The Government Revenue and Development

Estimations (the GRADE)

(last updated November 2023)



## 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 Goal (SDG) indicators in an individual country.

The research underpinning the GRADE modelled the effect of government revenue on several SDGs indicators, including basic and safe water, basic and safe sanitation, child school years, school attendance, and child and maternal survival, selected for their importance to survival[1]. Governance indicators strongly affect the relationship between government revenue and SDG targets. Additional revenue has much more impact in well-governed countries (see figure 1).

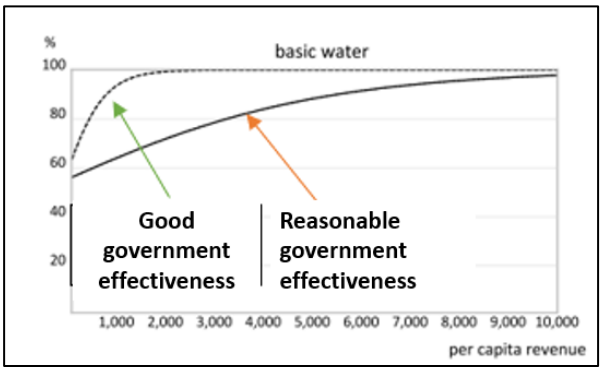



**Figure 1 The effect of governance on the effectiveness of government spending**

GRADE employed unbalanced panel data modelling for 217 countries between 1960-2000 and expressed health determinants as percentages ranging from 0 to 100. A linear relationship between revenue and these variables would not be appropriate, as this would not respect these boundaries. We employed a logistic function as the correct specification for the model. In contrast, a standard panel logistic function would impose

[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

the same shape 'S' curve on all countries, which is inappropriate. **We augmented the logistic function parameters with measures of governance quality, which allows each country to have a different 'S' shape as its government's quality varies**. Additional revenue has a much more significant impact in lower-income countries than in high- or upper-middle-income (higher-income) countries. However, 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 has been incorporated into our 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.

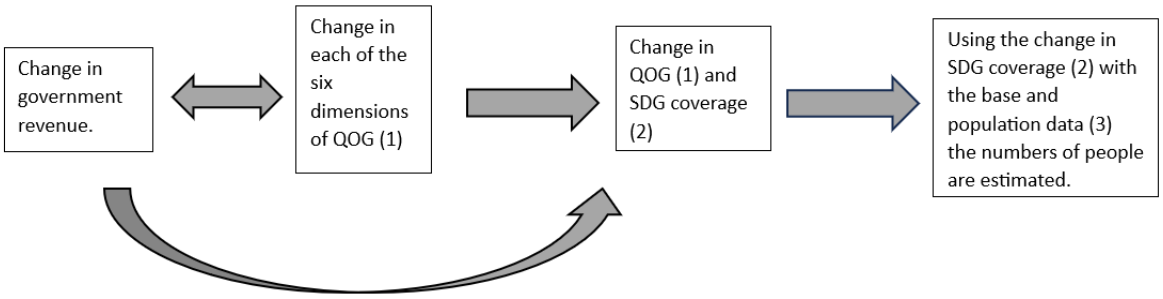



**Figure 2 Schematic diagram showing how the changes in government revenue and governance impact the SDG indicators in the GRADE online model.**

(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?

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 the determinants of health and survival is helpful because the policies and practices of other governments, multinational organisations, corporations, and banks may influence government revenue. In 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. 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, we know that sectors outside the health sector account for much of the increased survival in low- and middle-income

[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

countries. For example, spending on education increases maternal literacy, which is known to improve child survival.

## Does GRADE assume that governments spend additional revenue on specific sectors?

**No**. All governments allocate resources according to their national priorities. GRADE models the relationship between government revenue and the SDG indicators and, therefore, assumes that governments will spend the same amount of additional revenue as in recent years. In addition, 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 revenue and SDG targets. Additional revenue has much more impact in well-governed countries (see figure 1).

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

The reasons for this are as follows.

1. In wealthy or 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 a low-income country 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 increase will be 0.16% on average. Thus, extra revenue will go much further regarding access to services that contribute to health and ultimately save lives.

2. Gains were smaller at higher levels of development. 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 40 to 20 per 1000 live births involves reducing less 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], we use the August 2022 update. The UNU WIDER GRD dataset has general and central government revenue, and we used the former because the latter would underestimate the total revenue in fiscally decentralised states. In addition, data which includes and excludes grants are available, and we used 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. Where there were missing data for government revenue per capita, we used linear interpolation with two known data points.

[3] UNU WIDER Government Revenue Dataset (GRD)

Where there is data in the GRD on revenue (but not excluding grants and including social contributions), we used the annual changes to guide interpolation if there was a data point available.

## Which source is used for Gross Domestic Product?

The GRD expresses all data as a percentage of GDP, expressed as % of 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 GRADE use?

The modelling used constant 2015 USD, so 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 were taken from World Development Indicators[5]. Appendix A: Definitions for the SDGs used in GRADE

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

Two sources of educational data are available. First, school attendance has the most complete data and is our preferred estimate. We continue to provide the second, school life expectancy, as it has been used in several studies.

**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 think this is a better estimate to use because it is divided into three school levels and the school population data used is available by gender.

**School life expectancy (SLE),** both primary and secondary for both sexes, is the number of years of education a child of school entrance age can expect to attend. The maximum SLE was 17 years, and we expressed all countries as a percentage of 17 years, which provided a variable between 0 and 100. We then modelled the impact of an increase in government revenue on SLE. To estimate the number of children who would spend an extra year in school, we used the number of children who are aged five years in any year.

## What source is used for governance indicators?

GRADE uses Worldwide Governance Indicators (see Appendix B: The Worldwide Governance Indicators)Appendix B: The Worldwide Governance Indicators.

[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

## After an increase in revenue, when do benefits accrue?

Increased government revenue significantly affect the governance indicators, yielding a remarkably consistent picture over a ten-year horizon 8. This effect has been incorporated into our model and online visualisation.

## Where can the data used for the models be obtained?

At the bottom of the visualisation, under advanced, there is a button to download the data.

## Why do these estimates fluctuate?

The government revenue per capita and the quality of governance vary between years, so the estimates may fluctuate over time.

## Which 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, and often this will be the same as the final value.

## 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 particularly designed to be repurposed. To overcome this, a new version of the model has been developed which is designed to be freely re-used 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.

[8] 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

## Who funded the research underpinning GRADE?

The GRADE project is 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.

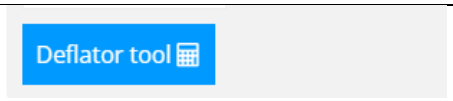
### Using the GRADE Model – a step-by-step guide

On the GRADE homepage[9], select the second tab, called the GRADE Model. Click on the map to use the model. The model can be used for single- and multiple-country analyses.

### Single country analysis


1. **Select the country from the drop-down list.**

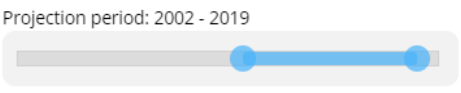
2. **Estimates of additional revenue can be entered from the drop down.**
   - Absolute additional revenue in (note this can be in USD, Millions of USD, or Billions of 2015 USD
   - Additional revenue per capita in 2015 USD
   - Increase as a percentage of government revenue per capita. (Note: if projecting 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).
   - CSV file




3. **Currency**
   If your estimates are in current USD, convert to constant 2015 USD using the deflator tool or another deflator tool.

- 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.
- If estimates are only available for one year, convert this into a percentage of government revenue and project this over several years


NOTE: The tool can also 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.




4. **Projection period**
   Adjust the start and end slider buttons to ensure the longest time possible (may be limited due to data availability).

[9] GRADE https://medicine.st-andrews.ac.uk/grade/

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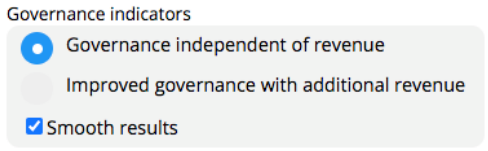
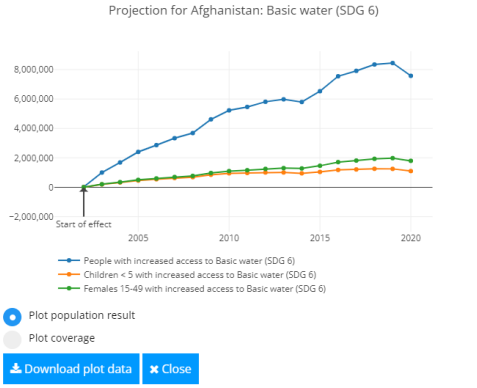
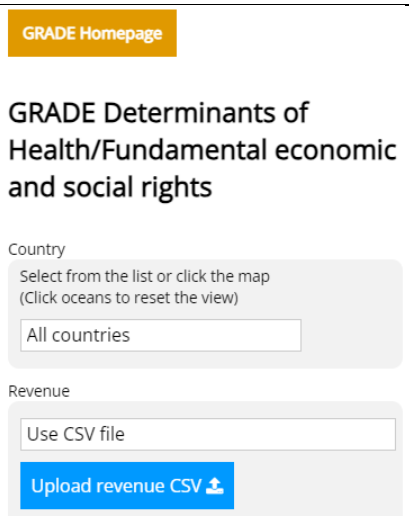
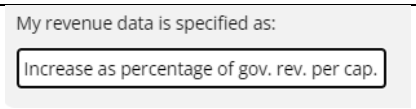
|---|---|
| | |
|  | **5. The impact of governance**<br>Additional government revenue improves governance indicators. To include this effect in your estimations (recommended) select the button Improved governance with additional revenue.<br><br>The "Smooth results" checkbox is ticked by default and will apply smoothing to the population results between the first year of increased revenue, and the start of the effect. Untick to remove smoothing. |
|  | **6. Select the outcome or SDG indicator of interest.** |
|  | **7. The projection**<br>This appears on the panel on the right and can be plotted as the population numbers or as percentage coverage.<br><br>**8.** 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 percentages. |

## Multiple-country analyses




**1. Select All countries from the drop down list.**

**2. Estimates of additional revenue – select 'Use CSV file' from the drop down.**




**3. My revenue is specified as**
This can be absolute additional revenue in 2015 USD, additional revenue per capita in 2015 USD or (recommended) 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
```

**4.** Upload data for multiple countries as a CSV file in the format shown.

Column 1 'REVENUE' (indicating in step 3 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 (recommended) and shown here.

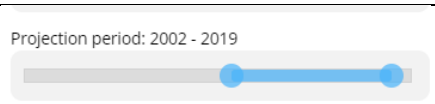
Column 2 "ISO" detailing the country's ISO-3 code

Column 3 "YEAR" listing the year in which the increase in revenue began. Generally, select the earliest and latest years where data is available.

The actual column order is unimportant.

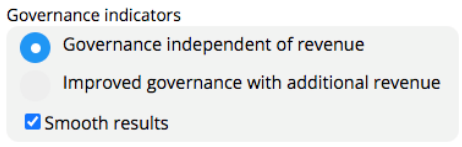
- If estimates are available for several years, convert these to 2015 USD, express as a percentage of government revenue (see next panel) and use the average.
- If estimates are only available for one year, convert this into a percentage of government revenue and project this over several years


NOTE: 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.




**5. Projection period**

Adjust the start and end slider buttons to ensure the longest time possible (may be limited due to data availability).




**6. The impact of governance**

Additional government revenue improves governance indicators. To include this effect in your estimations (recommended) select the button Improved governance with additional revenue.

The "Smooth results" checkbox is ticked by default and will apply smoothing to the population results between the first year of increased revenue, and the start of the effect. Untick to remove smoothing.


**7. Select the SDG of interest (note it is possible to download all outcomes)**


**8. Select + on the 'Advanced' option**


**9. Select the 'Multiple country projection' option.**

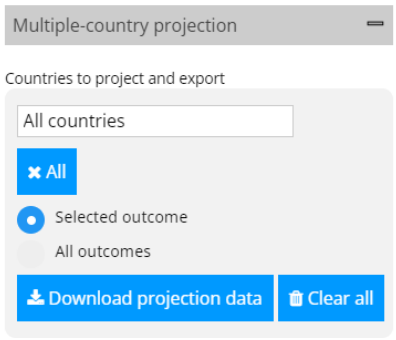
**Other options:**

**Target SDG**

This function can be used to estimate the additional government revenue required to increase the coverage of the SDGs in each country to a target coverage selected by the user.

**Data sources**

The population data and government revenue data used in GRADE can be downloaded here).




**10. Choose either the selected outcome or all outcomes.**

The downloaded projection data contains all current coverage and the improved coverage with additional revenue.

Appendix A: Definitions for the SDGs used in GRADE [10]

**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[11] 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 [12].

**Child School Years –** Here, we use school life expectancy (primary and secondary), for both sexes (years)–the number of years a person of school entrance age can expect to spend within the specified education level. For a child of a certain age, school life expectancy is calculated as the sum of age-specific enrolment rates for the specified levels of education. The part of enrolment not distributed by age is divided by the school-age population for the level of education they are enrolled in, multiplied by the duration of that level of education. The result was added to the sum of the age-specific enrolment rates. A relatively high school life expectancy indicates a greater probability of children spending more years in education and higher overall retention within the education system. Note that the expected number of years does not necessarily coincide with the expected number of education grades completed because of repetition. Since school life expectancy is an average based on participation in different levels of education, the expected number of years of schooling may be pulled down by the number of children who never go to school. The maximum SLE was 17 years, and we expressed the SLE for each country and year as a percentage of this to model the change if there is a change in government revenue and governance. We then multiply this by the number of children starting school, which we assume to be five.

[10] The World Bank. Databank - The World Bank. 2020.
[11] UNESCO Out of School rates https://education-estimates.org/out-of-school/data/
[12] UIS School age population http://data.uis.unesco.org/index.aspx?queryid=3847

## Appendix B: The Worldwide Governance Indicators

The WGI reports aggregate and individual governance indicators for over 200 countries and territories over 1996–2019 for six governance dimensions (see Table 1). These are composite indicators 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 [13].

**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 |

[13] Kaufmann D, Aart Kraay. Worldwide Governance Indicators. 2020.