source accessible on-premises, available when needed, and free from faecal and priority chemical contamination.
Basic sanitation services - the population using at least, that is, improved sanitation facilities not shared with other households. This indicator encompasses both people using basic sanitation services and those using safely managed sanitation services. Improved sanitation facilities include flush/pour flush to piped sewer systems, septic tanks or pit latrines, ventilated improved pit latrines, compositing toilets, or pit latrines with slabs.
Safely managed sanitation services –the population using improved sanitation facilities, not shared with other households, and where excreta are safely disposed of in situ or transported and treated offsite. Improved sanitation facilities include flush/pour flush to piped sewer systems, septic tanks or pit latrines, ventilated improved pit latrines, compositing toilets, or pit latrines with slabs.

Education
School attendance – Here, we use UNESCO[12] estimates of out-of-school rates for primary, lower, and upper secondary schools to model the impact of government revenue and governance on in-school rates or school attendance. To estimate the number of children who would benefit from an increase in government revenue, we used the percentage change at each level of education and multiplied this by the school-age population for that level [13].

The Worldwide Governance Indicators

The WGI reports aggregate and individual governance indicators for over 200 countries and territories from 1996 for six governance dimensions (see Table 1). These are composite indicators that are based on more than 30 data sources. First, individual questions from the underlying sources are assigned to one of the aggregate indicators. The compilers then rescale the data to make them comparable across sources using the unobserved component model. The resulting composite measures are units of a standard normal distribution with mean zero, running from -2.5 to +2.5, and higher values corresponding to better governance [14].

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[11] The World Bank. Databank - The World Bank. 2020.
[12] UNESCO Out of School rates https://education-estimates.org/out-of-school/data/
[13] UIS School age population http://data.uis.unesco.org/index.aspx?queryid=3847
[14] Kaufmann D, Aart Kraay. Worldwide Governance Indicators. 2020.

Table 1: Definitions of dimensions of Quality of Governance Worldwide Governance Indicators

Dimension of Governance	What it captures
Control of corruption	Perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests
Government effectiveness	Perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies
Political stability	Perceptions of the likelihood that the government will be destabilised or overthrown by unconstitutional or violent means, including politically motivated violence and terrorism
Regulatory quality	Perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development
The rule of law	Perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence
Voice and accountability	Perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media