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Adaptation to land constraints: Is Africa different?

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1. Introduction

- ❑ Some 215 years ago, Malthus argued that pop. growth cyclically outstrips agricultural productivity
- ❑ In much of the world, economic history has not been kind to Malthus, because of “induced innovations”
- ❑ But what about Africa?
 1. Very poor and vulnerable; poverty still heavily rural
 2. Mixed success/potential with agric. intensification
 3. Very limited success with industrialization
 4. Population to double by 2050
 5. Land/water is a constraint for many, many Africans



1. Introduction

- ❑ This paper seeks to understand how countries adopt to population pressures & ask “Is Africa different?”
- ❑ Framework based on decomposing growth in farm income:

$$\Delta \ln \frac{\text{Output}}{\text{Pop.}} = \Delta \ln \frac{\text{Land}}{\text{Pop.}} + \Delta \ln \frac{\text{Output}}{\text{Land}}$$

Growth in rural population is the sum of fertility & net migration:

$$= \Delta \ln \frac{\text{Output}}{\text{Land}} + \Delta \ln \text{Land} - \Delta \ln \text{fertility} - \Delta \ln \text{migration}$$

Shrinking farm sizes

The diagram illustrates the relationship between the components of the equation and the concept of 'Shrinking farm sizes'. A central box labeled 'Shrinking farm sizes' has four arrows pointing to the four terms in the equation above: $\Delta \ln \frac{\text{Output}}{\text{Land}}$, $\Delta \ln \text{Land}$, $\Delta \ln \text{fertility}$, and $\Delta \ln \text{migration}$. Each of these four terms is enclosed in a blue rounded rectangular box.



1. Introduction

- ❑ In terms of data and methods, we make use of FAOSTAT ag production and land data, census & survey data on farm sizes, DHS data on rural fertility rates & occupations, some WB data on remittances
- ❑ On methods, our approach is fairly exploratory
- ❑ Establishing causation is a problem with Boserup's theory: consider impact of migration, agroecology, etc
- ❑ IV not plausible, but we aspire to identification via control vars., fixed effects & first differencing
- ❑ Nevertheless, you might see we only really present some stylized facts



2. Land expansion

- ❑ If farm sizes are shrinking, why not expand land use?
- ❑ Africa is typically thought of as land abundant, but this neglects the heterogeneity within Africa

Region	Period	Hectares per agric. worker (FAO)	Hectares per holding (censuses)
Africa - high density ^b (n=5)	1970s	0.84	1.99
	2000s	0.58	1.23
Africa - low density ^b (n=11)	1970s	1.65	2.65
	2000s	1.37	2.82
South Asia (n=5)	1970s	0.78	2.01
	2000s	0.55	1.19
China & S.E. Asia (n=4)	1970s	0.80	2.08
	2000s	0.68	1.58



2. Land expansion

- ❑ Several important facts & mysteries emerge from census, FAO and FAO-IIASA data:
 1. Farm sizes are shrinking in high-density Africa.
 2. Some high-density countries still have unused land, but smallholders face major constraints to using that land (e.g. Ethiopia, Madagascar).
 3. Even in countries with unused land (e.g. Ethiopia), there are major constraints to using new lands: different agronomics, disease burdens, infrastructure
 4. Farm sizes are unchanged (on average) in low density Africa, but still very small on average

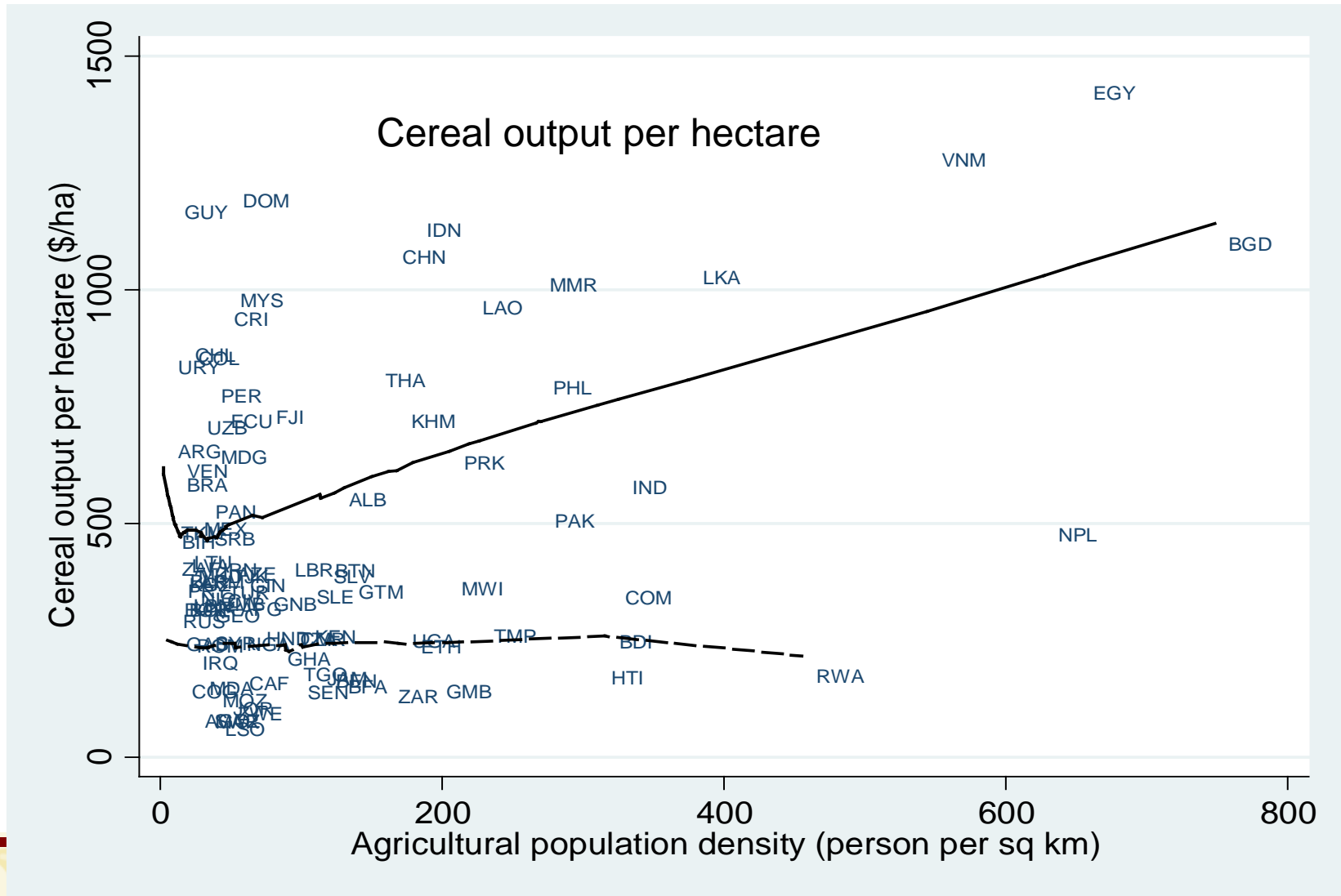


3. Agricultural intensification

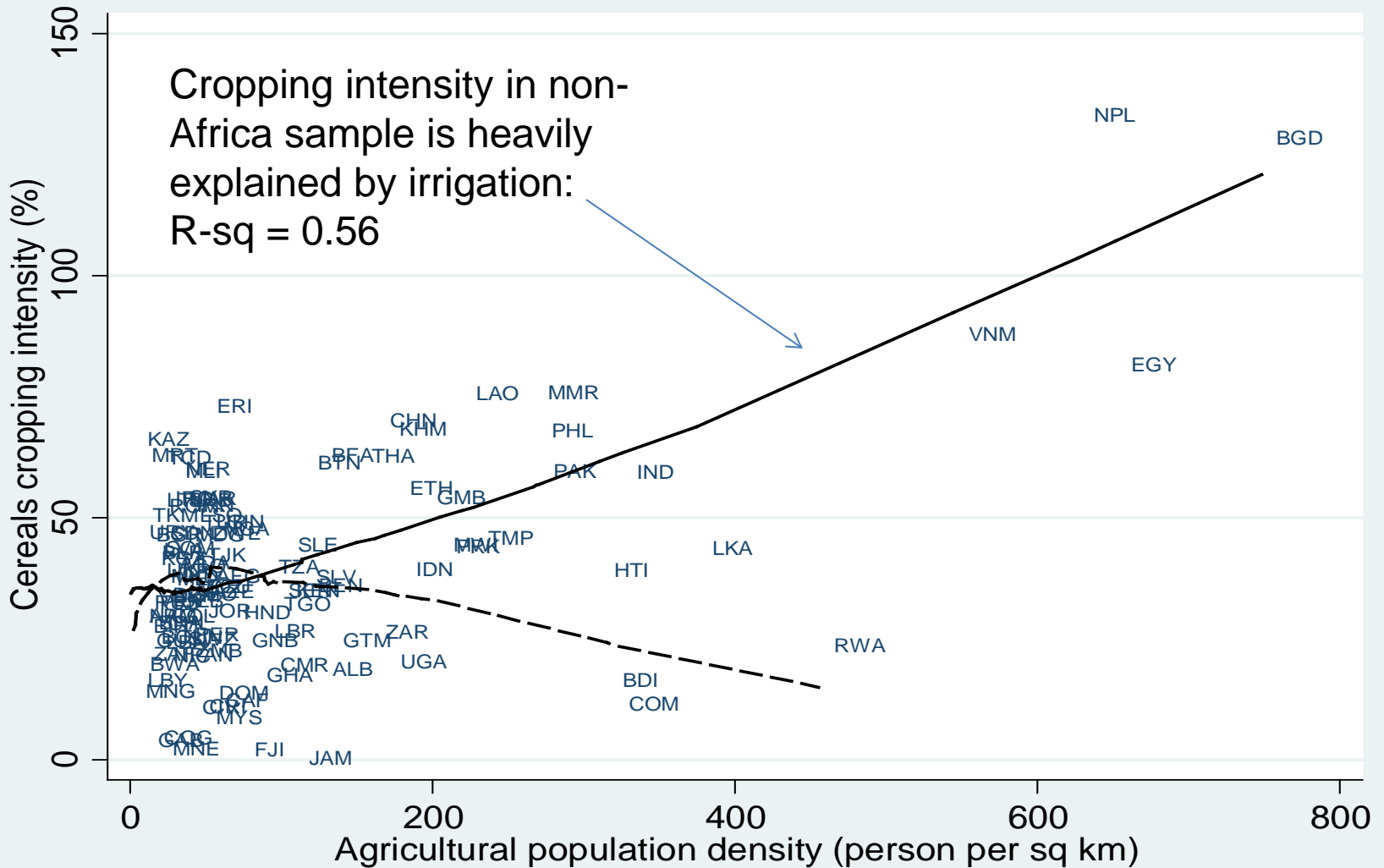
- ❑ In the framework above, the most welfare-relevant indicator of intensification is just output per hectare
- ❑ Boserup focused more on cropping intensity, and the ag-econ profession & CGIAR looks a lot at yields
- ❑ But switching to high value crops is obviously also a potentially important adaptation, especially in SSA.
- ❑ So I'm going to show you a series of graphs, and then some more formal econometric tests.
- ❑ We decompose ag output into cereal and non-cereals.
- ❑ Cereals output can be also decomposed into yields & cereal cropping intensity



3. Agricultural intensification



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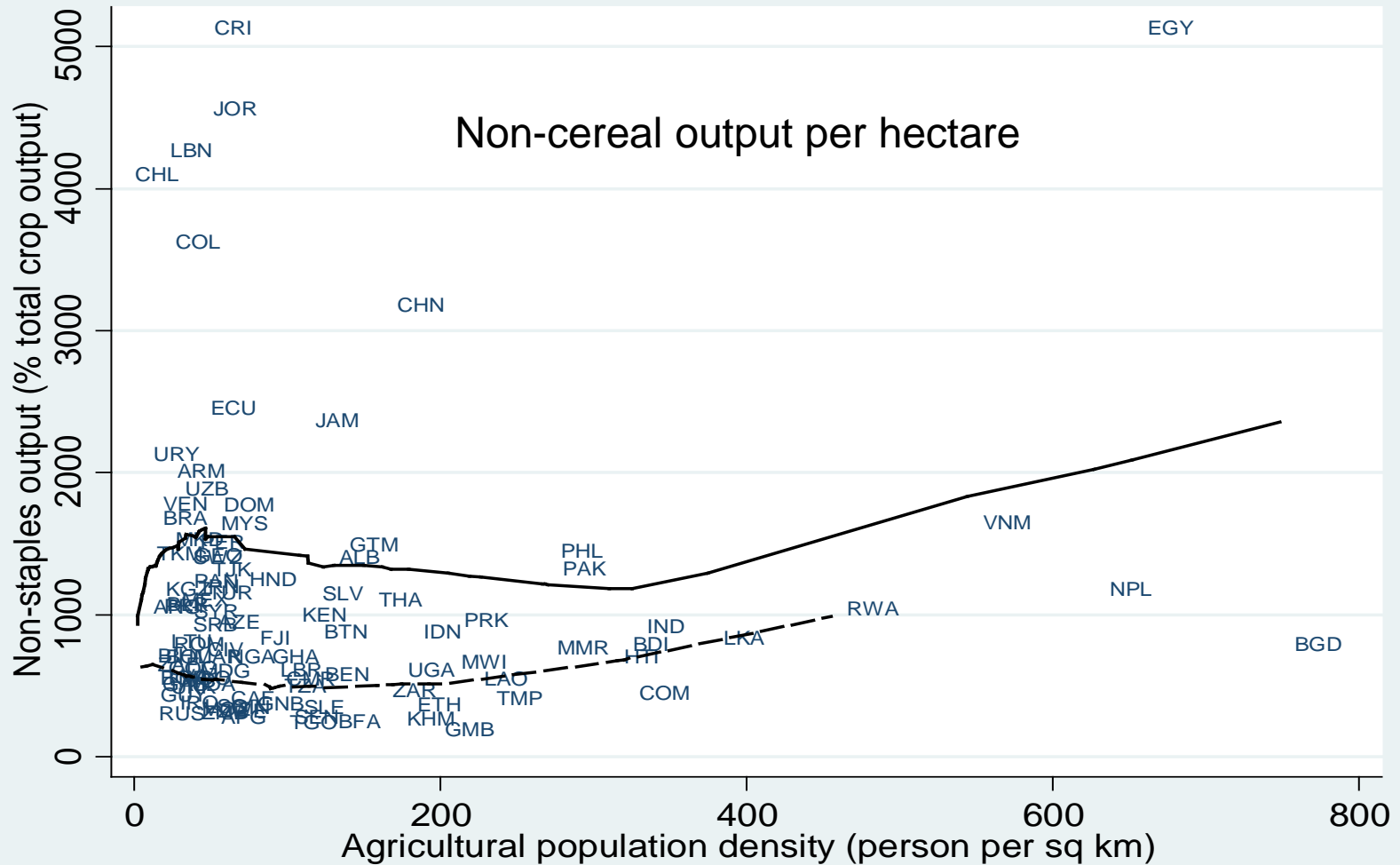


Table 4. Log-log estimates of agricultural value per hectare and its three components

Regression No.	R1	R2	R3	R4
Dep. var.	Agric. output per ha	Cereal output per ha	Cereal crop intensity	Non-cereal output per ha
Population density	0.33***	0.18***	0.20***	0.28***
Density*Africa	-0.11**	-0.23***	-0.01	-0.01
Road density	0.14***	0.09**	-0.03	0.19***
Number of ports	0.14***	0.21***	0.03	0.15***
Urban agglom (%)	0.29***	-0.09	0.31***	0.31***
Regional fixed effects?	Yes	Yes	Yes	Yes
Sign of SSA dummies?	+ in E.Africa	Zero	Neg.	+ in E.Africa
AE controls	Yes	Yes	Yes	Yes
No. Obs	243	243	243	243
R-square	0.8	0.74	0.67	0.79



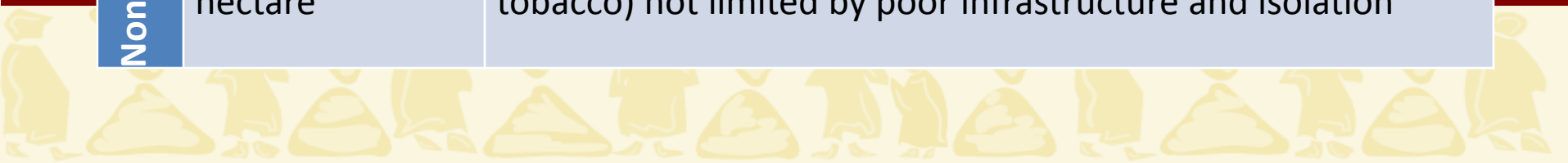
Table 5. Log-log estimates of specific agricultural inputs

Regression No.	R1	R2	R3	R4
Dep. var.	Fertilizers per hectare	Cattle/oxen per hectare	Irrigation per hectare	Capital per hectare
Population density	0.76***	0.42***	0.59***	0.24***
Density*Africa	-0.32**	0.15*	-0.47***	-0.10***
Road density	-0.08	0.31***	0.04	0.07**
Number of ports	0.50***	0.07	0.24***	0.12***
Urban agglom (%)	0.38	0.03	0.24**	-0.03
Regional fixed effects	Yes	Yes	Yes	Yes
Sign of SSA dummies?	Zero	Neg.	Zero	Zero
AE controls	Yes	Yes	Yes	Yes
No. Obs	0.73	0.77	0.92	0.77
R-square	0.69	0.74	0.91	0.73



Table 7. Potential explanations of Africa's agricultural intensification trajectory

	Stylized facts	Potential explanations
Low productivity of cereals sector	Low fertilizer application	Agronomic constraints (e.g. low soil fertility) Poor management practices, low human capital High transport costs (see regression 1 in Table 4); Low rates of subsidization (structural adjustment)
	Low adoption of improved varieties	More varied agroecological conditions and crop mix Lower returns because of limited use of other inputs (e.g. irrigation); Lower investment in R&D
	Low use of plough/ tractors	Tsetse fly in humid tropics Feed/land constraints in some densely populated areas
	Low rates of irrigation	Hydrological constraints; High costs of implementation and maintenance; Poor access to markets limits benefits
Noncereals	High non-cereal output per hectare	Agroecological suitability; Colonial introduction of cash crops; Non-perishable cash crops (cotton, coffee, cocoa, tea, tobacco) not limited by poor infrastructure and isolation



3. Reducing rural fertility rates

- ❑ Reducing fertility rates is a response to land constraints that is entirely consistent with Becker-type theories of fertility as a choice variable
- ❑ Yet not really examined in ag. or dev. Economics
- ❑ We ask 2 questions
 - 1) Do land constraints reduce achieved fertility rates?
 - 2) Do land constraints reduce desired fertility rates?
- ❑ A difference between desired & achieved fertility rates is termed the “unmet need for contraception”.
- ❑ Suggests scope for policy interventions



3. Reducing rural fertility rates

Figure 3. Rural fertility rates and rural population density

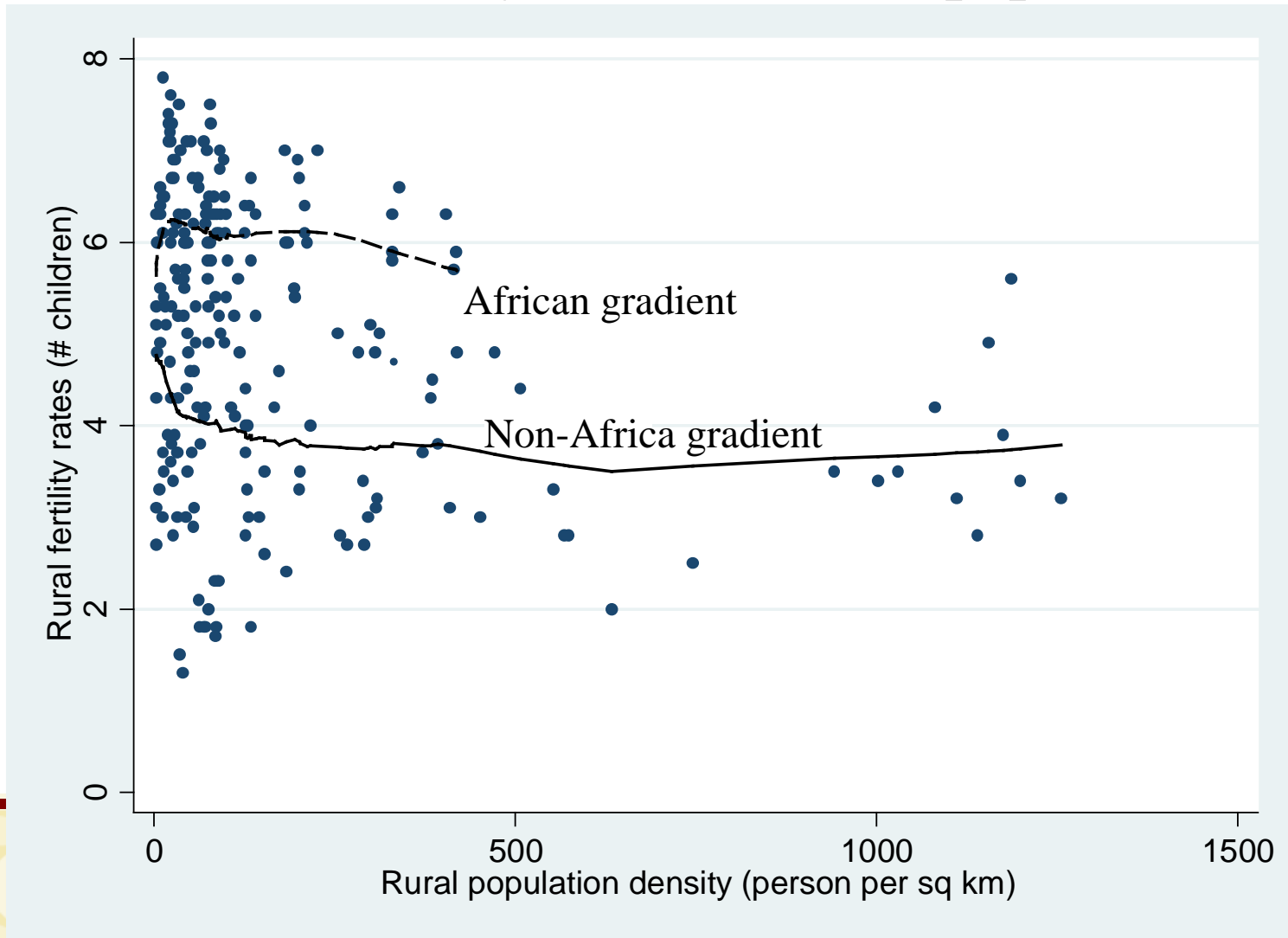
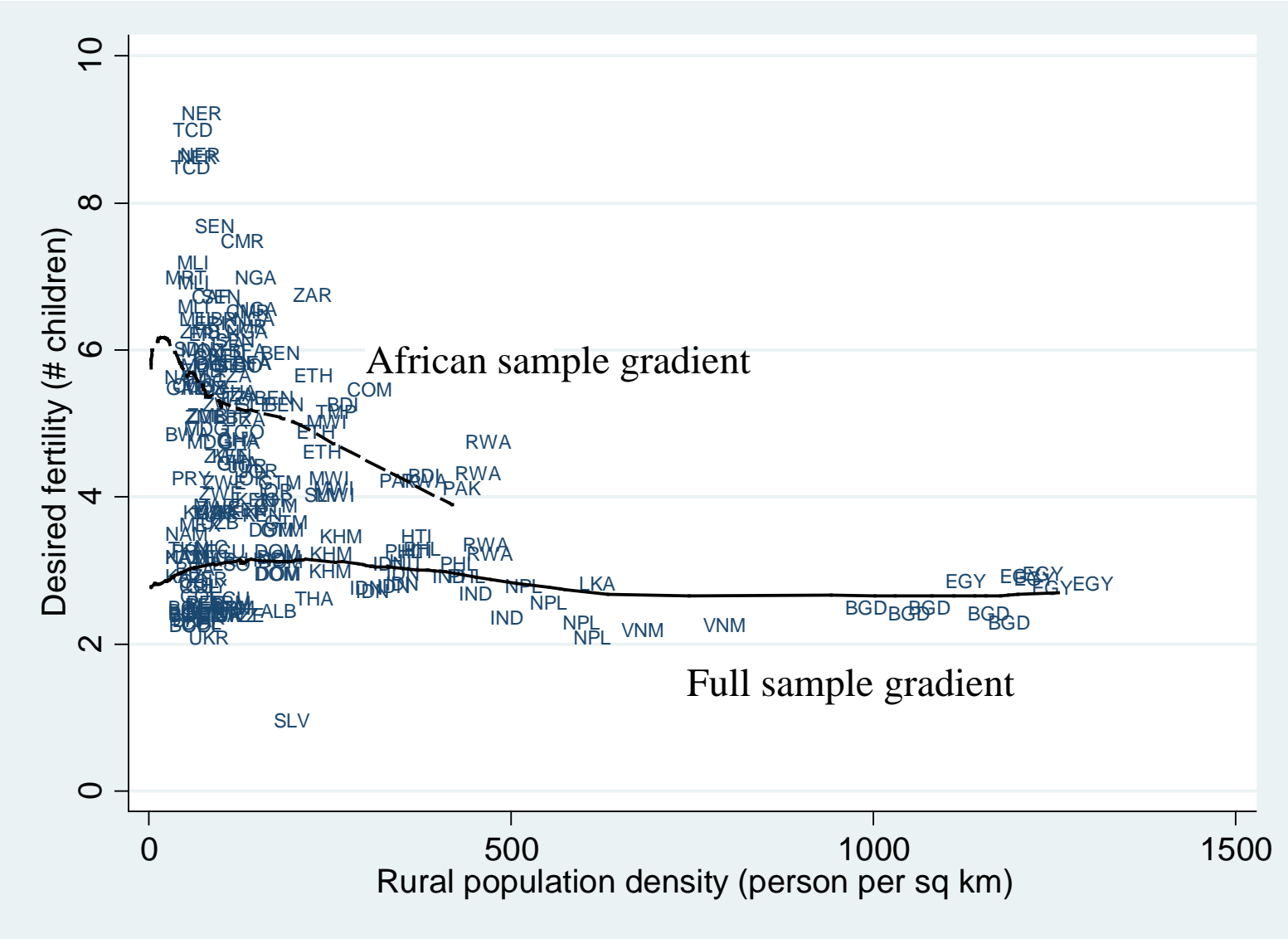


Figure 4. Desired rural fertility & population density



F5. Unmet contraception needs (%) and rural population density in Africa

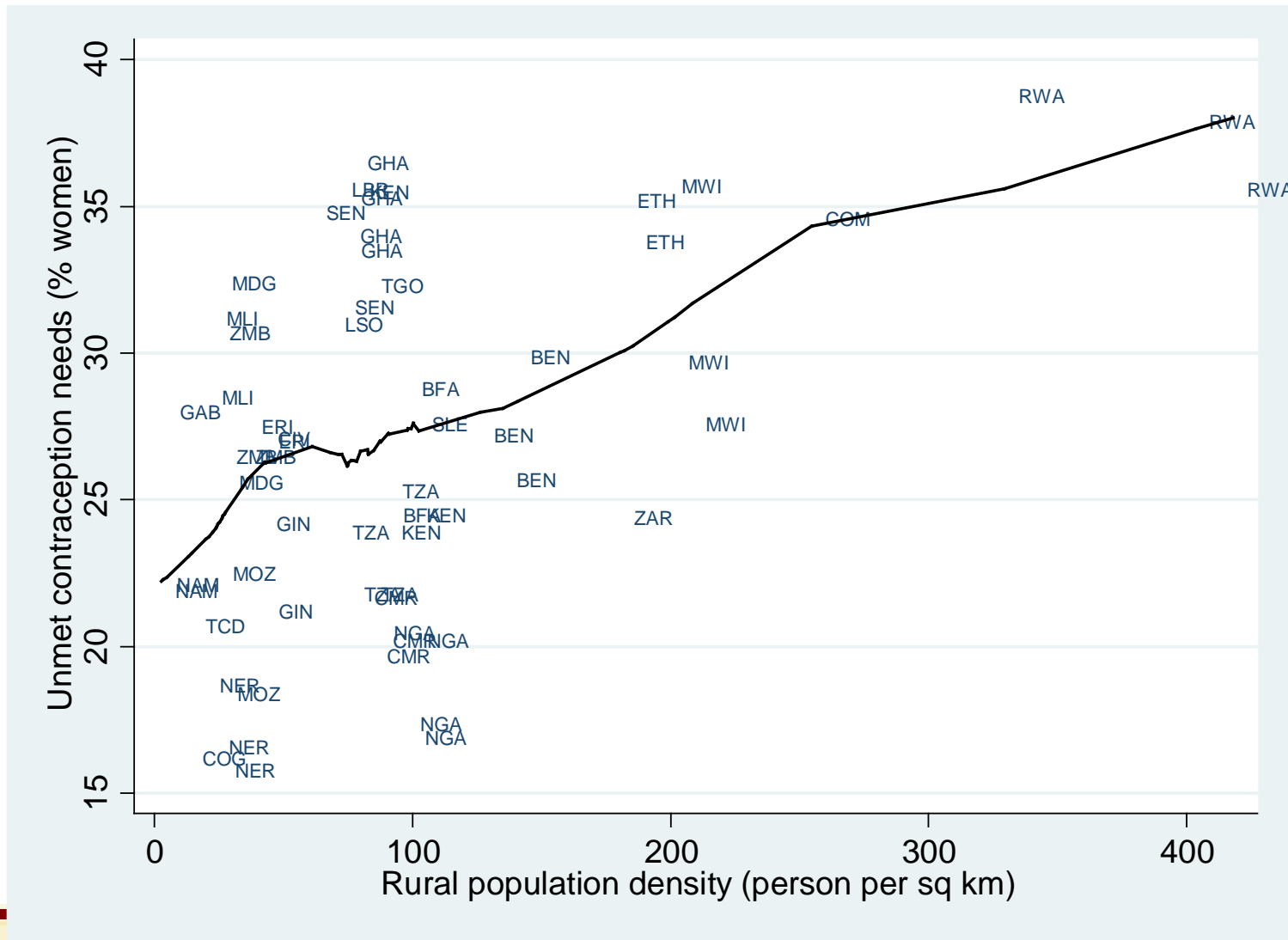


Table 8. Elasticities between rural fertility indicators & rural population density

Regression number	1	2	3	4
Dependent variable	Actual fertility	Actual fertility	Desired fertility	Desired fertility
Model	Linear	Log-log	Linear	Log-log
	b/se	b/se	b/se	b/se
Pop density (per 100 m ²)	-0.14***	-0.09***	-0.11***	0.00
Density*Africa	0.05	0.09***	-0.34***	-0.07***
Female sec. education (%)	-0.02***	-0.05***	-0.01**	-0.08***
Ag. output per worker, log	-0.58***	-0.13***	0.01	0.06***
Africa dummy	1.25***	-0.15	2.13***	0.67***
Number of observations	165	165	164	164
R-square	0.75	0.76	0.77	0.81



4. Nonfarm diversification

- ❑ Much neglected in 1980s literature on Boserup
- ❑ Subsequent literature on rural non-farm (RNF) sector shows non-farm income is big in rural areas of LDCs
- ❑ But not much specific literature looking at pop density
- ❑ Often suggested there is a U-shaped relationship between farm size and RNF employment: landless poor are pushed into RNF, rich are pulled in
- ❑ Do high density rural areas see more out-migration?
- ❑ Difficult to tell with domestic migration, but int. migration boomed in last 10 years; e.g. remittances now 22% of rural income in Bangladesh. Systematic?



Table 9. Speculative estimates of rural nonfarm employment shares for men and women in the 2000s

<u>High density Africa</u>			<u>Low density Africa</u>			<u>Other LDCs</u>		
Country	W	M	Country	W	M	Country	W	M
Benin	50.4	23.7	Burkina Faso	12.9	8.1	BGD	53.4	44.5
Congo (DRC)	14.0	23.5	Chad	13.7	9.6	Bolivia	71.4	25.9
Ethiopia	34.3	9.7	Cote d'Ivoire	31.7	22.1	Cambodia	36.0	
Kenya	47.1	37.3	Ghana	50.1	26.6	Egypt	69.4	
Madagascar	17.8	15.3	Mali	44.6	16.0	Guatemala	79.1	
Malawi	41.5	36.0	Mozambique	5.2	23.0	Haiti	24.0	19.0
Nigeria	65.5	37.0	Niger	60.2	35.8	India	22.4	
Rwanda	7.3	14.2	Senegal	63.7	37.1	Indonesia	59.2	39.5
Sierra Leone	25.2	20.1	Tanzania	7.2	10.5	Nepal	90.5	34.2
Uganda	15.5	20.3	Zambia	30.1	19.5	Philippines	16.2	42.6



Table 11. Elasticities between RNF employment indicators and rural population density for women and men

Regression No.	R1	R2	R3	R4	R5	R6
Sample	Women	Women	Women	Men	Men	Men
Population density	0.47	0.09	0.15	-0.33	-0.32	-0.31
Density*Africa	-0.19**	-0.22**	-0.15*	0.03	-0.02	-0.02
Africa dummy	-0.25	0.1	0.04	-0.43	0.09	0.09
Sec. educ. by gender		0.03	0.11		0.35***	0.35***
Road density		0.14*	0.15**		0.17*	0.17*
Electricity		0.20**	-0.07		0.09	0.09
Ag. Output/worker, log			0.46***			0.01
No. Obs.	162	122	95	74	74	74
R-square	0.2	0.53	0.24	0.55	0.55	0.55



Figure 6. National remittances earnings (% GDP) and rural population density

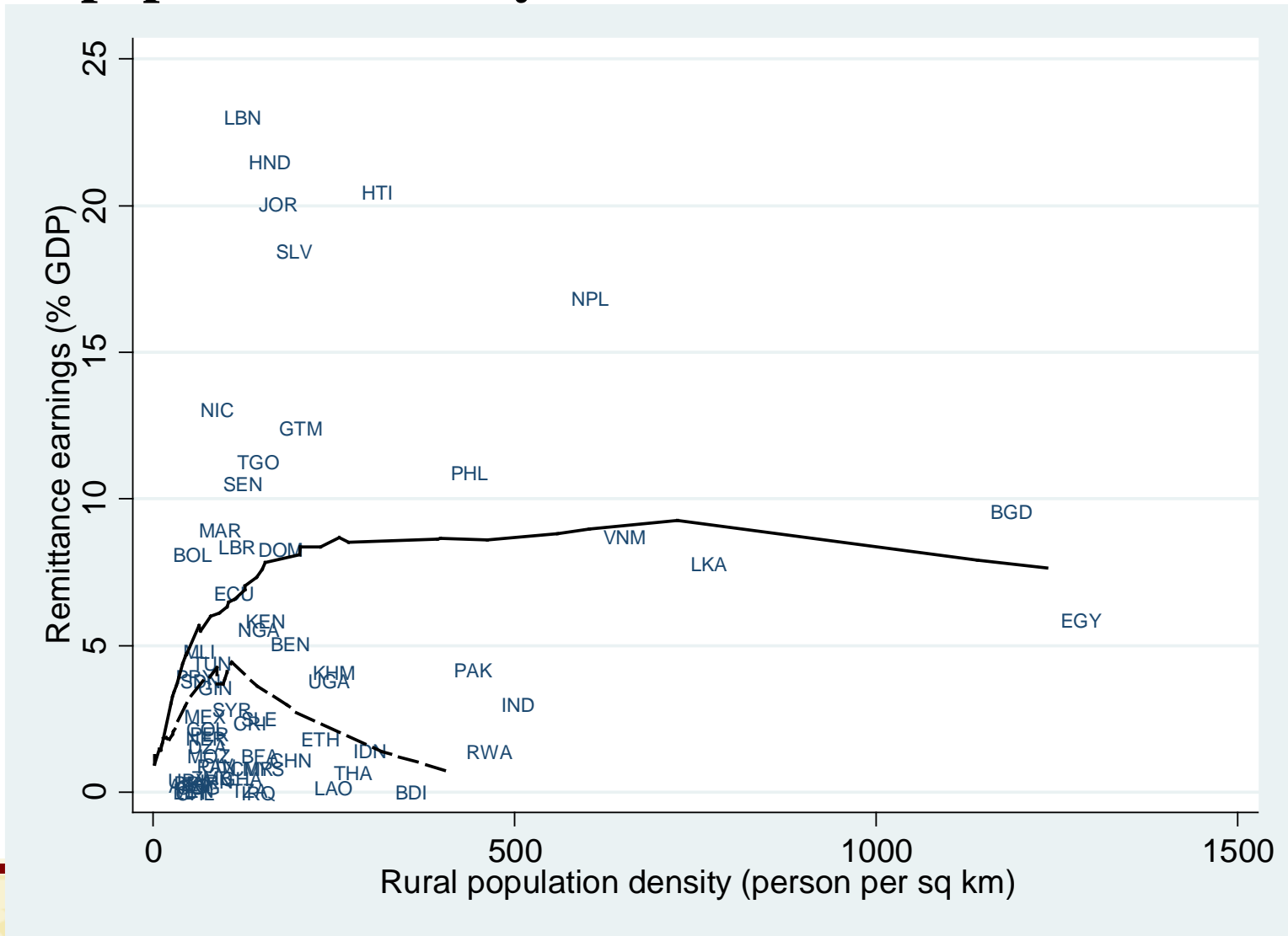


Table 11. Estimating elasticities between national remittance earnings (% GDP) and population density

Estimator	OLS	Robust	OLS	Robust
Structure	Levels (logs)	First difference	Levels (logs)	First difference
Density variable	Agricultural	Agricultural	Rural	Rural
Population density	0.25***	0.97**	0.31***	1.17***
Population density* Africa	0.05	-0.94	0.04	-1.22**
Total population	-0.24***	-1.31**	-0.23***	-0.82
Lagged remittances		-0.21***		-0.24***
Lagged population density		0.06		0.06
West Africa dummy	-0.67*		-0.49	
Central Africa dummy	-1.55***		-1.40***	
East Africa dummy	-0.90**		-0.74*	
Southern Africa dummy	0.14		0.24	
1977-87 dummy	0.15		0.12	
1987-97 dummy	0.33*	-0.09	0.28*	-0.06
1997-2007 dummy	0.79***	0.19	0.72***	0.24*
Number of observations	231	147	231	159
R-square	0.39	147	0.4	0.22

5. Conclusions

- ❑ Land pressures are severe in much of Africa, esp. high density SSA, where small farms are getting smaller, and will continue to get smaller as pop. grows
- ❑ Yet history shows that rural people are generally resourceful in adapting to mounting land constraints (though Boserupian intensification is only part of it)
- ❑ The question we posed is whether Africa is different
- ❑ In many ways, the answer is yes . . .



5. Conclusions

- ❑ **Adaptation 1 - Agricultural Intensification**
- ❑ **Africa has intensified agriculture**, but largely through high value non-perishable crops (HVCs)
- ❑ Much less historical success with cereals, and much less potential given limited potential for irrigation
- ❑ *Should we shift emphasis of research and development strategies from cereals to HVCs?*
- ❑ CGIAR, for example, barely looks at cash crops like coffee, tea, cotton, cocoa, tobacco (even though cash buys food!)

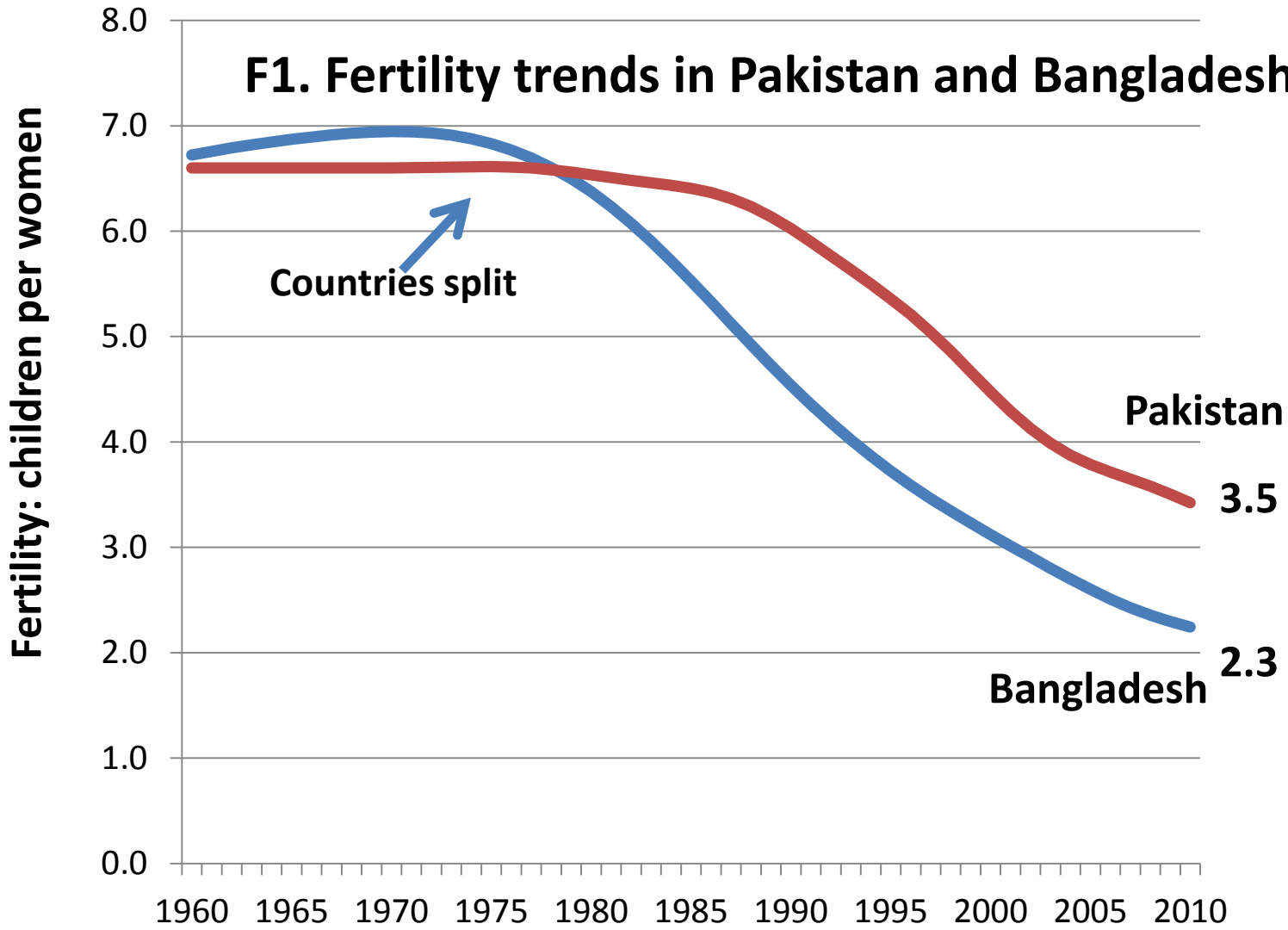


5. Conclusions

- ❑ **Adaptation 2 - Reducing fertility rates**
- ❑ Higher densities (smaller farms) appear to lead to a desired reduction in fertility in Africa
- ❑ But desired reductions are not met by access to contraceptive technologies (broadly defined)
- ❑ High-density East Africa now shows mixed policies
- ❑ Ethiopia & Rwanda are investing in family planning (*), but Museveni (Uganda) has resisted family planning (population growth is “a great resource”)
- ❑ Asian experience suggests FP yields high returns



F1. Fertility trends in Pakistan and Bangladesh



5. Conclusions

- ❑ **Adaptation 3 – Nonfarm diversification**
- ❑ Weak evidence, but evidence that is there suggests that nonfarm sector doesn't just grow without engines like education, infrastructure, agriculture (also true for African cities?)
- ❑ Boom in overseas migration and remittances is new, and unexpected.
- ❑ 20 years ago, BGD and Pakistan were regarded as too big to benefit from remittances. Not true now.
- ❑ Why isn't Africa getting more remittances?



5. Conclusions

- ❑ Finally, we ask whether the results we find warrant a re-think in the way high density countries pursue rural development
- ❑ Are SSA countries thinking through the implications of rural pop. growth for farm sizes and rural welfare?
- ❑ Do SSA countries need rural development strategies that are more integrated with respect to smallholder intensification, commercial farms, family planning, migration and rural nonfarm development?
- ❑ What are the costs of not doing so?

