



FRED DATA ACTIVITY · MACROECONOMICS

Decomposing Cross-Country GDP Per Worker Differences Using FRED

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Section 1 of 8 — Introduction

INTRODUCTION

Why Do Some Countries Produce So Much More Than Others?

There are vast differences in the production capacities across countries.

This activity demonstrates how to use the aggregate production function and FRED data to decompose GDP per-worker differences between countries.

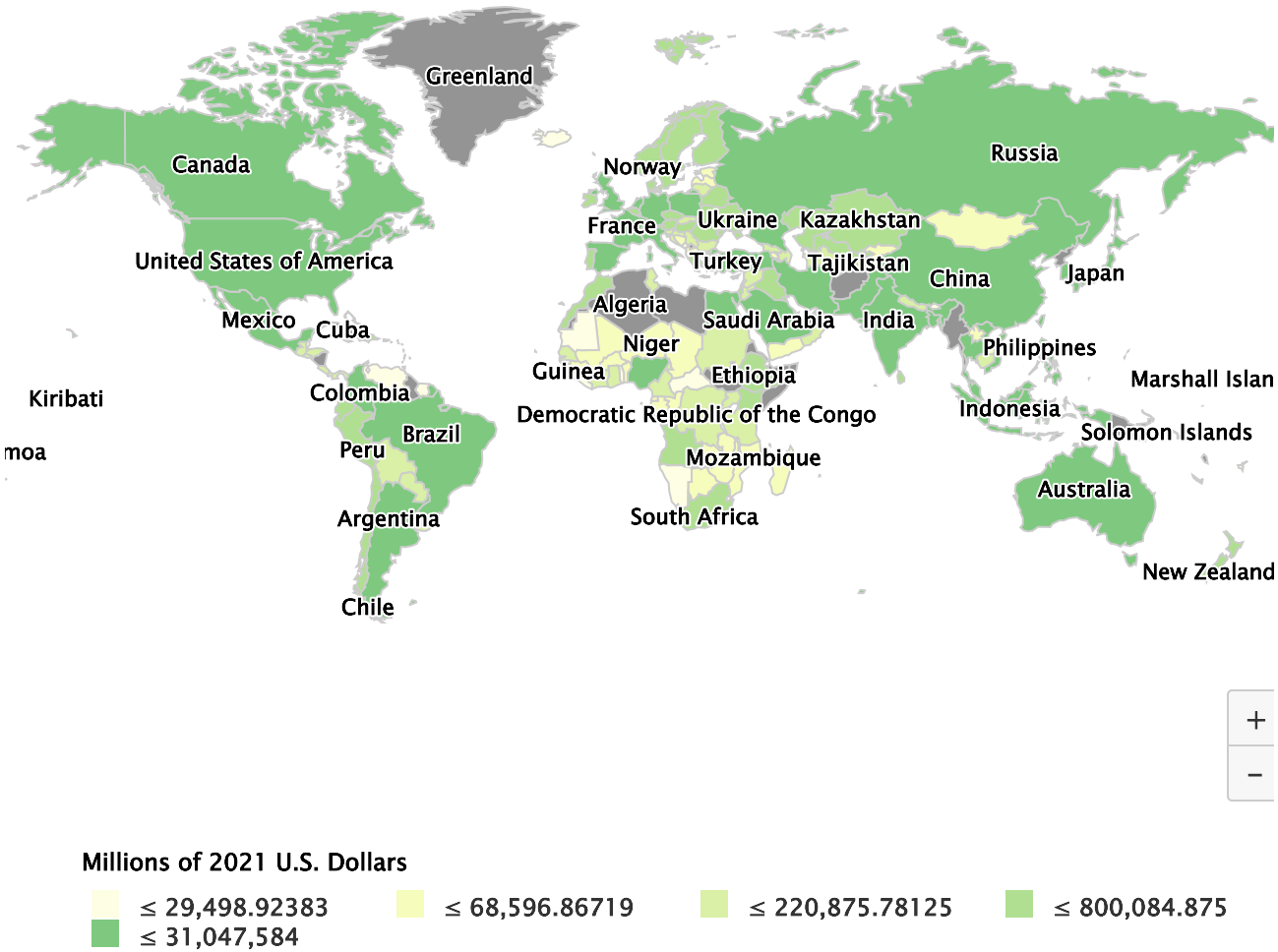
In particular, we will use data from the Penn World Table to estimate counterfactual scenarios in FRED.

By doing so, we will quantify the extent to which the GDP gap between two countries is driven by differences in human and physical capital versus differences in total factor productivity.

This analysis sheds light on why some countries are significantly wealthier than others.

FRED

2023 Real GDP at Constant National Prices by Nation (Millions of 2021 U.S. D



Sources: University of California, Davis; University of Groningen via FRED®

[Customize](#)

Live data from FRED — this is the kind of gap you'll be decomposing below.

BACKGROUND

The aggregate production function

Macroeconomists use the aggregate production function to model how a country's total output relates to the factors of production behind it.

For this exercise, we will model a country's output using a Cobb–Douglas production function:

$$Y = AK^{\alpha}H^{1-\alpha}$$

Y total output (GDP)

A total factor productivity (TFP)

K physical capital

H human capital

$\alpha = 0.3$ output elasticity w.r.t. capital

$1-\alpha = 0.7$ output elasticity w.r.t. labor

Human capital H is the product of the number of workers N and average hours worked per worker h , so $H = N \times h$. Substituting and dividing both sides by N gives the **per-worker production function**:

$$\frac{Y}{N} = \frac{AK^{0.3}N^{0.7}h^{0.7}}{N^{0.7}N^{0.3}} = A\left(\frac{K}{N}\right)^{0.3}h^{0.7}$$

Solving for A , total factor productivity can be backed out from data on output, capital, workers, and hours:

$$A = \frac{\frac{Y}{N}}{\left(\frac{K}{N}\right)^{0.3} h^{0.7}}$$

This is the one formula you'll reuse in every table below — the calculators do this arithmetic for you live as you type.

SETUP

Set up your comparison

Choose the country and year you'll compare against the United States — this drives every label, FRED series code, and chart from here on.

COMPARISON COUNTRY

FRED COUNTRY CODE

YEAR

Brazil

BRA

2023

FRED identifies each country with a 3-letter code (e.g. **USA**, **BRA**, **MEX**, **CHN**, **IND**) — you'll see it on the series page.

Load illustrative example numbers

THE QUESTION THIS WORKSHEET ANSWERS

$$\underbrace{\left(\frac{Y}{N}\right)_{US} - \left(\frac{Y}{N}\right)_X}_{\text{total gap}} = \underbrace{\text{TFP effect}}_{\text{technology}} + \underbrace{\text{capital \& hours effect}}_{\text{inputs}}$$

PART I

Estimate total factor productivity for the United States

▼ Show FRED steps (recommended)

- 1 Go to **Federal Reserve Economic Data (FRED)** and search for

Real GDP at Constant National Prices for United States

RGDPNAUSA666NRUG
- 2 Click **Edit Graph**, scroll to *Customize data*, and add these series one at a time:
 - Capital Stock at Constant National Prices, US

RKNANPUSA666NRUG
 - Number of Persons Engaged, US

EMPENGUSA148NRUG
 - Average Annual Hours Worked by Persons Engaged, US

AVHWPEUSA065NRUG
- 3 Scroll to the **Formula** section and enter, with a = GDP, b = capital, c = persons engaged, d = hours:

$$(a / c) / ((b / c)^{0.3} * d^{0.7})$$

then click **Apply formula**. That single series is A_{US} .

Once you have your values from FRED (or if you'd rather work it out by hand), fill in your 2023 values below and the productivity numbers update automatically:

United States, 2023						
Y (GDP)	K (CAPITAL)	N (WORKERS)	H (HOURS)	K/N	(K/N)^0.3	H^0.7
24977151	8082292	167.53971	1788.88	482,410.413	50.702	189

Units don't need to match FRED exactly — just be consistent. The calculator recomputes on every keystroke.

PART II

Estimate total factor productivity for Brazil

▼ Show FRED steps (recommended)

- 1 Repeat the same steps on FRED, this time for Brazil:

Real GDP at Constant National Prices for Brazil

RGDPNABRA666NRUG

- 2 Under *Customize data*, add:

- Capital Stock at Constant National Prices, Brazil

RKNANPBRA666NRUG

- Number of Persons Engaged, Brazil

EMPENGBRA148NRUG

- Average Annual Hours Worked by Persons Engaged, Brazil

AVHWPEBRA065NRUG

Series codes on FRED follow the pattern `SERIES + COUNTRYCODE + suffix` — swap in your country's 3-letter code above and search FRED to confirm the exact series exists for that country.

- 3 Scroll to **Formula** and enter the same formula as before:

$$(a / c) / ((b / c)^{0.3} * d^{0.7})$$

then click **Apply formula** to get A_X .

Once you have your values from FRED (or if you'd rather work it out by hand), fill them in below for 2023:

Brazil , 2023

8/6/26, 10:25 AM

Decomposing the GDP Gap — US vs Brazil (2023)

Y (GDP)	K (CAPITAL)	N (WORKERS)	H (HOURS)	K/N	(K/N)^0.3	H^0.7
3904424	1707394	99.29755	1993.72	171,947.284	37.206	20.4

PART III

Brazil's counterfactual GDP — with U.S. technology

What would Brazil produce per worker if it kept its own capital and hours, but had the United States' total factor productivity?

$$\left(\frac{\widehat{Y}}{N}\right)_X = A_{US}\left(\frac{K_X}{N_X}\right)^{0.3} h_X^{0.7}$$

▼ Show FRED steps (recommended)

- 1
- Start from A_{US} , the total factor productivity you estimated in Part I. On FRED, add Brazil's capital, workers, and hours series again (as in Part II) alongside your A_{US} series.
- 2
- Scroll to **Formula** and enter — with a,b,c,d the U.S. GDP/capital/persons/hours series and e,f,g Brazil's capital/persons/hours:

$$((a / c) / ((b / c)^{0.3} * d^{0.7})) * ((e / f)^{0.3} * g^{0.7})$$

then click

Apply formula.

Once you have your value from FRED (or if you'd rather work it out by hand), fill it in below for 2023 — or pull in the numbers you already entered above:

↓ Pull A(US) and Brazil's K, N, h from above

Brazil , counterfactual with U.S. technology

A (FROM US)	K (COMPARISON)	N (COMPARISON)	H (COMPARISON)	K/N	(K/N)^0.3	H^0.7
15.545	1707394	99.2975	1993.72	171,947.284	37.206	2

PART IV

Decompose the GDP-per-worker gap

With $(Y/N)_{US}$, $(Y/N)_X$, and the counterfactual $(\widehat{Y/N})_X$ in hand, split the total gap into a technology piece and an inputs piece.

1 · TOTAL GAP

109,761.5

$(Y/N)_{US} - (Y/N)_X$

2 · EXPLAINED BY TFP

78,704.62

$(\widehat{Y/N})_X - (Y/N)_X$

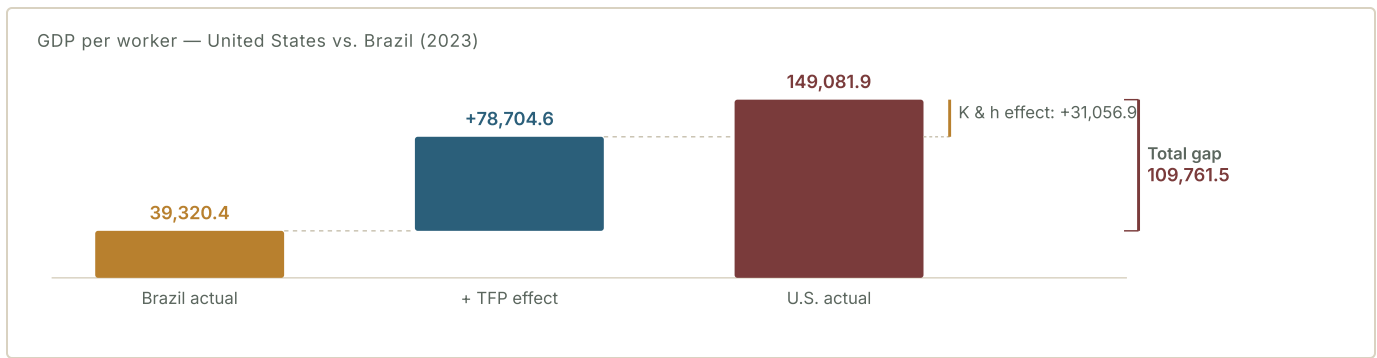
3 · EXPLAINED BY CAPITAL & HOURS

31,056.88

$(Y/N)_{US} - (\widehat{Y/N})_X$

✓ checks out — TFP effect + capital & hours effect = total gap

Visualizing the decomposition



Combine all three GDP per worker series and Embed your FRED graph

Bring the United States, comparison country, and counterfactual series together on one FRED graph, then embed it here.

To add the GDP per worker of the US:

- 1 Start with the FRED counterfactual series you estimated in Part III. Click **Edit Graph** and select **Add Line**, then add [Real GDP at Constant National Prices for United States](#)

[RGDPNAUSA666NRUG](#) .

- 2 Scroll to *Customize data*, and add the series [Number of Persons Engaged, US](#)

[EMPENGUSA148NRUG](#) .

- 3 $\frac{a}{b}$

Scroll to the **Formula** section and enter: $\frac{a}{b}$ then click **Apply Formula**.

To add the GDP per worker of Brazil:

- 1 Start with the same FRED counterfactual series you estimated in Part III. Click **Edit Graph** and select **Add Line**, then add [Real GDP at Constant National Prices for Brazil](#)

[RGDPNABRA666NRUG](#) .

- 2 Scroll to *Customize data*, and add the series [Number of Persons Engaged, Brazil](#)

[EMPENGBRA148NRUG](#) .

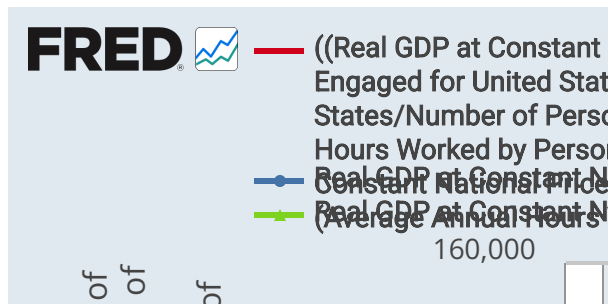
- 3 $\frac{a}{b}$

Scroll to the **Formula** section and enter: $\frac{a}{b}$ then click **Apply Formula**.

Once all three series — the US, Brazil, and the counterfactual — are on the same graph, continue with embedding it below:

- 1 Go to the final graph you created on the FRED website.
- 2 In the lower left-hand corner, click **"Share Graph."**
- 3 Select **"Embed in Website."**
- 4 Click **"Make it Responsive"** and copy the corresponding code.
- 5 Paste the embed code below.

```
<div class="embed-container"><iframe src="https://fred.stlouisfed.org/graph/graph-landing.php?g=1XMCa&width=670&height=475" scrolling="no" frameborder="0" style="overflow:hidden;" allowTransparency="true" loading="lazy"></iframe></div><script src="https://fred.stlouisfed.org/assets/stlrich-fred/fred-graph-react/embed.min.js" type="text/javascript"></script>
```



Your graph will render above once you paste valid embed code.

PART V

Answer Reflection Questions, Save & Submit your Work

1. TFP is the "residual" — whatever capital and hours don't explain. What real-world factors (institutions, technology adoption, worker skill, misallocation)

might be hiding in your TFP gap — and how would explicitly measuring education/skill change your estimate?

Write your answer here...

2. Does a lower estimated A mean workers in Brazil are less capable or less hardworking? Why or why not — what is this model actually measuring?

Write your answer here...

3. This exercise assumes the same capital share ($\alpha = 0.3$) for both countries. Is that realistic? How might your decomposition change if the comparison country's true capital share were different?

Write your answer here...

Your inputs are saved automatically in this browser as you work.

[Download my results](#)

[Clear saved work](#)

Downloading creates a single, self-contained HTML file with your inputs, calculations, chart, and reflection answers — open it in any browser, or upload it wherever your instructor collects submissions.

Interactive worksheet — adapted from the FRED GDP-gap decomposition activity · Andres J. Vargas, Purdue University
Department of Economics