Natural Resources and structural transformation:discussant

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Types of Natural Resources

- **Agriculture (Extractive and Renewables)**
  - Fishery, Forestry, Agriculture etc
- **Minerals (Extractive)**
  - Iron, copper, diamonds etc
- **Energy (Extractive and Renewables)**
  - Oil, coal, bio, solar, wind, hydro etc

Each has slight different impact on structural transformation process.

-External Trade (exchange rate/macro economic policy

-Technological development and its trajectories

-Type of knowledge required (local/global/generic/specific/ tacit/codified)

Focus on Agriculture

Tanzania: Sectoral changes in GDP and Employment

	Value Added				Employment			
	1960	1975	1990	2010	1960	1975	1990	2010
Agriculture	26.3	17.1	31.0	30.1	89.5	89.1	86.1	73.4
Industry	22.6	29.2	20.1	26.4	1.4	2.8	2.7	6.0
Services	51.2	53.7	48.9	43.6	9.0	8.1	11.3	20.6

Groningen Data base

--productivity of agriculture and industry is growing in more traditional sense

--Service productivity is declining—informal sector?

Above demonstrate slightly different trends from the rest of African country

Why structural change necessary?

Economic development result from below

- Growth
- Making the economy more productive
  - Focusing not only on the size but components
  - Source of long term sustainable growth

# Possible explanations for structural transition not occurring in SSA/Africa

- Population growth eats up the increased agricultural productivity (diminishing return of labour)
- Absorption by manufacturing is inhibited by the higher wage caused by
  - High food cost in urban areas (efficiency wage hypothesis)
  - Natural resource boom (Dutch disease)
- Transition perhaps also inhibited by skill mismatch
  - Education/training need to be aligned with the labour demand
- Lack of investment in the countries to productive sectors?
- Lack of Institutional capacity?

Comparison of Food prices
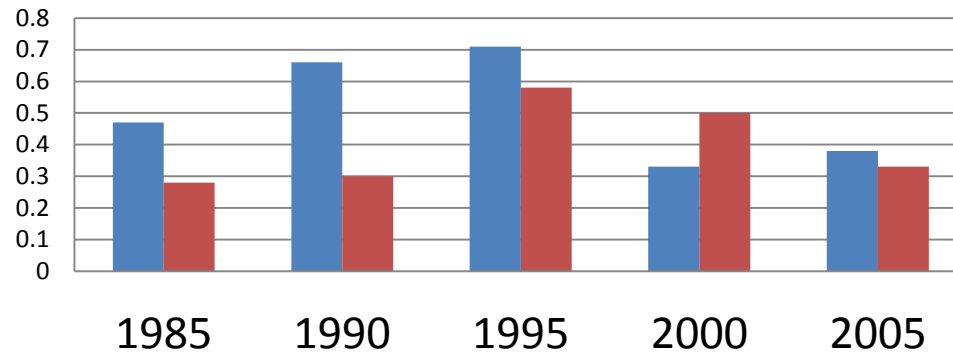# Sub Saharan Africa and East Asia

Wheat (US$/1KG)
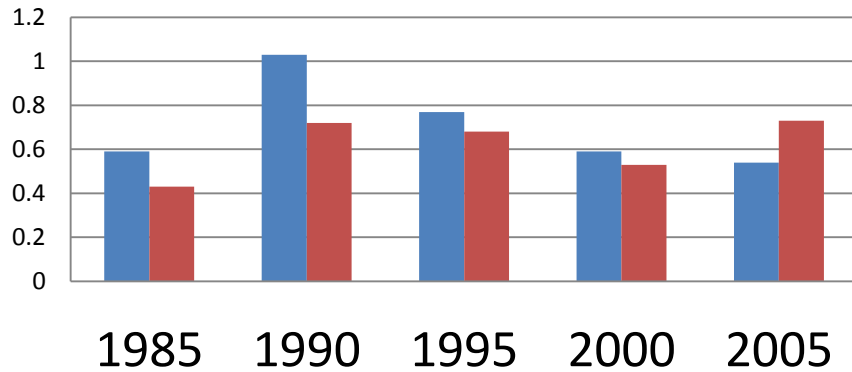
Rice (US$/1KG)
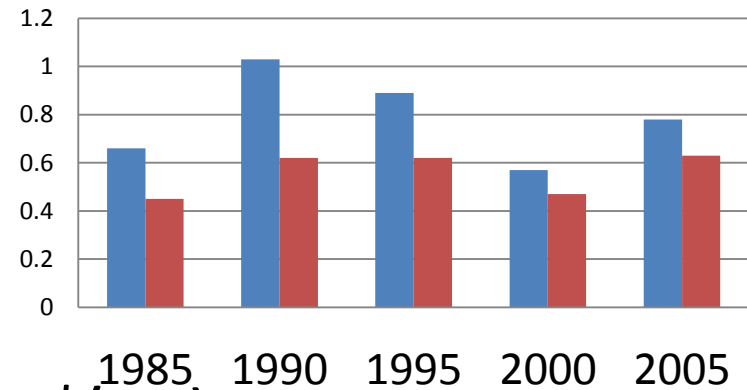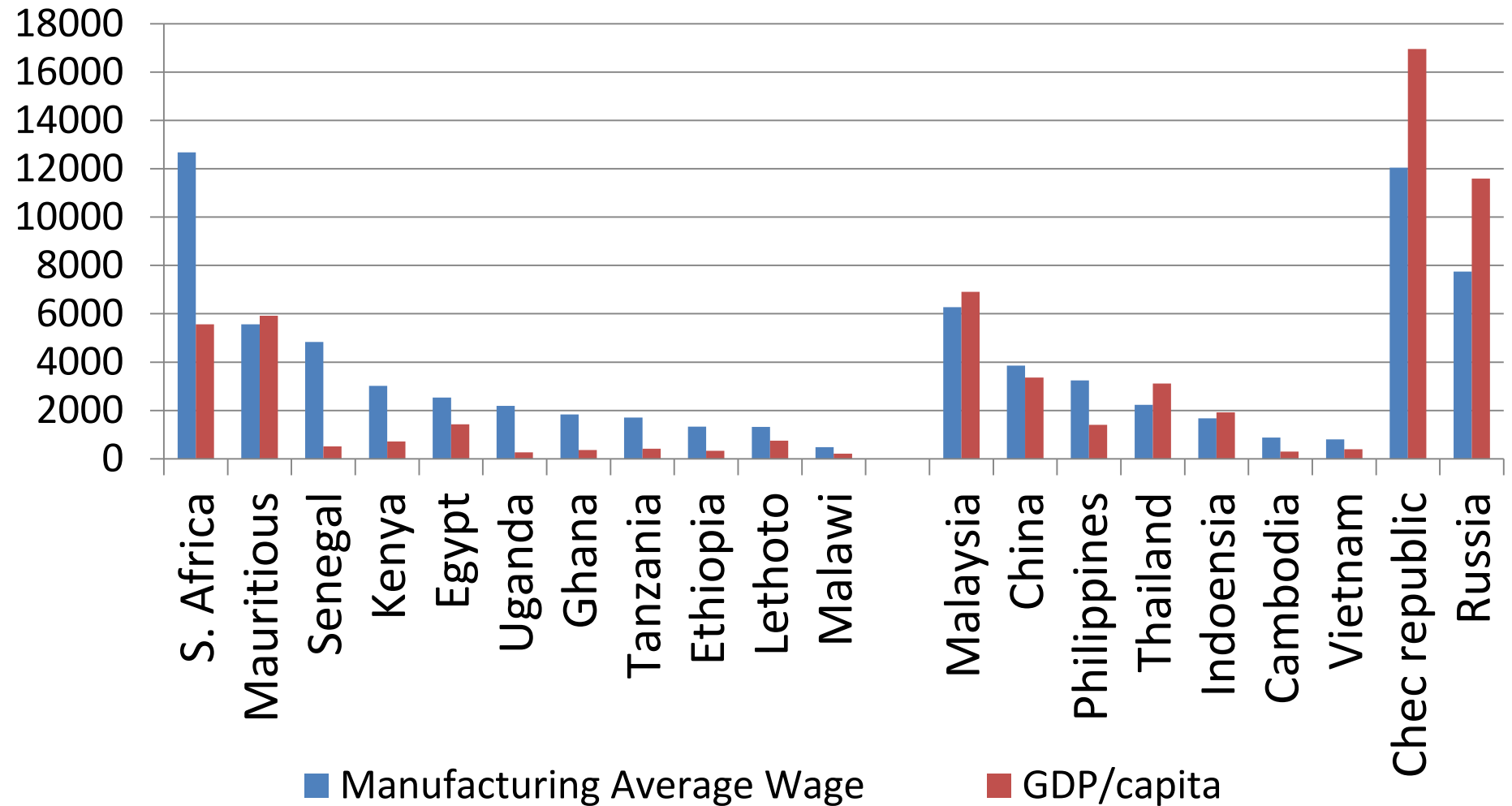
Maize (US$/1KG)

■ SSA   ■ EA developing countries

Source:Hirano, 2013 based on ILO data

Comparison between Manufacturing Average Wage and GDP/capita

Source: Hirano, 2013 based on most recent data available from UN statistics.

TABLE 3.7:   GROSS DOMESTIC HIGHER EDUCATION EXPENDITURE ON R&D (HERD), 2010

COUNTRIES	SURVEY YEAR	HERD (PPP$ M)	HERD % OF GDP	HERD PER CAPITA (PPP$)
Angola	2011	24.3	0.02%	1.24
Cape Verde	2011	1.5	0.06%	2.92
Ethiopia	2010	88.3	0.10%	1.06
Ghana	2010	5.7	0.01%	0.23
Kenya	2010	254.6	0.38%	6.29
Lesotho	2011	0.5	0.02%	0.22
Malawi	2010	113.1	0.92%	7.59
Mali	2010	19.6	0.12%	1.27
Mozambique	2010	35.7	0.17%	1.52
Namibia	2010	18.6	0.13%	0.81
Senegal	2010	41.0	0.17%	3.30
South Africa	2010	1 077.0	0.20%	21.48
Tanzania	2010	278.05	0.45%	31.60
Togo	2010	6.4	0.10%	1.03
Uganda	2010	60.4	0.13%	1.81
Zimbabwe[z]	2012	118.0		

z Zimbabwe: Data is in national currency

Source: ASTII R&D surveys 2010 or latest year available

GDP, PPP and population data sourced from African Development Bank

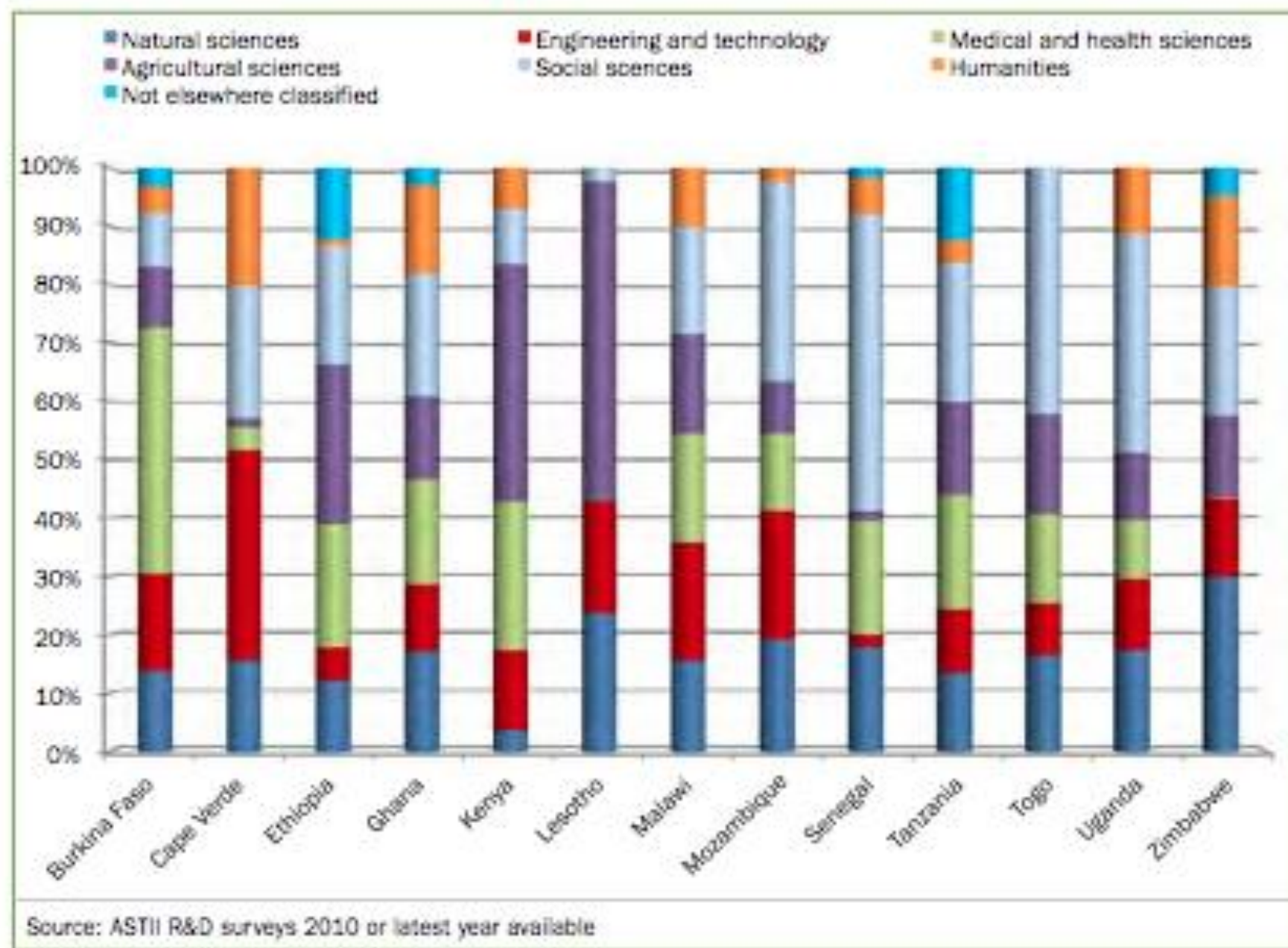# FIGURE 3.4: RESEARCHERS BY FIELD OF SCIENCE (PERCENTAGES)

Source: ASTII R&D surveys 2010 or latest year available

TABLE 4.21:   SHARE OF EXPENDITURE FOR THE FOUR CATEGORIES OF INNOVATION ACTIVITIES FIRMS ENGAGED IN FOR REPORTING COUNTRIES

	INTRAMURAL (IN-HOUSE) R&D	EXTRAMURAL (OUT-SOURCED) R&D	ACQUISITION OF MACHINERY OR ACQUISITION OF SOFTWARE§	ACQUISITION OF OTHER EXTERNAL KNOWLEDGE	TOTAL
Ghana	38.2	19.1	18.6	24.1	100.0
Kenya	27.2	12.6	39.5	20.7	100.0
Lesotho	16.4	0.9	81.2	1.4	100.0
Nigeria	14.8	18.3	62.1	4.8	100.0
Senegal	39.0	15.6	5.5	39.9	100.0
South Africa	21.2	11.4	59.6	7.8	100.0
Tanzania	7.2	4.1	87.3	1.4	100.0
Uganda	27.4	52.3	15.6	4.7	100.0
Zambia	73.9	1.2	23.0	1.9	100.0

Source: ASTII innovation surveys, 2008-2010 for Ghana, Nigeria, Tanzania, Uganda and Zambia, and 2008-2011 for Kenya, 2010-2012 for Lesotho, 2009-2011 for Senegal and 2005-2007 for South Africa

§ For Nigeria, the data cover only acquisition of software

Theoretical discussion of Structural transformation

- **Current view**
- Sustained and high level of economic growth are highly associated with structural transformation process of moving resources from more productive sector from less productive sector through industrialization mainly to manufacturing. (i.e. East/SE Asia and many developed countries)

- **Alternative views**
- Service based development possible? (e.g India)
- Latin American scholars (Perez, Lederman, Maloney etc in 2000s): focus on knowledge component on activity
  - Natural resource based development (NRBD) is possible
  - Latent comparative advantage (Lin, 2011)

Possible areas for future investigations in improving labour productivity in agriculture

- Realities of African agriculture: how innovation (technology/institutional change) can be incorporated to improve productivity? Requires systemic perspective?

    -Improve labour productivity

- Under what conditions, increase in productivity of agriculture lead to the structural transformation ?

    -Encourage structural transformation

Future potentials for Natural Resources in Africa

- Require different type of knowledge
  - Local specific and tacit
  - Highly variable
  - Complex combination of various things (macro/micro)
- Growing potential in local/regional market
  - Growing population
  - Regional integration
 - Infrastructure/connectivity

Escaping Low Productivity Trap of Agriculture

Low productivity trap can be escaped by innovation: technological development and institutional change.

- Technological change
  - Introduction of embodied technology
    - Fertilizer, tractor, seed varieties
  - Knowledge creation and innovation
    - Human resources: more agricultural specialist etc
    - Research inputs
- Institutional change (improving knowledge flow)
  - Extension services, association, public research institute
  - University/public research institute-Industry linkage
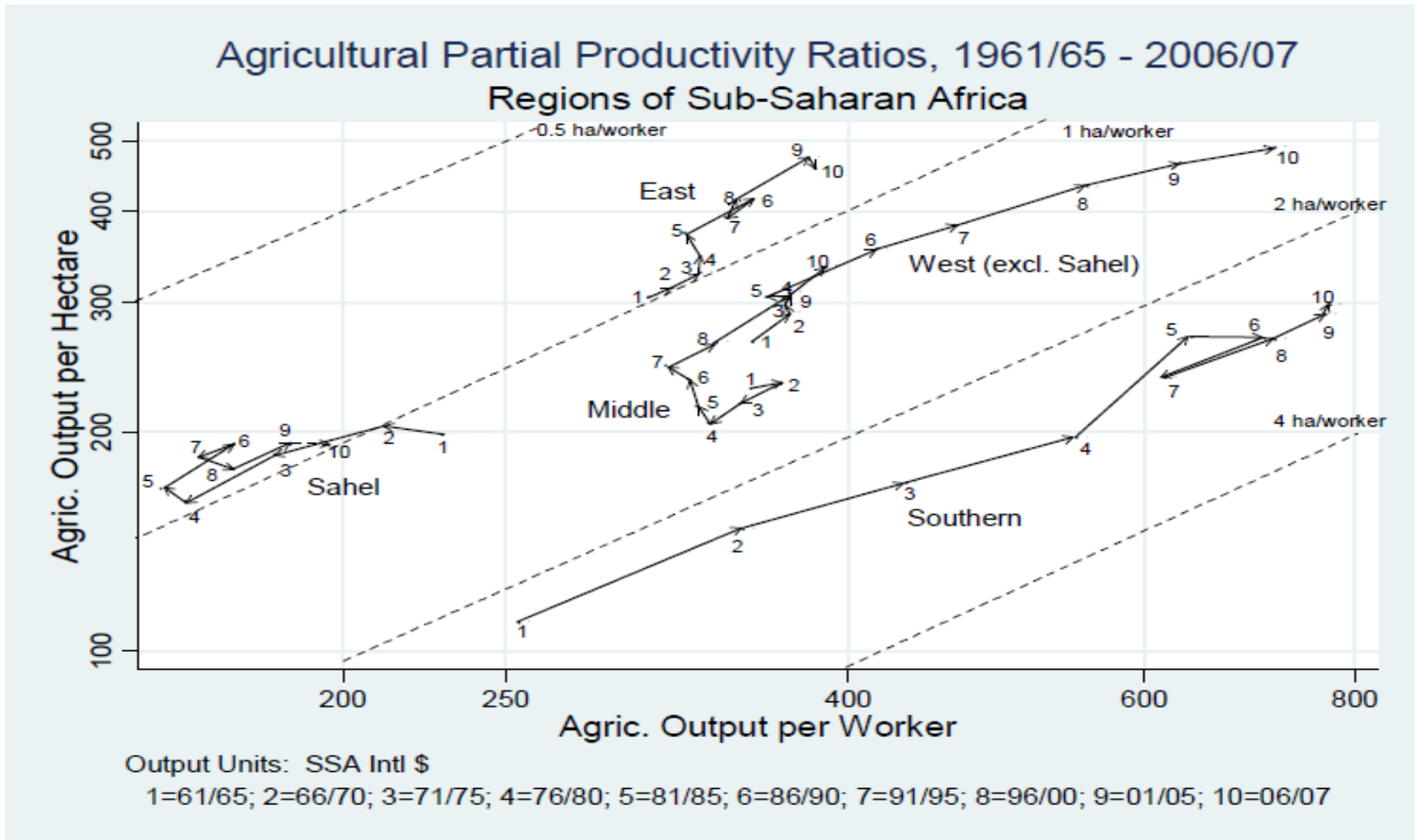 - Access to information and knowledge from aborad

International Comparison of Partial Productivity Ratios in Agriculture

1961/65 - 2001/05
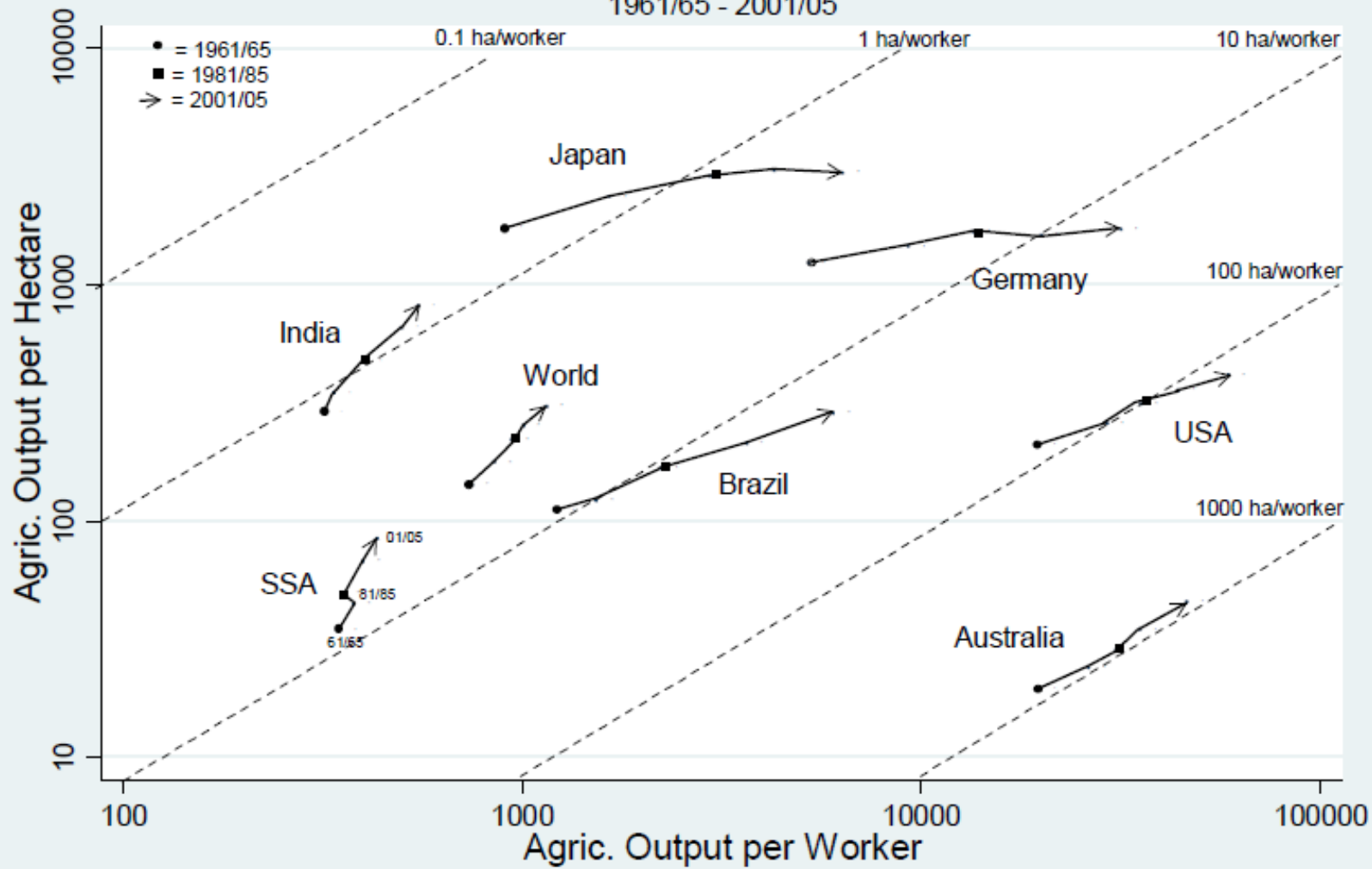
Source: Block, 2010

Heterogeneity among African regions in changes of productivity

Source: Block, 2010

Agricultural productivity in Africa: Myths? Are there alternative path?

- Large scale is more productive than Small holder
  → Not Necessarily

- Introduction of labour saving machine would increase productivity → Not Necessarily

- Agricultural/rural life provides less sustainable livelihood—more vulnerable employment
  → Yes because of climate change

- Biotechnology is harmful for agriculture ????

Revisit the Myths:

Need to understand clearly what each implies in Regional/local context

Need to approach in complementary or systemic manner

Theoretical understanding of Structural transformation 1

- **Classical view 1**

- Dual Sector Model (A.Lewis, 1954)

  – Surplus labour in Agricultural (subsistence) sector will move to manufacturing (capitalist) sector because marginal labour productivity of agriculture is low (surplus, cheap labour).

  – Above are under assumption labour productivity stay constant

If Dual Sector Model is correct, the marginal cost of labour should be cheaper, making it attractive for more productive activities such as manufacturing.

Theoretical understanding of Structural transformation 2

- **Classical view 2**
- Ricardian rent theory: diminishing returns to increments of labour and capital applied to an inelastic supply of land represented fundamental constraint on economic growth.
  - Pessimistic view of technological progress;
  - In reality
    - Real cost of agricultural production had declined in spite of land resource constraint
    - TFP of agriculture increase in economic growth
    - Technological change released inelastic resource supplies.

  But above is not happening in Africa

Theoretical discussion of Structural transformation

- **Current view**
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Population Growth (annual growth rate)
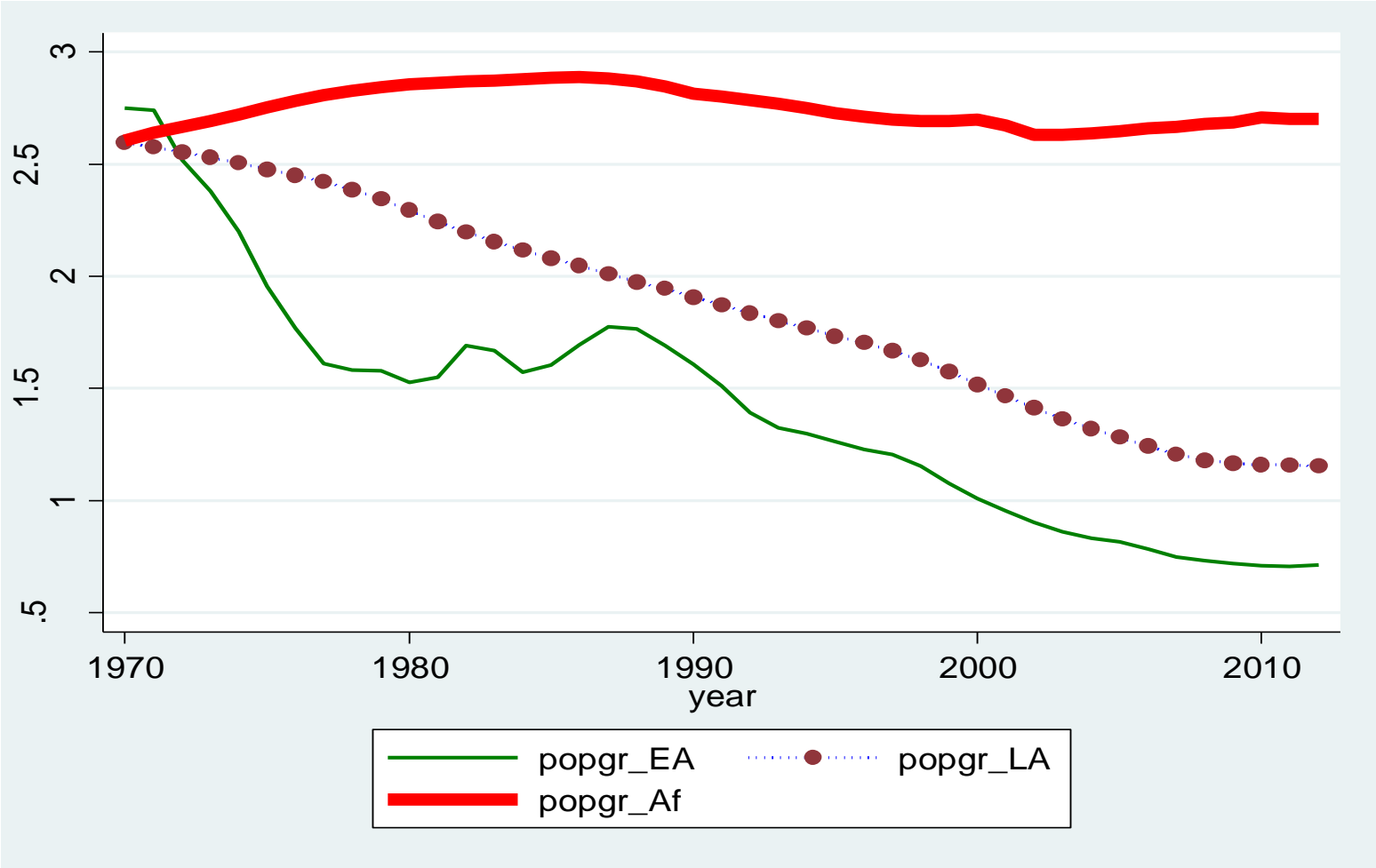
Source: WDI, 2013

From outlook

TABLE 3A.72:   TANZANIA: GERD AND SOURCES OF FUNDS IN MILLIONS TANZANIAN SHILLINGS (2010/11)

GERD	TOTAL	BUSINESS	GOVERNMENT	HIGHER EDUCATION	PRIVATE NON PROFIT
GERD BY SECTOR AND SOURCES OF FUNDS	**166 686.0**	*	**22 915.5**	**143 770.5**	*
Business sector	132.2	*	10.0	122.2	*
Direct government	31 711.4	*	13 850.9	17 860.5	*
General university funds	64 186.0	*	-	64 186.0	*
Higher education	553.4	*	148.4	404.9	*
Private non profit	87.0	*	68.7	18.3	*
Funds from abroad	70 015.9	*	8 837.4	61 178.5	*
* Sector not surveyed					

TABLE 4.16: HIGHLY IMPORTANT SOURCES OF INFORMATION FOR INNOVATION FOR TANZANIAN FIRMS, NUMBER AND PERCENT OF INNOVATION-ACTIVE FIRMS

CATEGORY	INFORMATION SOURCE	INNOVATION-ACTIVE FIRMS	
		NUMBER	PERCENT
Internal sources	**Sources within same enterprise group**	**52**	**61.9**
External Sources			
Market	Suppliers of equipment	27	32.1
	Clients or customers	56	66.7
	Competitors	23	27.4
	Consultants	14	16.7
Institutional	Universities or technical colleges	6	7.1
	Government or private research institutions	10	11.9
Other	Conferences	14	16.7
	Scientific journals	8	9.5
	Professional associations	17	20.2
Source: Tanzania Commission for Science and Technology (COSTECH)			

TABLE 4.17:   HIGHLY IMPORTANT EFFECTS OF INNOVATION FOR TANZANIAN FIRMS: NUMBER AND PERCENT OF INNOVATION-ACTIVE FIRMS

CATEGORY	EFFECT OF INNOVATION	INNOVATION-ACTIVE FIRMS	
		NUMBER	PERCENT
Product	Increased range of goods	39	46.4
	Entered new market	31	36.9
	Increased market share	32	38.1
	Improved quality of goods or services	51	60.7
Process	Improved flexibility of production	31	36.9
	Increased capacity of production	38	45.2
	Reduced labour costs per unit of labour	31	36.9
Other	Reduced environmental impacts	40	47.6
	Improved working conditions on health	39	46.4
	Met governmental regulatory requirements	36	42.9
Source: ASTII Innovation Survey, 2008-2010, Tanzania Commission for Science and Technology (COSTECH)			

TABLE 3.3: GROSS DOMESTIC PUBLIC EXPENDITURE ON R&D (PUBLIC GERD), 2010

COUNTRIES	SURVEY YEAR	PUBLIC GERD (PPP$ M)	PUBLIC GERD % OF GDP	PUBLIC GERD PER CAPITA (PPP$)
Angola	2011	90.4	0.08%	4.61
Ethiopia	2010	176.3	0.21%	2.13
Ghana	2010	153.4	0.38%	6.29
Kenya	2010	519.6	0.78%	12.83
Malawi	2010	134.4	1.10%	9.02
Mali	2010	112.4	0.66%	7.32
Mozambique	2010	90.0	0.42%	3.85
Senegal	2010	108.9	0.45%	8.76
South Africa	2010	1 991.8	0.38%	39.73
Tanzania	2010	322.4	0.52%	7.19
Togo	2010	15.3	0.25%	2.50
Uganda	2010	152.1	0.32%	4.55
Zimbabwe[z]	2012	143.1[z]		

z Zimbabwe advised that the GDP figure is not reliable for use with the R&D data. Zimbabwe's R&D expenditure data is in national currency.

Source: ASTII R&D surveys 2010 or latest year available

GDP, PPP and population data sourced from African Development Bank

Source: UNESCO-UIS (as of June 2013), ASTII R&D surveys 2010 or latest year available
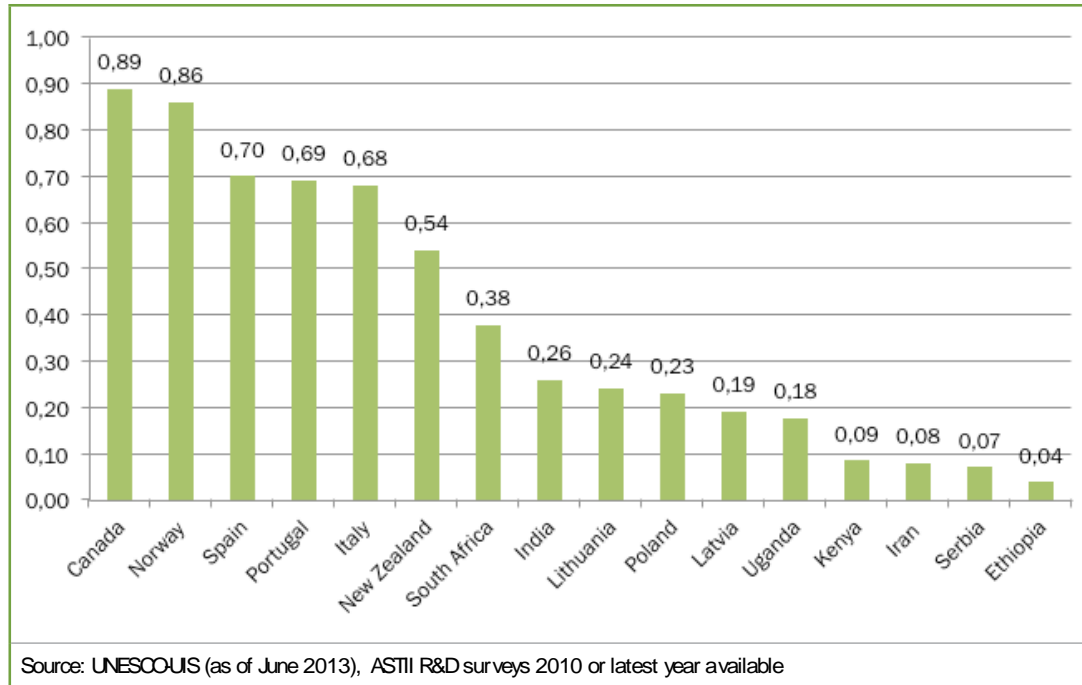
TABLE 3.16:   R&D PERSONNEL AND RESEARCHERS (FTE)

COUNTRIES	TOTAL R&D PERSONNEL	TOTAL RESEARCHERS	RESEARCHERS AS A % OF R&D PERSONNEL	R&D PERSONNEL PER MILLION INHABITANTS	RESEARCHERS PER MILLION INHABITANTS
Angola**	6 408.0	2 245.0	35.0	327	114
Burkina Faso	2 049.4	742.4	36.2	128	46
Cape Verde	37.0	25.0	67.6	74	50
Egypt	89 764.4	41 568.4	46.3	1 088	504
Ethiopia	8 279.0	3 701.0	44.7	100	45
Ghana	3 004.4	940.6	31.3	123	39
Kenya	42 566.0	9 305.0	21.9	1 051	230
Lesotho	13.7	11.9	86.9	6	5
Malawi	1 720.6	732.1	42.6	115	49
Mali	856.0	442.5	51.7	56	29
Mozambique	2 164.5	912.4	42.2	93	39
Senegal	5 642.3	4 679.0	82.9	454	376
South Africa	29 486.4	18 719.0	63.5	588	373
Tanzania	2 928.6	1 599.6	54.6	65	36
Togo	443.7	220.3	49.7	74	37
Uganda	2 006.9	1 262.7	62.9	60	38
Zimbabwe	1 740.8	1 305.2	75.0	133	100

Source: ASTII R&D surveys 2010 or latest year available

** In the case of Angola "R&D personnel" and "researchers" include university lectures who are not necessarily conducting research

Table 3.17 shows the FTE data for total R&D personnel and researchers and Table 3.18 shows the FTEs as percentage of headcount.

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Lesotho	16.4	0.9	81.2	1.4	100.0
Nigeria	14.8	18.3	62.1	4.8	100.0
Senegal	39.0	15.6	5.5	39.9	100.0
South Africa	21.2	11.4	59.6	7.8	100.0
Tanzania	7.2	4.1	87.3	1.4	100.0
Uganda	27.4	52.3	15.6	4.7	100.0
Zambia	73.9	1.2	23.0	1.9	100.0

Source: ASTII innovation surveys, 2008-2010 for Ghana, Nigeria, Tanzania, Uganda and Zambia, and 2008-2011 for Kenya, 2010-2012 for Lesotho, 2009-2011 for Senegal and 2005-2007 for South Africa

§ For Nigeria, the data cover only acquisition of software

Box 2.1. **Policy findings of the NEPAD-OECD Africa Investment Initiative at national and regional levels** (cont.)

- The **Tanzania** Investment Policy Review highlights the following priorities for improving FDI attractiveness: *i*) rationalise investment incentives; *ii*) strengthen domestic suppliers; *iii*) make small- and medium-sized enterprises more competitive through better access to finance; *iv*) increase land tenure security for investors; *v*) facilitate access to private investment in infrastructure.

At the regional level, the joint project between the NEPAD-OECD Africa Investment Initiative and the 14 member states of the Southern African Development Community (SADC) addresses four policy areas that present specific risks and bottlenecks for further expansion of domestic and foreign investment: *i*) investor protection; *ii*) FDI restrictions; *iii*) a level playing field for private investment in infrastructure; *iv*) tax incentives for investment. The objective is to avoid a detrimental "race-to-the-bottom" among neighbouring countries in these areas by providing a benchmark against which member states can plan and assess progress in improving their investment policy. Endorsement of the completed framework by the SADC Ministers of Investment and Finance is targeted for end 2015.
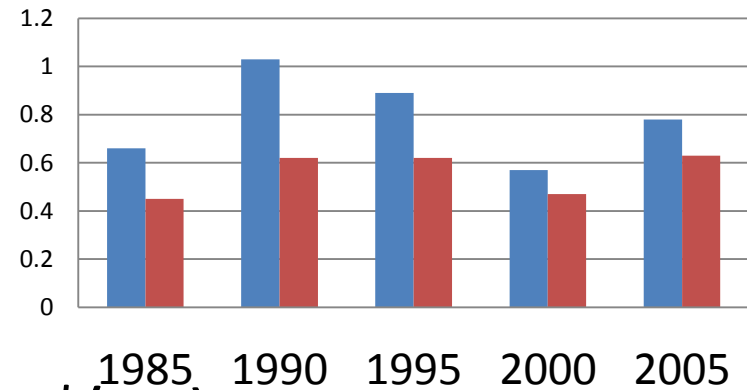
Source: NEPAD-OECD Africa Investment Initiative, www.oecd.org/investment/investmentfordevelopment/africa.htm.

Comparison of Food prices
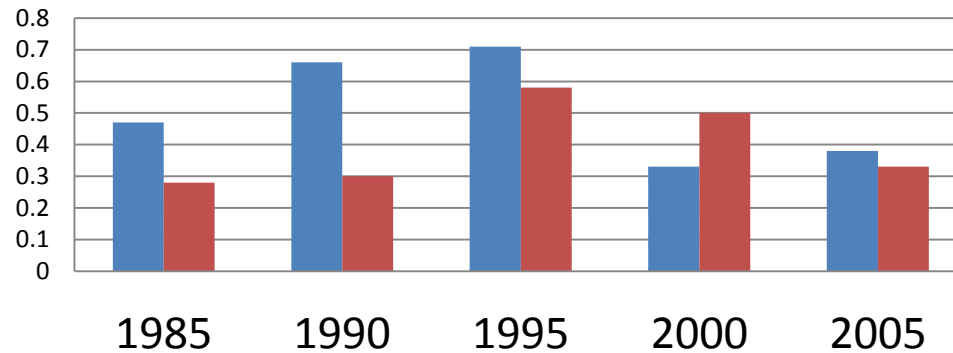# Sub Saharan Africa and East Asia
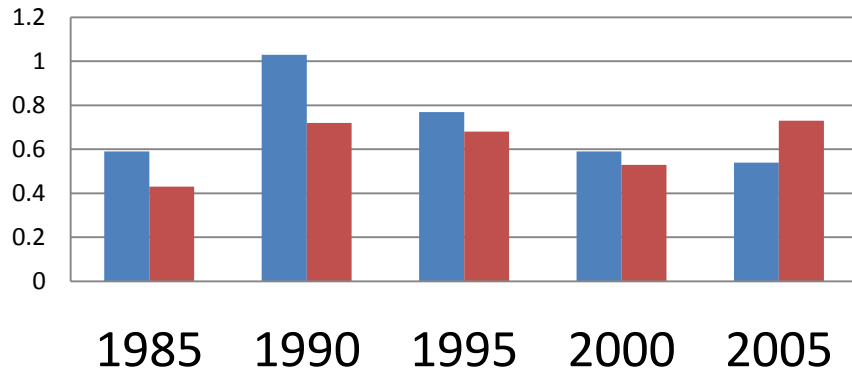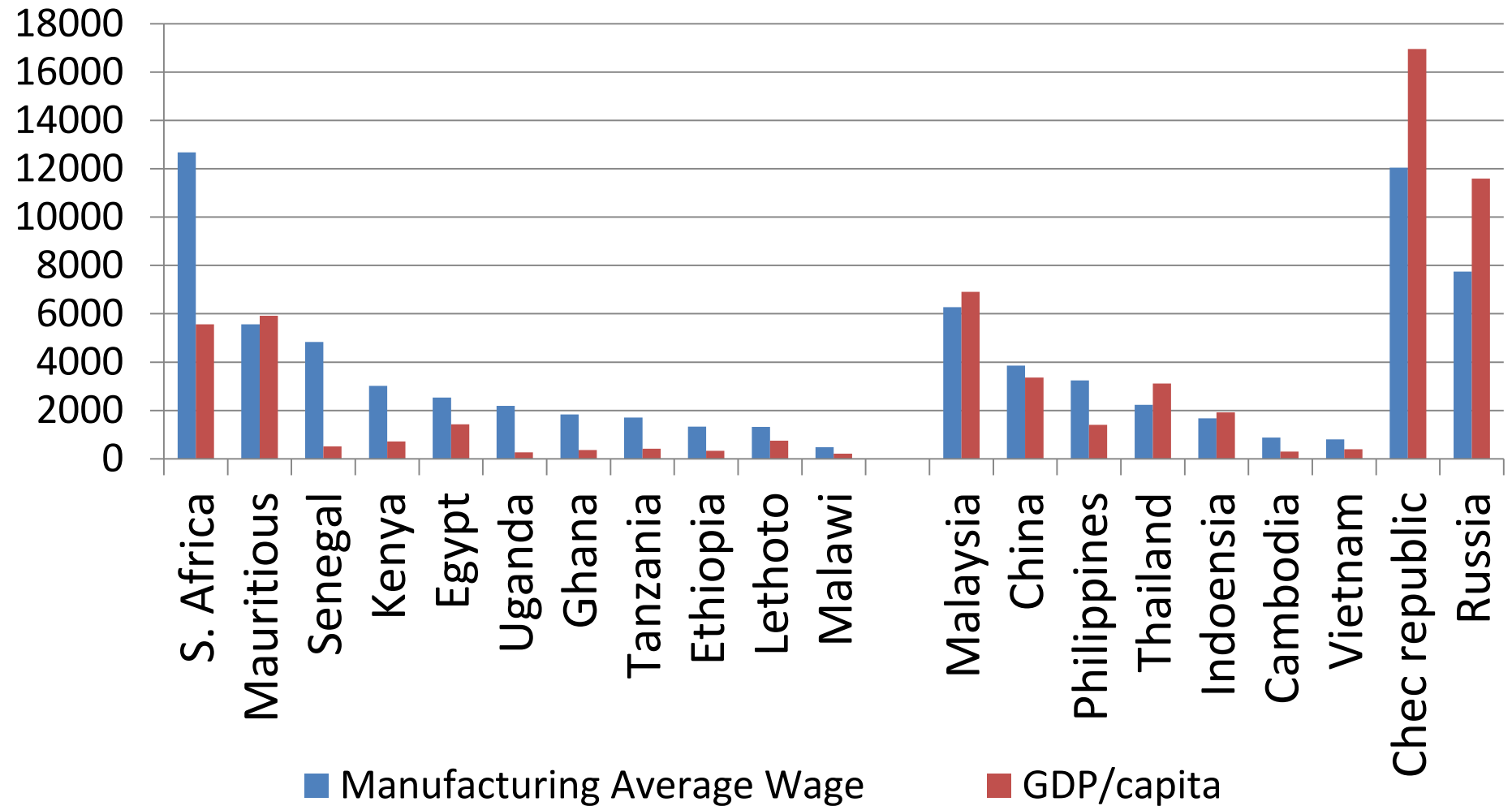

Source:Hirano, 2013 based on ILO data

# Comparison between Manufacturing Average Wage and GDP/capita

Source: Hirano, 2013 based on most recent data available from UN statistics.

Dutch disease

- Phenomena whereby the currency is overvalued due to export boom of natural resources (usually minerals);

- The overvaluation would translate into weakening competitiveness of exports and domestic industries (this also means drawing labour to the booming sector contribute to higher wage; increase of imports, such as food);

- Increase flow of money may lead to over spending by government (if not invested wisely).

# African export commodity by type in '000 dollars

YEAR
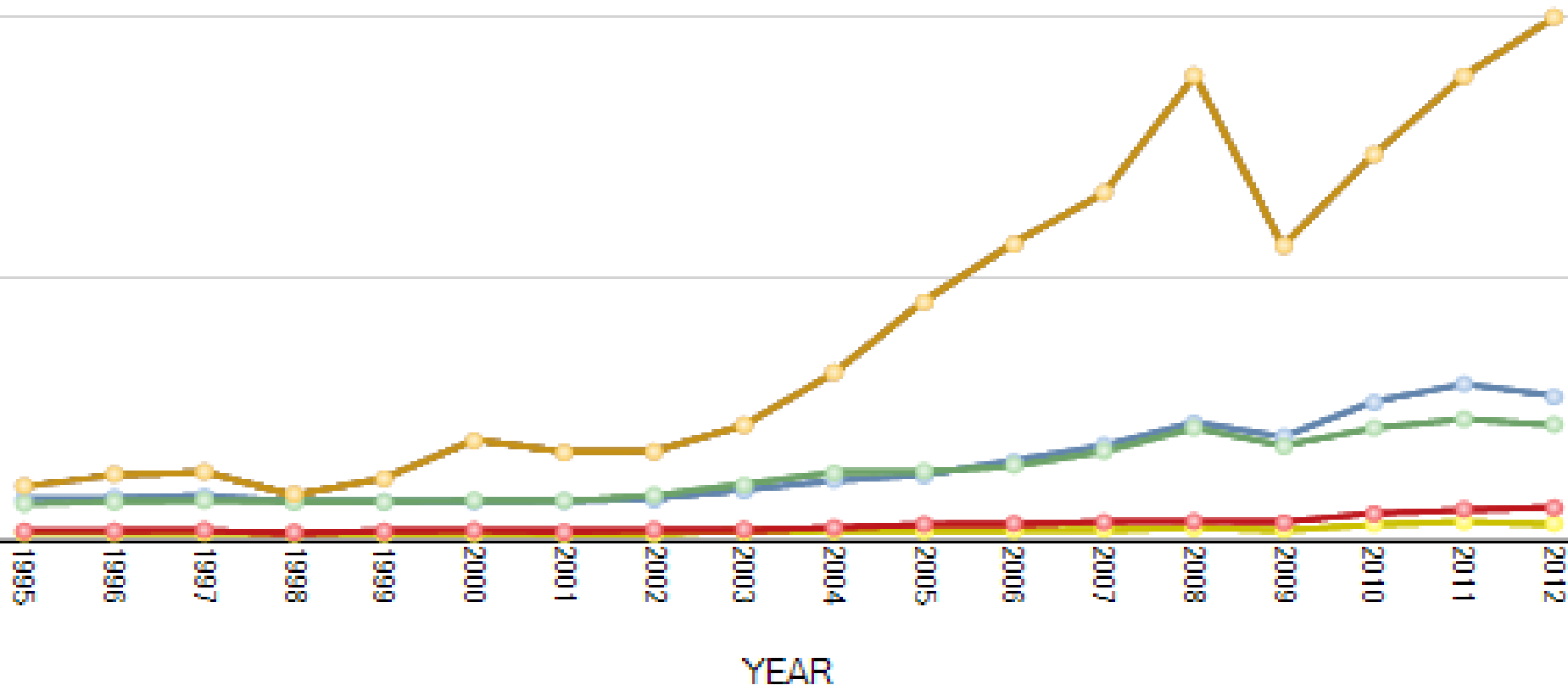
PRODUCT
- Primary commodities, excluding fuels (SITC 0 + 1 + 2 + 4 + 68)
- Agricultural raw materials (SITC 2 less 22, 27 and 28)
- Fuels (SITC 3)
- Pearls, precious stones and non-monetary gold (SITC 667 + 971)
- Manufactured goods (SITC 5 to 8 less 667 and 68)

EXCHANGE RATE OVERVALUEATION

IMF Data Mapper ®

Real Effective Exchange Rates (2000=100) (Annual Average Index, 2000 = 100)

- Oil-importing countries
- Oil-exporting countries
- Sub-Saharan Africa

©IMF, 2012, Source: AFR Regional Economic Outlook (Fall 2013)
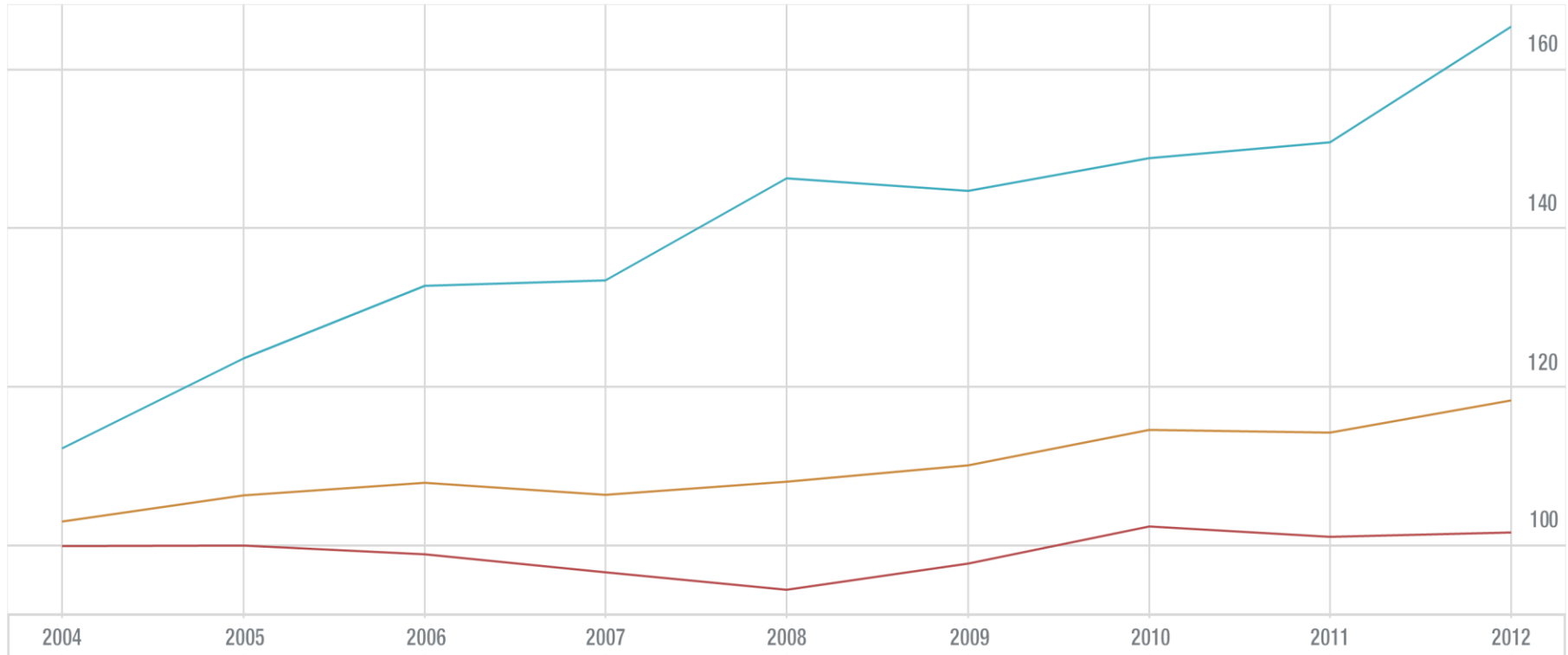
Food imports as percentage of merchandise imports
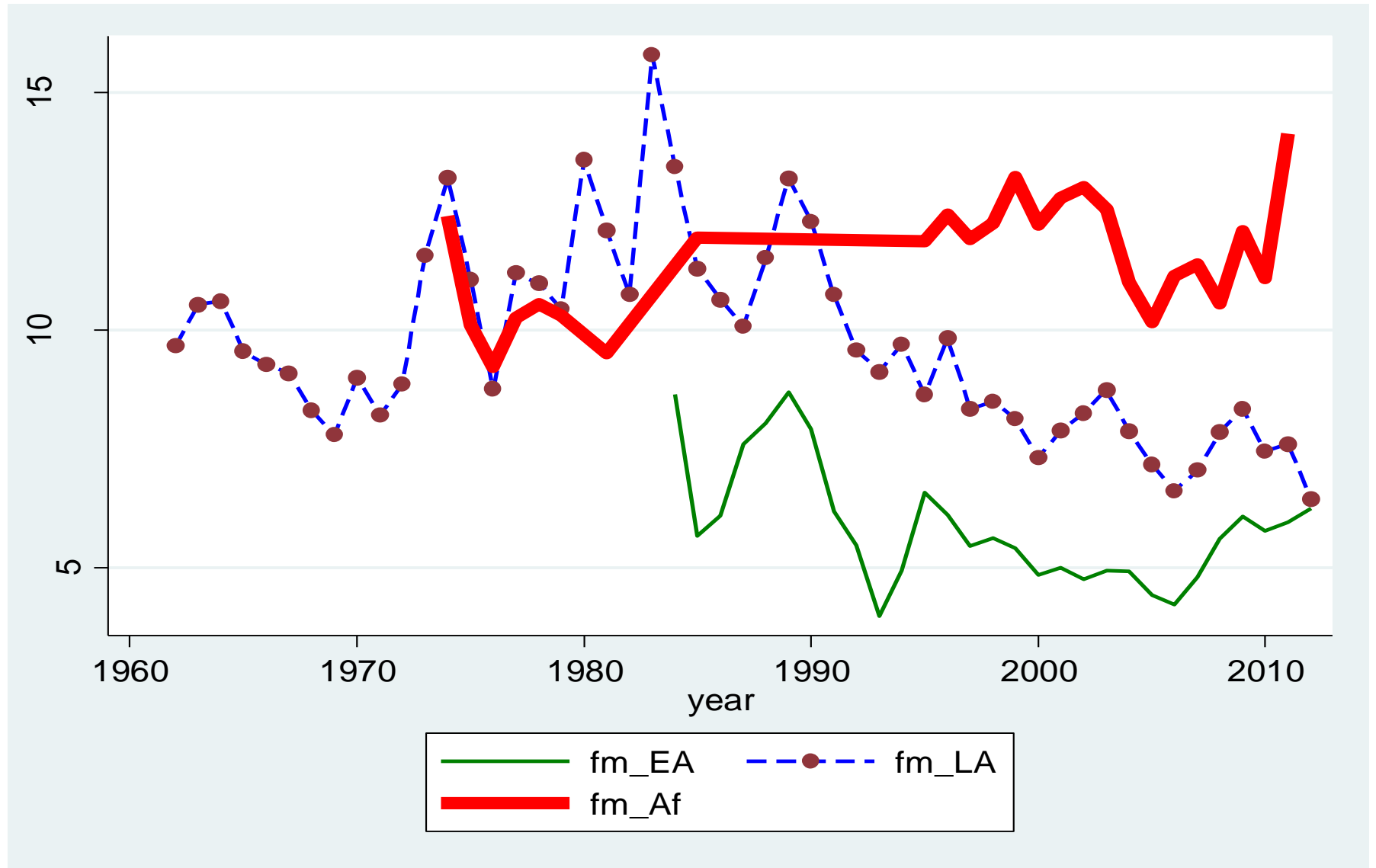
Source: WDI, 2013

Education attainment

	Highest level attained		
	Primary	Secondary	Tertiary
Kenya	53.3	32.8	3.1
Mauritius	37.4	51.3	5.2
SSA median	32.9	22.6	1.95
India	20.9	40.7	5.8

Source: Barro and Lee, 2010

Contribution to GDP growth (2002-2008)

	SSAfrica	N. Africa	World	China*	SE Asia*
Productive					
Agriculture	16,4	7,8	4,0	9,4	11,8
Mining, infrastructure	25,4	44,0	8,1	-	11,3
Manufacturing	7,0	8,5	16,3	27,4	26,8
Expenditure					
Personal consumption	60,6	42,9	54,6	30,0	53,4
Government consumption	15,9	11,9	17,6	12,1	9,9
Fixed capital formation	20,3	26,6	25,7	48,2	25,5
Trade surplus	2,0	13,2	-	15,5	9,7

Source: based on Hirano 2013, 2009 which made calculation from data obtained from UN statistics
Note: * is for 2002-2007

Institutional barrier?

	Road density (Km of road per 100 sqkm land, 2007)	Cost to Export (US$ per container)	Efficiency of customs clearance (1=low, 5= high)	Value Lost to Electrical Outages (% of sales)	ICRG Corruption (0=high risk, 6=low risk)	Transparency, accountability of public sector (1=low 6=high)
SEAsia (me	35.0	774	2.6	3.4	2.5	3.0
SSAfrica*	14.5	1927	2.2	6.1	2.3	2.8

Source: IMF 2012 based on World bank Wrold Development Indicators. * road density is 2004 data

Summary

- So far, much of employment in SSA is in Agriculture (subsistence) sector. But productivity of this sector remains low, underemployment exist (labour surplus) to be released into other sectors.
- The conventional structural transformation seems missing [Agriculture → Industry →Service]
  - Education/Human resources?
- Service sector is growing: but limited understanding on what is happening especially on productivity and employment dynamics.
- There are some rupture in translating recent economic growth into transforming structurally allocating resources to productive sector to create PRODUTIVE and SUSTAINABLE EMPLOYMENT.
  - investment; institution?

Possible areas for future research

- Understand why structural transformation is not happening in Sub-Saharan Africa from Agriculture to other sector

   -systemic understand to coordinate human resource and institutional development?

- Understand productivity and employment dynamics in the service sector

   -knowledge contents, productivity, sustainability

- Direction of investment where does the fruit of growth is absorbed?   Does it go to productive sector?

- How to improve existing low productivity of agriculture?
  - Important for structural transformation
  - Food security

Sectoral Share of GDP and Employment in Sub Saharan Africa

Sector	Value added (% of GDP) 2000	Value added (% of GDP) 2010	Employment (%) 2000	Employment (%) 2011
Agriculture	16.0	12.2	66.4	61.8
Industry (Manufacturing)	14.7	11.6	7.9	8.7
Service	53.5	58.4	25.7	29.5

Source: WDI, 2013 ; ILO(2013)

THANK YOU!

Agricultural Total Factor Productivity (TFP) in Africa

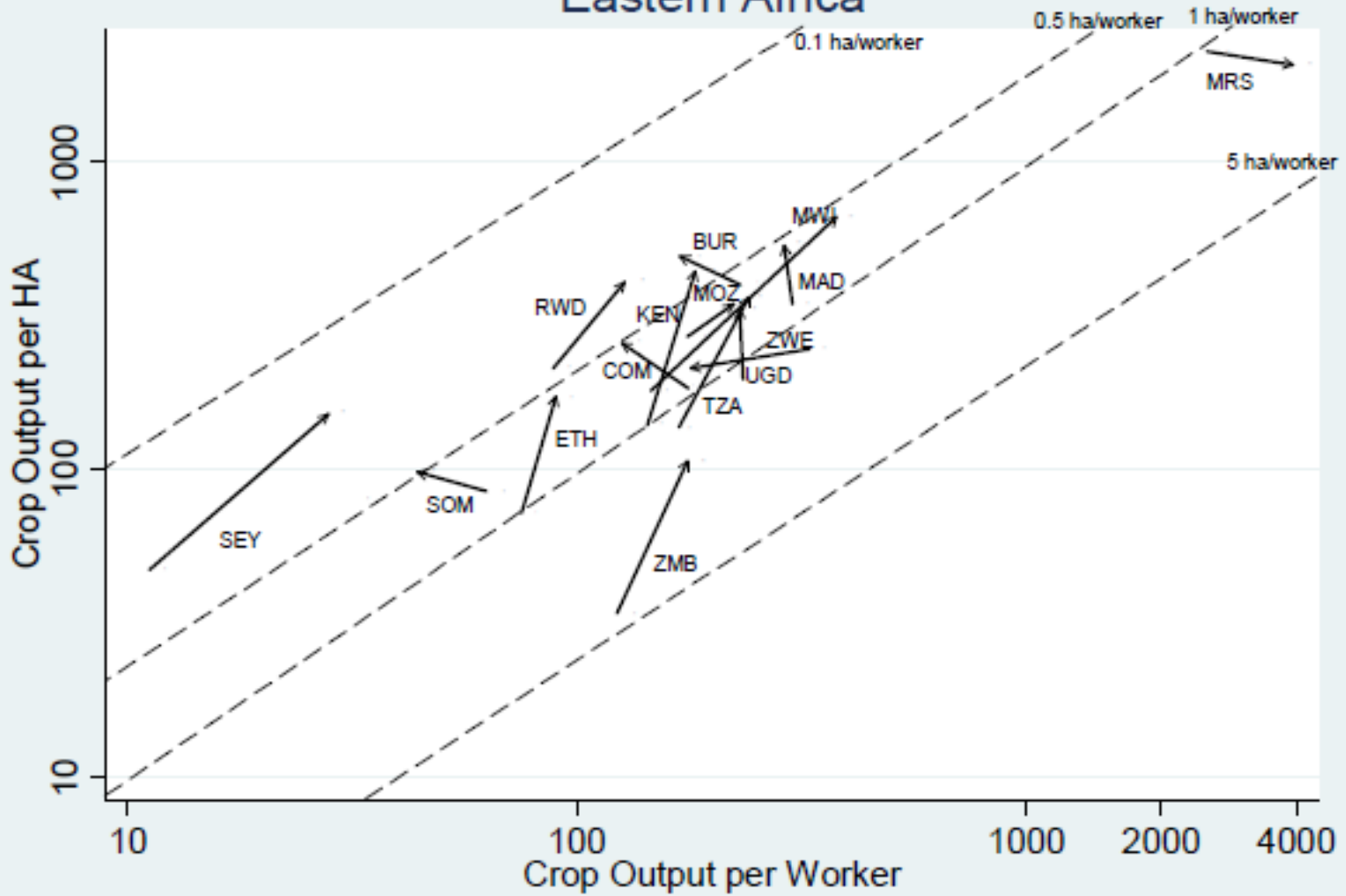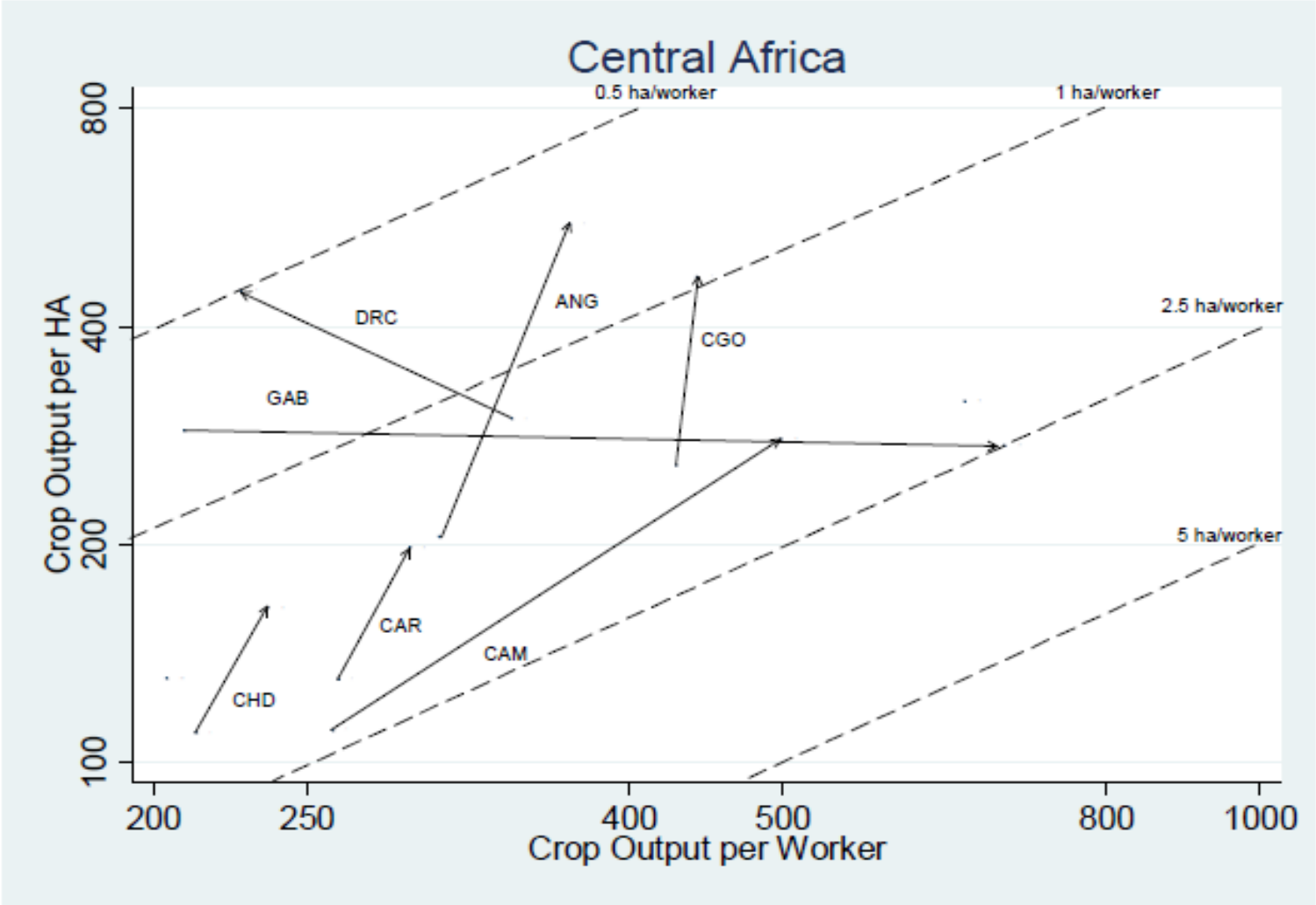|	1960-84	1985-2002	1960-2002	2002-2012
SSA	0.14%	1.24%	0.61%	
EA				
LA				

Source: Block 2010, xxxx, ccccc

Country specific partial productivity ratios

Western Africa
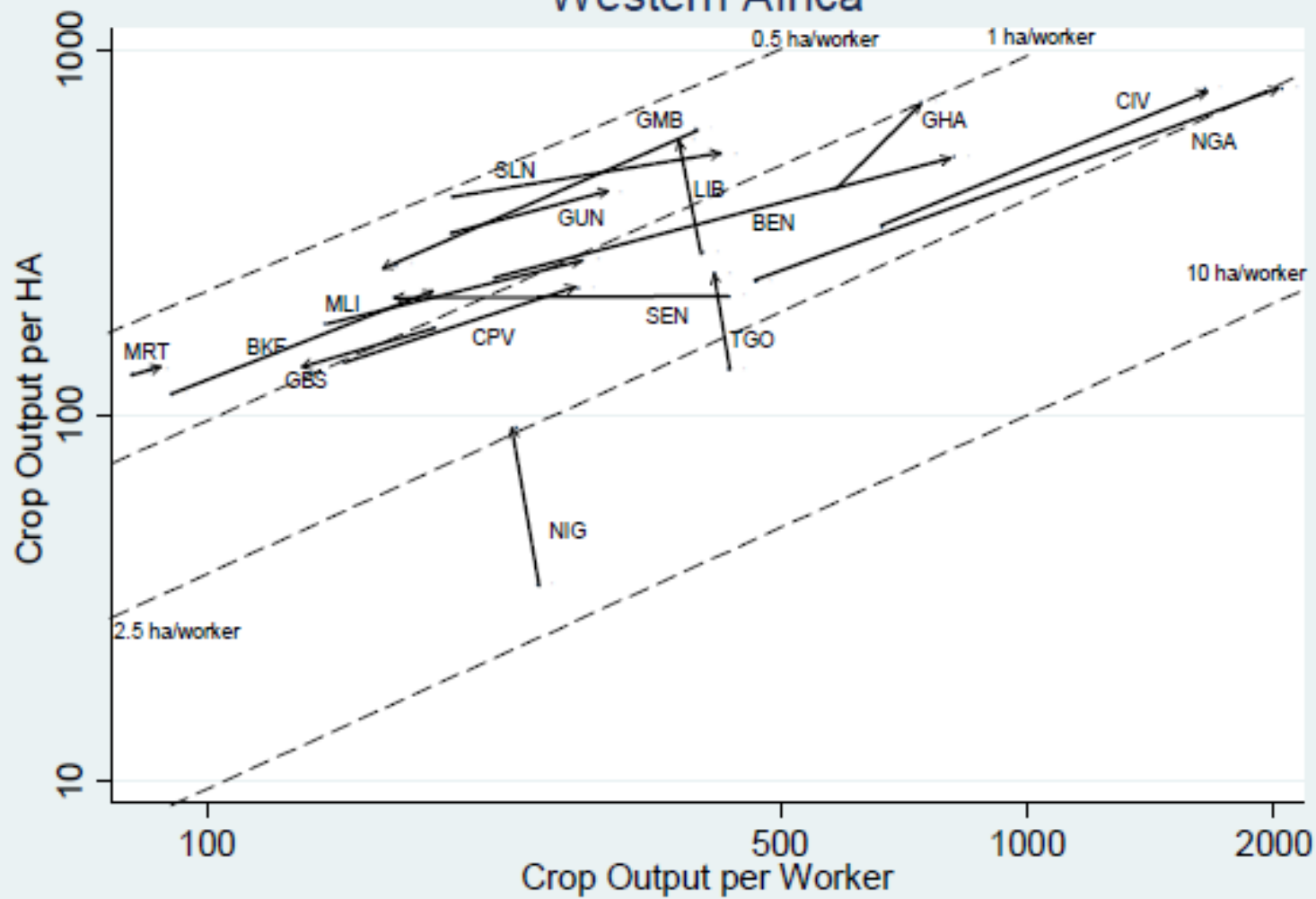
Eastern Africa

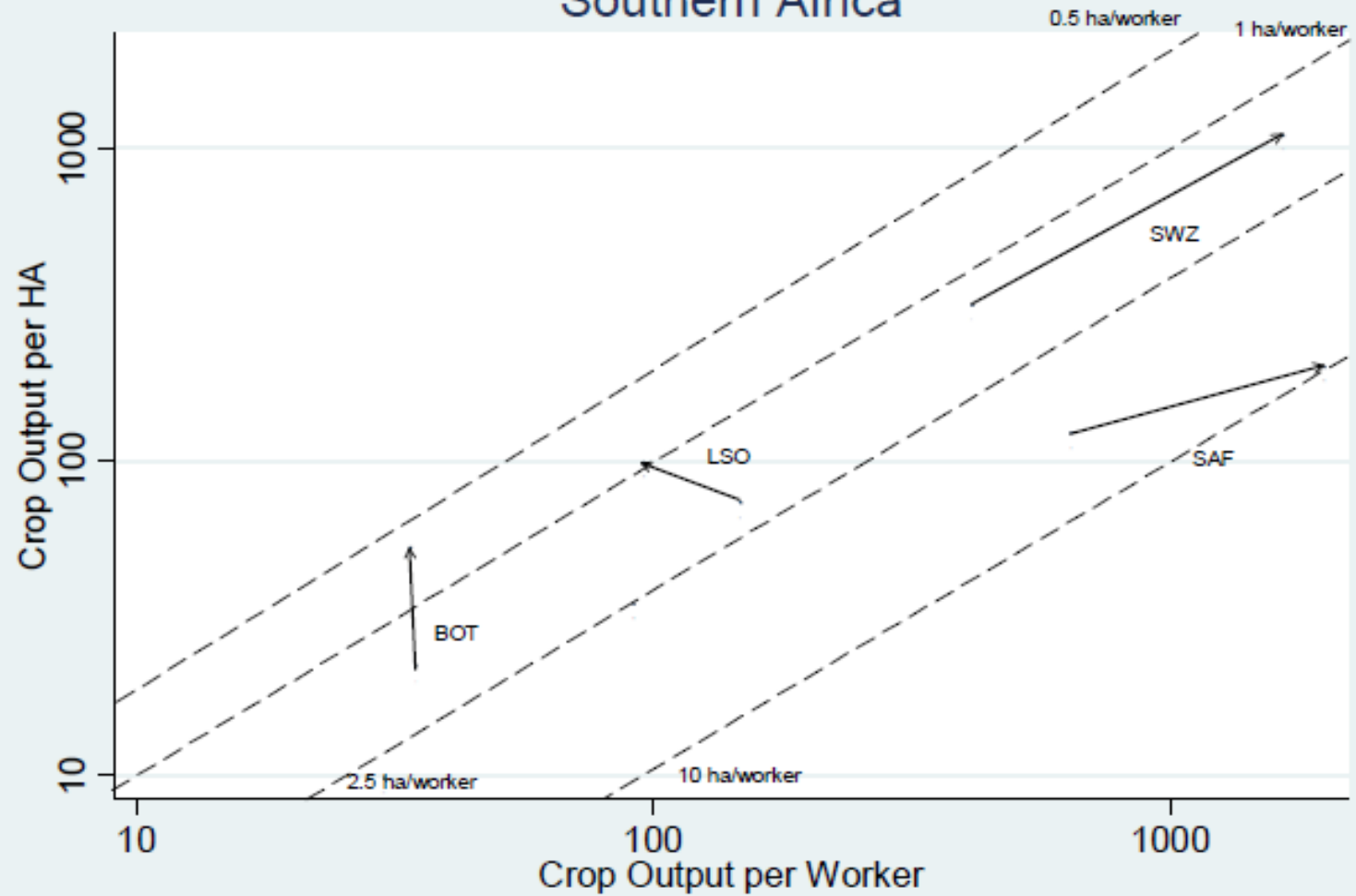Central Africa

Southern Africa

Food imports as percentage of merchandise imports

Source: WDI, 2013

Total unemployment rate (%)

Total employment-to-population ratio (%)

Vulnerable employment (million)   Share of vulnerable employment (%)

Legend:
- Vulnerable employment
- Vulnerable employment (projection)
- Share of vulnerable employment
- Share of vulnerable employment (projection)

Working poor (million) – US$2/day

Working poor as a share of total employment (%)

Legend:
- Working poor US$2/day
- Working poor US$2/day (projection)
- Working poor as a share of total employment
- Working poor as a share of total employment (projection)

TABLE 3.16:   R&D PERSONNEL AND RESEARCHERS (FTE)

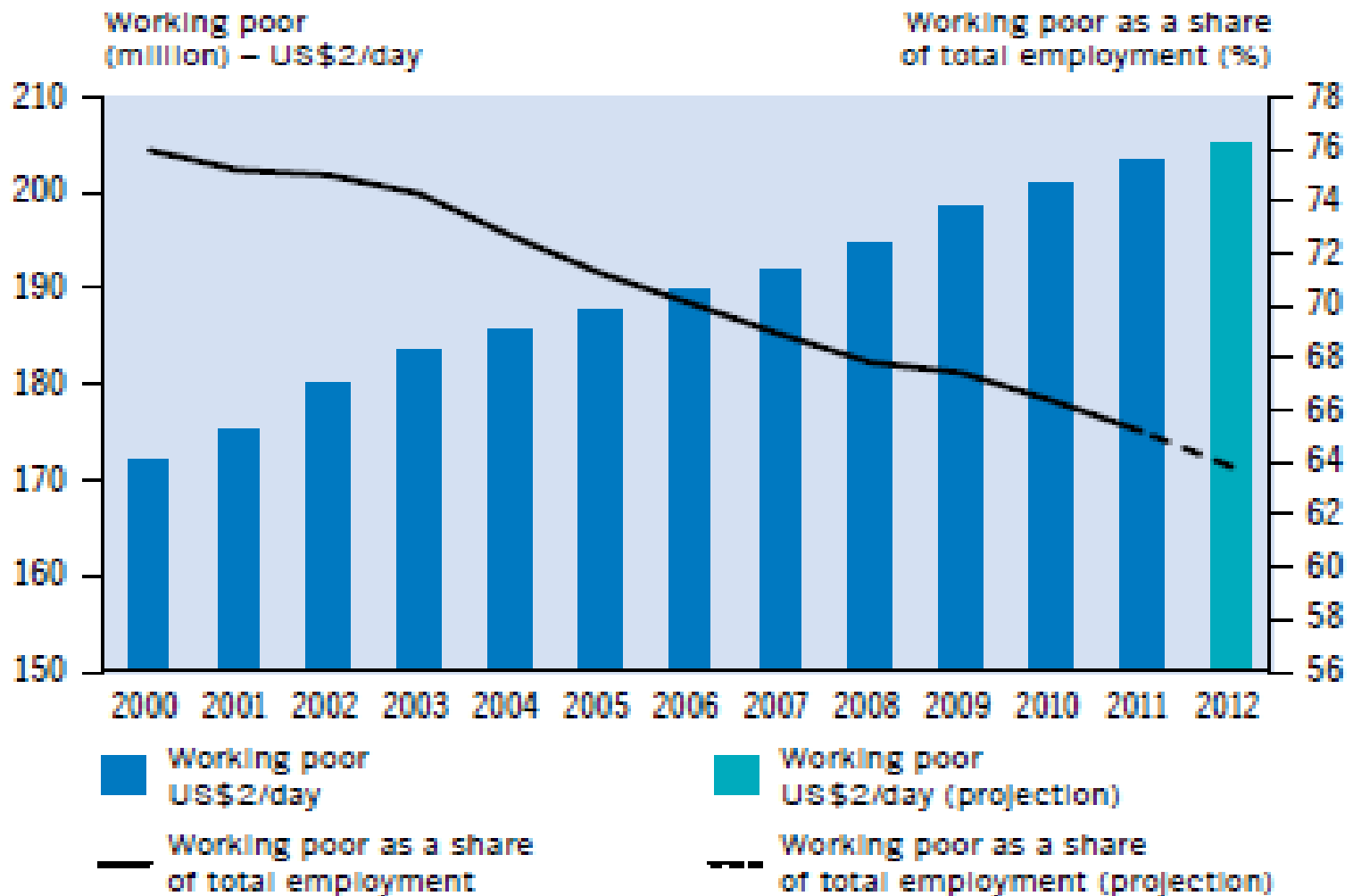| COUNTRIES	TOTAL R&D PERSONNEL	TOTAL RESEARCHERS	RESEARCHERS AS A % OF R&D PERSONNEL	R&D PERSONNEL PER MILLION INHABITANTS	RESEARCHERS PER MILLION INHABITANTS
Angola**	6 408.0	2 245.0	35.0	327	114
Burkina Faso	2 049.4	742.4	36.2	128	46
Cape Verde	37.0	25.0	67.6	74	50
Egypt	89 764.4	41 568.4	46.3	1 088	504
Ethiopia	8 279.0	3 701.0	44.7	100	45
Ghana	3 004.4	940.6	31.3	123	39
Kenya	42 566.0	9 305.0	21.9	1 051	230
Lesotho	13.7	11.9	86.9	6	5
Malawi	1 720.6	732.1	42.6	115	49
Mali	856.0	442.5	51.7	56	29
Mozambique	2 164.5	912.4	42.2	93	39
Senegal	5 642.3	4 679.0	82.9	454	376
South Africa	29 486.4	18 719.0	63.5	588	373
Tanzania	2 928.6	1 599.6	54.6	65	36
Togo	443.7	220.3	49.7	74	37
Uganda	2 006.9	1 262.7	62.9	60	38
Zimbabwe	1 740.8	1 305.2	75.0	133	100

Source: ASTII R&D surveys 2010 or latest year available

** In the case of Angola "R&D personnel" and "researchers" include university lectures who are not necessarily conducting research

Table 3.17 shows the FTE data for total R&D personnel and researchers and Table 3.18 shows the FTEs as percentage of headcount.

TABLE 3A.72: TANZANIA: GERD AND SOURCES OF FUNDS IN MILLIONS TANZANIAN SHILLINGS (2010/11)

GERD	TOTAL	BUSINESS	GOVERNMENT	HIGHER EDUCATION	PRIVATE NON PROFIT
GERD BY SECTOR AND SOURCES OF FUNDS	**166 686.0**	*	**22 915.5**	**143 770.5**	*
Business sector	132.2	*	10.0	122.2	*
Direct government	31 711.4	*	13 850.9	17 860.5	*
General university funds	64 186.0	*	-	64 186.0	*
Higher education	553.4	*	148.4	404.9	*
Private non profit	87.0	*	68.7	18.3	*
Funds from abroad	70 015.9	*	8 837.4	61 178.5	*
* Sector not surveyed					

TABLE 4.16: HIGHLY IMPORTANT SOURCES OF INFORMATION FOR INNOVATION FOR TANZANIAN FIRMS, NUMBER AND PERCENT OF INNOVATION-ACTIVE FIRMS

CATEGORY	INFORMATION SOURCE	INNOVATION-ACTIVE FIRMS	
		NUMBER	PERCENT
Internal sources	**Sources within same enterprise group**	**52**	**61.9**
External Sources			
Market	Suppliers of equipment	27	32.1
	Clients or customers	56	66.7
	Competitors	23	27.4
	Consultants	14	16.7
Institutional	Universities or technical colleges	6	7.1
	Government or private research institutions	10	11.9
Other	Conferences	14	16.7
	Scientific journals	8	9.5
	Professional associations	17	20.2
Source: Tanzania Commission for Science and Technology (COSTECH)			

TABLE 4.17: **HIGHLY IMPORTANT EFFECTS OF INNOVATION FOR TANZANIAN FIRMS: NUMBER AND PERCENT OF INNOVATION-ACTIVE FIRMS**

CATEGORY	EFFECT OF INNOVATION	INNOVATION-ACTIVE FIRMS	
		NUMBER	PERCENT
Product	Increased range of goods	39	46.4
	Entered new market	31	36.9
	Increased market share	32	38.1
	Improved quality of goods or services	51	60.7
Process	Improved flexibility of production	31	36.9
	Increased capacity of production	38	45.2
	Reduced labour costs per unit of labour	31	36.9
Other	Reduced environmental impacts	40	47.6
	Improved working conditions on health	39	46.4
	Met governmental regulatory requirements	36	42.9
Source: ASTII Innovation Survey, 2008-2010, Tanzania Commission for Science and Technology (COSTECH)			

TABLE 3.3:   **GROSS DOMESTIC PUBLIC EXPENDITURE ON R&D (PUBLIC GERD), 2010**

COUNTRIES	SURVEY YEAR	PUBLIC GERD (PPP$ M)	PUBLIC GERD % OF GDP	PUBLIC GERD PER CAPITA (PPP$)
Angola	2011	90.4	0.08%	4.61
Ethiopia	2010	176.3	0.21%	2.13
Ghana	2010	153.4	0.38%	6.29
Kenya	2010	519.6	0.78%	12.83
Malawi	2010	134.4	1.10%	9.02
Mali	2010	112.4	0.66%	7.32
Mozambique	2010	90.0	0.42%	3.85
Senegal	2010	108.9	0.45%	8.76
South Africa	2010	1 991.8	0.38%	39.73
Tanzania	2010	322.4	0.52%	7.19
Togo	2010	15.3	0.25%	2.50
Uganda	2010	152.1	0.32%	4.55
Zimbabwe[z]	2012	143.1[z]		

z Zimbabwe advised that the GDP figure is not reliable for use with the R&D data. Zimbabwe's R&D expenditure data is in national currency.

Source: ASTII R&D surveys 2010 or latest year available

GDP, PPP and population data sourced from African Development Bank

FIGURE 3.1:   GLOBAL BERD/GDP (%), SELECTED COUNTRIES
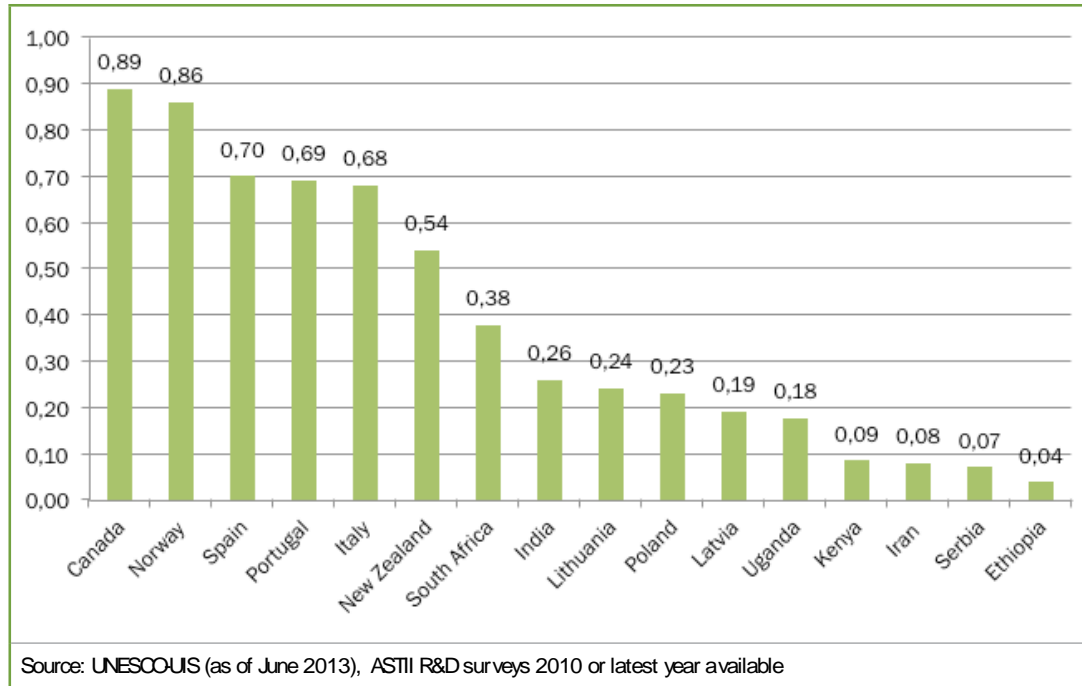

Source: UNESCO-UIS (as of June 2013), ASTII R&D surveys 2010 or latest year available

TABLE 3.16:   R&D PERSONNEL AND RESEARCHERS (FTE)

COUNTRIES	TOTAL R&D PERSONNEL	TOTAL RESEARCHERS	RESEARCHERS AS A % OF R&D PERSONNEL	R&D PERSONNEL PER MILLION INHABITANTS	RESEARCHERS PER MILLION INHABITANTS
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Zimbabwe	1 740.8	1 305.2	75.0	133	100

Source: ASTII R&D surveys 2010 or latest year available

** In the case of Angola "R&D personnel" and "researchers" include university lectures who are not necessarily conducting research

Table 3.17 shows the FTE data for total R&D personnel and researchers and Table 3.18 shows the FTEs as percentage of headcount.

TABLE 4.21: **SHARE OF EXPENDITURE FOR THE FOUR CATEGORIES OF INNOVATION ACTIVITIES FIRMS ENGAGED IN FOR REPORTING COUNTRIES**

|	INTRAMURAL (IN-HOUSE) R&D	EXTRAMURAL (OUT-SOURCED) R&D	ACQUISITION OF MACHINERY OR ACQUISITION OF SOFTWARE§	ACQUISITION OF OTHER EXTERNAL KNOWLEDGE	TOTAL
Ghana	38.2	19.1	18.6	24.1	100.0
Kenya	27.2	12.6	39.5	20.7	100.0
Lesotho	16.4	0.9	81.2	1.4	100.0
Nigeria	14.8	18.3	62.1	4.8	100.0
Senegal	39.0	15.6	5.5	39.9	100.0
South Africa	21.2	11.4	59.6	7.8	100.0
Tanzania	7.2	4.1	87.3	1.4	100.0
Uganda	27.4	52.3	15.6	4.7	100.0
Zambia	73.9	1.2	23.0	1.9	100.0

Source: ASTII innovation surveys, 2008-2010 for Ghana, Nigeria, Tanzania, Uganda and Zambia, and 2008-2011 for Kenya, 2010-2012 for Lesotho, 2009-2011 for Senegal and 2005-2007 for South Africa

§ For Nigeria, the data cover only acquisition of software

Agricultural Productivity [Cereal Yield (kg/ha)]
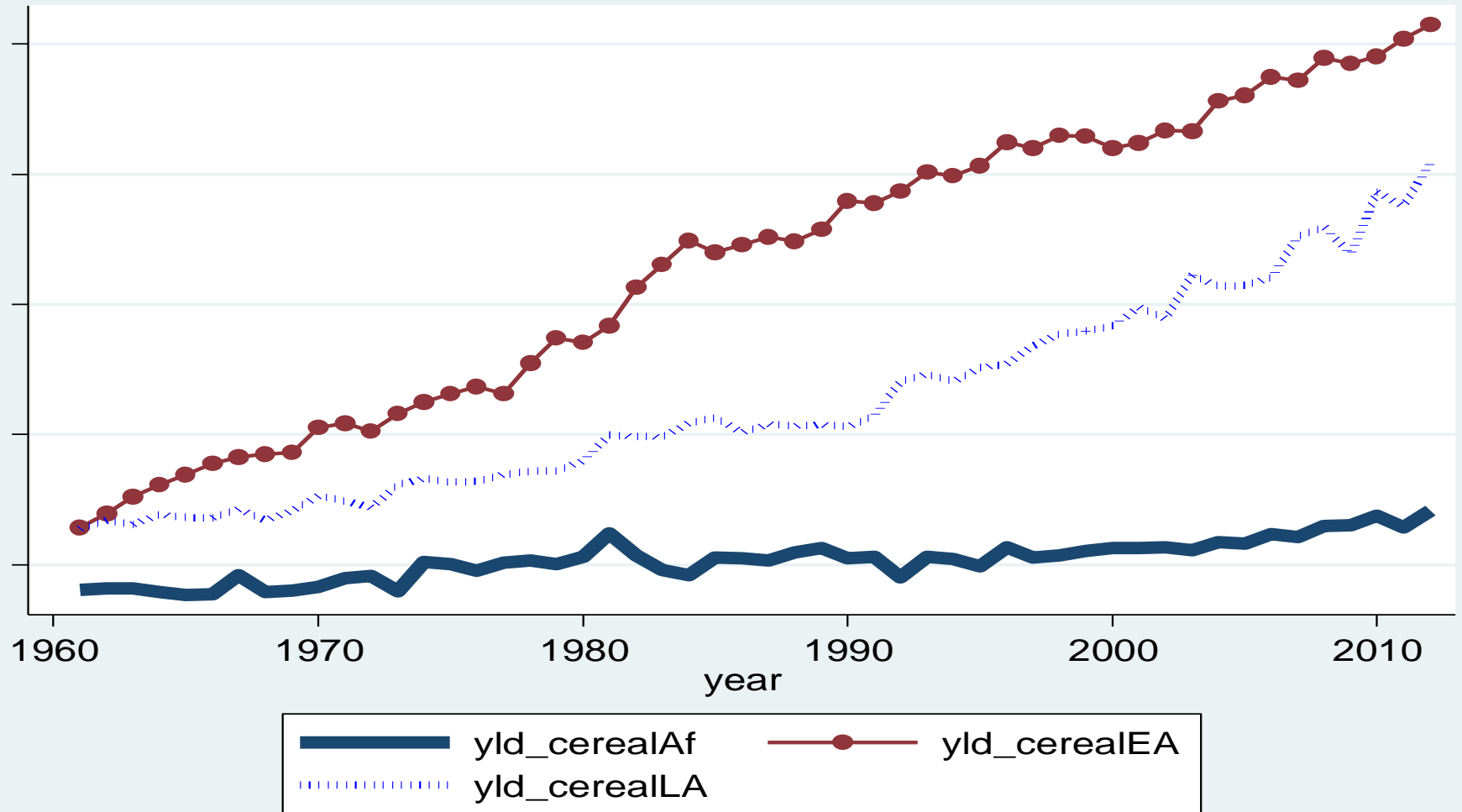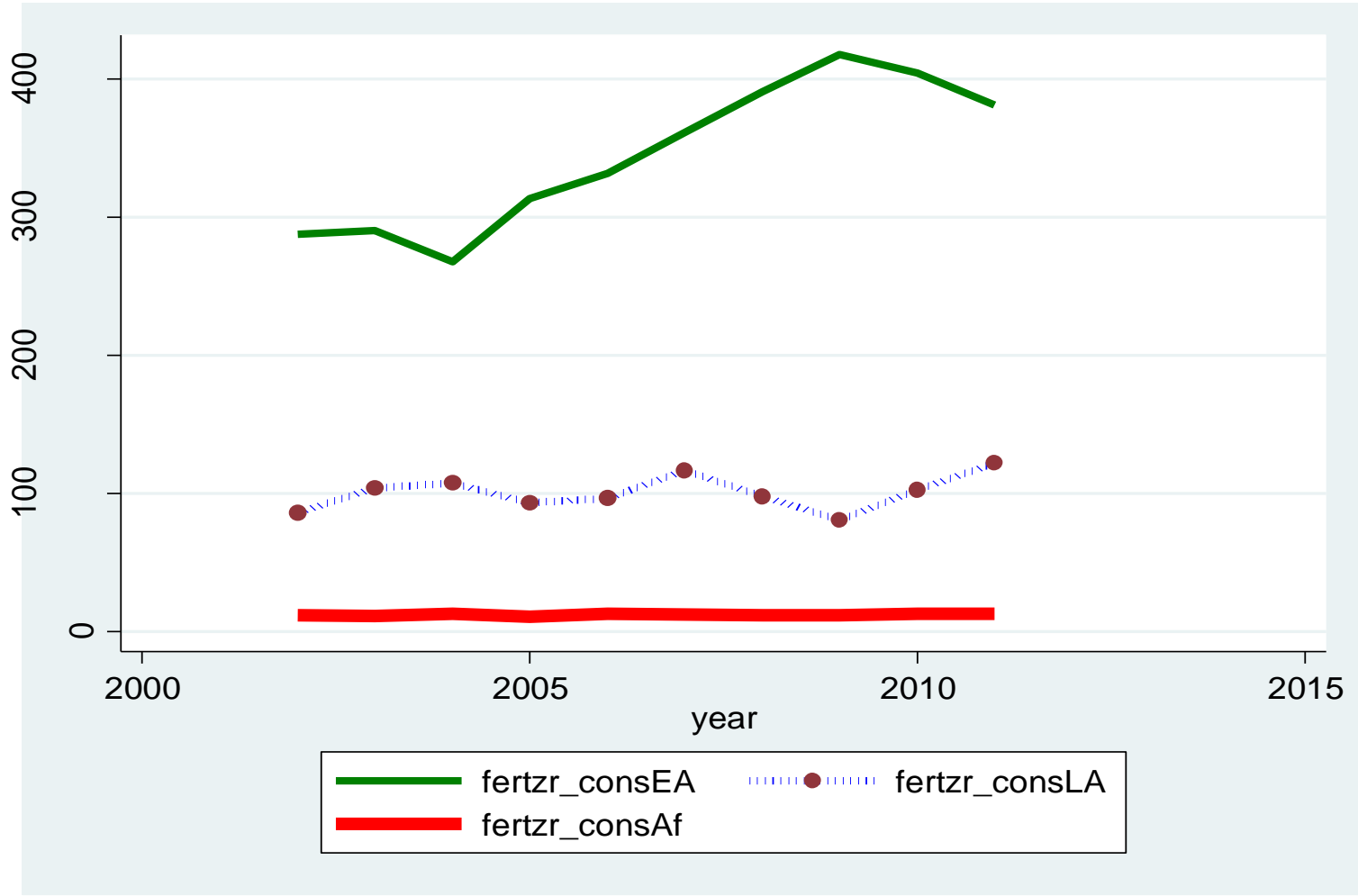

Source: WDI, 2013

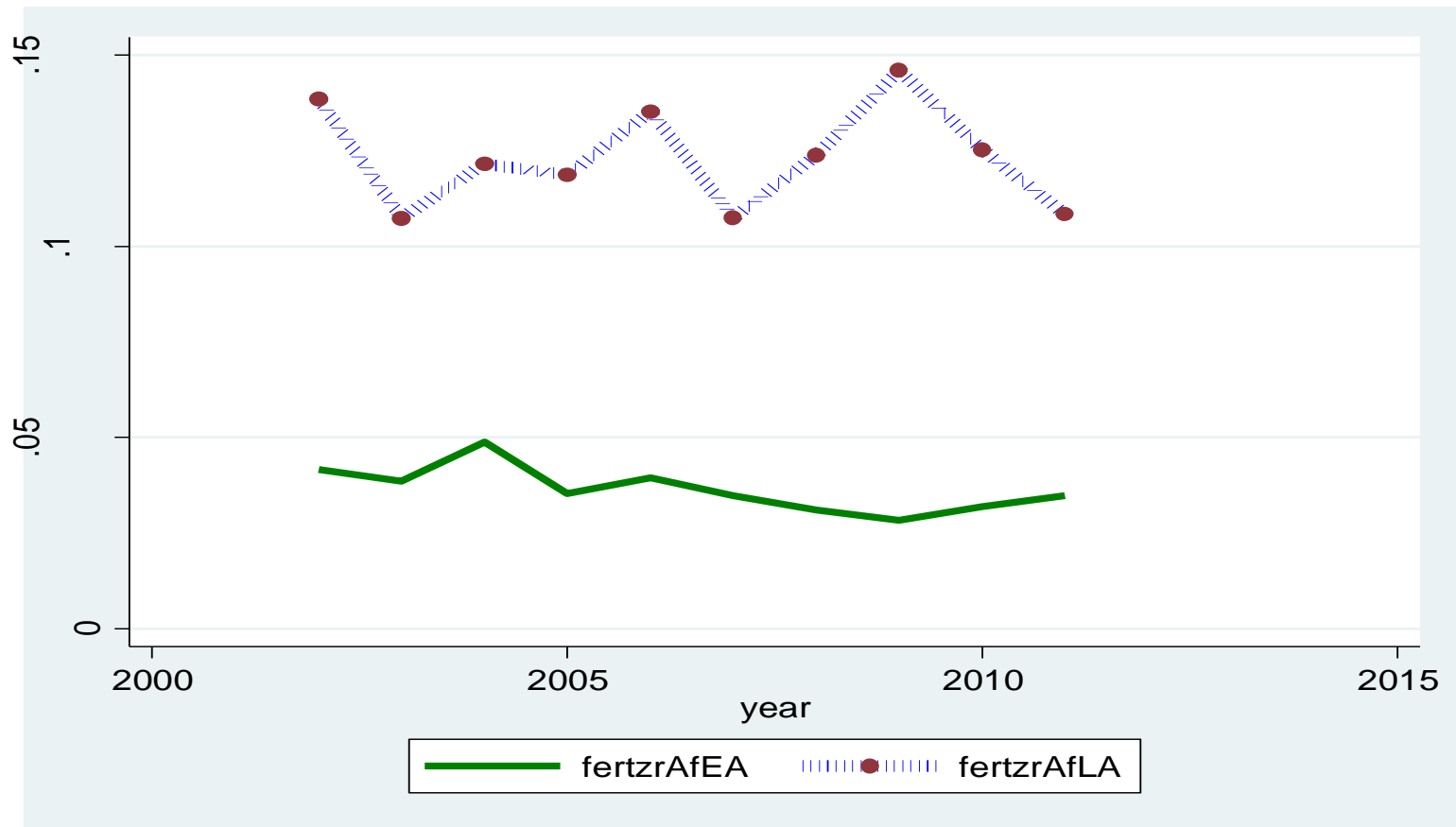# Land expansion/Agricultural land in million hectare
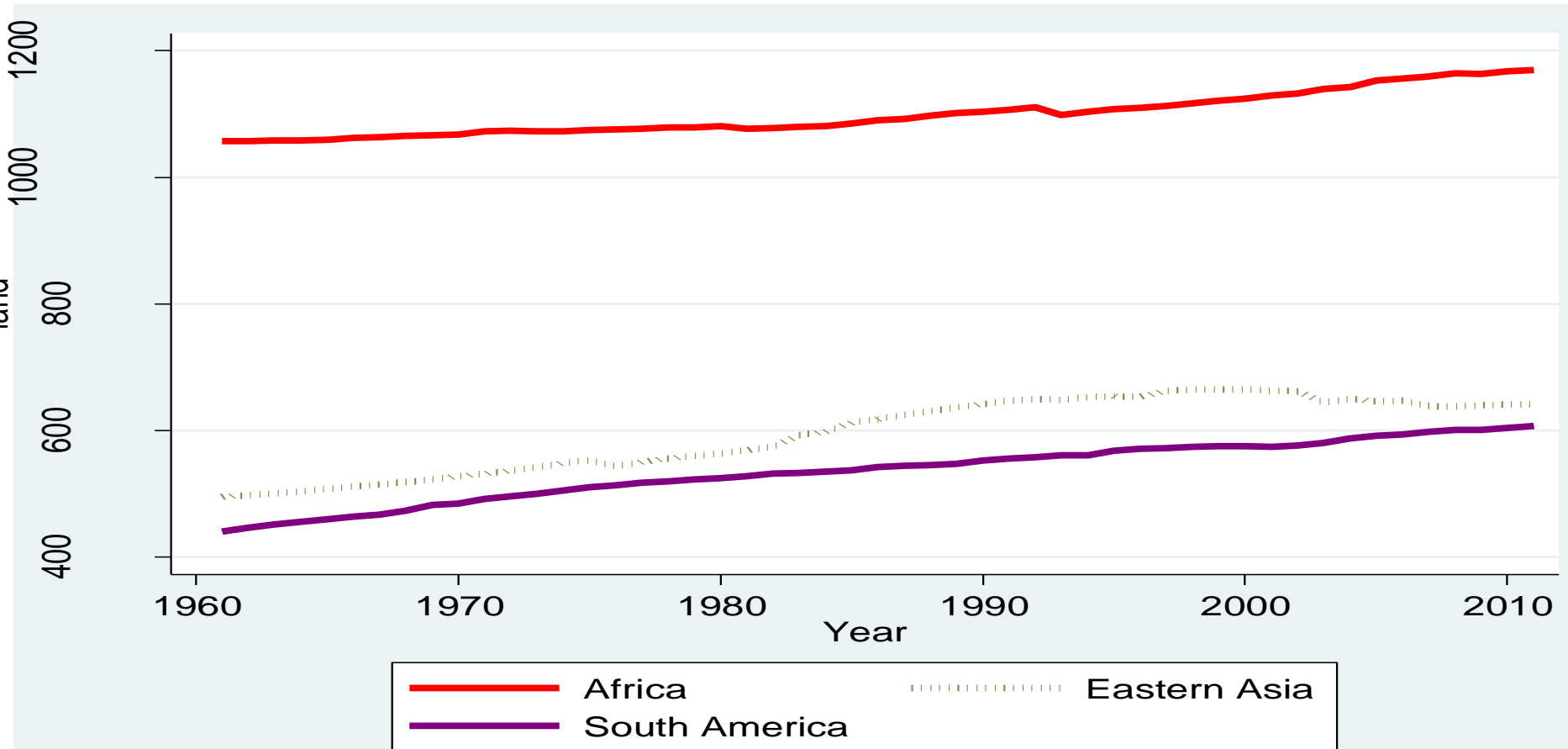
Source: FAOSTAT, 2013

Modern Input Use [Chemical Fertilizer in Kilogram per hectare of arable land]

Source: WDI, 2013

Fertilizer Consumption in Africa in proportion to EA and LA

Source: WDI, 2013

Why productivity in agriculture is important?

Theoretical understanding of Structural transformation 1

- **Classical view 1**
- Dual Sector Model (A.Lewis, 1954)
  - Surplus labour in Agricultural (subsistence) sector will move to manufacturing (capitalist) sector because marginal labour productivity of agriculture is low (surplus, cheap labour).
  - Above are under assumption labour productivity stay constant

If Dual Sector Model is correct, the marginal cost of labour should be cheaper, making it attractive for more productive activities such as manufacturing.

Theoretical understanding of Structural transformation 2

- **Classical view 2**
- Ricardian rent theory: diminishing returns to increments of labour and capital applied to an inelastic supply of land represented fundamental constraint on economic growth.
  - Pessimistic view of technological progress;
  - In reality
    - Real cost of agricultural production had declined in spite of land resource constraint
    - TFP of agriculture increase with economic growth
    - Technological change released inelastic resource supplies.

  But above is not happening in Africa