EPIC
IMMUNIZATION
COSTING

Estimating the costs of scaling up immunization: evidence from the EPIC studies

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Outline

- Motivation
- EPIC Study background
- Issues with pooling data
- Basic data description
- Analytic approach
- Results
- Next steps
- Conclusions

Motivation

Purpose of EPIC Study: to update evidence on routine immunization program costs and financing based on detailed facility-level analysis

- Multi-country study using a common approach

- Useful to have better information on costs of supporting immunization services:
  - What is the average cost per fully immunized child (as compared to historical benchmarks)?
  - How do costs differ across countries and what explains these differences?
  - What are the site-level determinants of the cost per outcome?
  - What are the costs of scaling up?

EPIC Study Country Characteristics (Year 2011)

Country	GNI per capita	Infant Population	DTP3 Coverage Level [1]
Uganda	$470	1,326,826	80%
Benin	$720	348,577	85%
Zambia	$1,180	567,320	81%
Ghana	$1,420	1,011,012	91%
Moldova	$1,980	47,537	93%
Honduras	$2,030	177,733	91%

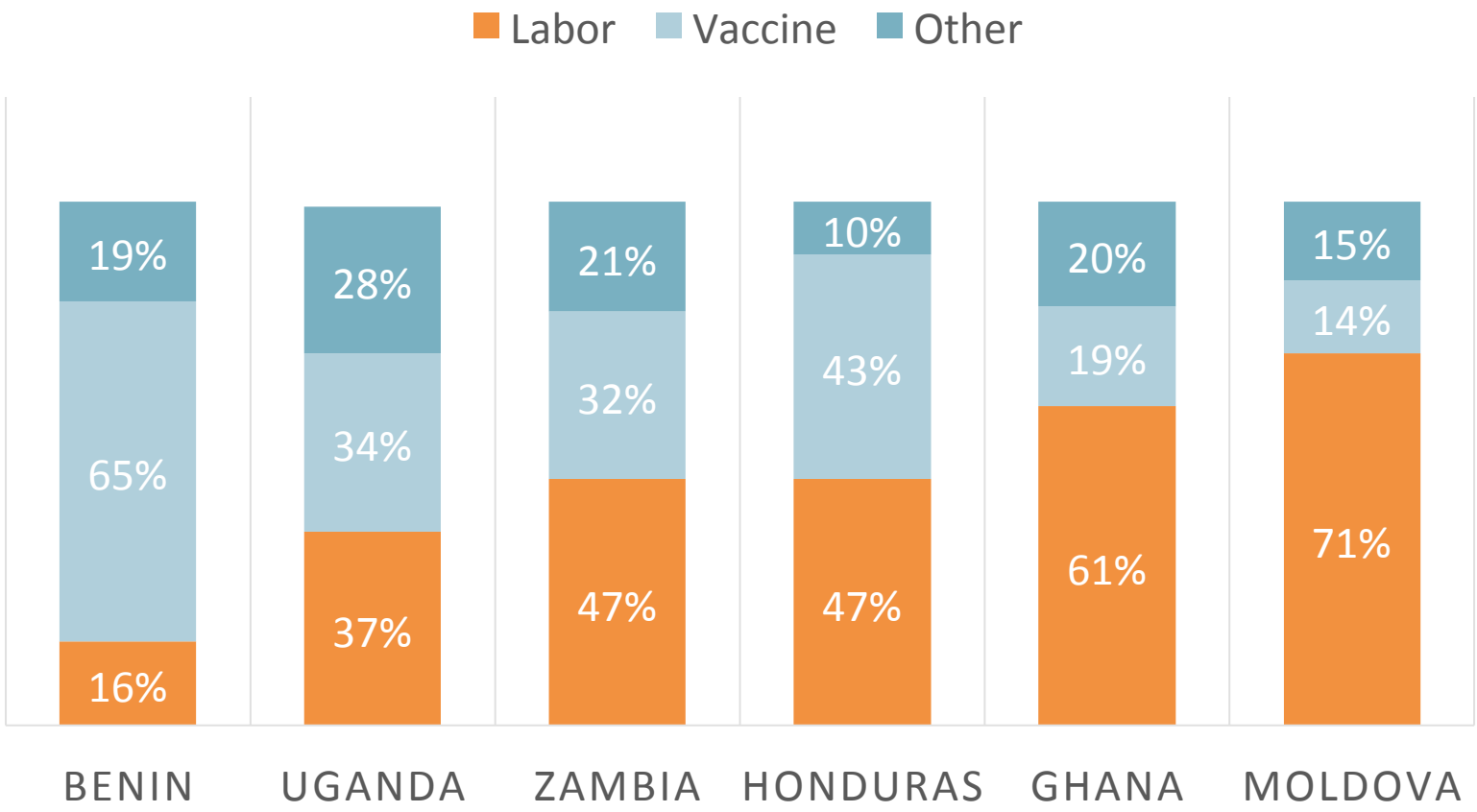
[1] WUENIC Estimates, 2011. DTP3 = Diptheria, Tetanus, Pertussis Vaccine, 3rd dose

Facility Unit Costs for the EPIC Studies

Country	Weighted Average Cost/ Dose	Weighted Average Cost/ Fully Immunized Child (i.e. DTP3)	Share of Above Facility Costs	Government Share of Total Financing of Immunization Program
Benin	$2	$25	6%	45%
Uganda	$5	$44	16%	45%
Ghana	$5	$51	31%	85%
Zambia	$7	$66	26%	82%
Honduras	$9	$128	14%	64%
Moldova	$18	$332	18%	95%

2011 US Dollars

Cost Profiles for the EPIC Studies – Facility Level



Pooling data I

- Data from 6 country studies available in a (mostly) standardized format.
- Some 'real' differences between country studies – questions asked in different ways, some questions not asked, some concepts inherently local (e.g. definitions of HS level)
- Additional differences in data coding and format.
- Consistency checks with communication with country teams to resolve apparent inconsistencies
- Goal to develop a **publicly accessible common dataset** with standardised definitions, missing data chased where possible, links between summary and details information.

Pooling data II

- Where up to so far:
  - Still working on preparing full dataset
  - Current cost information don't include regional/national level costs
  - Don't yet have a full division of cost categories for all countries
  - Some explanatory variables still 'in progress'

- For this analysis:
  - Any missing data imputed by mean regression imputation (will underestimate uncertainty, though only minor missingness)
  - Avoided variables with country-level missingness
  - Avoided variables with known measurement error (this comes back later)

Descriptive statistics I

- Sites per country /total

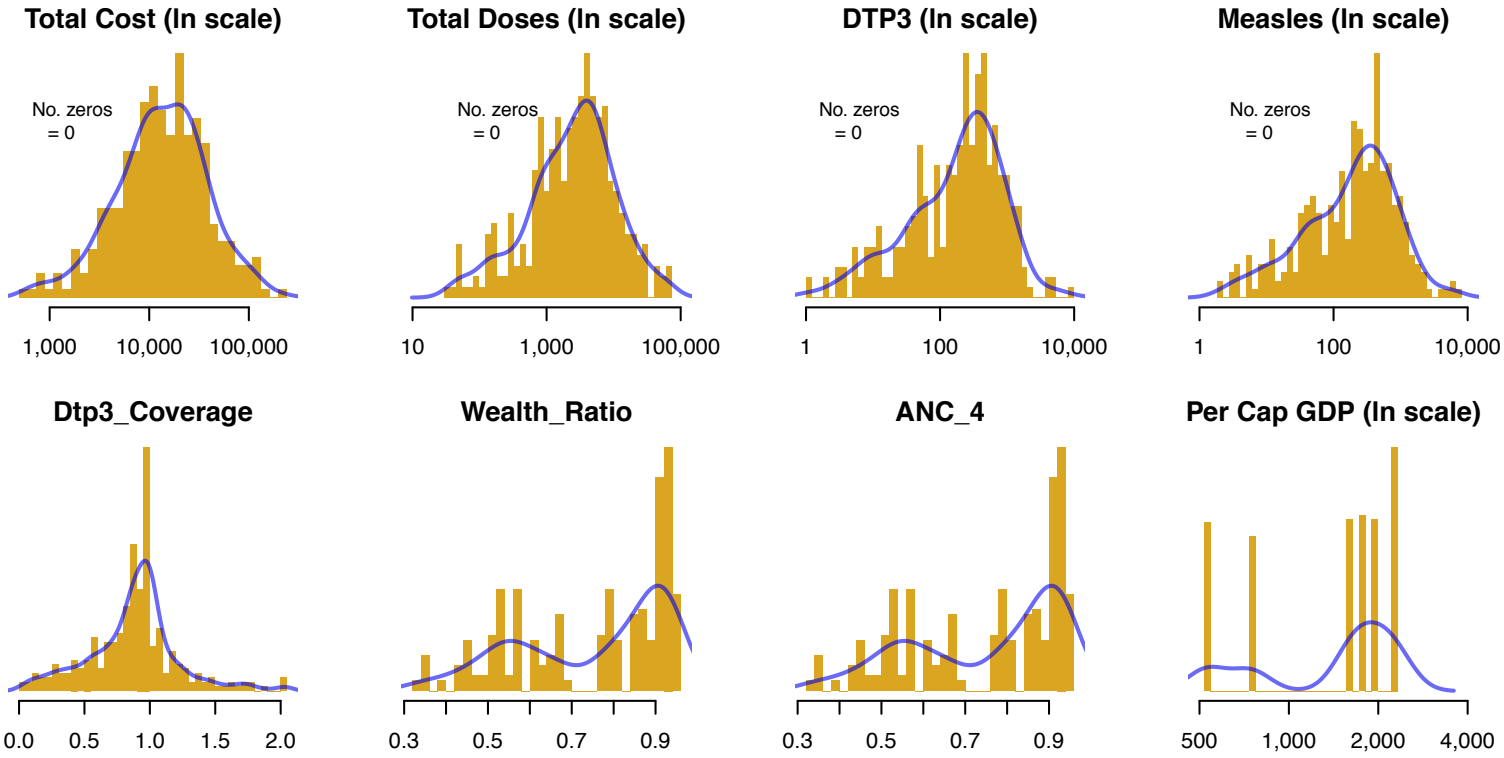
County	N
Benin	45
Ghana	50
Honduras	71
Moldova	50
Uganda	49
Zambia	51
TOTAL	**316**

- Major cost/outcome variables

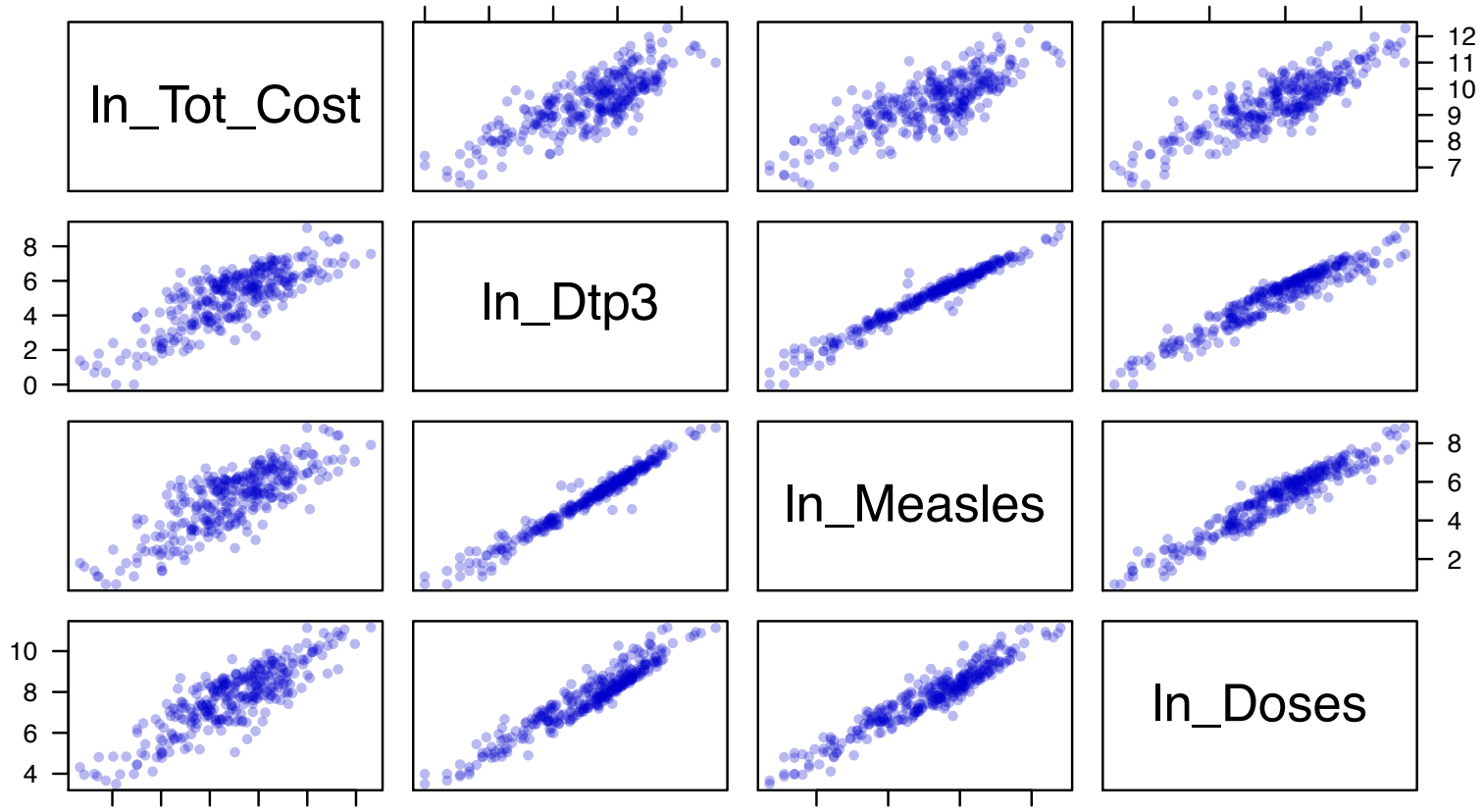
Variable	Mean (sd)
Total cost (USD)	21,700 (25,600)
Total Doses	5,993 (10,056)
Total DTP3	439 (774)
… facility	289 (514)
… outreach	150 (325)
Total Measles	450 (781)
… facility	303 (545)
… outreach	147 (316)

Descriptive statistics II

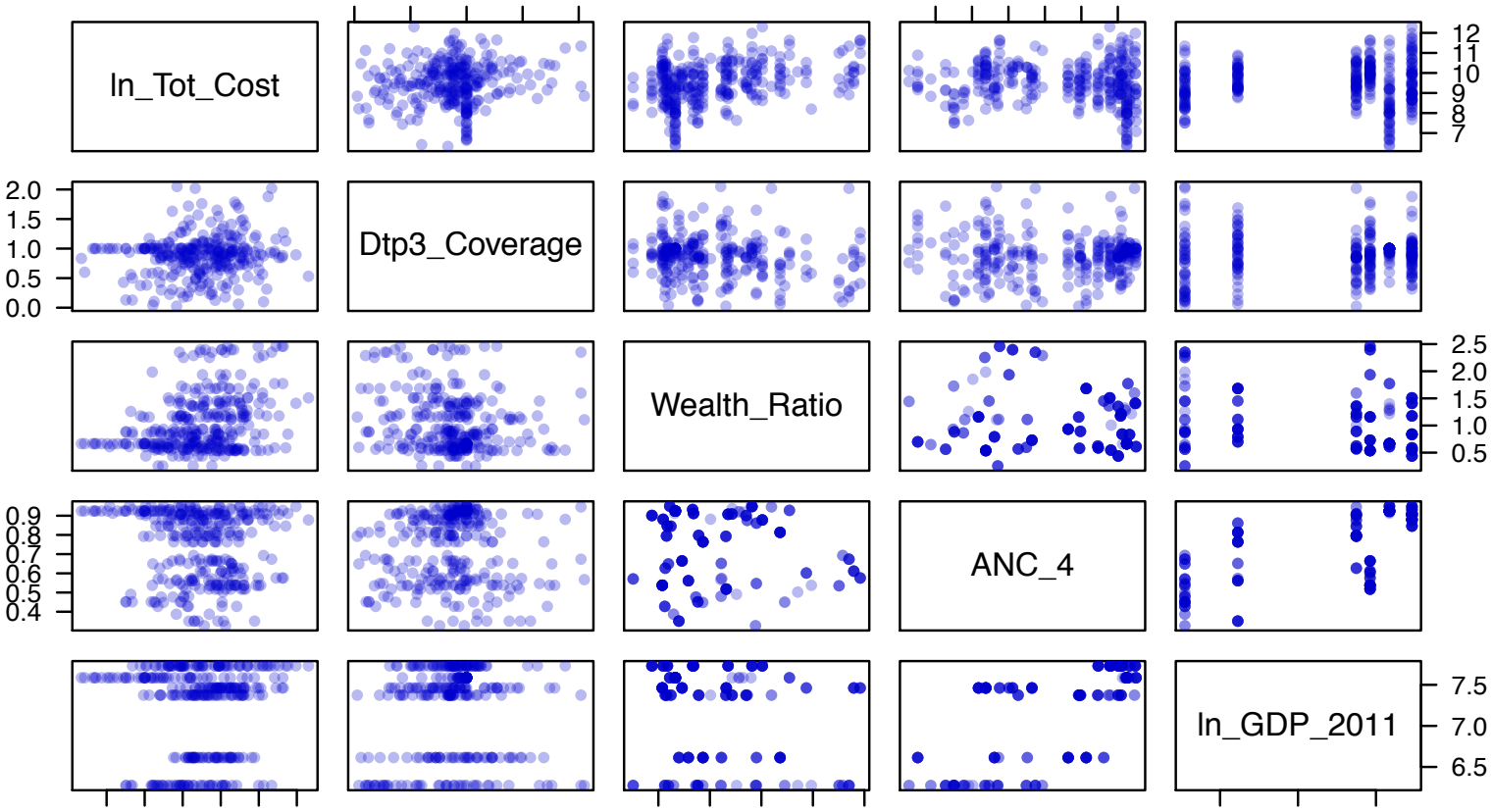
- Distribution of costs/outcomes:



Descriptive statistics III



Descriptive statistics IV



Analytic approach I

- Issues to deal with:
  - In each country, cluster sampling approach for site selection
    → Analysis adopted multilevel model with random effects for cluster levels
  - Comparability of some measures across countries
    → Presence/absence of beds used to proxy for health system level
    → 'peri-urban' and 'semi-urban' categories pooled into 'urban' category
  - Some potentially informative variables still under construction
    → Restricted subset of parameters used in these analyses
  - Little price variation within country
    → Limited scope to investigate impact of price differentials

Analytic approach II

$$ln(TC_i) = \beta_0 + \sum_{j \epsilon J} \beta_j X_{ij} + \delta_{c_i} + \delta_{p_i} + \varepsilon_i$$

- → Regression on log total cost – implies multiplicative relationship between costs and linear predictor
- → Predictors include logged measures of service provision (e.g total doses), other characteristics of site / setting, and log per capita GDP (crude country-level price index)
- → Random effects for country (δ_c) and province (δ_p).
- → Operationalized in a Bayesian framework, weakly informative priors for regression coefficients and variance terms

Results I

	Model specification					
Variable*	1	2	3	4	5	6
Intercept	9.48 (0.06)	9.48 (0.31)	9.46 (0.27)	9.47 (0.27)	9.52 (0.19)	9.55 (0.25)
Output volume						
ln(Doses)			1.03 (0.03)	1.03 (0.03)	1.05 (0.04)	0.98 (0.19)
ln(Doses) sq				-0.03 (0.02)	-0.02 (0.02)	0.07 (0.03)
Other predictors						
Govt Owned					-0.09 (0.11)	-0.11 (0.10)
Urban					0.09 (0.10)	0.08 (0.10)
ln(pre capita GDP)					0.26 (0.18)	0.35 (0.25)
ANC4					0.13 (0.08)	0.05 (0.07)
Facility Delivery					-0.13 (0.07)	0.03 (0.07)
Wealth Ratio					-0.04 (0.07)	-0.11 (0.07)
Country random effects for intercept		Yes	Yes	Yes	Yes	Yes
Country random effects for ln(Doses)						Yes
Variance parameters						
Error term	1.06 (0.04)	0.86 (0.04)	0.44 (0.02)	0.44 (0.02)	0.43 (0.02)	0.41 (0.02)
WAIC*	932.5	833.4	399.8	400.8	399.4	361.3

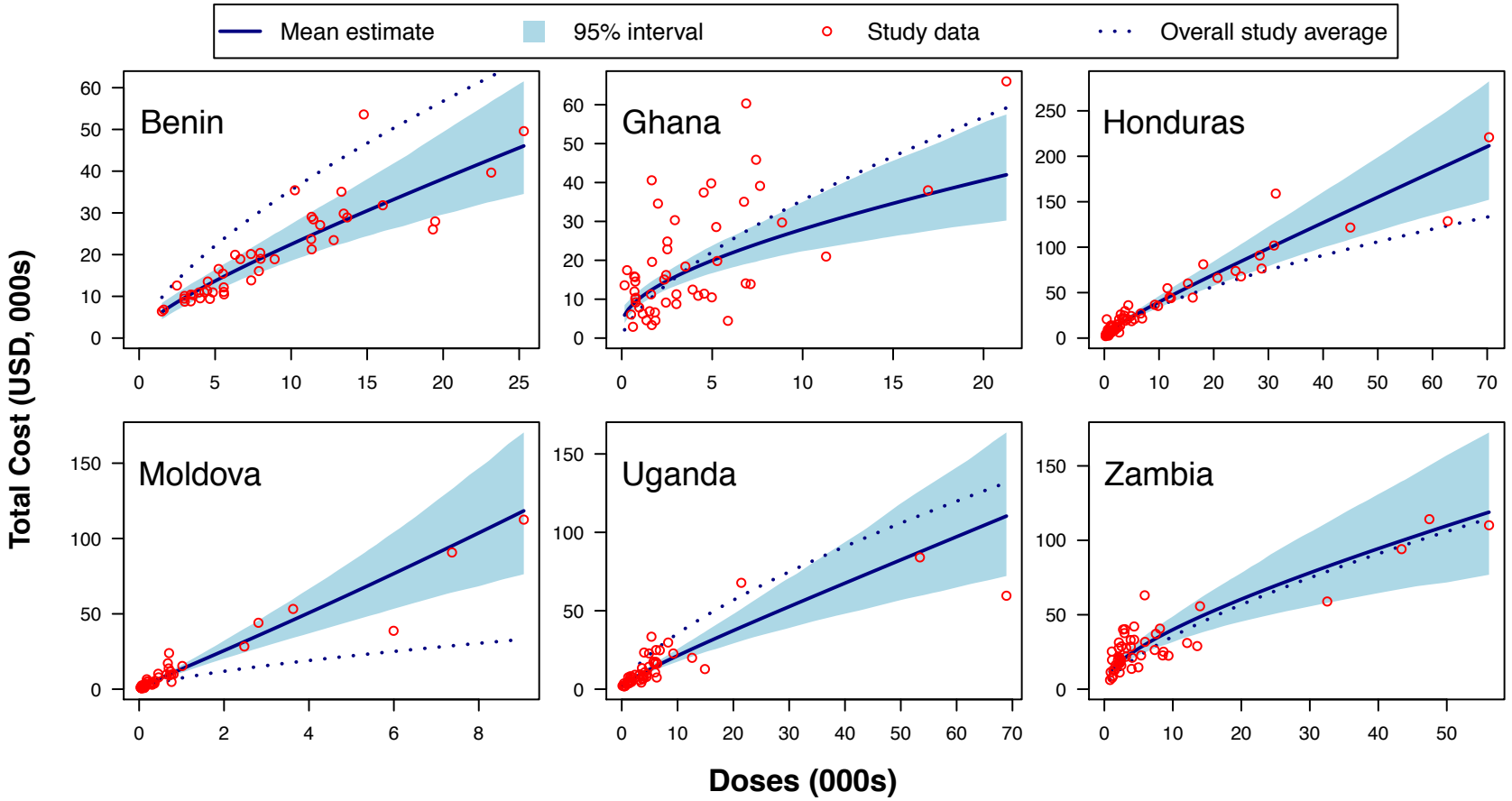
* Watanabe-Akaike information criterion approximates out-of-sample prediction error for the fitted model. Lower values suggest better model fit.

First Differences

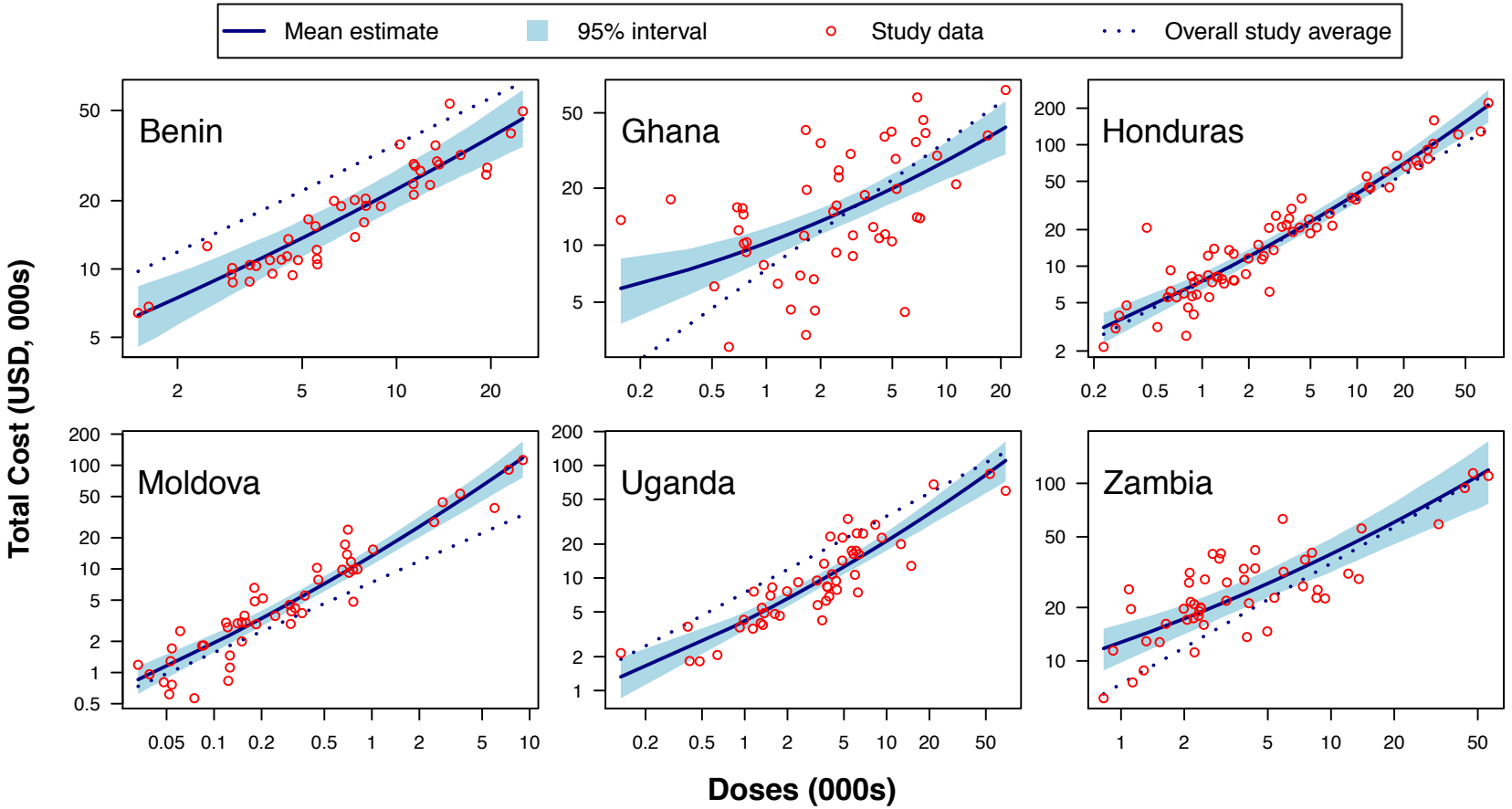
Comparison*		Percentage difference in average cost per dose**
Each country, vs. overall mean	*Benin*	-39% (-67%, 0.0%)
(incl. per-capita GDP effects):	*Ghana*	3.7% (-41%, 66%)
	Honduras	-7.0% (-48%, 48%)
	Moldova	98% (11%, 231%)
	Uganda	-41% (-67%, -2.5%)
	Zambia	56% (-13%, 160%)
Government-owned sites, vs non-government-owned sites.		-10% (-27%, 9.7%)
Urban sites, vs rural sites.		8.9% (-9.9%, 32%)
ANC coverage 20% higher.		3.8% (-5.8%, 14%)
Facility delivery rates 20% higher.		-1.3% (-4.3%, 7.2%)
Wealth ratio 20% higher.		-4.0% (-8.6%, 0.07%)
GDP 20% higher.		13% (-5.6%, 34%)
Service delivery volume 20% higher	*Benin*	-4.9% (-7.8%, -1.9%)
(vs country median):	*Ghana*	-9.9% (-12%, -7.9%)
	Honduras	-5.1% (-6.4%, -3.8%)
	Moldova	-3.1% (-4.9%, -1.4%)
	Uganda	-4.9% (-6.7%, -3.0%)
	Zambia	-4.9% (-7.8%, -1.9%)
	OVERALL	-8.7% (-11%, -6.5%)

* Controlling for all other model parameters except for those described in the comparison.

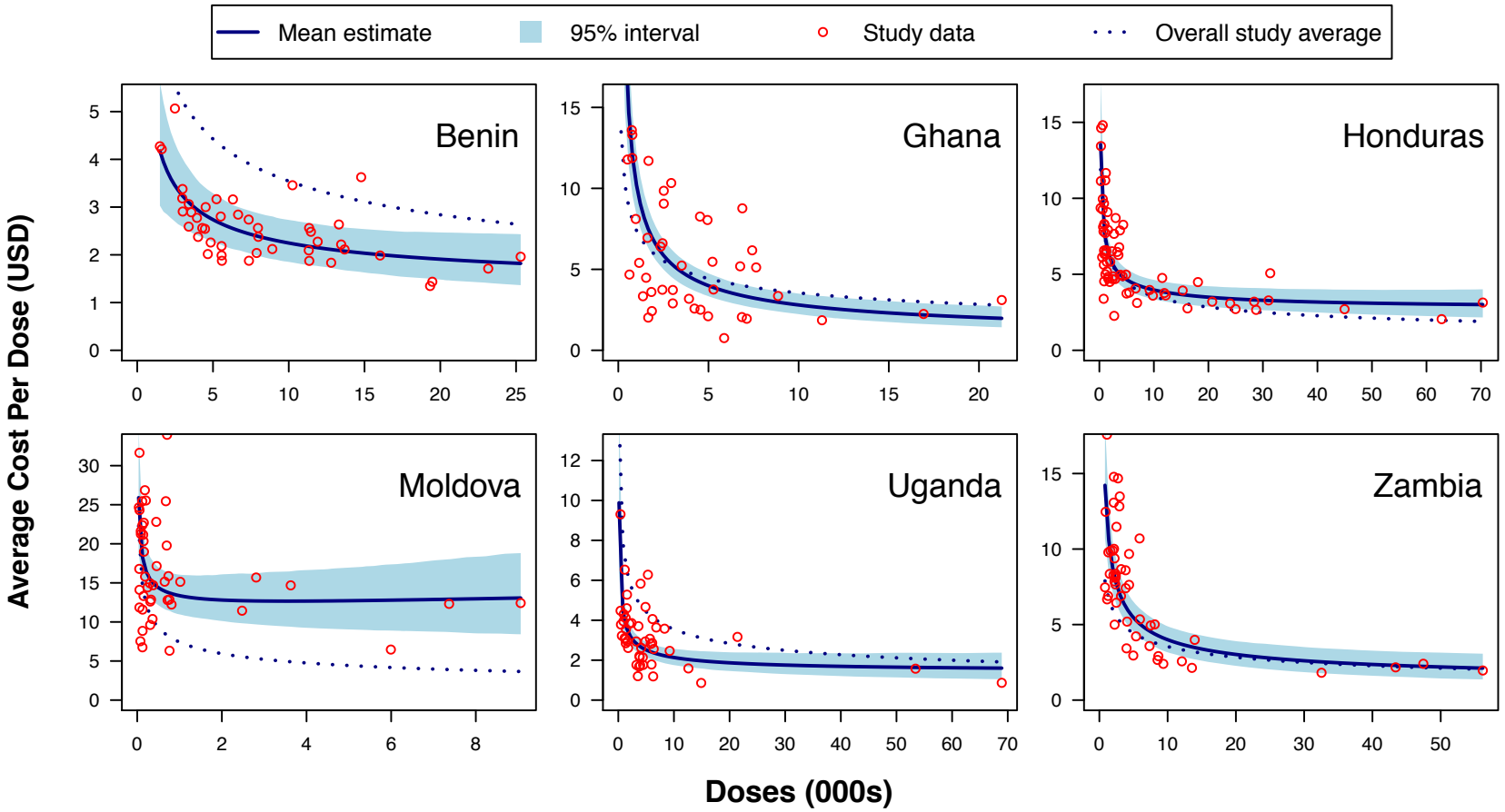
Total costs with increasing service volume



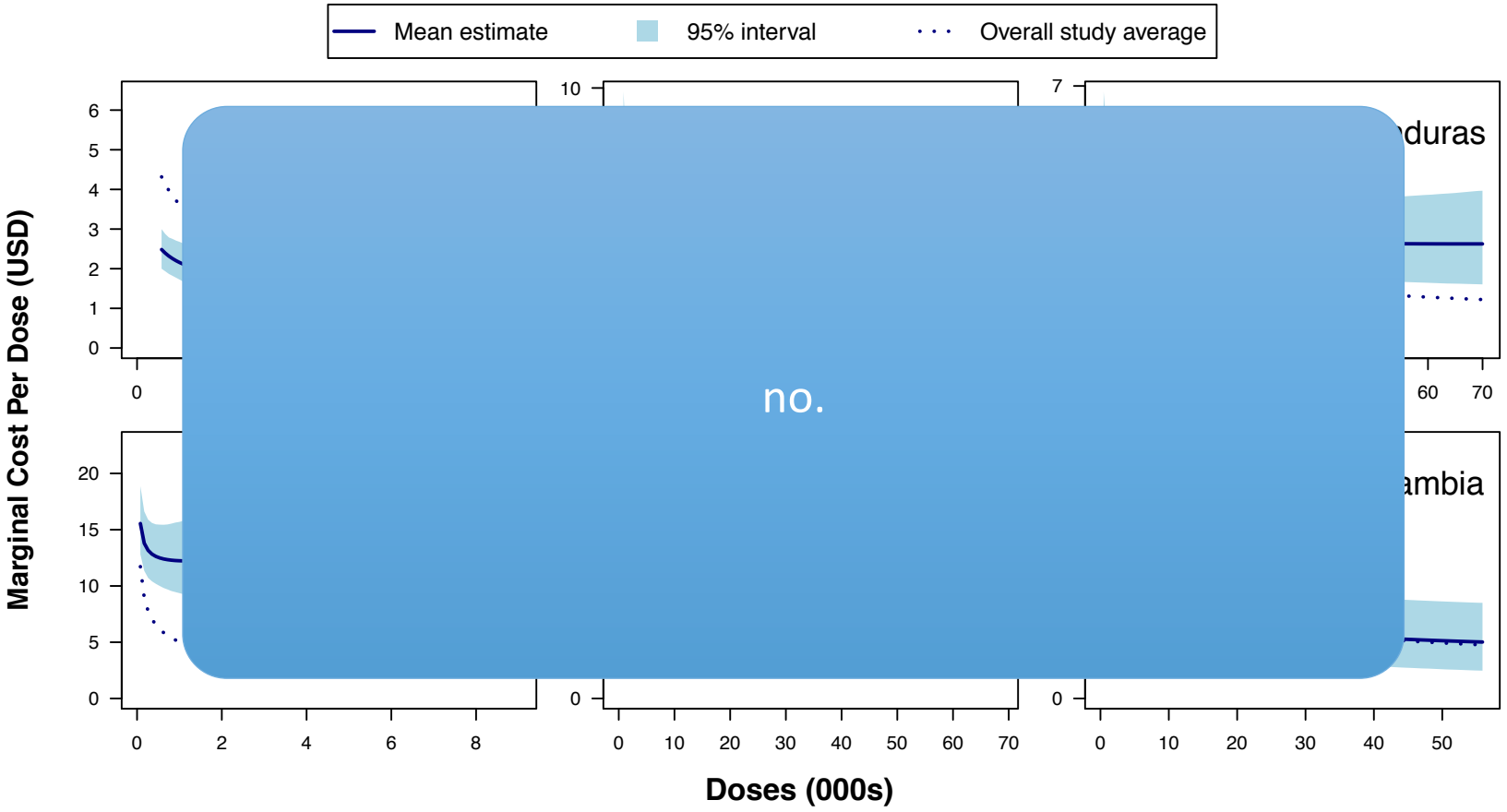
Total costs with increasing service volume (log-log)



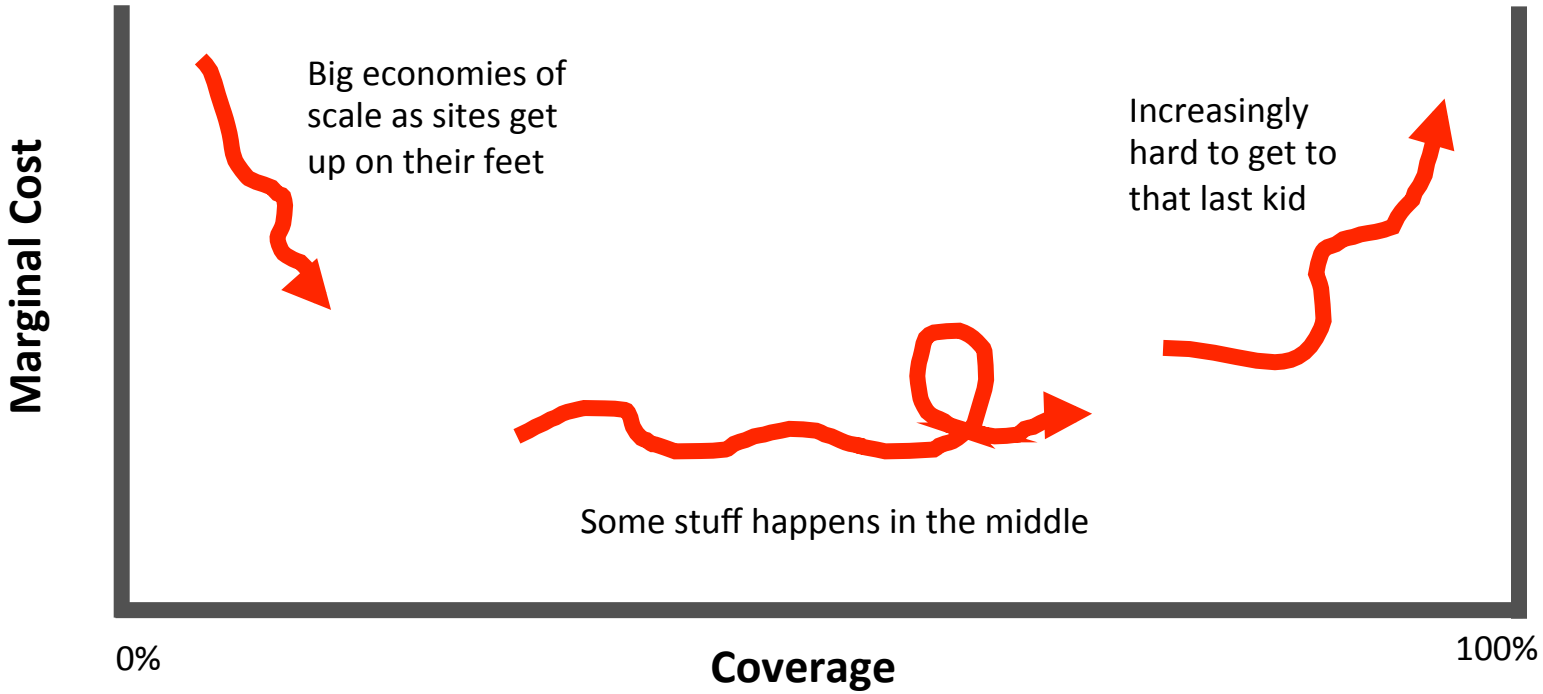
Average costs with increasing service volume



Marginal costs with increasing service volume?



What we expect:



- Possibly: expectations wrong, or observing sites not yet near full coverage
- More likely: estimates biased without controlling for catchment pop

Conclusions

- Service volume a clear cost determinant → strong negative relationship with average costs
- Relationship of costs to service volume different by country, though qualitative relationship the same
- Other determinants (those assessed so far) have rel. weak relationship to total costs
- Strong conclusions on costs of scaling up: not there yet.

Next steps

- Finish data processing – cleaner data, inclusion of regional/national overheads
- Reconsider specification with full range of covariates available
- Estimating marginal costs: can we make use of noisy measure of catchment population?
- Approaches for projecting future national costs under various scenarios.
- Project website forthcoming: *immunizationcosting.org*