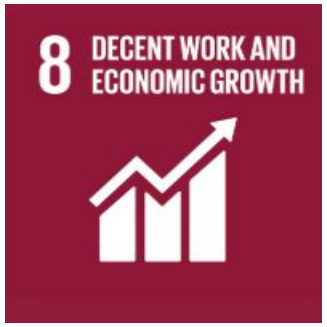
UNIVERSITY
OF COLOGNE

EEMP 2024 – GROUP 1

Angelika Stauch, Patrik Zoltan Peter, Oskar Matthias Lange

18/11/2024

Research Question & Hypothesis



“Do improvements in education predict higher economic growth?”

Null-hypothesis:

- average years of schooling have **no** relation to GDP per capita

Alternative:

- average years of schooling have a **relation** to GDP per capita

(log) GDP per capita = a + b*Average years of schooling + … + e

linear regression form

Data Overview

Description	Value
Type of data	Observational; Panel data
Timeframe	1999 – 2022
Countries	156

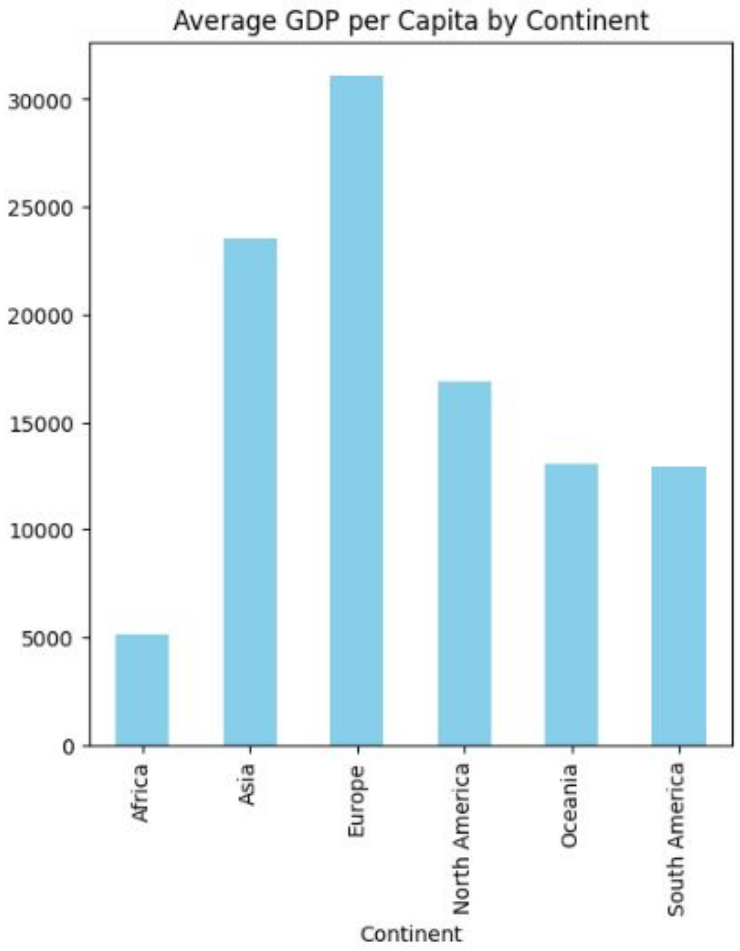
Description	Value
Number of Observations	3586
Variables	10
Currency	US$ PPP

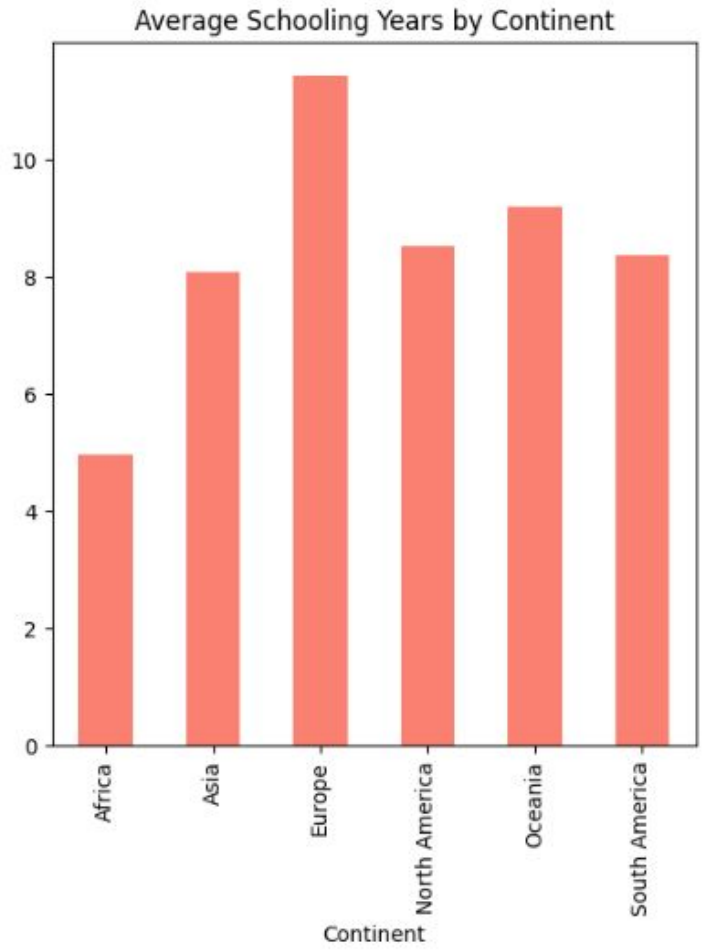
Data Sources:
raw.githubusercontent.com/AStauch/GroupWork_EEMP_NameResearchQuestion/refs/heads/main/Data/0.Data Sources and Variables.txt

	Country	Year	GDP_PPP	AvYearsSchooling	educationLevel	Continent	IncomeGroup	LifeExp	Urbanization	UnemploymentRate	Log_GDP_PPP
1	Albania	1999	3471.667789	8.472385	Middle	Europe	LM	75.183	41.169	20.840	8.152390
2	Algeria	1999	8813.539568	6.424954	Middle	Africa	LM	70.032	59.118	28.542	9.084044
3	Angola	1999	3221.132886	3.387043	Low	Africa	L	45.386	48.897	16.430	8.077488
4	Argentina	1999	11508.157050	8.732238	Middle	South America	UM	73.722	88.952	14.050	9.350811
5	Armenia	1999	2347.799582	10.418350	High	Europe	L	70.257	64.947	11.200	7.761234
...	...	...	...	...	...	...	...	...	...	...	...
3633	Uruguay	2022	32746.315280	9.058220	Middle	South America	H	78.000	95.688	7.870	10.396546
3634	Uzbekistan	2022	9042.343916	11.911150	High	Asia	LM	71.674	50.466	4.507	9.109674
3635	Vanuatu	2022	3203.616623	7.183210	Middle	Oceania	LM	70.492	25.816	5.219	8.072036
3637	Zambia	2022	3864.894367	7.284893	Middle	Africa	LM	61.803	45.761	4.374	8.259690
3638	Zimbabwe	2022	3660.835501	8.807762	Middle	Africa	LM	59.391	32.395	9.256	8.205447

3586 rows × 11 columns

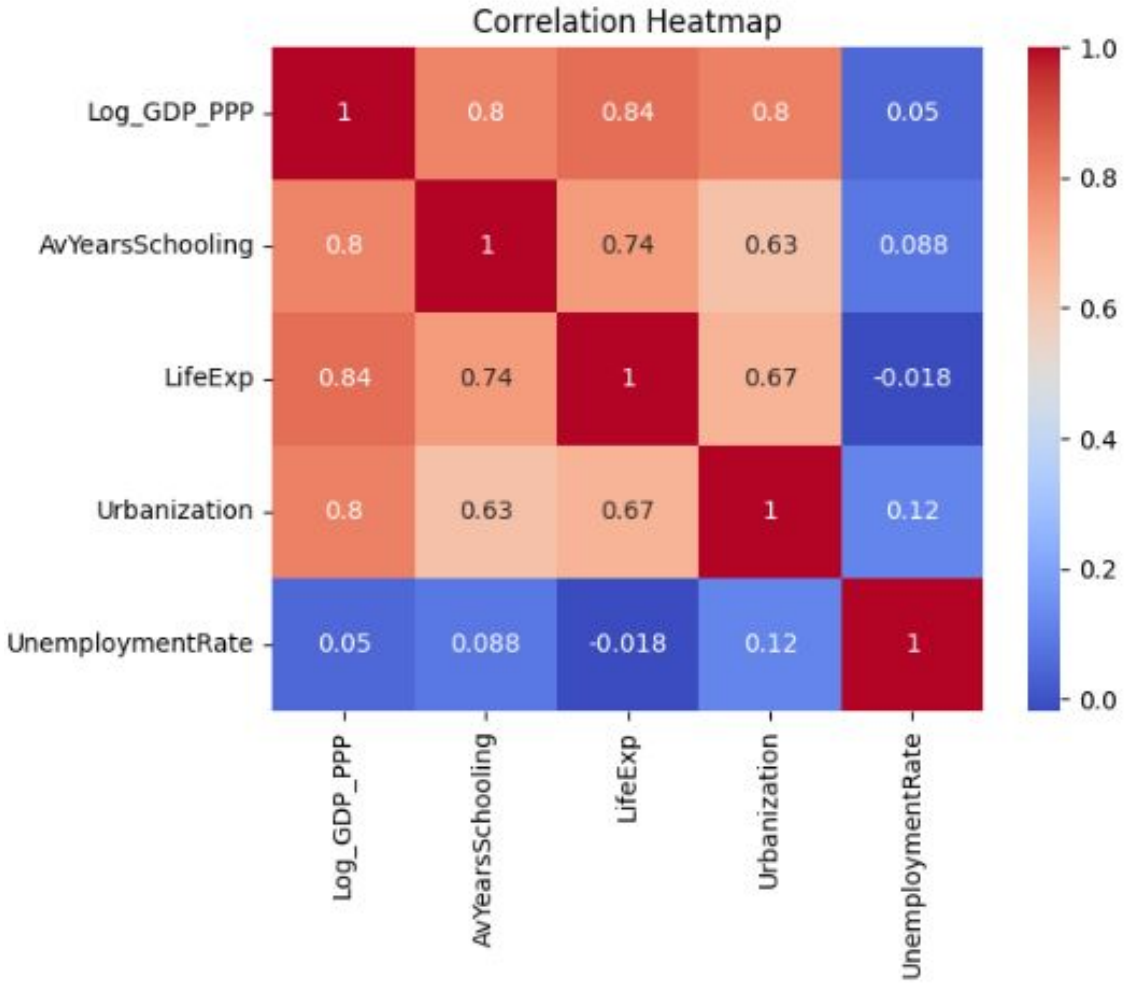
Visualization





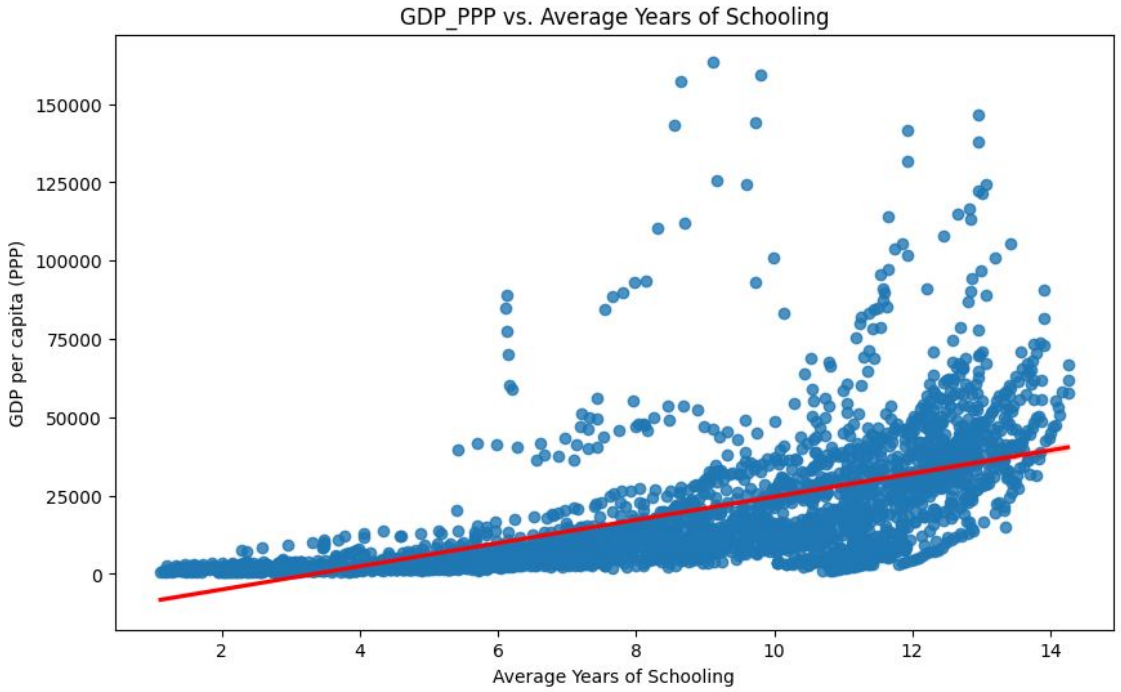
- Europe leads in both metrics
- Africa lags behind
- Other continents show balanced trends

Visualization



- Simplifying relationships between variables
- Strong positive correlation between schooling, life expectancy, urbanization and GDP
- Weak influence of unemployment rate

Simple Regression



	Log_GDP_PPP
	(1)
AvYearsSchooling	0.290***
	(0.014)
Intercept	6.790***
	(0.122)
Observations	3586
S.E. type	by: Country
R^2	0.632

Significance levels: * p < 0.05, ** p < 0.01, *** p < 0.001.
Format of coefficient cell: Coefficient (Std. Error)

Specifications:

- Log GDP per capita
- Robust standard errors clustered on countries

- **Coefficient:** significant (p<0.001)
- **Acceptable standard errors:** conf. bands between ~ 26%–31,5% (for 5%-significance level)
- **R²:** moderate-high

Control Variables

LifeExp → AvYearsSchooling
LifeExp → Log_GDP_PPP

UrbanizationRate → AvYearsSchooling
UrbanizationRate → Log_GDP_PPP

UnemploymentRate → Log_GDP_PPP

- still a positive relation on AvYearsSchooling on Log_GDP_PPP
- R^2 increases substantially

- once adding country-level fixed effects, the relation becomes non-significant
- R^2 is now really high!

  -> overfit in our model?

	Log_GDP_PPP			
	(1)	(2)	(3)	(4)
AvYearsSchooling	0.290*** (0.014)	0.285*** (0.015)	0.098*** (0.016)	-0.036 (0.027)
UnemploymentRate			-0.002 (0.007)	-0.021*** (0.004)
Urbanization			0.020*** (0.003)	0.002 (0.006)
LifeExp			0.051*** (0.007)	0.004 (0.006)
Intercept	6.790*** (0.122)			
Year	-	x	x	x
Country	-	-	-	x
Observations	3586	3586	3586	3586
S.E. type	by: Country	by: Country	by: Country	by: Country
R^2	0.632	0.639	0.848	0.984

Significance levels: * p < 0.05, ** p < 0.01, *** p < 0.001. Format of coefficient cell: Coefficient (Std. Error)

Regional Effects

- Education drives growth, but regional disparities exist
- South America, Asia and Oceania show weaker returns on education compared to Africa
- Urbanization and life expectancy are significant contributors to GDP

	Log_GDP_PPP			
	(1)	(2)	(3)	(4)
AvYearsSchooling	0.285***	0.251***	0.302***	0.171***
	(0.015)	(0.023)	(0.034)	(0.027)
AvYearsSchooling:Continent[T.Asia]			-0.095	-0.127***
			(0.058)	(0.036)
AvYearsSchooling:Continent[T.Europe]			-0.098	-0.063
			(0.063)	(0.046)
AvYearsSchooling:Continent[T.North America]			-0.025	-0.014
			(0.043)	(0.038)
AvYearsSchooling:Continent[T.Oceania]			-0.028	-0.112*
			(0.072)	(0.047)
AvYearsSchooling:Continent[T.South America]			-0.128*	-0.210***
			(0.052)	(0.060)
Urbanization				0.021***
				(0.003)
LifeExp				0.054***
				(0.007)
UnemploymentRate				-0.010
				(0.008)
Continent	-	x	x	x
Year	x	x	x	x
Observations	3586	3586	3586	3586
S.E. type	by: Country	by: Country	by: Country	by: Country
R^2	0.639	0.675	0.682	0.867

Significance levels: * p < 0.05, ** p < 0.01, *** p < 0.001. Format of coefficient cell: Coefficient (Std. Error)

Difference-in-Difference Estimation

- Baseline advantage for Croatia
- Post-2013 growth for all countries
- Negative effect of EU Membership (Model 4)

	Log_GDP_PPP			
	(1)	(2)	(3)	(4)
AvYearsSchooling	0.207*** (0.025)	0.100*** (0.021)	0.148*** (0.025)	0.072 (0.038)
Treatment		0.709*** (0.102)	0.478*** (0.079)	0.765*** (0.072)
Post_2013		0.611*** (0.062)	0.343*** (0.053)	
EU_Croatia		-0.175 (0.156)	-0.187 (0.112)	-0.219** (0.051)
LifeExp			0.075*** (0.009)	0.016 (0.020)
Urbanization			0.013*** (0.002)	0.014* (0.005)
UnemploymentRate			-0.000 (0.005)	0.015 (0.008)
Intercept	7.156*** (0.267)	7.922*** (0.209)	1.300* (0.648)	
Year	-	-	-	x
Observations	176	176	176	176
S.E. type	iid	iid	iid	by: Country
R^2	0.281	0.620	0.810	0.947

Significance levels: * p < 0.05, ** p < 0.01, *** p < 0.001. Format of coefficient cell: Coefficient (Std. Error)

Causal Interpretation and Limitations

Challenges

Omitted Variable Bias

- Quality of Institution
- Historical Event

Reverse Causality

- Higher GDP → Better Education = Feedback Loop

Multicollinearity

- Strong correlations make coefficients unreliable

Solutions

Instrumental Variables

- Historical policies

Machine Learning

- Explore non-linear and heterogeneous effects

Dynamic Panel Models

- Address feedback loop over time

→ Findings only show association, countries with higher schooling levels tend to have higher GDP

Further Research

Step 1: Collect Data on additional variables

Step 2: Focus on regional subgroup analysis

Dimensions	Variable	Description
Health and Demographics	Infant Mortality Rate	Proxy for healthcare
	Population Age Structure (proportion of working-age population)	Reflect economic productivity potential
Politics	Political Stability	Fragile States Index
	Ease of Doing Business	World Bank Index
	Corruption Index	Measure of perceived corruption
Geospatial Data	Latitude	Proxy for climatic conditions

UNIVERSITY
OF COLOGNE

THANK YOU FOR LISTENING!

EEMP 2024 – GROUP 1

Angelika Stauch, Patrik Zoltan Peter, Oskar Matthias Lange

18/11/2024