

# The Role of Education in Enhancing Productivity: Some International Comparisons

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# How related is education to economic productivity?

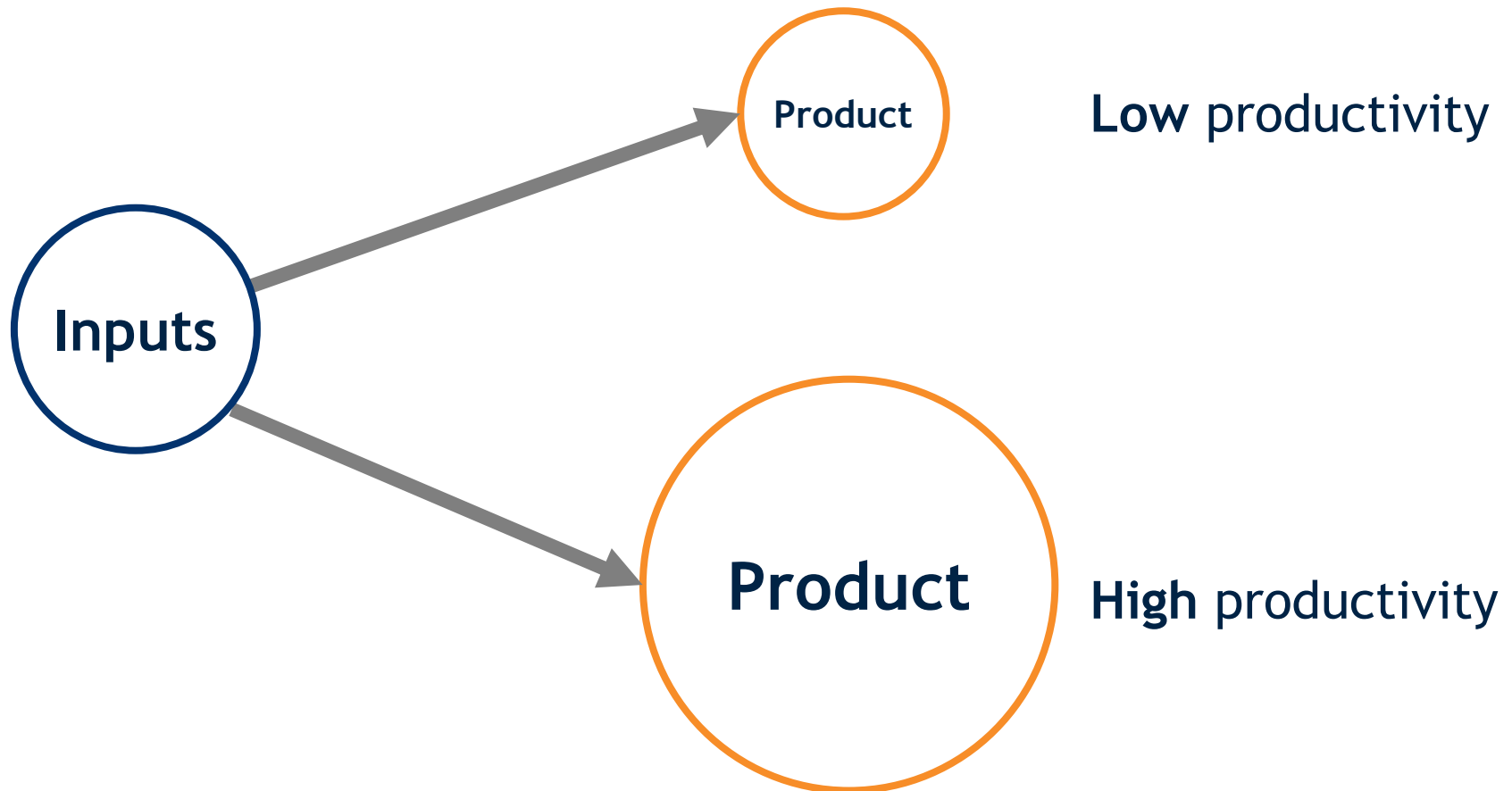
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1. What is economic productivity?
2. What are main drivers of productivity?
3. What are the perceived quality and performance of education system?
4. How related is education to the level of productivity as compared to other main drivers?

# What is economic productivity?

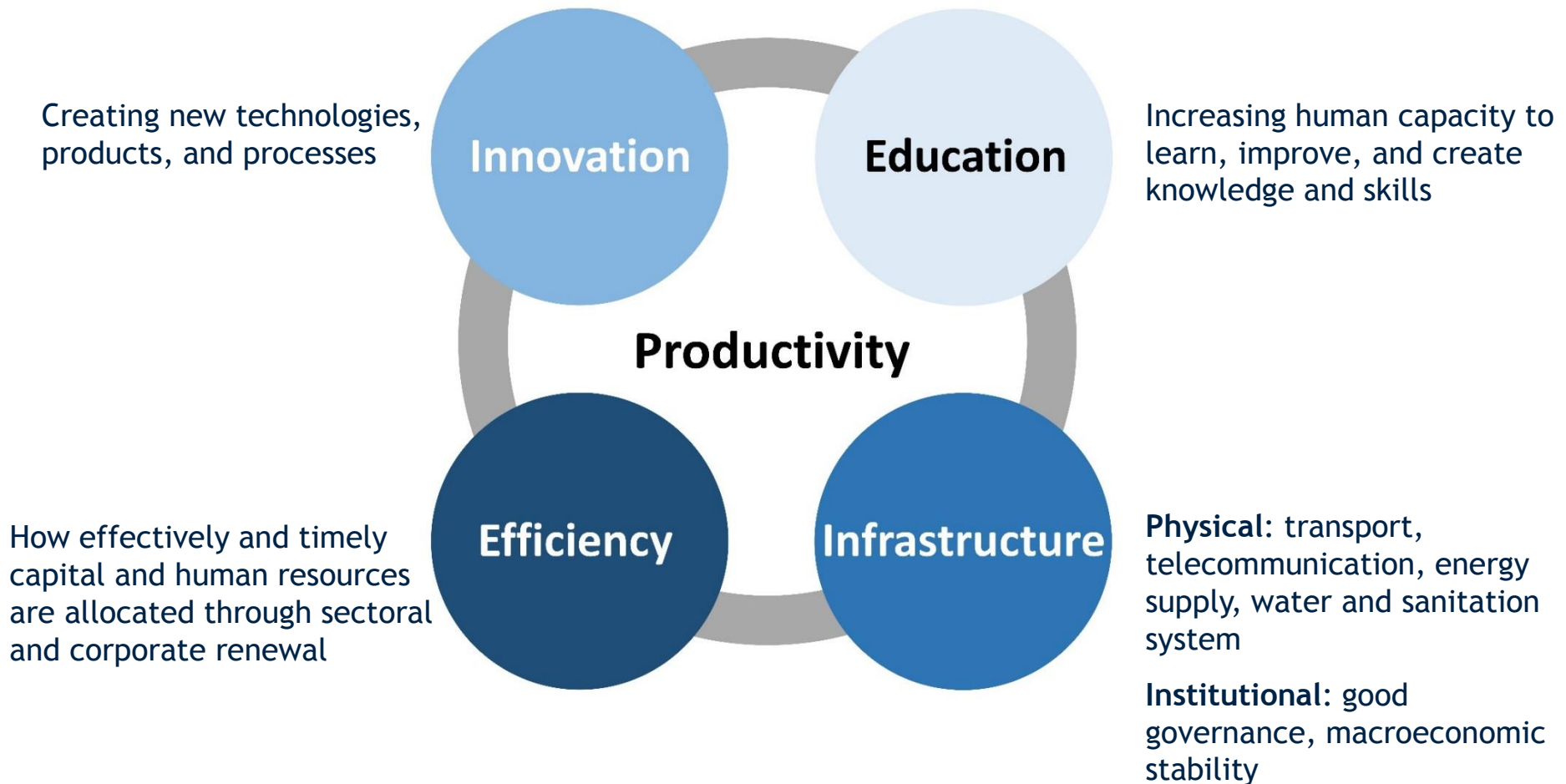
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**Productivity is the value of product per unit of input.**



# What are main drivers of productivity?

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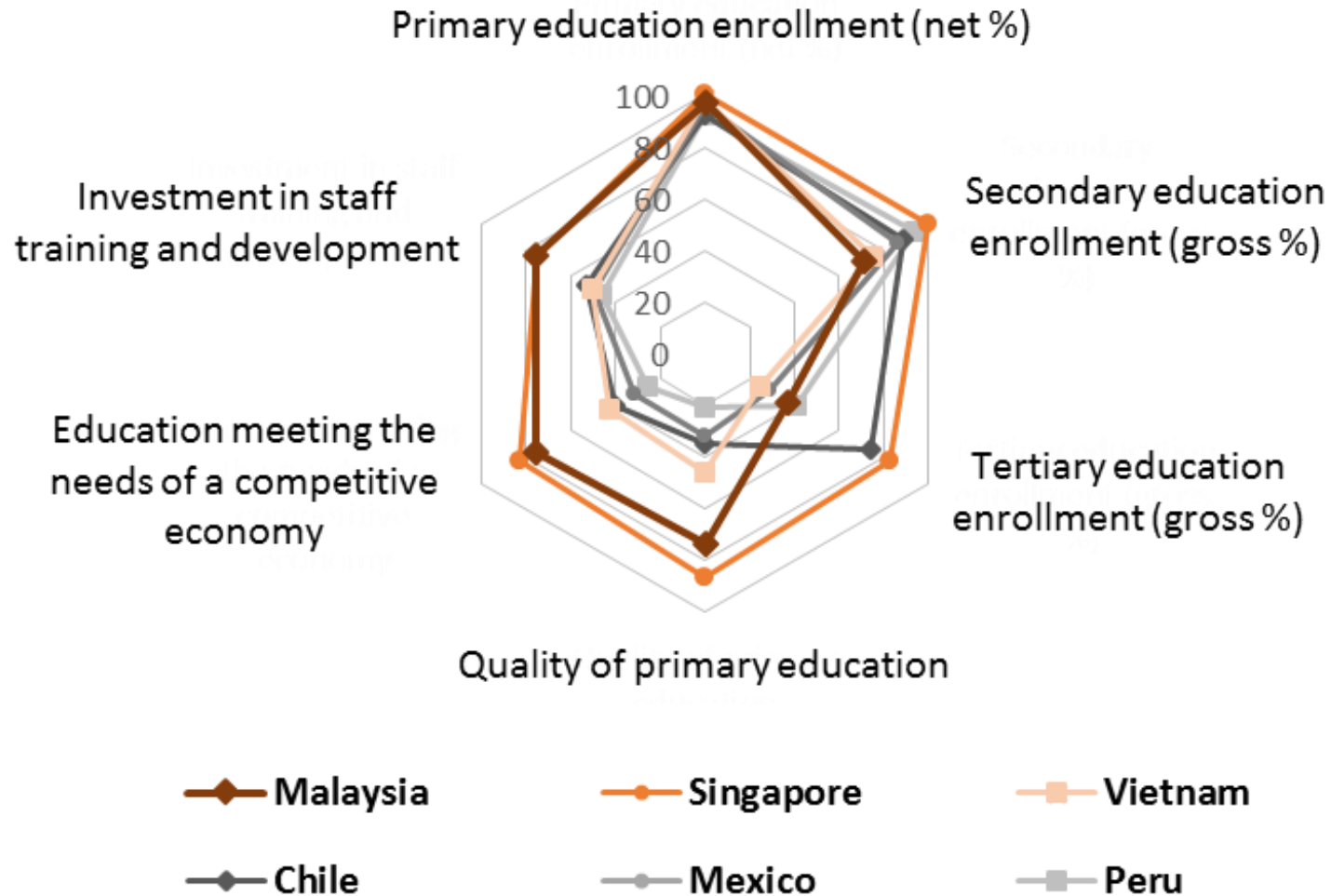
(Source: Kim, Loayza, and Meza-Cuadra. 2016. Productivity as the key to economic growth and development. Research Policy

# How related is education to economic productivity?

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2. What are main drivers of productivity?
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4. How related is education to the level of productivity as compared to other main drivers?

# Average school enrollment and the perceived quality of education vary country to country

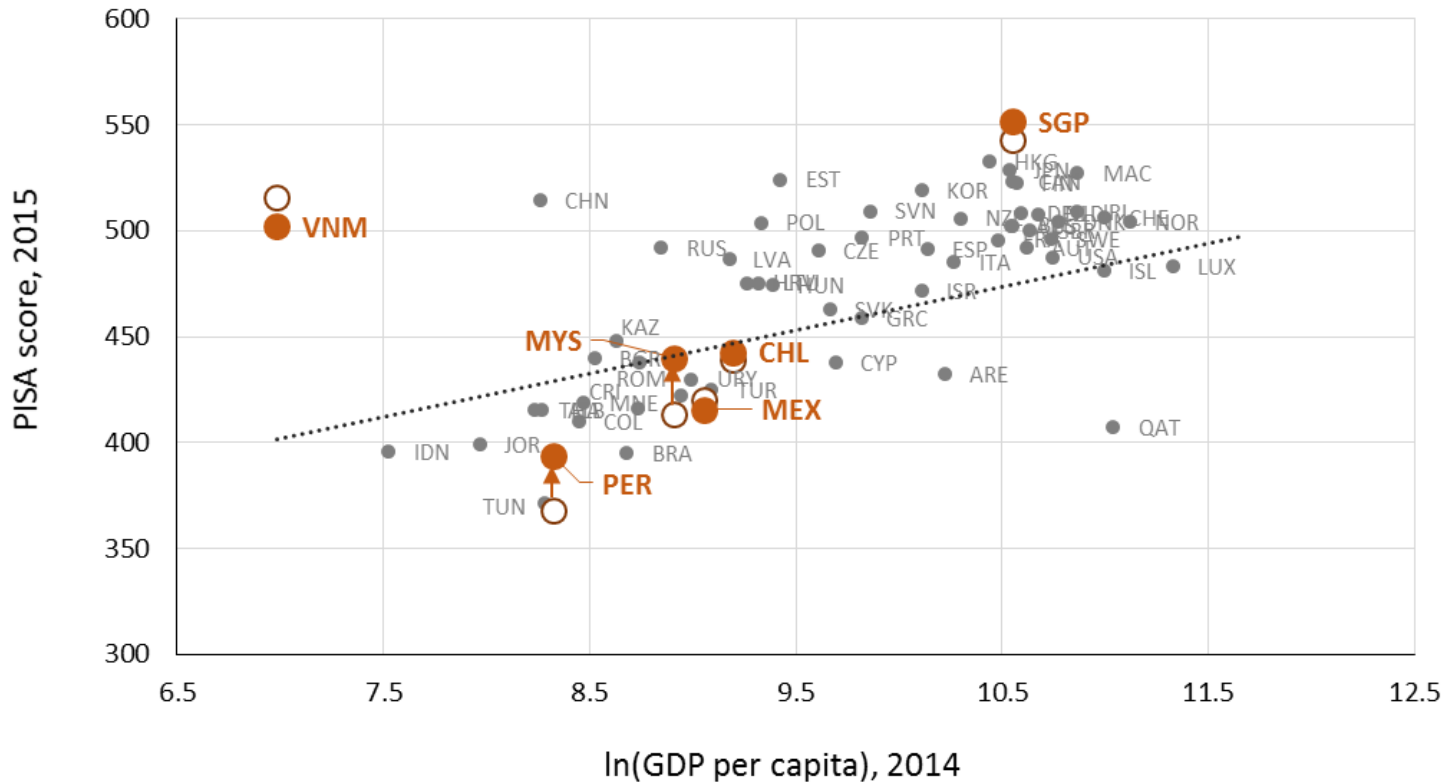


Scale: 1-100 (best)

Source: World Economic Forum. 2015. The Global Competitiveness Report 2015-2016.

# Comparison of students' test scores hints at the relative performance and quality of education system across countries

## PISA Score vs. GDP Per Capita



● 2015, all countries      ○ 2009, selected countries      ● 2015, selected countries

Source: OECD 2015. Average PISA scores over math, science, and reading scores.

Note: CHL = Chile, MEX = Mexico, MYS = Malaysia, PER = Peru, SGP = Singapore, VNM = Vietnam, PISA = Programme for International Student Assessment.

VNM: 2006 instead of 2009

# How related is education to economic productivity?

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1. How is economic productivity defined?
2. What are main drivers of economic productivity?
3. What are the perceived quality and performance of education system?
4. How related is education to the level of productivity as compared to other main drivers?



# How related is education to the level of productivity as compared to other main drivers?

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**Variance of total factor productivity is decomposed to variance explained by education and other main drivers.**

1. Measurement of Total Factor Productivity (TFP)
2. Construction of Indices of Education and Other Main TFP Drivers
3. Variance Decomposition
4. Results

# 1. Measurement of Total Factor Productivity

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Solow-Swan Model with the Cobb-Douglas function:

$$Y_{c,t} = A_{c,t}K_{c,t}^{\alpha}L_{c,t}^{1-\alpha}$$

$Y_{c,t}$ : *GDP, total*

$A_{c,t}$ : *total factor productivity (TFP)*

$K_{c,t}$ : *total capital using perpetual inventory method (depreciation  $\delta = 0.06$ )*

$L_{c,t}$ : *population aged 15 and above multiplied by labor force (% population)*

$\alpha$  (*capital share of income*) = 0.3

$c$ : *99 developing and developed countries*

$t$ : *1985 – 2014*

(Data: World Bank)

Note: Countries with natural resources as a main income source ( $\geq 40\%$  of GDP) were excluded.

## 2. Construction of Indices of Education and Other Main TFP Drivers

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- **Factor analysis** is used to build a synthetic index summarizing different dimensions of each main driver.
- Components of the education index

$$\begin{aligned} Edu = & \\ & \beta_1(\text{Government expenditure on education}) + \\ & \beta_2(\text{Primary education with good performance and quality}) + \\ & \beta_2(\text{Secondary education with good performance and quality}) + \\ & \beta_3(\text{High education with good performance and quality}) \end{aligned}$$

- 1) **Government expenditure on education (% of GDP)**
- 2) Primary education: **Secondary enrollment (gross %)**
- 3) Secondary education: **PISA score**
  - Countries without data: imputed using secondary completion rate, total (% of relevant age group)
- 4) High education: **Number of scientific journals (per capita)**

(Data: OECD; World Bank; UNESCO; TFP = Total Factor Productivity)

## 2. Construction of Indices of Education and Other Main TFP Drivers

### Constructed Index:

#### 1) Education

$Edu =$

$0.17 * z(\text{Government expenditure on education, \% of GDP}) +$

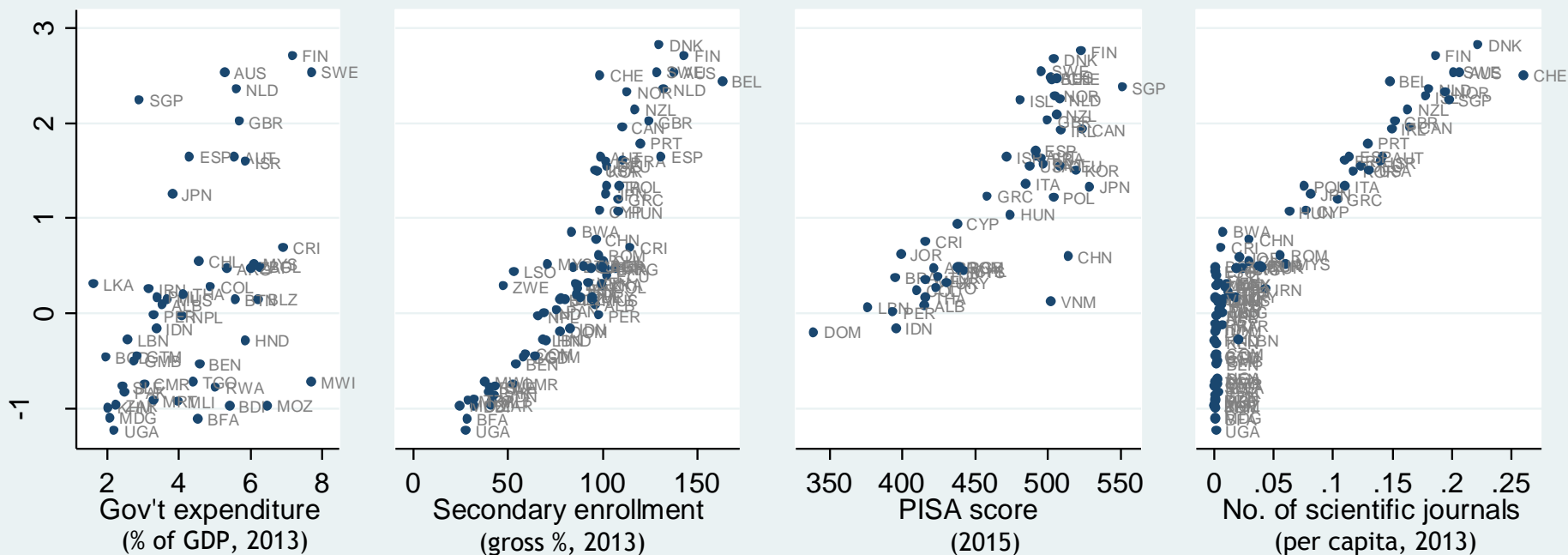
$0.36 * z(\text{Secondary enrollment}) +$

$0.35 * z(\text{PISA score}) +$

$0.32 * z(\text{No. of scientific journals, per capita})$

$z(X)$ : standardized

### Education Index vs. Components of the Index



Correlation 1985-2014:

0.46

0.92

0.91

0.84

## 2. Construction of Indices of Education and Other Main TFP Drivers

### 2) Innovation

$$\begin{aligned} \mathit{Innov} = & \\ & 0.55 * z(\text{Research and development expenditure, \% of GDP}) + \\ & 0.55 * z(\text{No. of patents, residents and nonresidents, per capita}) \end{aligned}$$

### 3) Efficiency

$$\begin{aligned} \mathit{Effi} = & \\ & 0.49 * z(\text{Goods market efficiency index}) + \\ & 0.22 * z(\text{Labor market efficiency index}) + \\ & 0.48 * z(\text{Financial market efficiency index}) \end{aligned}$$

### 4) Infrastructure, physical

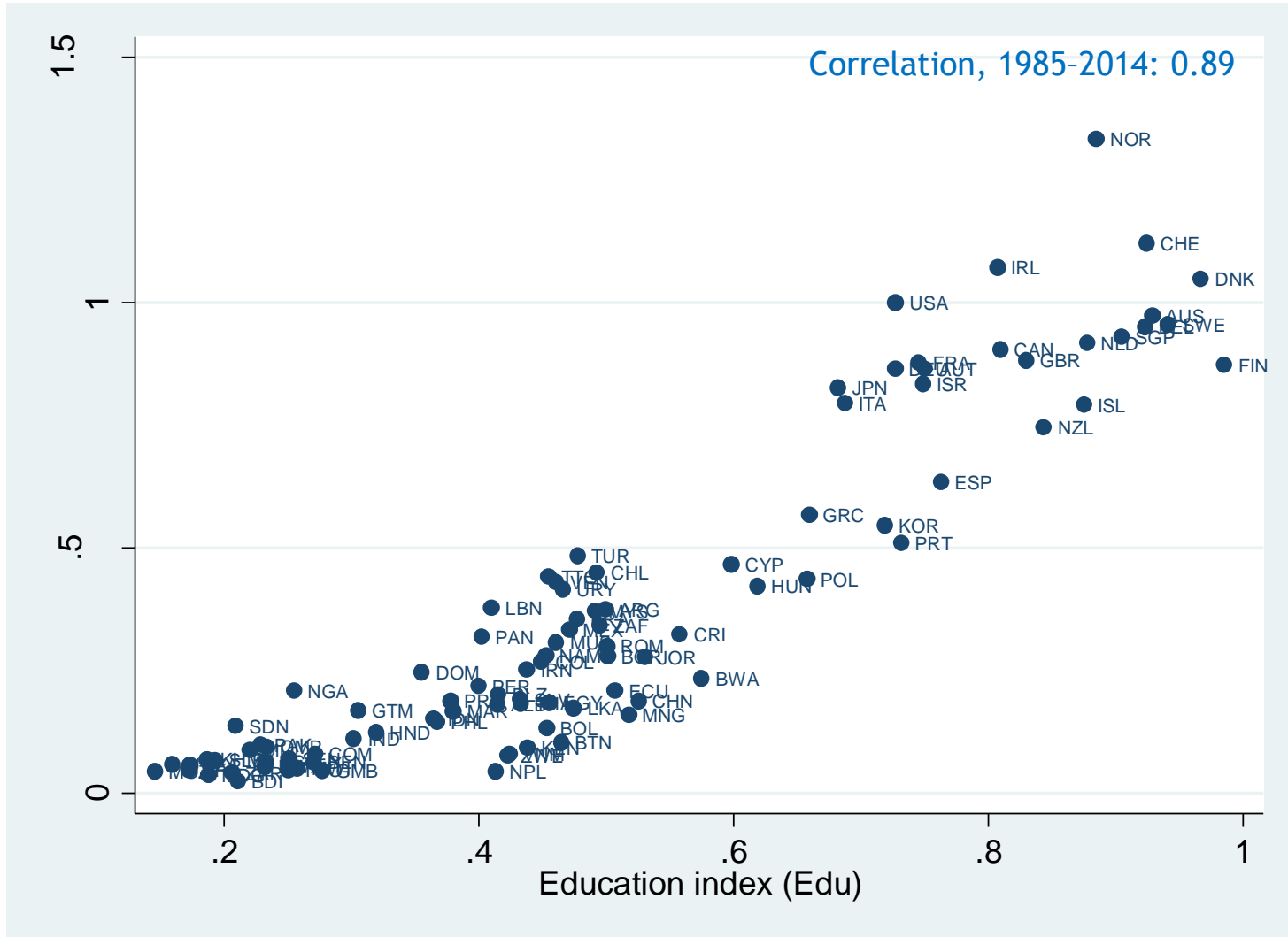
$$\begin{aligned} \mathit{Infra} = & \\ & 0.24 * z(\text{Fixed telephone subscriptions, per capita}) + \\ & 0.13 * z(\text{Mobile subscriptions, per capita}) + \\ & 0.23 * z(\text{Access to improved sanitation facilities, \% of population}) + \\ & 0.21 * z(\text{Access to improved water sources, \% of population}) + \\ & 0.21 * z(\text{Paved roads, km per capita}) + \\ & 0.20 * z(\text{Electricity production, kWh per capita}) \end{aligned}$$

### 5) Infrastructure, institutional

$$\begin{aligned} \mathit{Inst} = & \\ & 0.33 * z(\text{Governance index}) + \\ & 0.45 * (z(\text{Macroeconomic stabilizing factor}) + z(\text{Macroeconomic destabilizing factor})) \end{aligned}$$

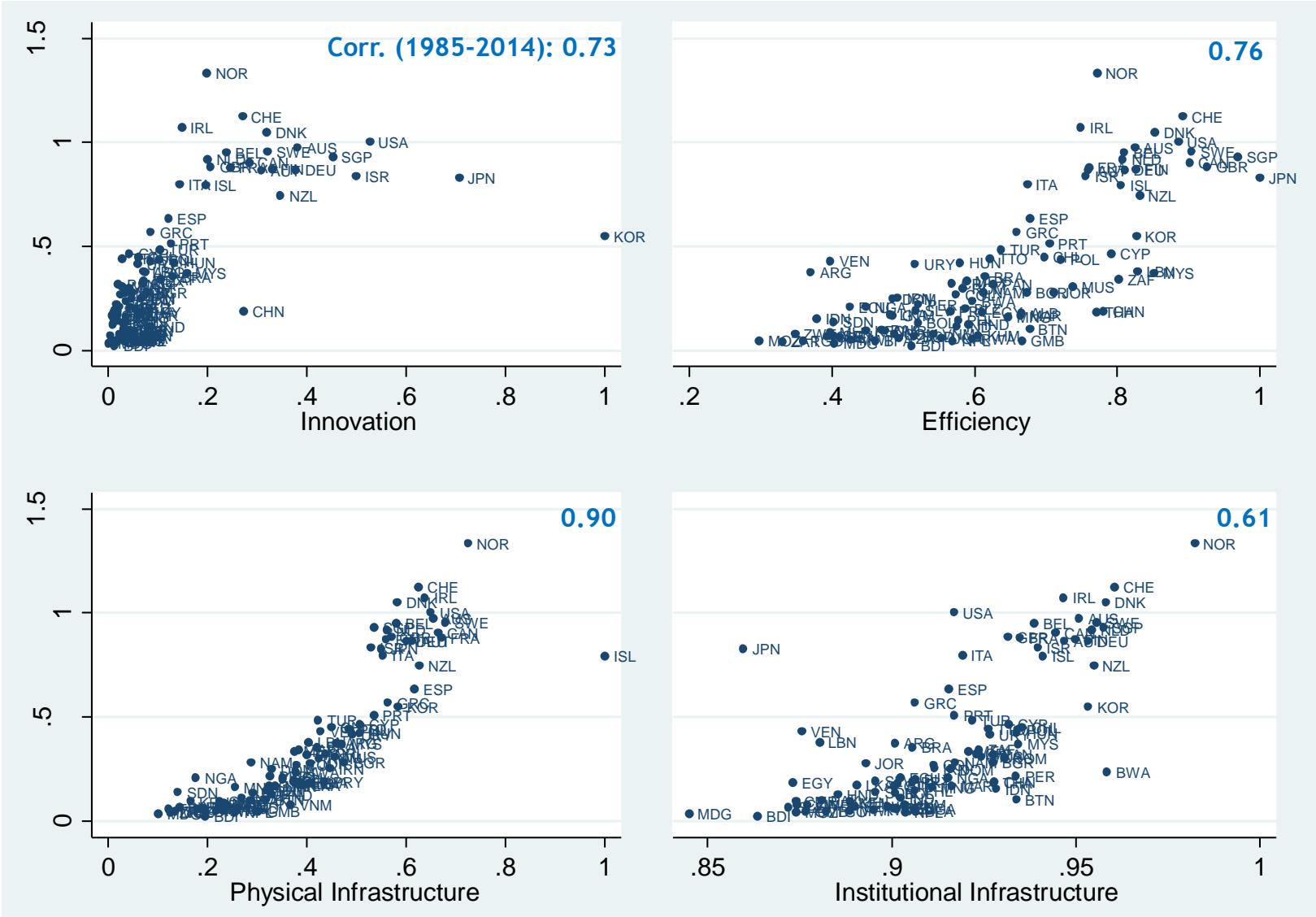
# Education is highly correlated with the level of total factor productivity

## Total Factor Productivity (US=1) vs. Education Index, 2014



# Innovation, efficiency, and infrastructure also show a high correlation with the level of total factor productivity

## Total Factor Productivity (US=1) vs. Other Main Driver's Index, 2014



### 3. Variance Decomposition

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- To examine the relative importance of each driver, variance of total factor productivity across countries is decomposed to variance explained by each main driver.
- Dominance analysis approach (Azen and Budescu 2003)

$$TFP_{c,t} \sim \text{func} (Innov_{c,t}, Educ_{c,t}, Effi_{c,t}, Infra_{c,t}, Institute_{c,t}, u_c)$$

$u_c$ : country dummies

$c$ : 99 countries, developing and developed

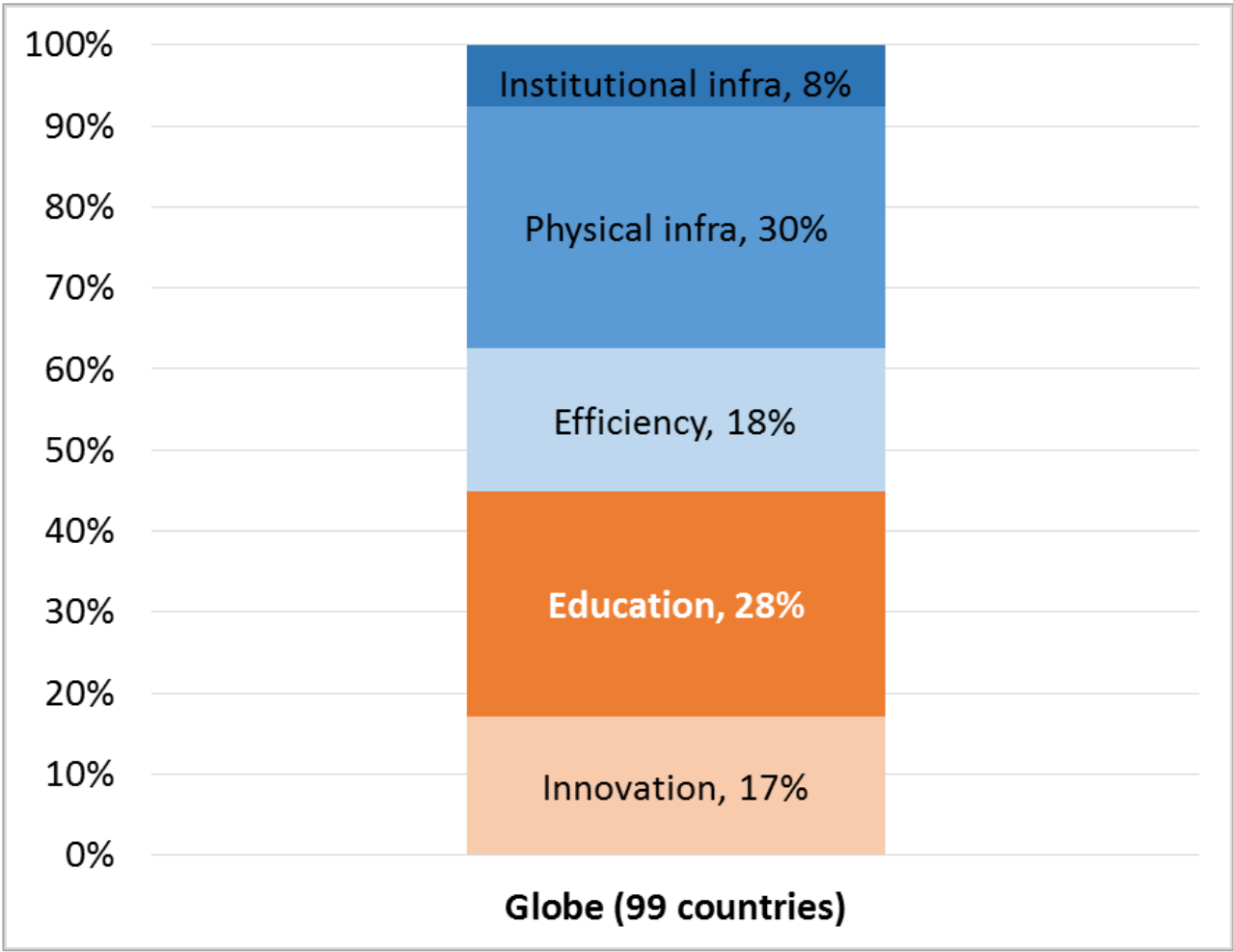
$t$ : 1985 – 2014

(Variance of TFP due to each driver is measured taking into account all possible subset models)



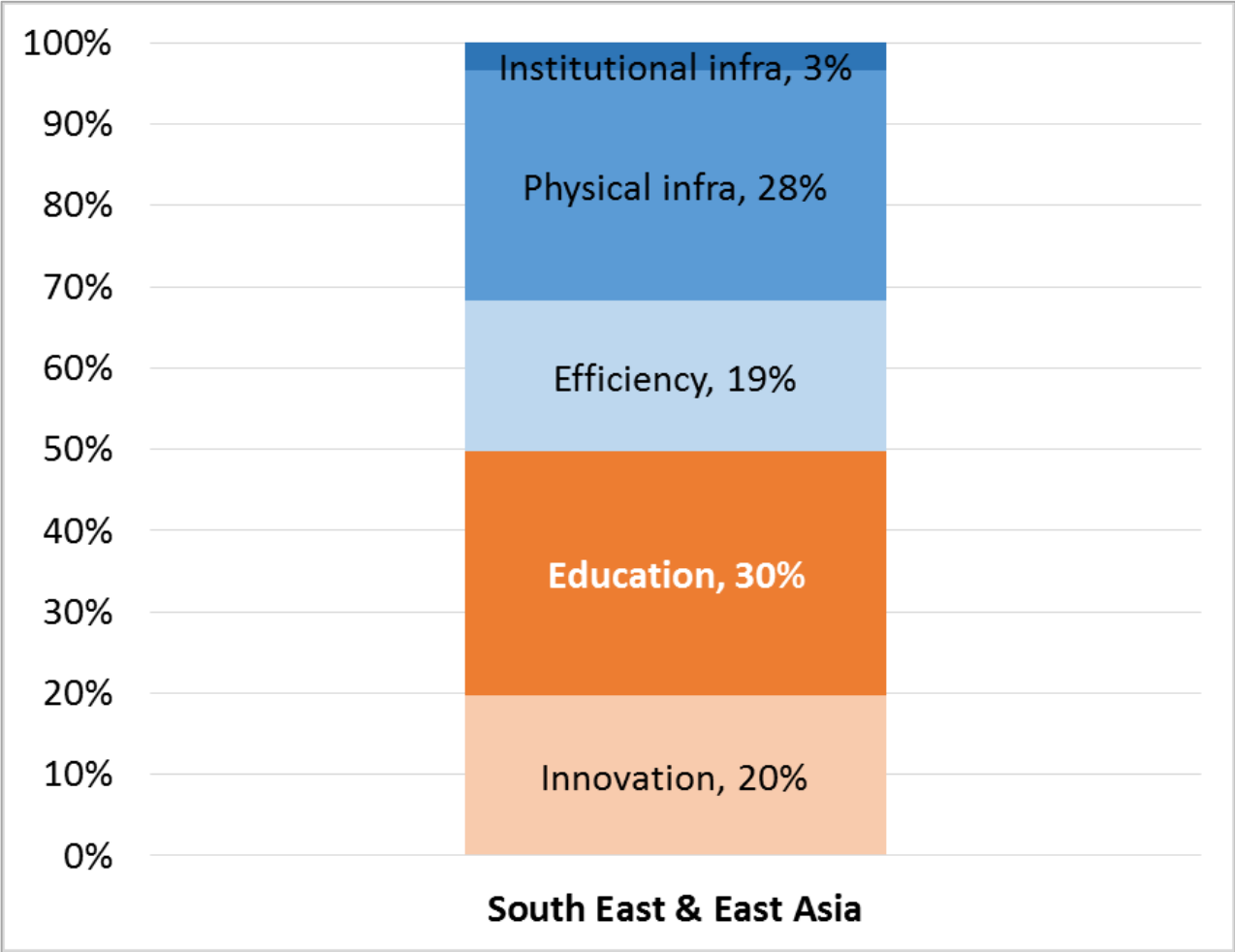
# Education is the second highest contributor to the variation of productivity globally for the last three decades

Variance of total factor productivity explained by each index, 99 developing and developed countries, 1985–2014



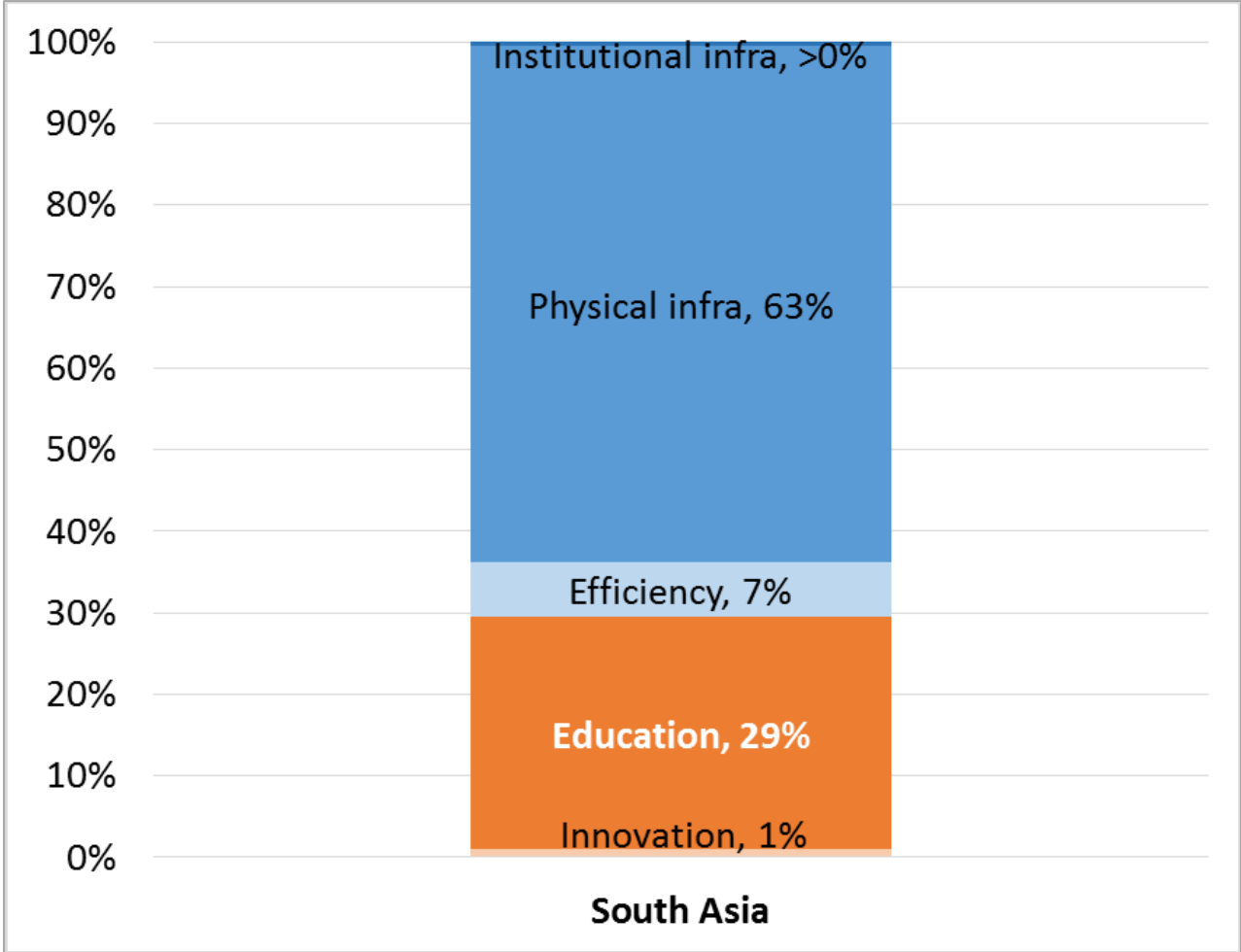
# In South East and East Asia, education is the highest contributor to the variation of productivity for the last three decades

Variance of total factor productivity explained by each index, South East and East Asia (13 countries), 1985–2014



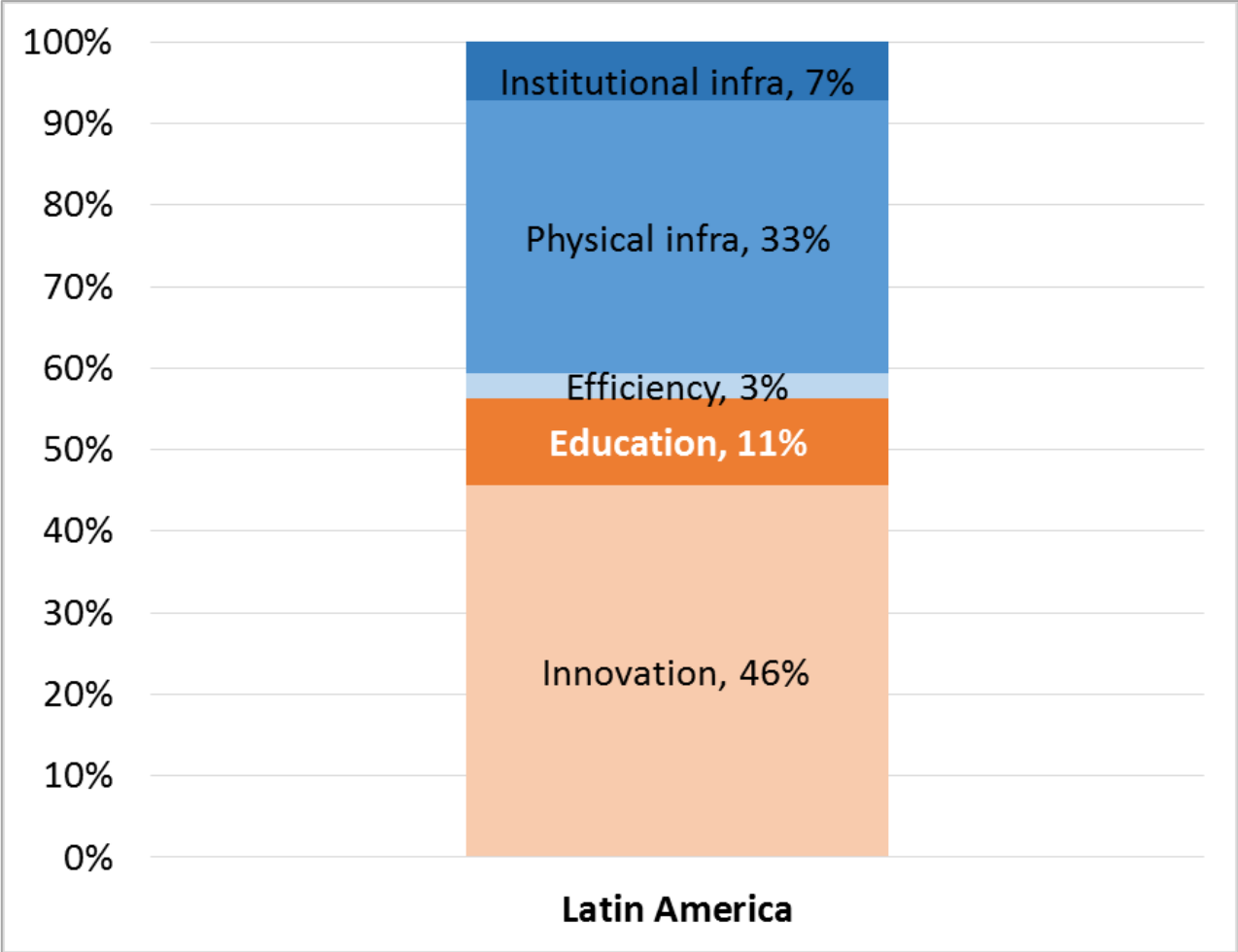
# In South Asia, education is the second contributor to the variation of productivity following physical infrastructure for the last three decades

Variance of total factor productivity explained by each index, South Asia (6 countries), 1985–2014



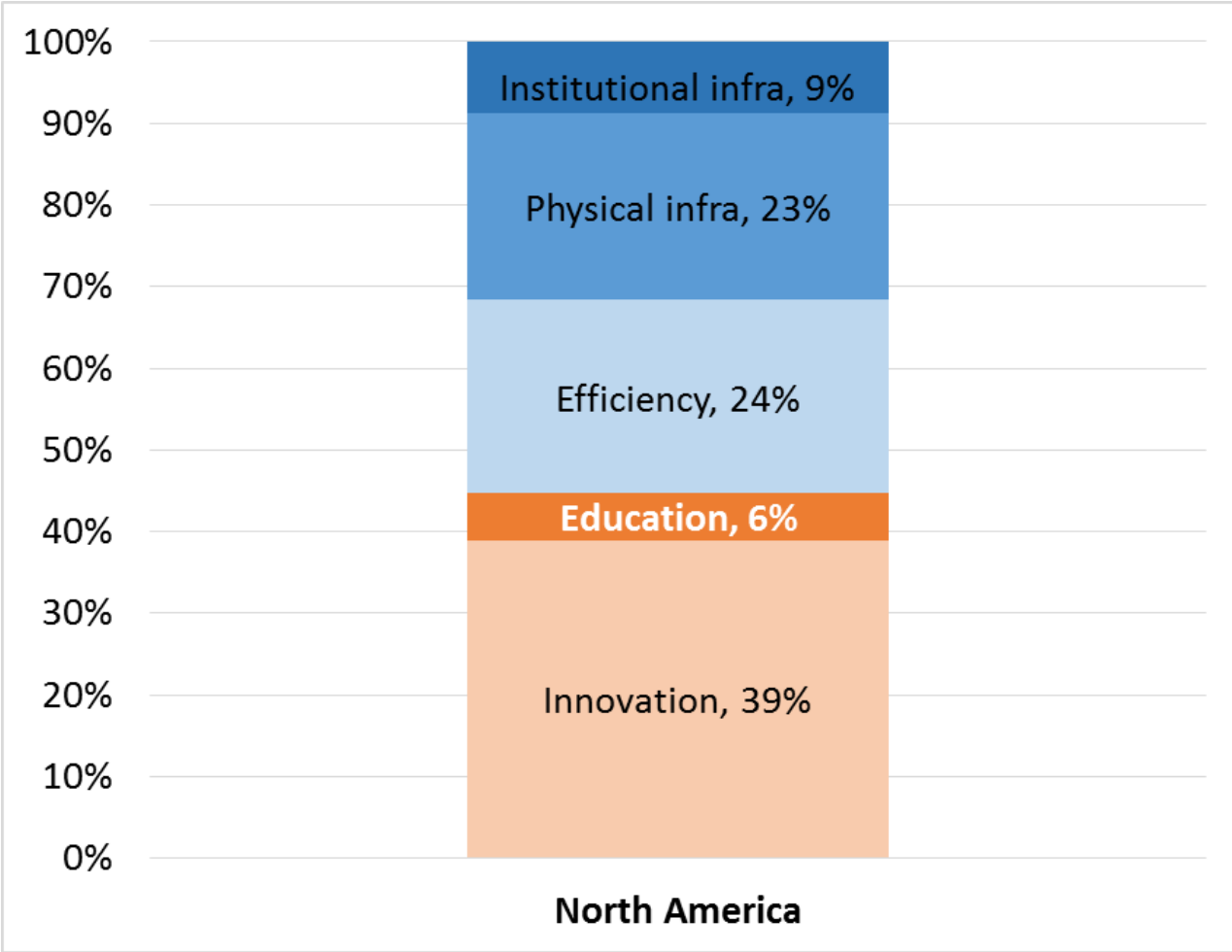
# In Latin America, education is the third contributor to the variation of productivity following innovation and physical infrastructure for 1985–2014

Variance of total factor productivity explained by each index, Latin America (19 countries), 1985–2014



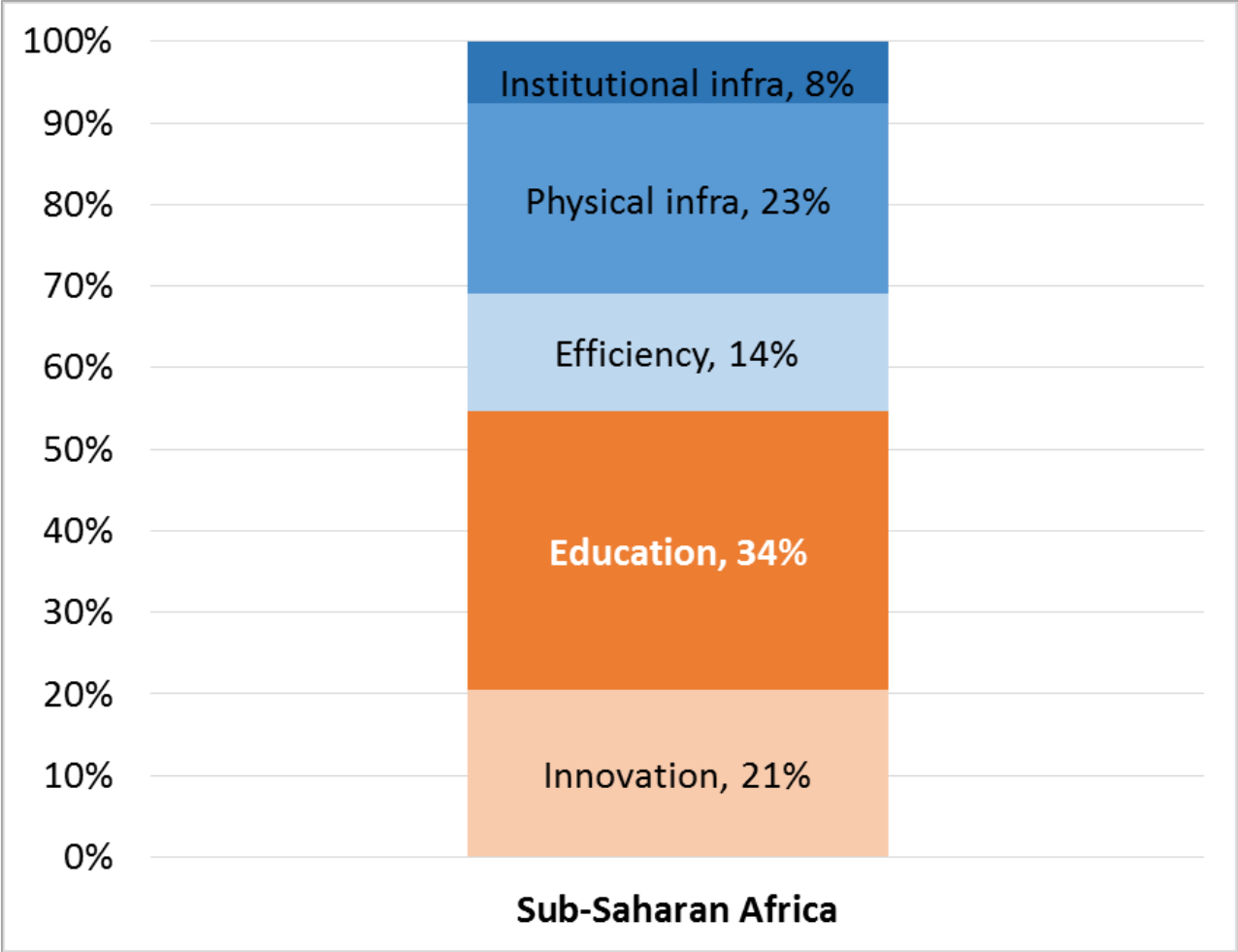
# In North America, education's contribution to the variation of productivity is the lowest among the main drivers for the period 1985–2014

Variance of total factor productivity explained by each index, North America (US and Canada), 1985–2014



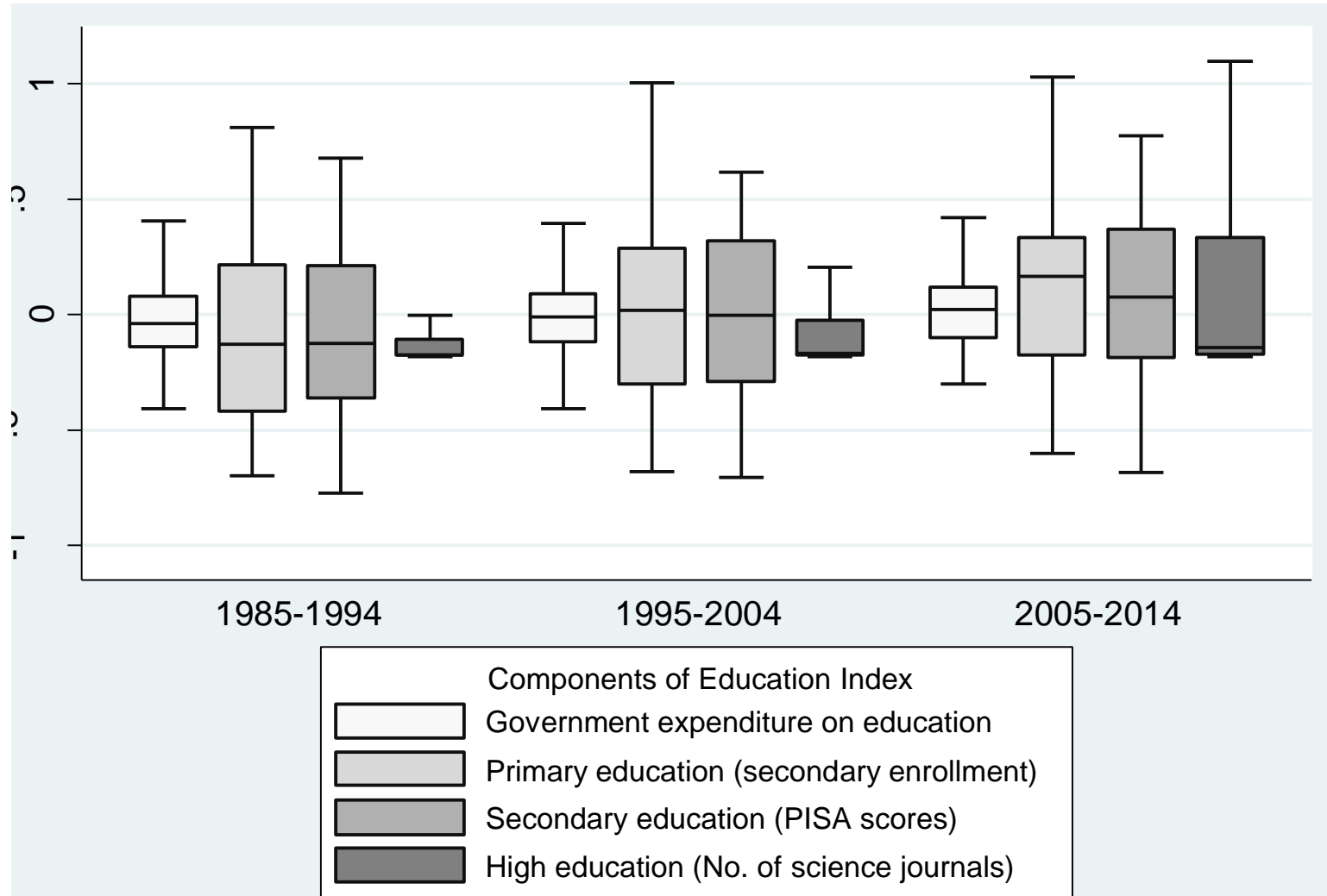
# In Sub-Saharan Africa, education is the highest contributor to the variation of productivity for the period 1985–2014

Variance of total factor productivity explained by each index, Sub-Saharan Africa (28 countries), 1985–2014



# High education with good quality is the fastest emerging driver of the education index

## Distribution of components of the education index across 99 countries



## Summary

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- Education plays an important role in increasing economic productivity.
  - Human capacity from the most basic skills to advanced capabilities
  - Advanced capabilities to adopt and implement new technology
  - An environment to generate new ideas
  
- Education is a key contributor to the variation of productivity globally for the period 1985–2014.
  
- The relative importance of education compared to other main drivers of productivity varies across regions.
  
- High education with good quality is the fastest growing driver of the education index at the global level for the period 1985–2014.



Thank you