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# Policy Memo Presentation

## Dated: Winter 2025

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# The Impact of primary school enrollment on GDP per capita in developing countries

# Research question & Relevance

## Research Question

Does increased primary school enrollment rate increase GDP per capita?

## Research Relevance

- **Empirical evidence**: Establishing a causal relationship is *crucial for designing effective education policies*: Glewwe et al, 2014 & Kobzev et al, 2018 have empirically tested this.
- **Resource Allocation**: Understanding causal relationship can helps governments and organizations *allocate education resources more effectively*.

# Hypothesis

**Null Hypothesis ($H_0$):**

→ Increased primary school enrollment rate ***has no effect*** on GDP per capita.

**Alternative Hypothesis ($H_1$)**

→ Increased primary school enrollment rate ***positively affects GDP per capita***.

# Data and variables

- **Data source: WB's World Development Indicators (WDI)**

  *Can be accessed at https://data.worldbank.org/*

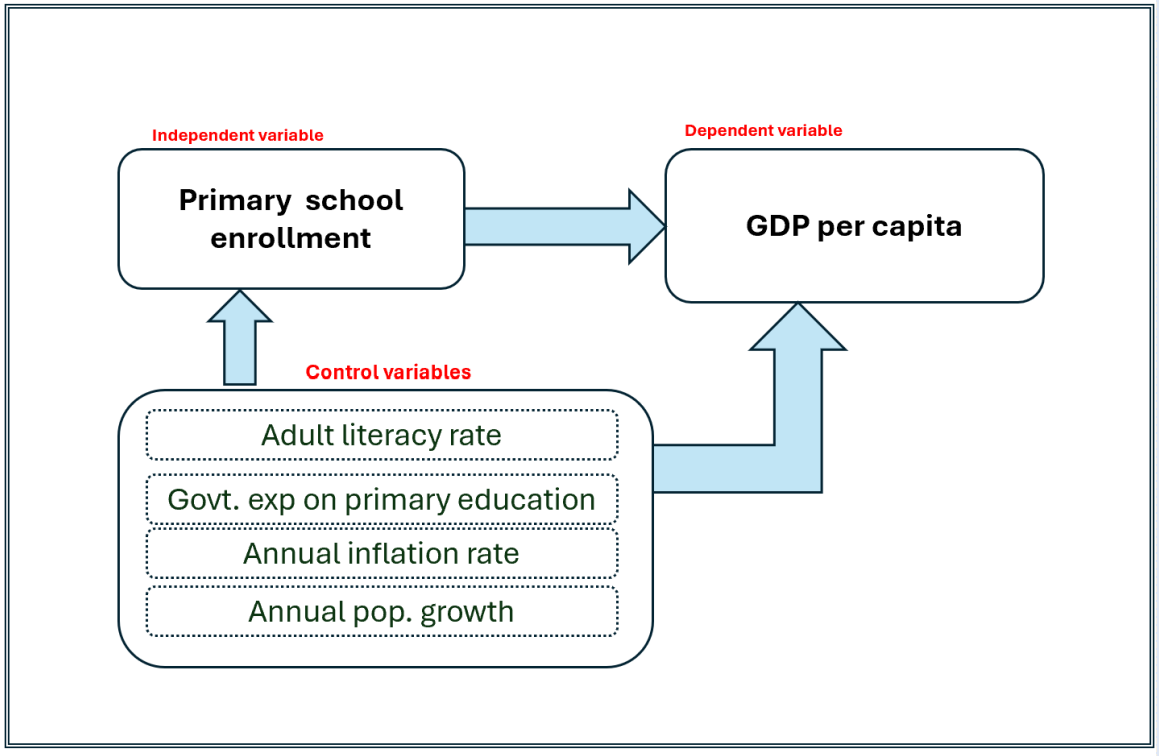
- country-Year panel dataset of:
  - 54 countries in Africa
  - 64 years – 1960-2023
  - Observations : 3,456, *each country has a record each year*
- Unit of Observation: A county-year –with data on GDP per capita, education etc
- Key variables of analysis: 7

# Table 1:Variable definitions

| Type | Name | Definition | Scale |
|---|---|---|---|
| Dependent | GDP per capita | Average economic output per person in thousand USD in a country. Computed as **GDP/total population** | Continuous |
| Independent | Primary School Enrollment | Number of school people enrolled in primary school in a year divided by total enrollments as % | Continuous |
| Control | Adult literacy rate | % of people ages 15 and over who are literate | Continuous |
| Control | Government expenditure on pri. Education | Govt expenditure on prim educ per stud as a % of GDP per capita | Continuous |
| Control | Annual inflation rate | Rate of price change in the economy as a whole, %. | Continuous |
| Control | Population growth rate | Rate at which population growths, from time time(t) to time (t+1) as % | Continuous |

**Notes**: Enrollment % can exceed 100% because the denominator accounts for school going age only, yet the numerator can have adults in primary, examples: Kenya : Primary 6-13, Ghana/Algeria/Morocco: 6-11
Countries are further categorized into regions: Eastern Africa , Middle Africa, Northern Africa, Southern Africa and Western Africa

# Impact Pathways




- Primary school lays the foundation for entry into higher education institutions-hence a more educated workforce-rise in innovation and boost in GDP;
- Literate adults make better decisions around taking their children to school
  → leads to increased enrollment
  →Literate adults can innovate and boosts GDP
- Increased inflation-prices for services and goods rise-education enrollment falls, GDP too falls
- Population growth leads to increased enrollments, while it reduced GDP per capita (If GDP remains constant and pop. Grows)



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# Table 2: Descriptive Statistics

| Variable | Mean | SD | Min | Max | Missing |
|---|---|---|---|---|---|
| GDP per capita "000" USD | 1351.27 | 2220.77 | 35.36 | 19141.51 | 306 |
| Enrollment in  pry School | 86.06 | 30.22 | 6.94 | 156.8 | 1166 |
| Adult literacy | 60.37 | 21.71 | 5.4 | 96.2 | 3132 |
| Govt. exp on education | 12.75 | 5.93 | 3.03 | 41.81 | 3066 |
| Annual inflation rate | 28.54 | 509.25 | -31.57 | 26762.02 | 442 |
| Population growth rate | 2.51 | 1.36 | -17.99 | 16.75 | 55 |

Observations :3456

- Literacy level slightly below current -68%
- Huge variation in GDP per capita, as low as < USD 20,000, and high as > USD 20 B

# EDA: Distributions and Data Transformation

**Fig 1 a: Distribution in GDP per capita for African countries (1960-2023), prior to transformation**

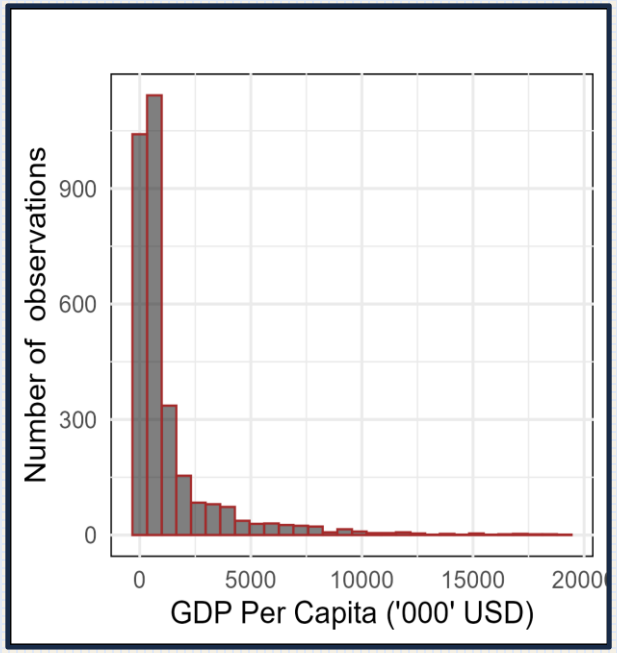



**Fig 1 b: Distribution in GDP per capita for African countries (1960-2023), post transformation**

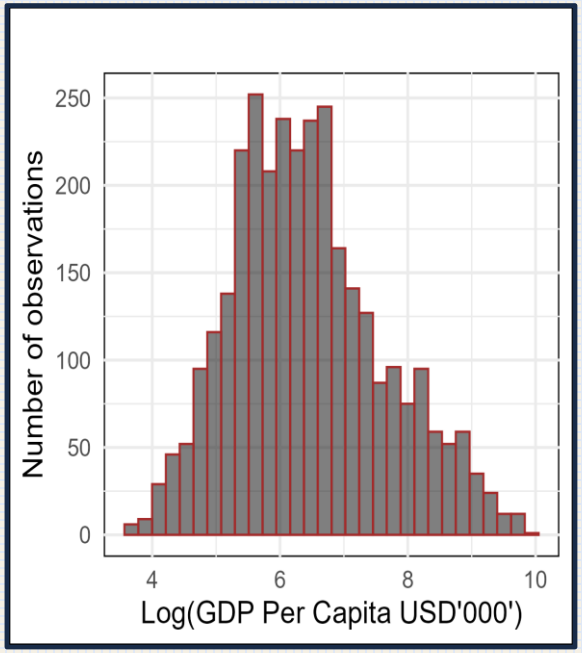
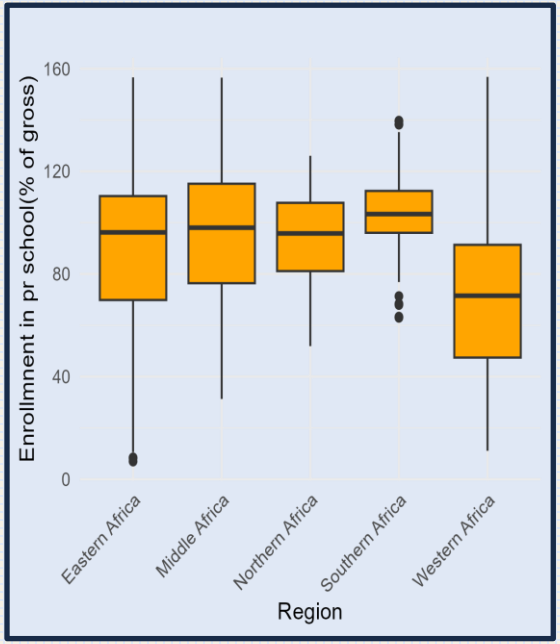



**Fig 1 c: Pry School enrollment by Sub-region for African countries (1960-2023)**




**Note**s: Figure 1 c is the distribution of raw GDP per capita values for all country-years and exhibits right-skewness. This is corrected in Figure 1b. Figure 1c presents primary school enrollment by region. Southern Africa is outperforming the rest, Western Africa has least median.. N=3456 observations.



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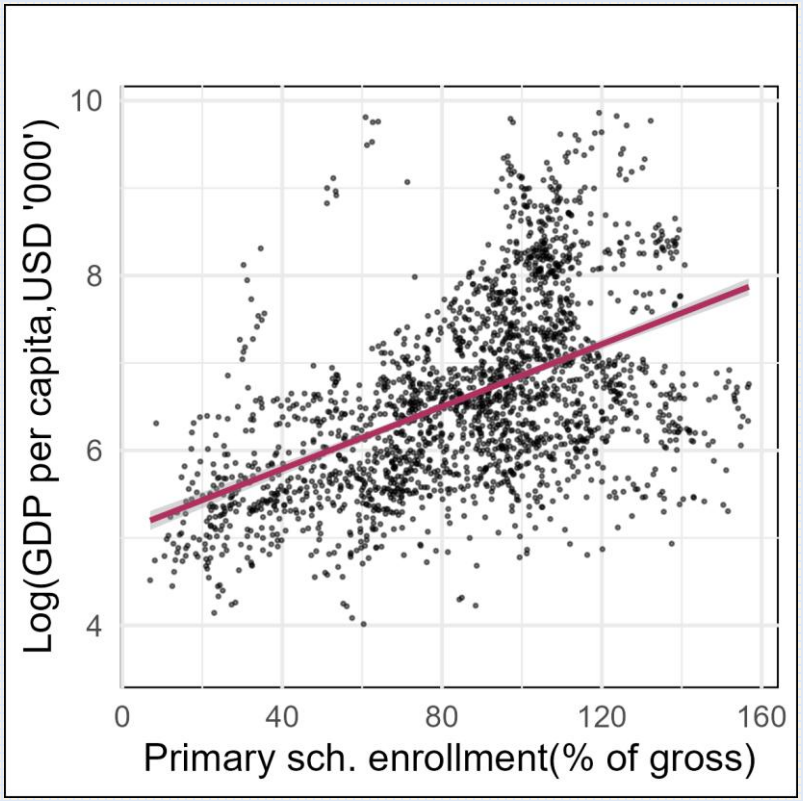
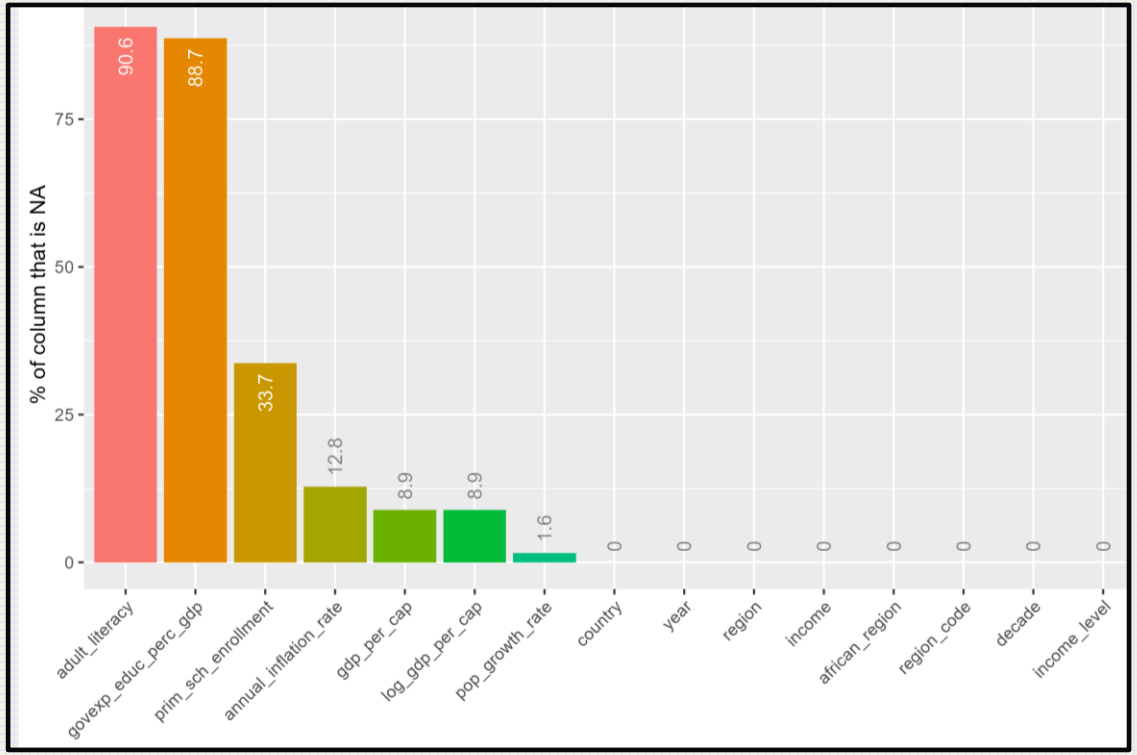
# EDA: How does GDP per capita relate with school enrollment?




- A strong positive relationship between GDP per capita and primary school enrollment rate
- At lower levels of enrollment, we observe lower GDP per capita
- At higher levels of enrollment, we observe higher GDP per capita
- A signal to investigate further if this is causal

**Note: Enrollment** % can exceed 100% because the denominator accounts for school going age only.

# EDA: Examining missing data and implications




## Notable missing observations

- ✓ Adult literacy and government expenditure on primary education at about 91% and 89% respectively.
- ✓ Primary school enrollment at 34%

**Impact:**

- ✓ biased estimates
- ✓ spurious/false regression results

**Solution**: multiple imputation



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# Table 3: OLS Regression analysis – prior to multiple imputation

Table 3: Impact of primary school enrollment on the Economy (GDP per Capita) for developing countries

| | *Dependent variable:* | | | | |
|---|---|---|---|---|---|
| | Log(GDP per capita,'000' USD) | | | | |
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
| Enrollment in pry school | 0.018*** | −0.005* | −0.014*** | −0.015*** | −0.014*** |
| | (0.001) | (0.002) | (0.005) | (0.004) | (0.004) |
| Adult literacy | | 0.035*** | 0.038*** | 0.040*** | 0.038*** |
| | | (0.003) | (0.004) | (0.004) | (0.006) |
| Govt. exp. on education | | | 0.007 | −0.007 | −0.022 |
| | | | (0.015) | (0.014) | (0.015) |
| Annual inflation rate | | | | −0.043*** | −0.031*** |
| | | | | (0.010) | (0.010) |
| Pop. growth rate | | | | | −0.063 |
| | | | | | (0.089) |
| Decade Effects | - | - | - | - | YES |
| Region Effects | - | - | - | - | YES |
| Constant | 5.075*** | 5.314*** | 6.208*** | 6.604*** | 6.262*** |
| | (0.059) | (0.189) | (0.500) | (0.466) | (0.729) |
| Observations | 2,230 | 276 | 89 | 89 | 89 |
| $R^2$ | 0.253 | 0.450 | 0.495 | 0.584 | 0.704 |
| Adjusted $R^2$ | 0.252 | 0.446 | 0.477 | 0.565 | 0.661 |
| Residual Std. Error | 0.930 (df = 2228) | 0.791 (df = 273) | 0.762 (df = 85) | 0.696 (df = 84) | 0.614 (df = 77) |
| F Statistic | 753.668*** (df = 1; 2228) | 111.555*** (df = 2; 273) | 27.785*** (df = 3; 85) | 29.522*** (df = 4; 84) | 16.611*** (df = 11; 77) |

Significance level: *p<0.1; **p<0.05; ***p<0.01

Data Source: The World Bank

# Table 2: OLS Regression analysis – post multiple imputation

Table 4: Impact of primary school enrollment on the Economy (GDP per Capita) for developing countries

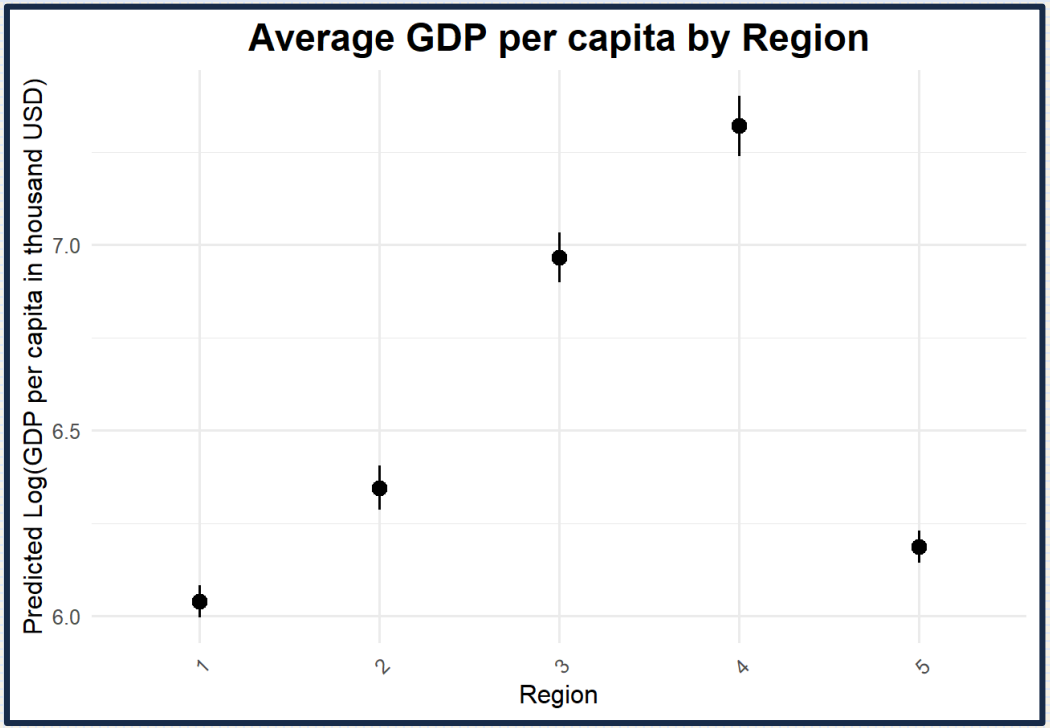
| | *Dependent variable:* | | | | |
|---|---|---|---|---|---|
| | Log(GDP per capita,'000' USD) | | | | |
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
| Enrollment in pry school | 0.017*** | 0.016*** | 0.017*** | 0.016*** | 0.010*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Adult literacy | | 0.017*** | 0.017*** | 0.015*** | 0.012*** |
| | | (0.003) | (0.003) | (0.003) | (0.002) |
| Govt. exp. on education | | | 0.041*** | 0.038*** | 0.025*** |
| | | | (0.008) | (0.008) | (0.006) |
| Annual inflation rate | | | −0.0002* | −0.0002 | −0.0002* |
| | | | (0.0001) | (0.0001) | (0.0001) |
| Pop. growth rate | | | | −0.120*** | −0.065*** |
| | | | | (0.014) | (0.011) |
| Decade Effects | - | - | - | - | YES |
| Region Effects | - | - | - | - | YES |
| Constant | 4.906*** | 3.950*** | 3.421*** | 3.889*** | 3.391*** |
| | (0.059) | (0.158) | (0.192) | (0.198) | (0.162) |
| Observations | 3,272 | 3,272 | 3,272 | 3,272 | 3,272 |
| $R^2$ | 0.169 | 0.180 | 0.186 | 0.204 | 0.533 |
| Adjusted $R^2$ | 0.169 | 0.179 | 0.185 | 0.203 | 0.531 |
| Residual Std. Error | 0.932 (df = 3270) | 0.927 (df = 3269) | 0.923 (df = 3267) | 0.913 (df = 3266) | 0.701 (df = 3256) |
| F Statistic | 665.920*** (df = 1; 3270) | 358.434*** (df = 2; 3269) | 187.192*** (df = 4; 3267) | 167.604*** (df = 5; 3266) | 247.430*** (df = 15; 3256) |

Significance level: *p<0.1; **p<0.05; ***p<0.01

Data Source:The World Bank

**Note:** Post imputation estimates are significant and logical to interpret. 184 observations identified as extreme dropped.

# Post estimation / Predictions from model




Region Codes: 1= Eastern, 2=Middle, 3=Northern, 4=Southern, 5=Western.

**The average predicted values of GDP per capita increase from the model for selected regions:**

- Lowest performing- Eastern approx. 420 thousand USD.
- Best performing- Southern approx. 520 thousand USD.
- All predictions statistically significant at 5% level



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# Discussion and limitations

→ Post-imputation analysis reveals that a **10%** increase in primary school enrollment leads to approximately a **10%** rise in GDP per capita, a statistically significant finding.
→ Governments should prioritize investments in primary education access and completion as a proven, cost-effective strategy for sustainable economic growth.

**Limitations**

The causal model does not account for all variables that might impact GDP per capita

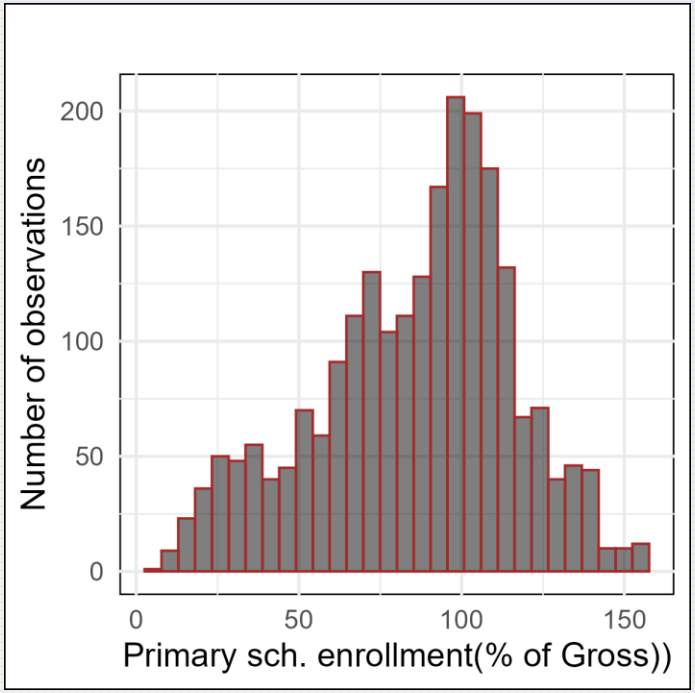
- → **Threat 1**: Many **missing data-** addressed through multiple imputation
- → **Threat 2: Outliers** present – detected using Cook's distance measure - combines residual magnitude and leverage to measure how much the fitted values would change if an observation were removed-dropped from analysis
- → **Threat 3**: **Multicollinearity** – Tested using variance inflation factor (VIF) and none of the covariates were collinear.

# THE END

Comments:

→ Take the time, I had rush on some tables

Appendix A: Robustness Checks, for final paper
Appendix B: Extra figures



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