Rural Infrastructure: Opportunities and Barriers

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The World Bank Group

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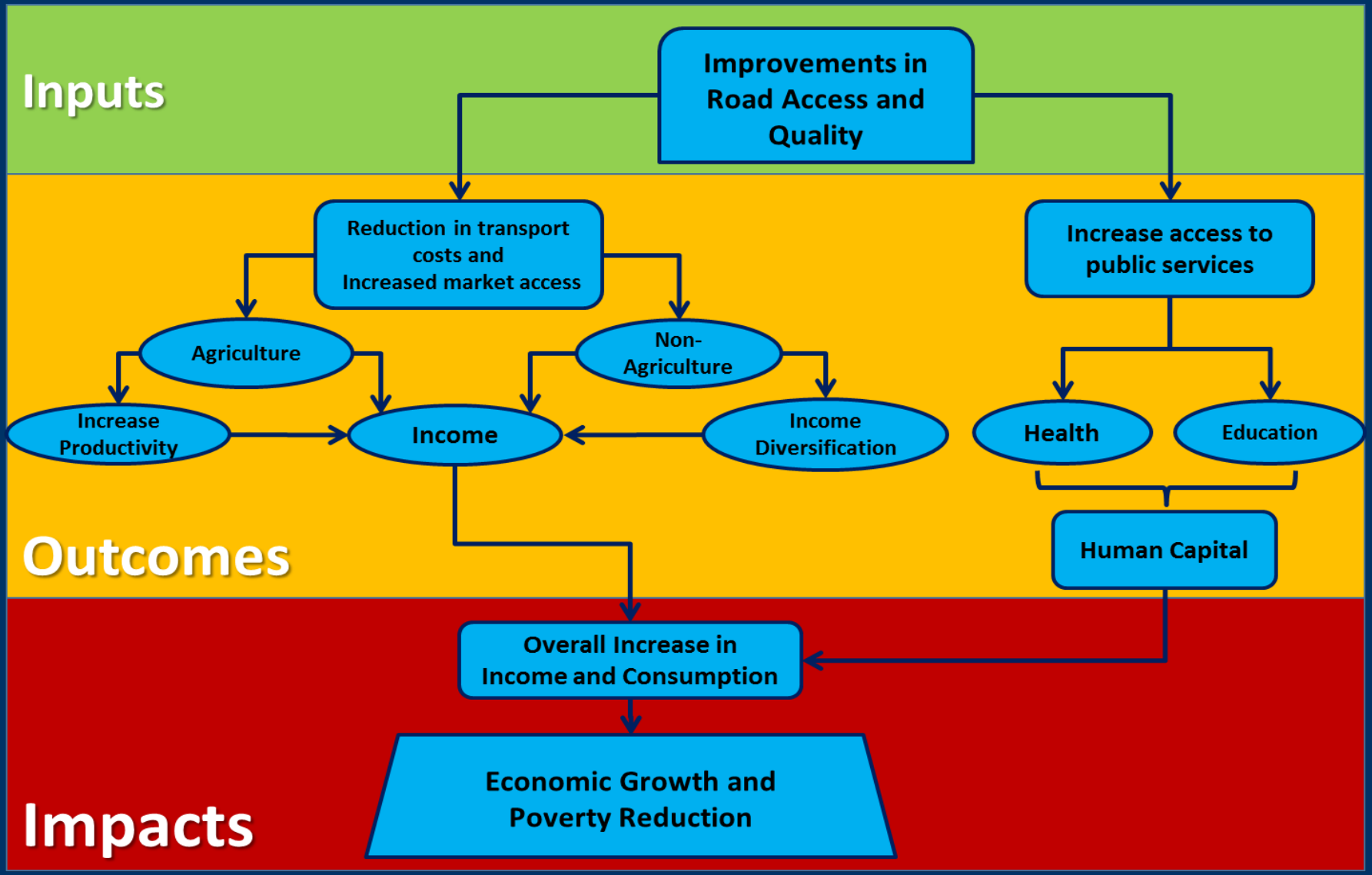
Rural Infrastructure

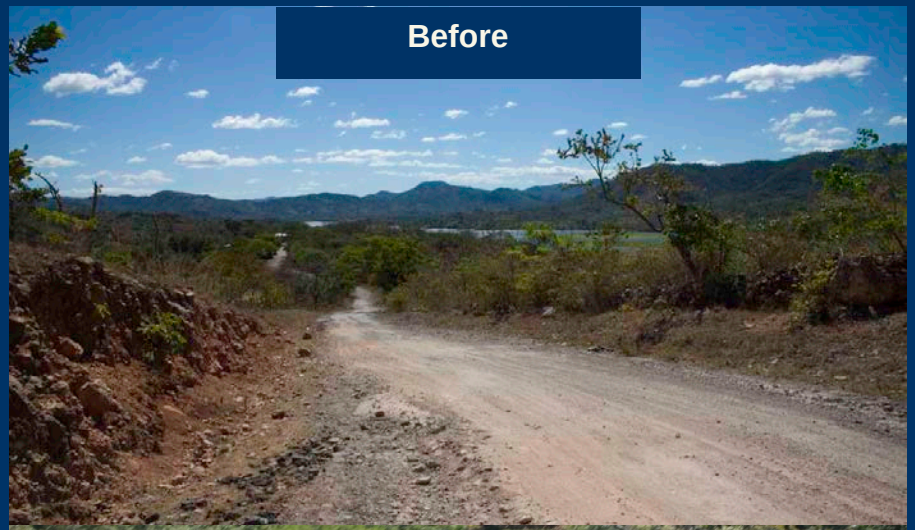
- Impacts of Roads
- Impacts of Electricity
- Impact of Information and Communication Technologies
- Complementarities

Impact Pathways

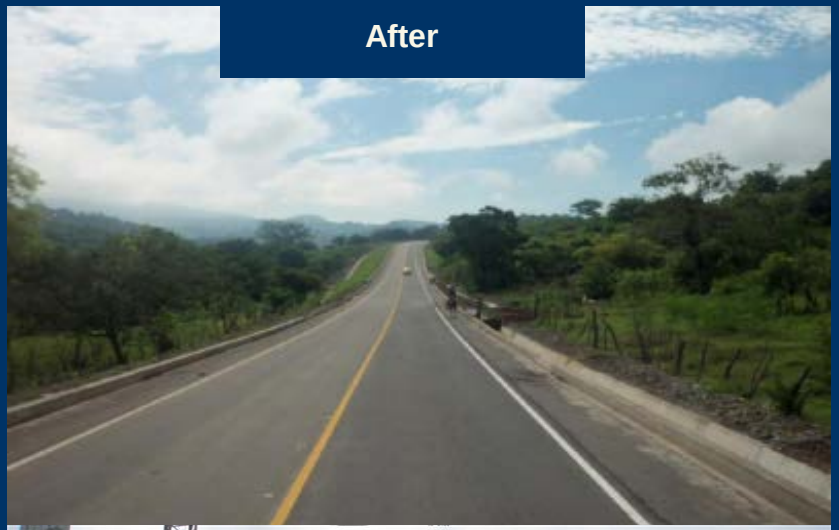


The Connectivity Project

Before



After



Theoretical Framework

- Impact on Agricultural Transportation Costs
  - Household uses x (with a unit cost of c), produces F(x) and self-consumes q units.
  - Sells F(x)–q in the market at price p and incurs (per-unit) transportation cost of t.
  - Objective function:

$$U(x, q|p, t, c) = (p - t)(F(x) - q) - cx + V(q)$$

Expected outcomes

- Affects agricultural income through:
  - Reduction in c leads to increased input demand and production

$$\frac{dx}{dt} = \frac{1}{(p-t)F''(x^*)} < 0$$

  - Reduction in t leads to increased input demand (and production) and reductions in self consumption:

$$\frac{dq}{dt} = -\frac{1}{U''(q^*)} > 0$$

Agriculture

- Increases in market access increase the productivity of farmers, through access to better inputs and/or technologies;
  - Fertilizer use increased over entire sample,

- Increase market participation, as easier access to markets might incentivize households to sell some or more of their production.
  - No change in the intensive margin of production or sales of agriculture products
  - We find significant increases for the quantities designated for auto consumption for full sample depending on specification

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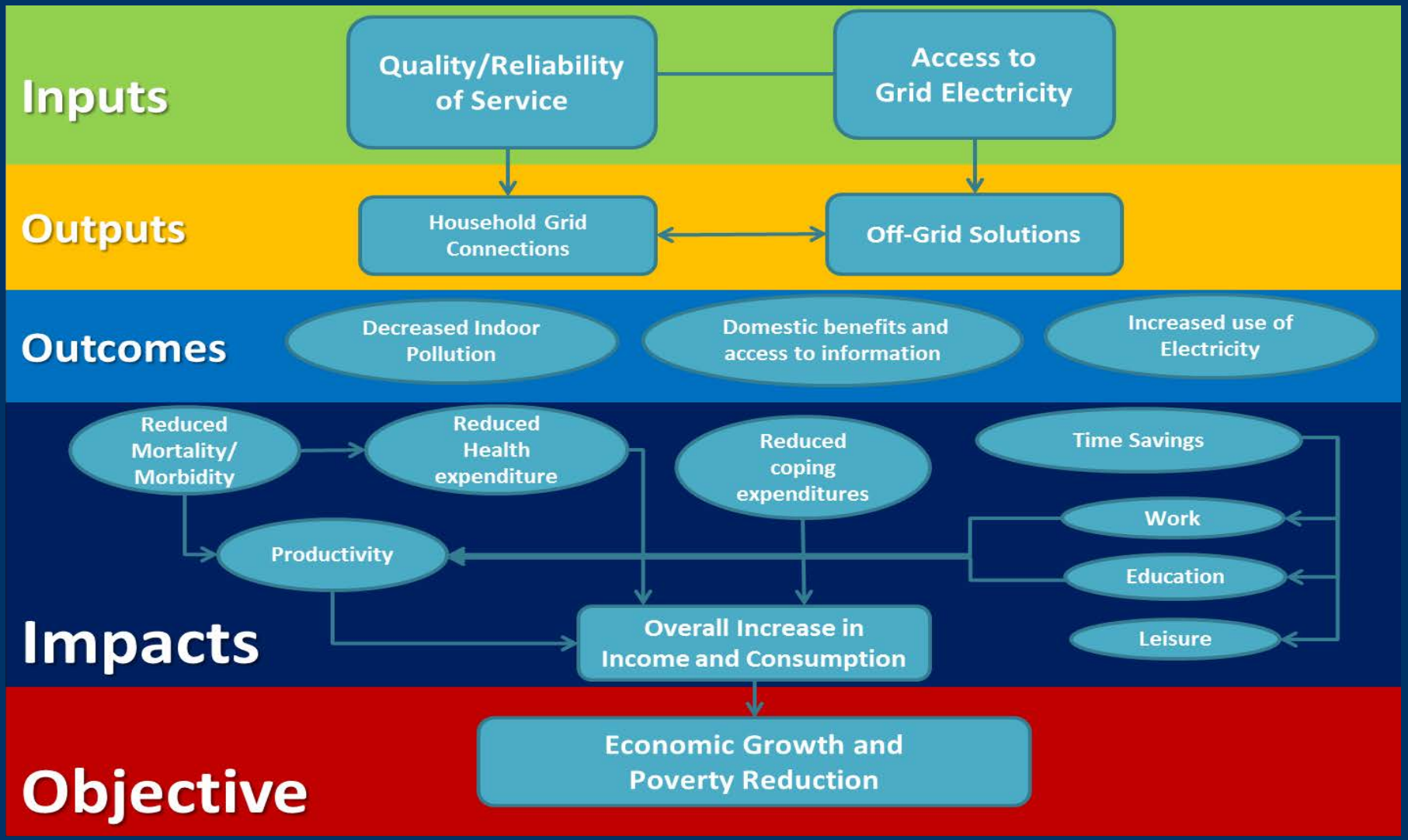
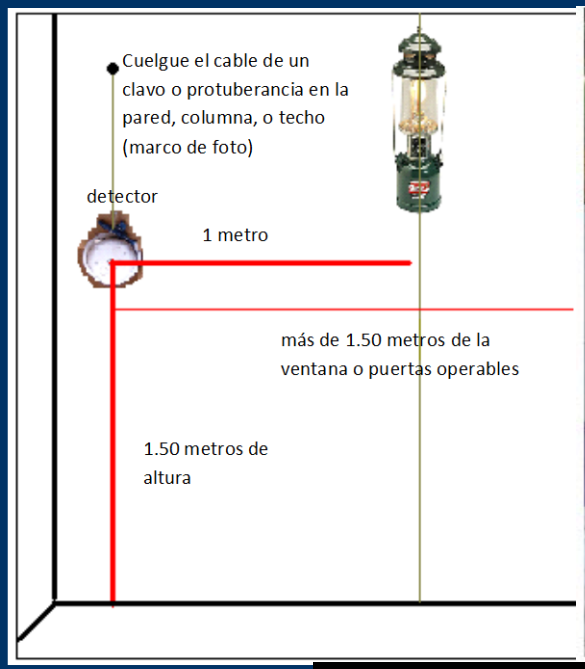
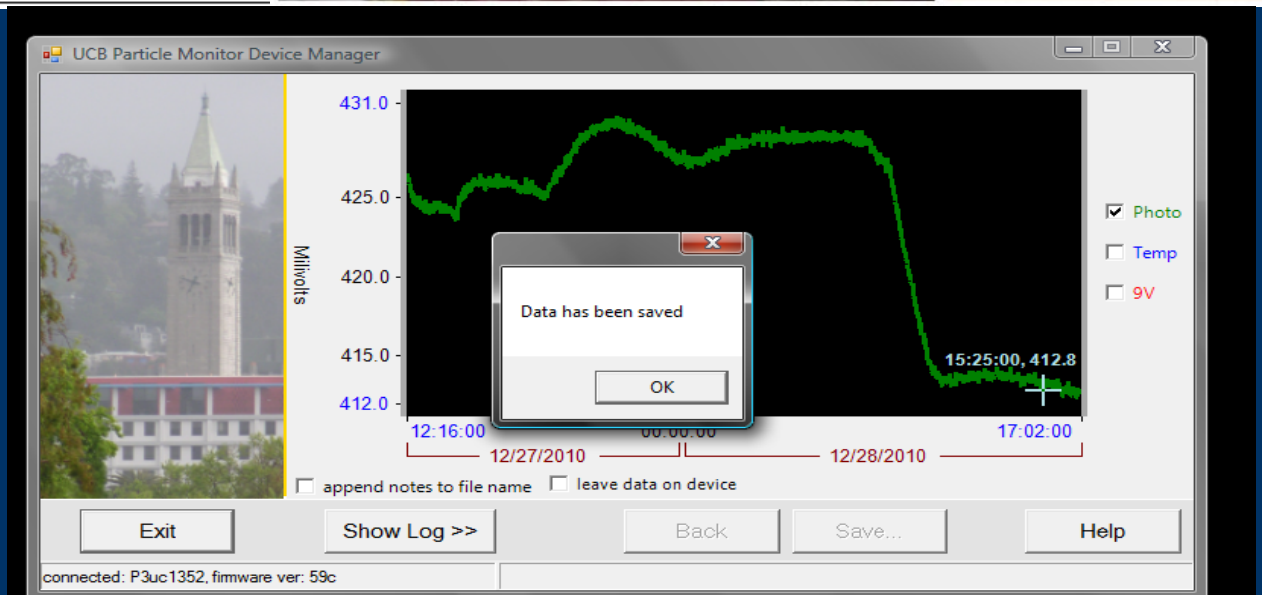
Impact path ways of rural electrification



El Salvador – Measuring Reduction of Indoor Pollution





How does infrastructure affect welfare?

$$\Delta Y_i \approx L\sum_j\left[\Delta Sl_{ij}\frac{y_{ij}}{l_{ij}}\right] + \Delta L\left[\sum_j Sl_{ij}\frac{y_{ij}}{l_{ij}}\right] + L\sum_j\left[Sl_{ij}\Delta\left(\frac{y_{ij}}{l_{ij}}\right)\right] + \Delta L\sum_j\left[\Delta Sl_{ij}\frac{y_{ij}}{l_{ij}}\right]$$

Change in the proportion of time for activity "i"

Change in the total number of hours worked by the household

Change in returns to labor

Interaction effect

Expected Results of Rural Electrification

Term	Theme	Indicator	Expected Impact	Gender heterogeneity
Immediate	Coverage and Access	• Percentage of households connected to the grid	Positive	No differentiated effect
		• Cost of electricity	Negative	No differentiated effect
		• Reliability of electric services	Positive	No differentiated effect
Short term	Coping costs	• Number of sources used	Negative	No differentiated effect
		• Consumption of electricity	Positive	No differentiated effect
		• Energy input collection time use	Negative	Larger effect for females
		• Coping expenses in other energy sources	Negative	No differentiated effect
	Health	• Indoor pollution	Negative	No differentiated effect
		• Incidence of acute respiratory disease among vulnerable groups	Negative	No differentiated effect
	Education, Leisure, and Information	• Hours in education or studying in the home	Positive	No differentiated effect
		• Hours spent in childcare	No change	No differentiated effect
		• Hours spent in entertainment and other leisure activities	Positive	Larger effect for females
	Productivity	• Total hours of work	Positive	Larger effect for females
		• Percentage of hours of agricultural	Negative	Larger effect for females
		• Percentage of hours of non-agricultural work	Positive	Larger effect for females
		• In home business productivity/revenue	Positive	Larger effect for females
Long term	Economic Growth	• Change in total income and expenditure	Positive	Larger effect for females
		• Percentage of poor households	Negative	Larger effect for females

Results of Rural Electrification

Term	Theme	Ethiopia	El Salvador
Immediate	Coverage and Access	15% points more likely to connect Spillover effects: 2% from baseline of 41% connection rate	11% to 19% more likely to connect 25% of the effect of the voucher
Short term	Coping costs	Changes in use of kerosene for lighting	Changes in use of kerosene for lighting
		No changes in cooking practices	No changes in cooking practices
	Health	N.A	65% reduction in overnight air pollutants
		N.A	Reduction of 37-44% on acute respiratory infections incidence among children < 6
	Education, Leisure, and Information	No effect	Increase hours of studying in 7%
		No effect	More appliance ownership
		No effect	Leisure reduced in average by 0.7 hours per day
	Productivity	No changes	Non agricultural independent activities increased by 13%
Long term	Economic Growth	N.A	Annual per capita income increased in $ 186 (34% of baseline income)
		N.A	Positive distributional effects

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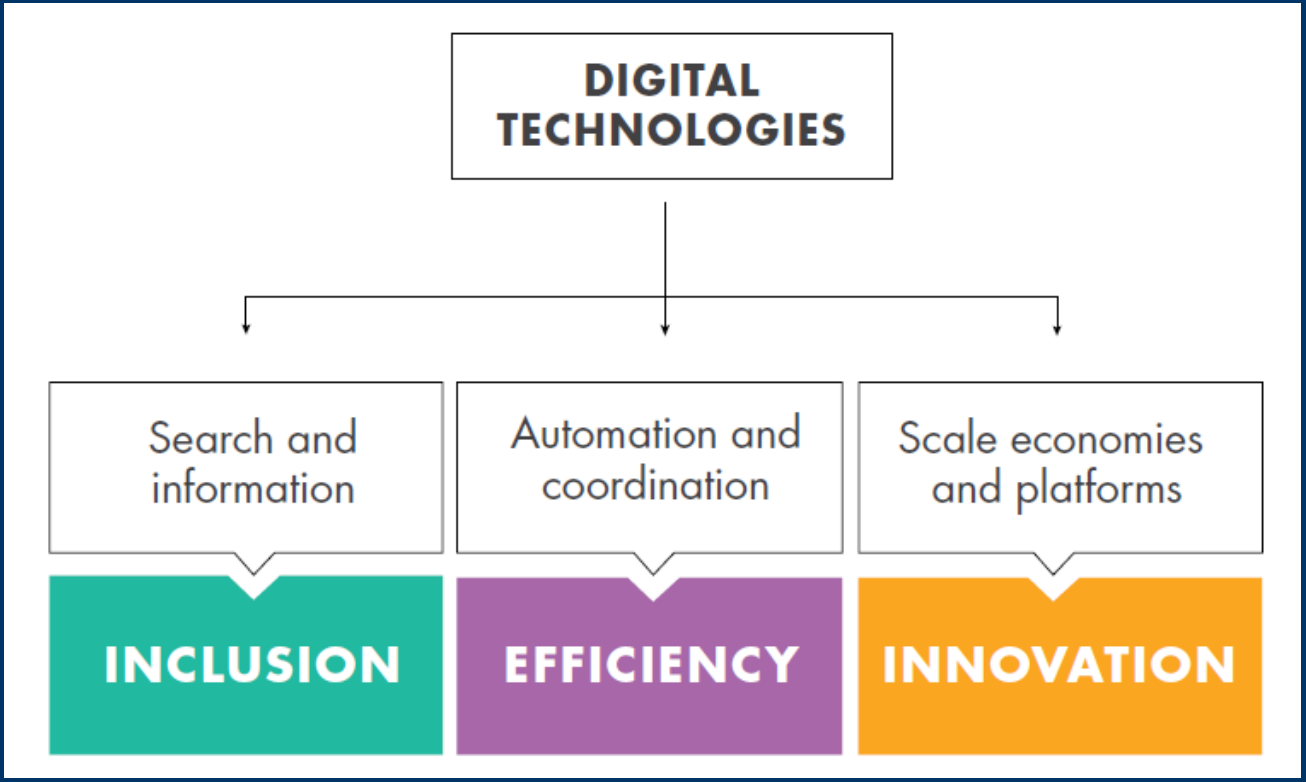
The main mechanisms to promote development



Expand the information base, lower information costs and create information goods

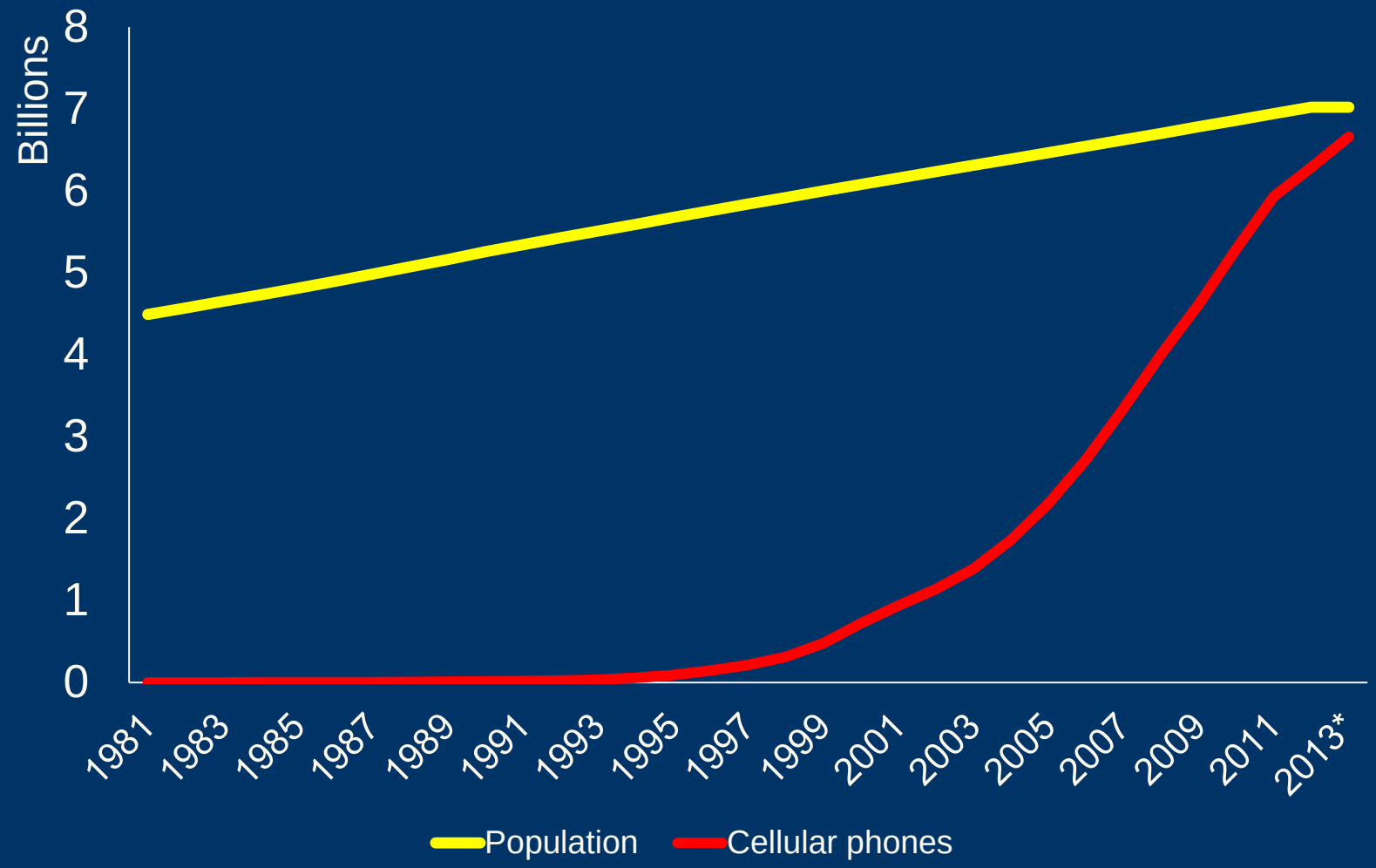
SOURCE: *WDR 2016*

Connectivity

Content

Capability

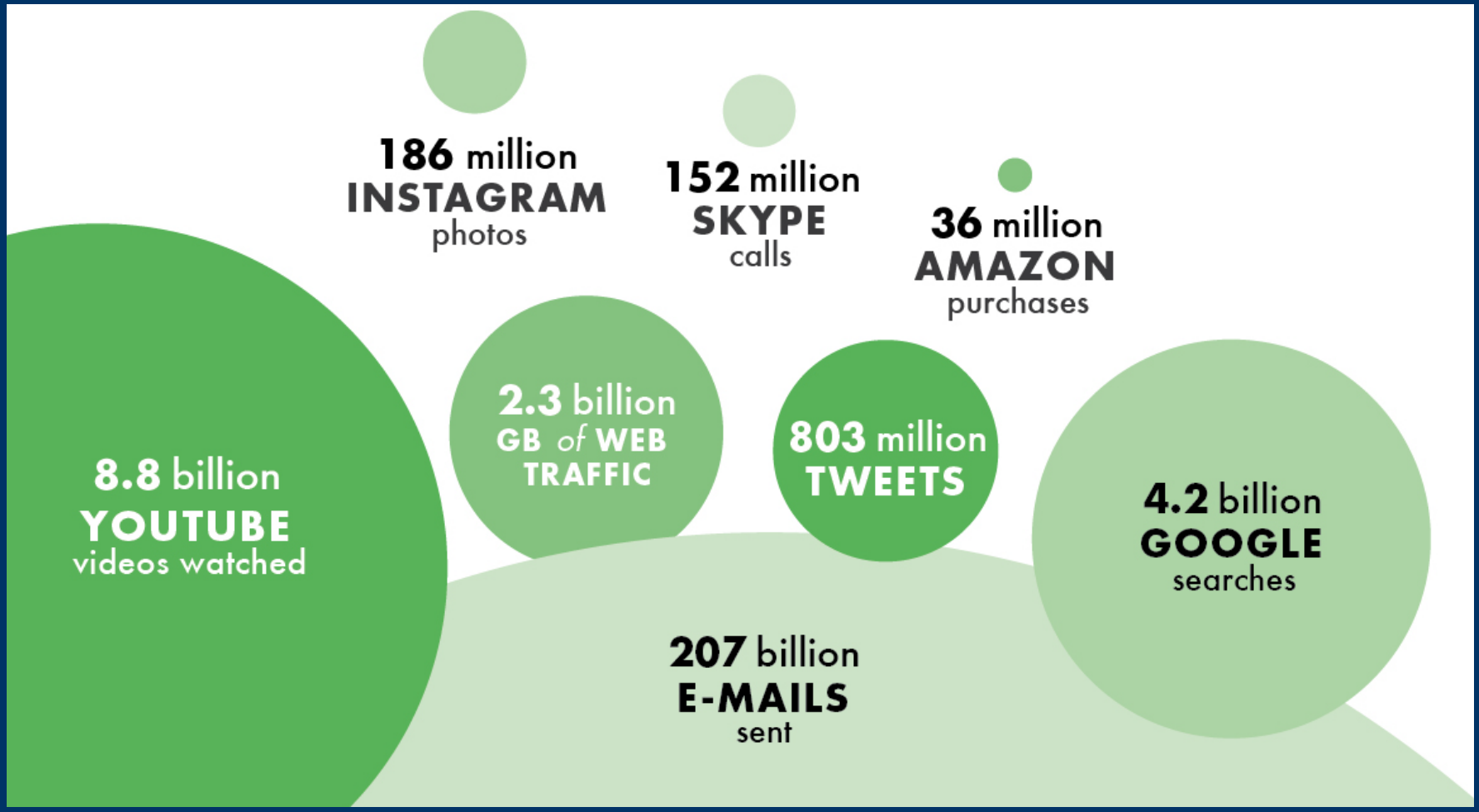
Cellular Phone subscription and Population



Source: Mobile phone subscriptions are from the International Telecommunication Union (ITU) and country categories are from the World Bank.

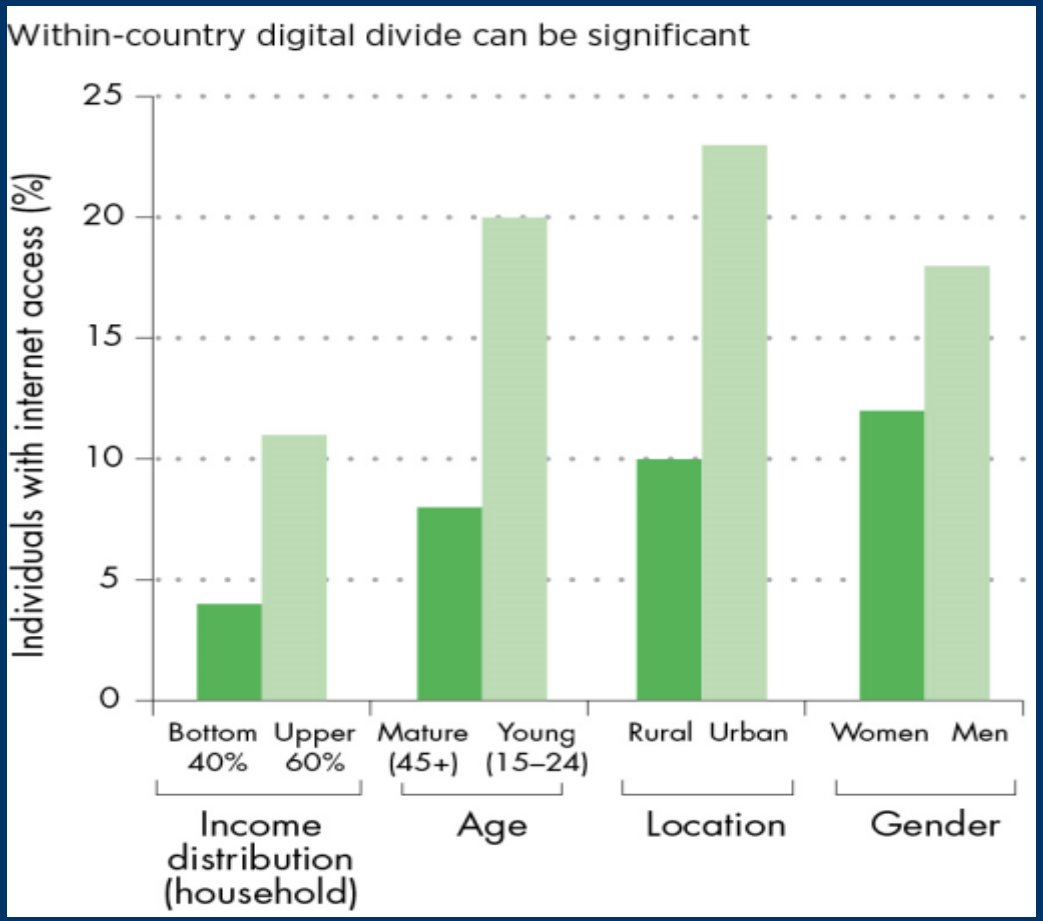
Digital revolution has brought many private benefits

A typical day in the life of the internet



SOURCE: *WDR 2016 team; http://www.internetlivestats.com/one-second/ (As compiled on May 29, 2015)*

… between and within countries—in access and capability



SOURCE: WDR 2016 team, based on Research ICT Africa surveys (various years) for 10 African countries.

Percentage of Households that Own a Mobile Phone, by Residence Area

	% Urban	% Rural	% All
Bolivia (2007) a/.	77.6%	18.7%	57.0%
Brazil (2009) a/.	83.3%	53.2%	78.8%
Colombia (2010) a/.	90.2%	71.7%	86.0%
Ecuador (2010) a/.	82.9%	59.7%	75.5%
Mexico (2007) a/.	66.6%	45.0%	55.2%
Peru (2010) a/.	82.2%	47.1%	70.4%
India (2011) b/.	76.0%	51.2%	59.2%
Bangladesh (2010) c/.	82.7%	56.8%	63.7%
Tanzania (2010) d/.	77.5%	34.2%	45.4%
Kenya (2010) e/.	71.9%	55.0%	59.8%
South Africa (2008 / 09) f/.	87.5%	82.0%	85.7%
Liberia (2009) g/.	69.0%	20.7%	43.2%
Malawi (2010) h/.	72.7%	32.3%	39.0%
Ghana (2010) i/.	63.4%	29.6%	47.7%
Nigeria (2009) j/.	88.3%	60.3%	70.6%
Egypt (2008) k/.	54.1%	27.8%	40.5%
Ehtiopia (2011) l/.	65.2%	12.8%	24.7%
Uganda (2011) m/.	86.8%	53.1%	59.4%
Senegal (2011) n/.	95.4%	81.7%	88.4%
Mozambique (2011) o/.	66.8%	20.0%	34.1%
Nepal (2011) p/.	91.6%	71.9%	74.7%
Zimbabwe (2011) q/.	90.1%	48.0%	62.2%
Rwanda (2010) r/.	71.8%	35.1%	40.3%
Cambodia (2010) s/.	90.1%	56.2%	61.9%
China (2010) t/.	76.3%	60.7%	67.9%

Source: Nakasone, Torero and Minten (2013). **"The Power of Information: The ICT Revolution in Agricultural Development". IFPRI.**

A significant digital divide remains

6 BILLION *without* BROADBAND

4 BILLION *without* INTERNET

2 BILLION *without* MOBILE PHONES

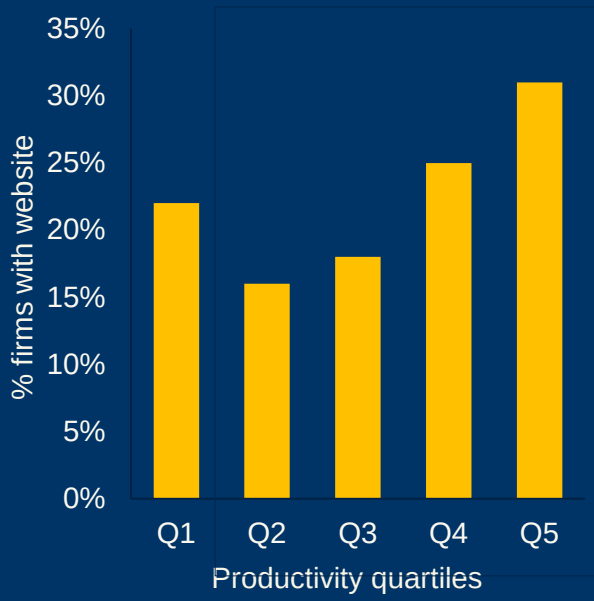
0.4 BILLION *without* A DIGITAL SIGNAL

Divides persist between and within countries—in access and capability

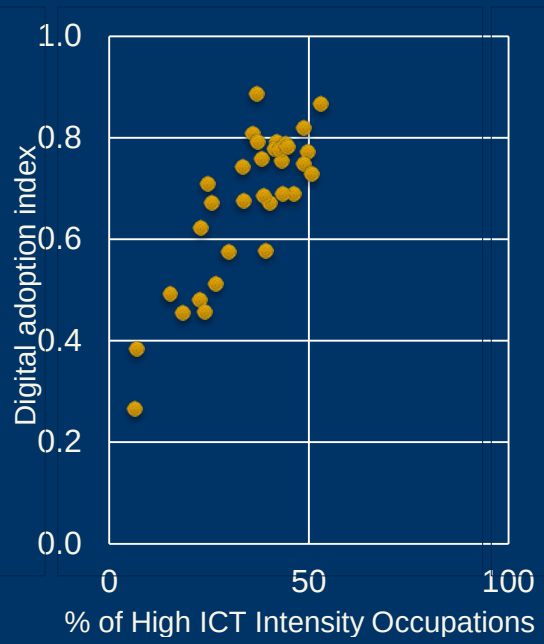
SOURCE: *WDR 2016 team based on Research ICT Africa and ITU data*

Digital technologies tend to be:

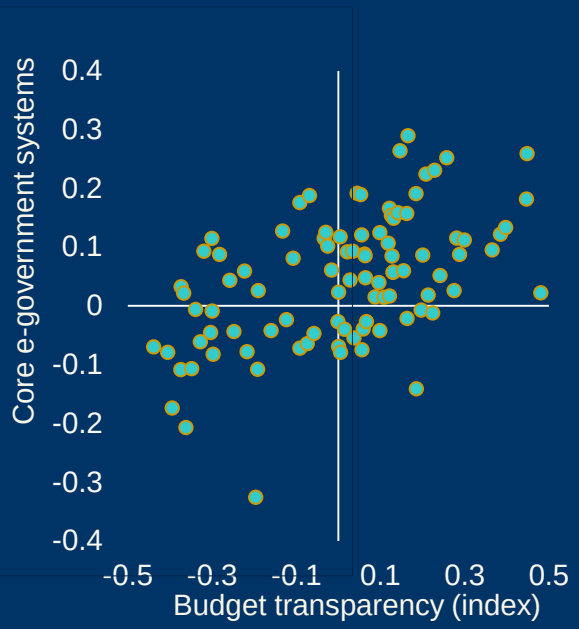
Productivity-biased



Skills-biased



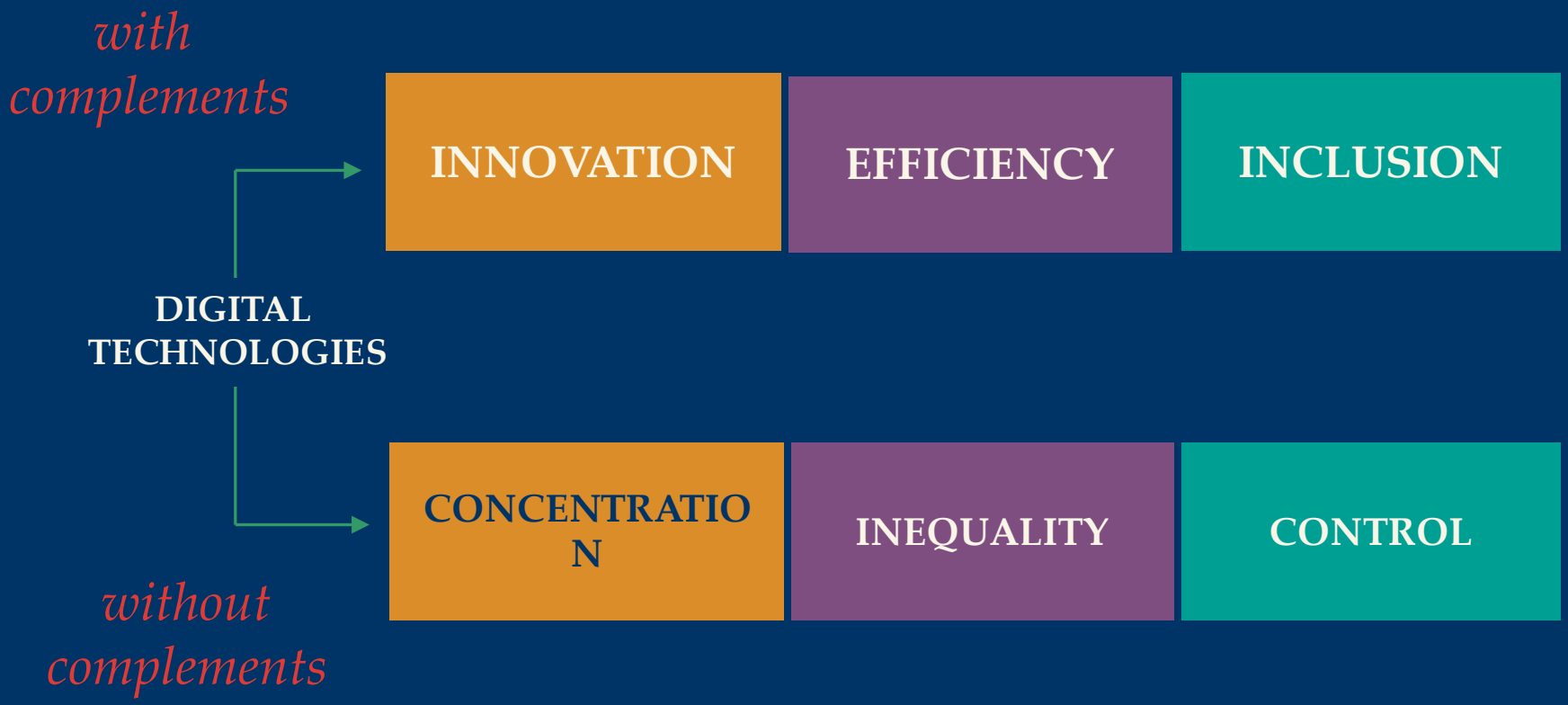
Voice-biased

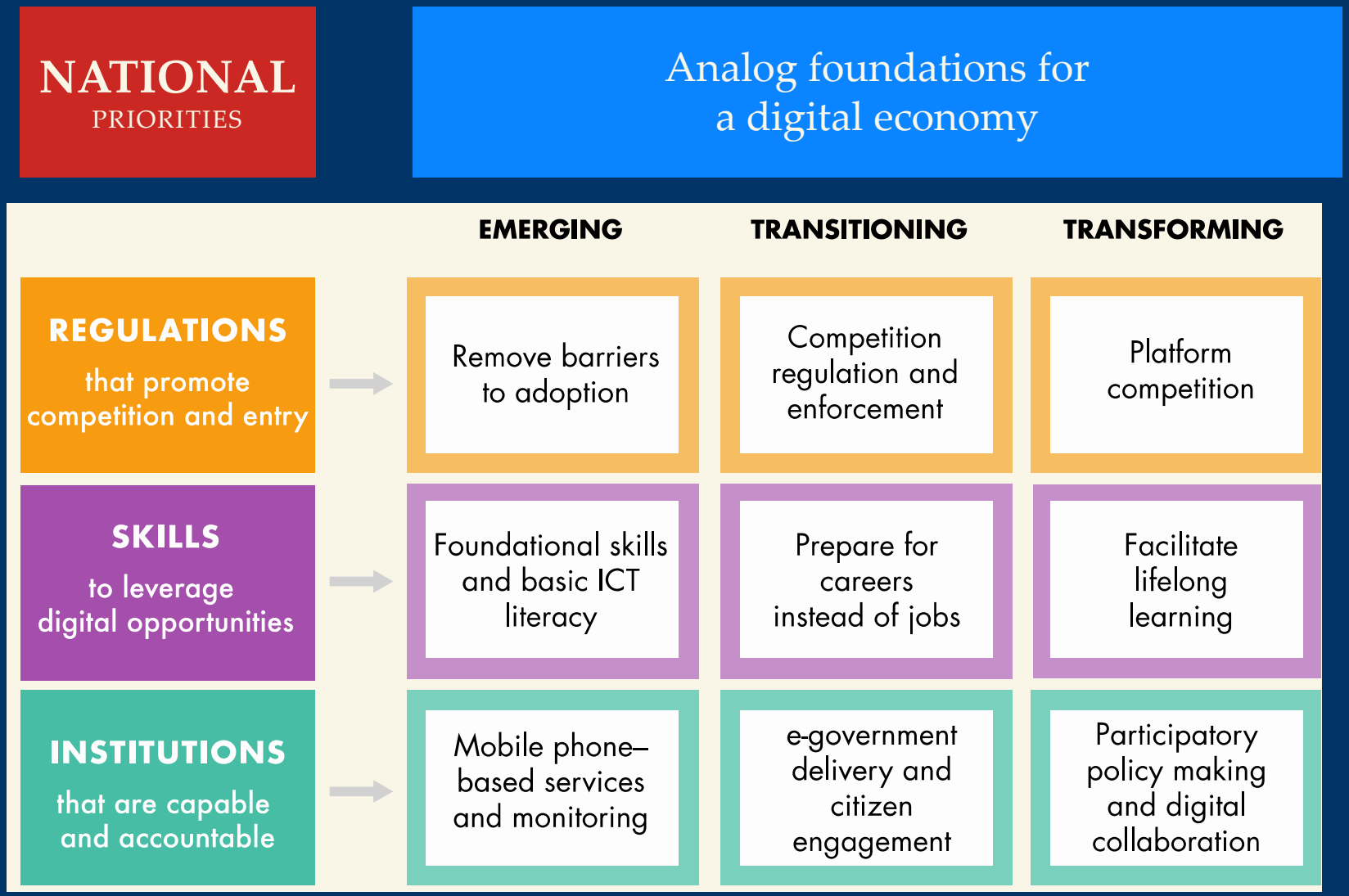


Limiting the aggregate gains from the digital revolution

SOURCE: *WDR 2016 team based on Research ICT Africa and ITU data*

Digital technologies hold benefits as well as risks





SOURCE: *WDR 2016 team.*

Race between technology and complements

- High-income
- Upper-middle-income
- Lower-middle-income
- Low-income

Complements: *Index of quality of institutions, skills and regulations.*

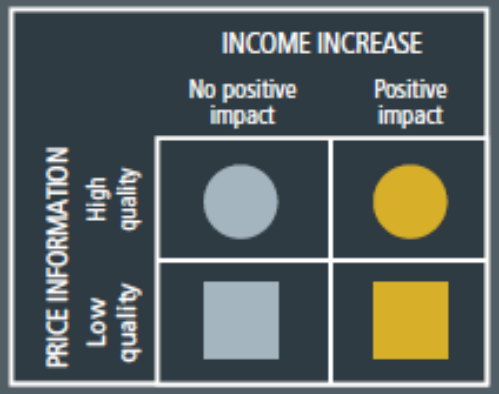
Technology: *Digital adoption index - businesses, people and governments.*

SOURCE: *WDR 2016 team. For more details see figure 5.3 in the full Report.*

ICT Impact on agriculture

- Extension services
- Market information
- Policy environment, laws, and regulations
- Natural resources and geography
- Health

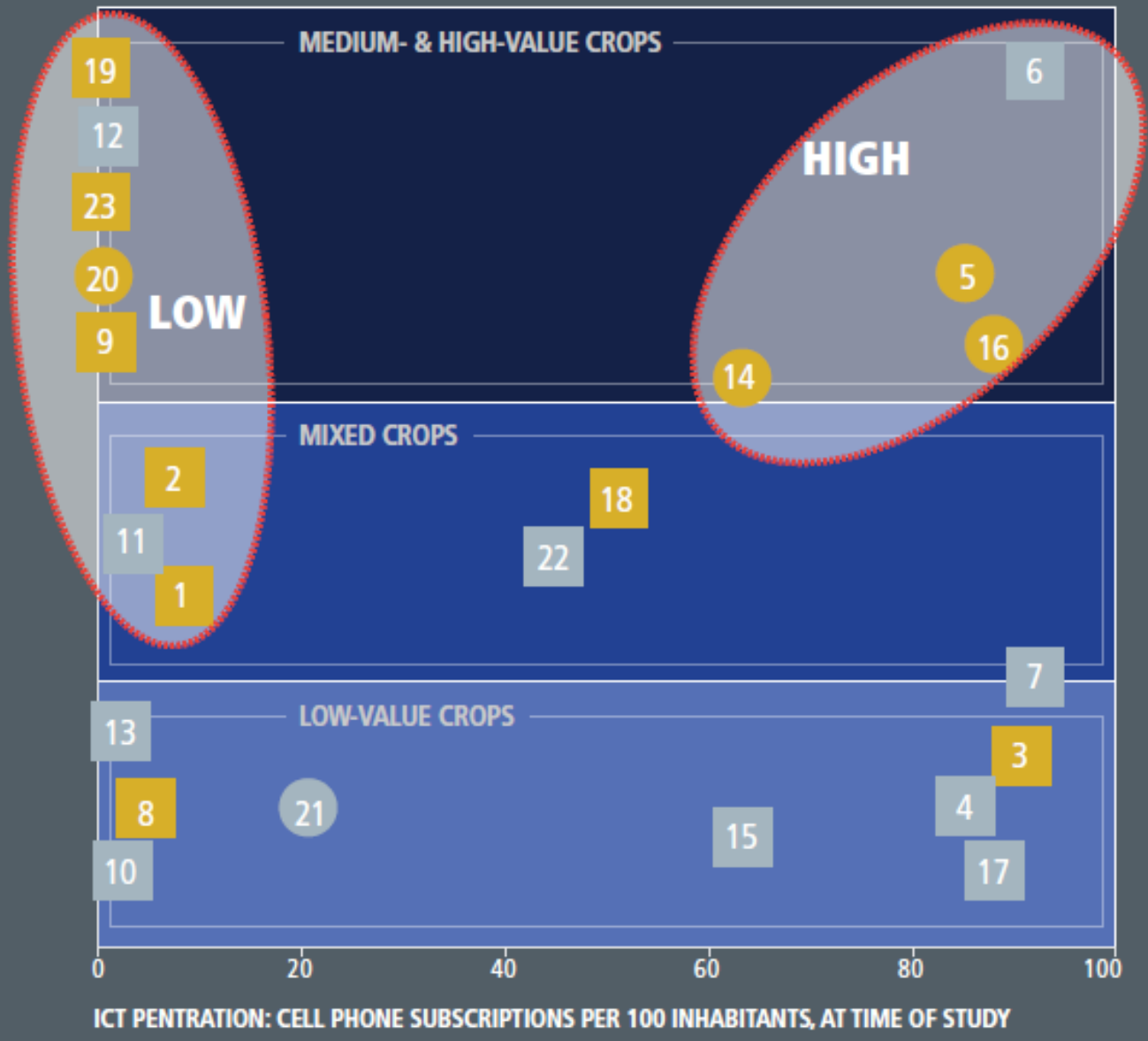
Results at the Micro Level



WHEN ICT PENETRATION IS LOW, almost any price information—general or specific—tends to have a positive impact on farmer income.

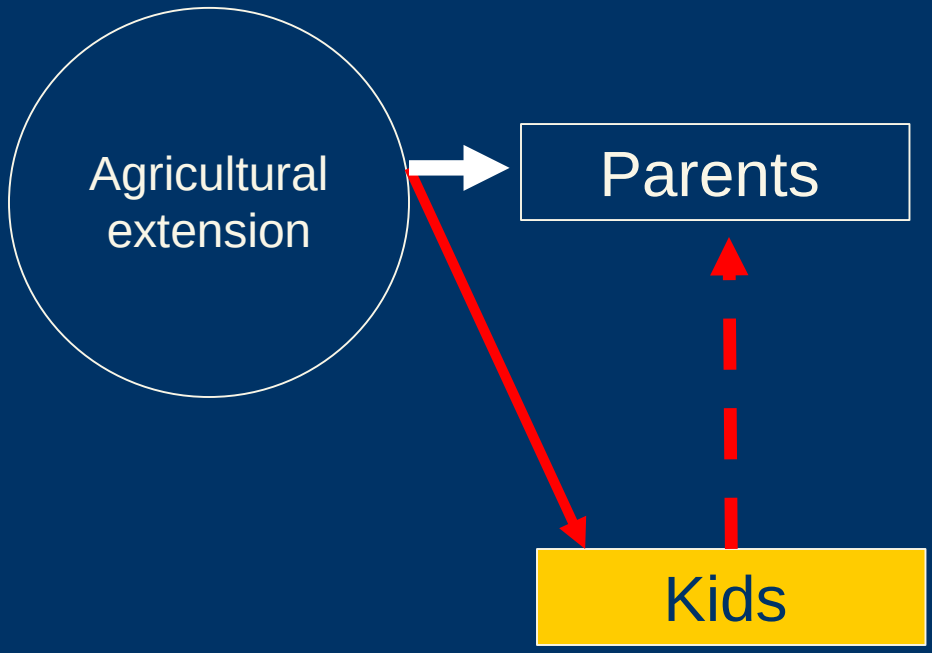
WHEN ICT PENETRATION IS HIGH, price information needs to be more specific to have a positive impact on farmer income, particularly for high-value crops that have a shorter shelf life.

*Numbers in graph correspond to numbered case studies in table.

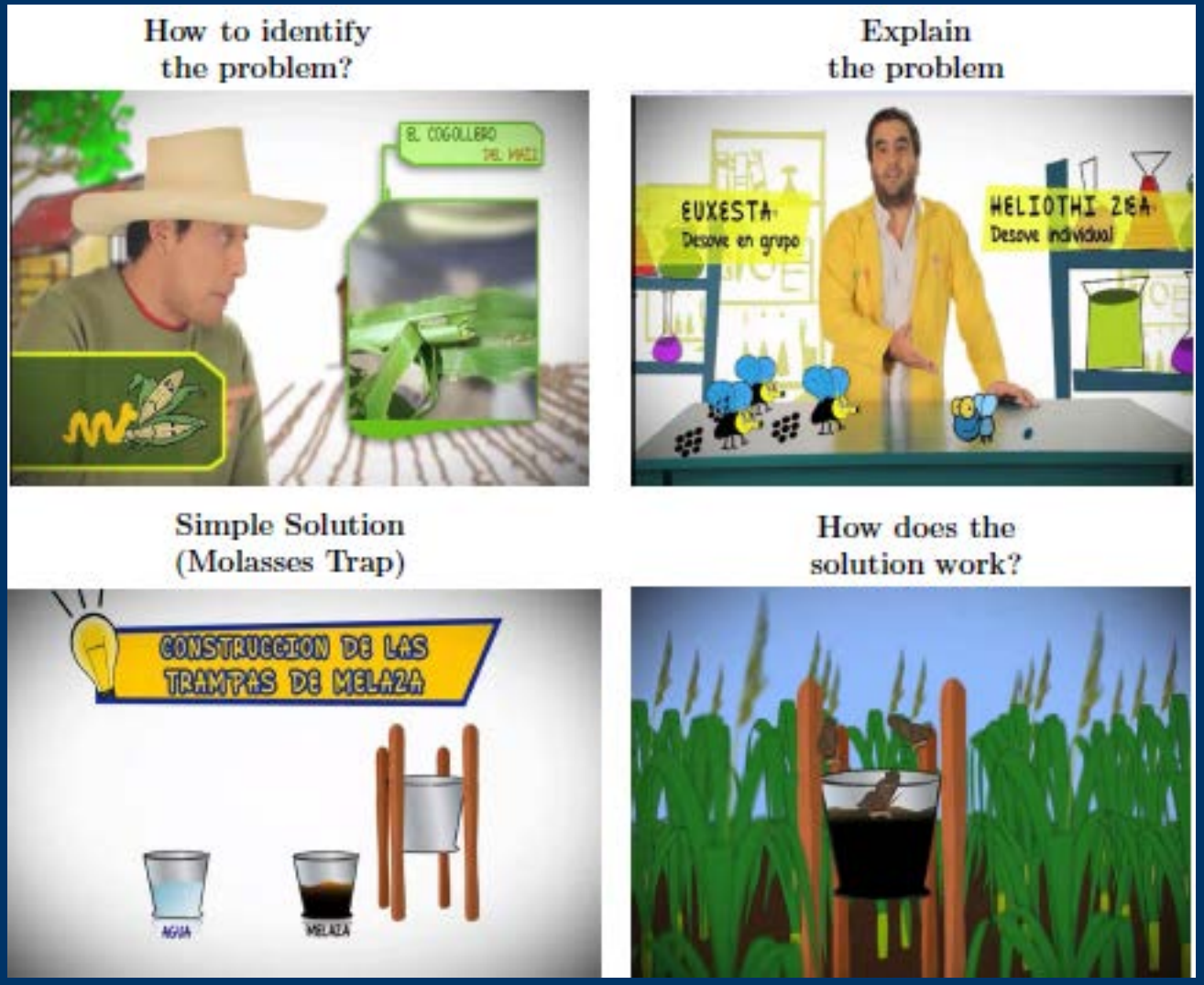


Kids to Parents: Extension

- Traditional Agricultural Extension: costly, hard to reach remote areas, accountability of extension workers.
- ICTs can solve many of these shortcomings.
- Problem: Computer-illiterate adult population in rural areas.



Kids and ICTs for Extension: Example (molasses trap for corn earworm



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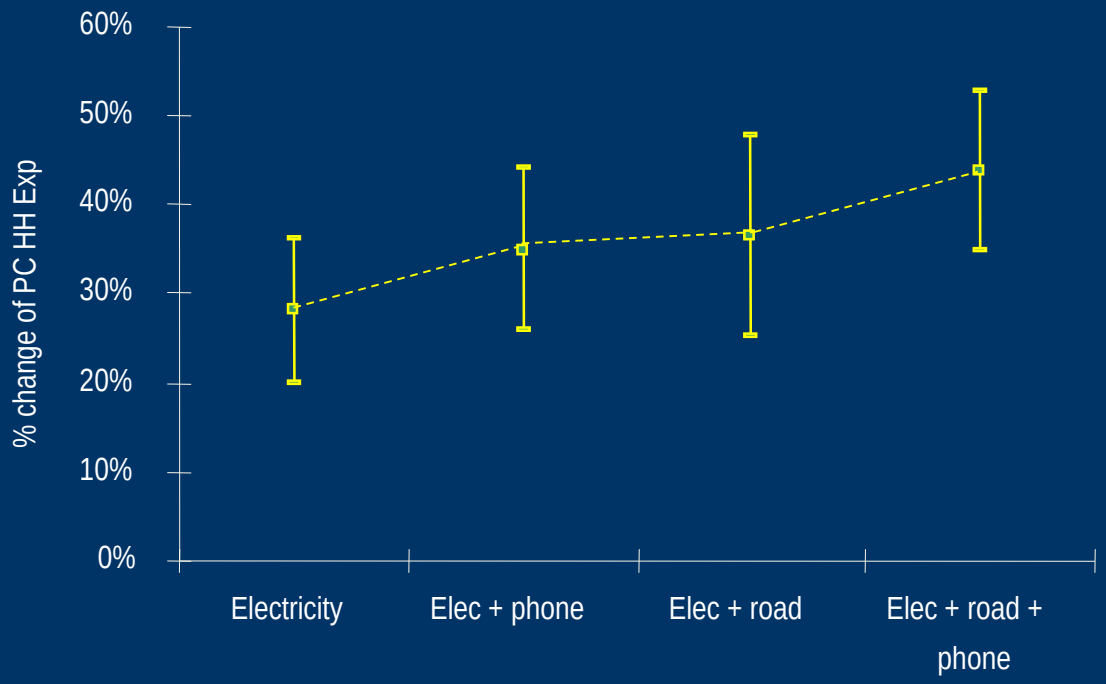
Complementarities of infrastructure

Bangladesh, 2000-2004



Source: Chowdhury and Torero, 2006

- **Infrastructure does seem to have an impact on household's welfare**
- **There exists complementarities in the provision of different types of infrastructure**

We need to be out of synchrony

http://amazinglytimedphotos.com/soldier-yawning/#.U7Zny7HfpD8