Measuring Seasonal Poverty

Paul Christian[1] Brian Dillon[2] Ben Glasner[2]

ASSA 2018

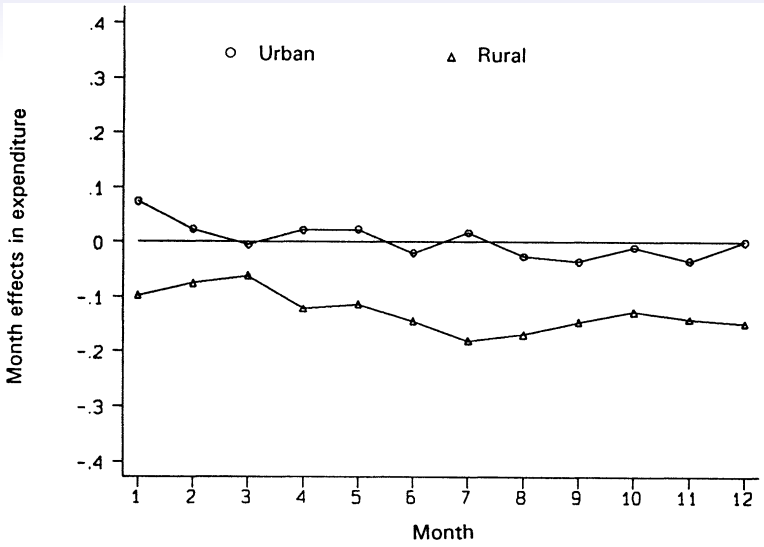
[1]World Bank
[2]University of Washington

Broad motivation

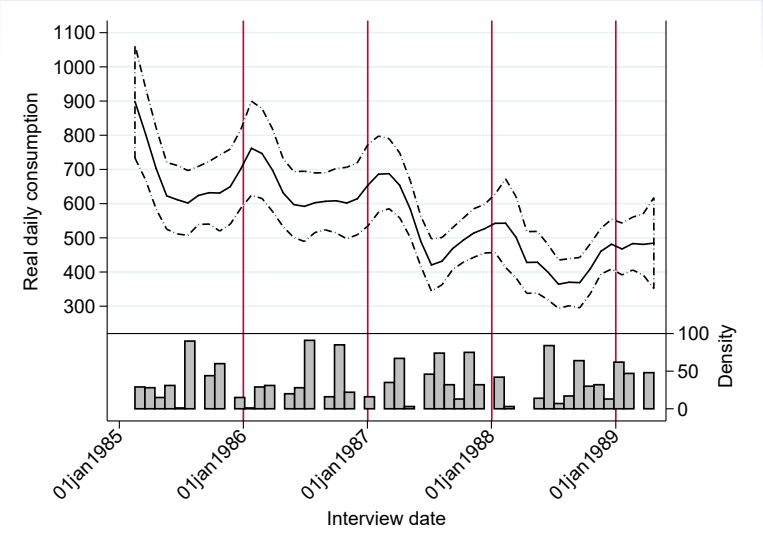
Poverty measurement

Standard poverty measures are based on annualized consumption.

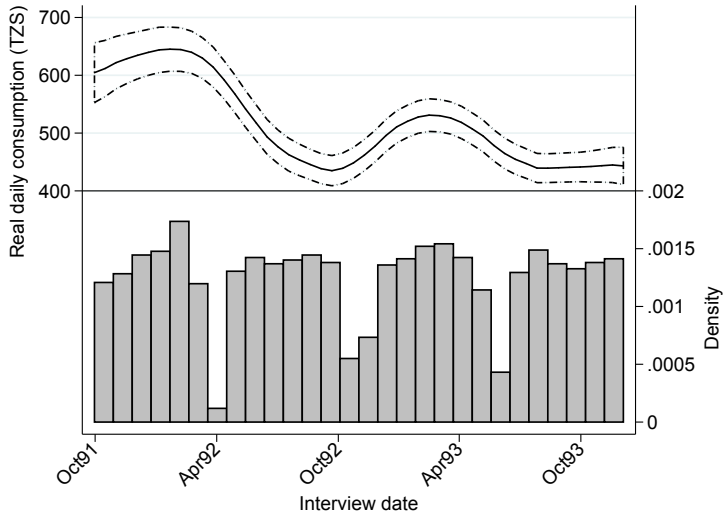
Is a year the right time frame for conceptualizing poverty?



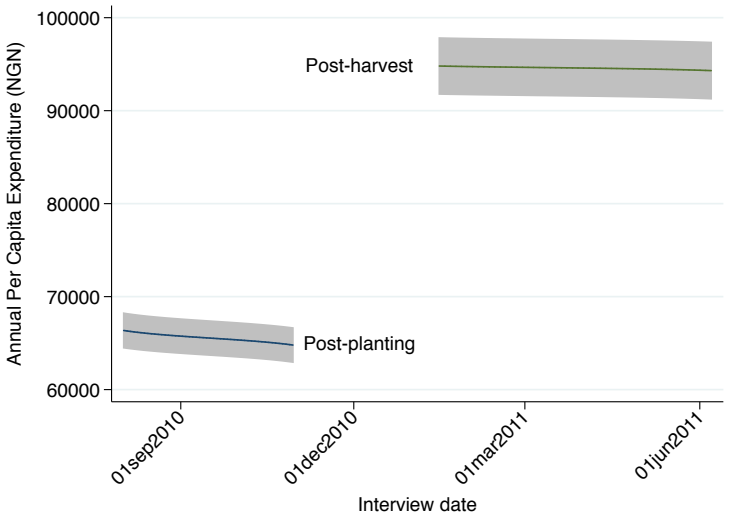
Thailand, 1975-1986



Cote d'Ivoire, 1985 - 1989



Tanzania, 1991-1994



Nigeria, 2010-2011

Broad motivation

Poverty measurement

Standard poverty measures are based on annualized consumption.

Is a year the right time frame for conceptualizing poverty?

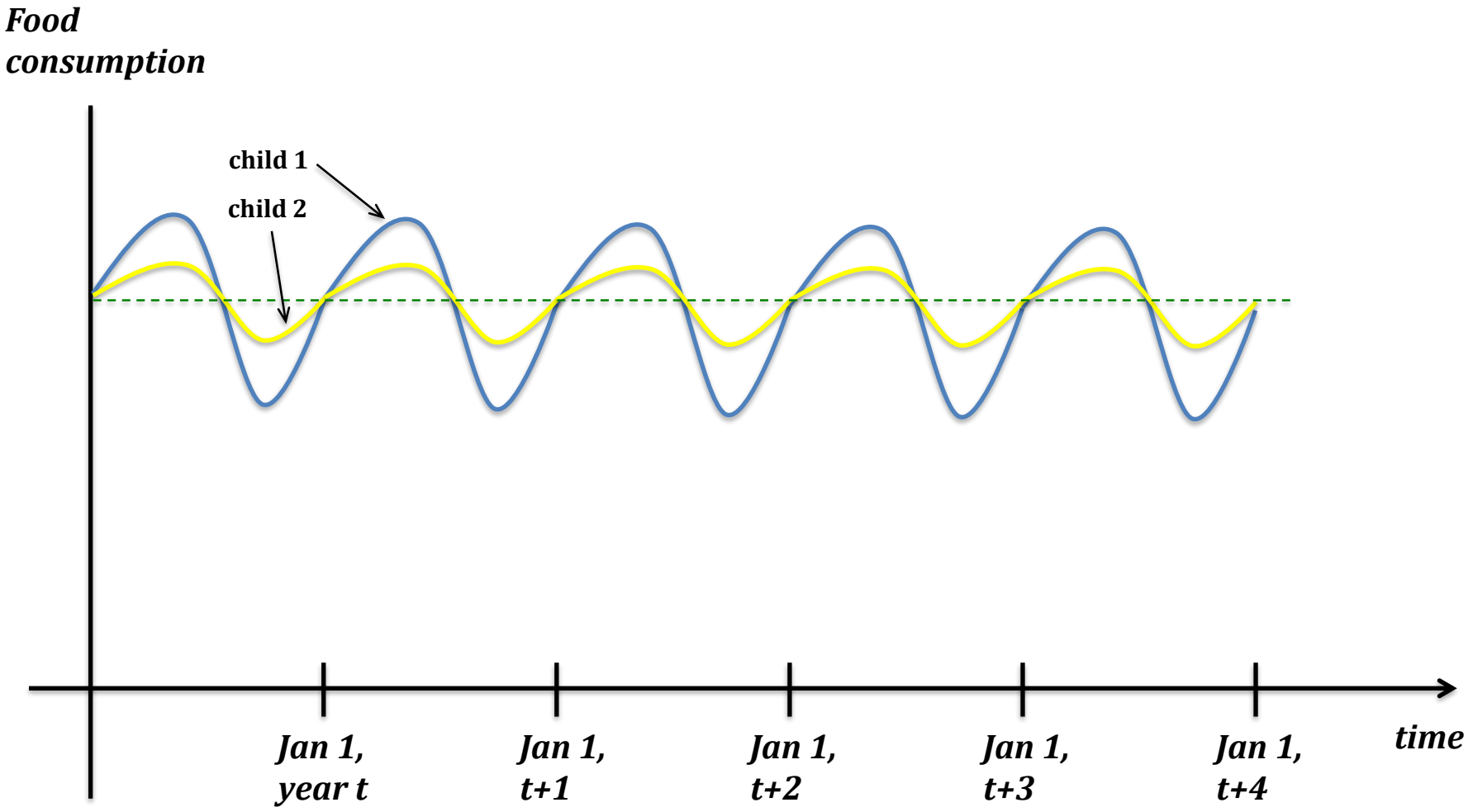
Consumption seasonality

In most low-income countries, consumption has a strong seasonal component, especially in rural areas.

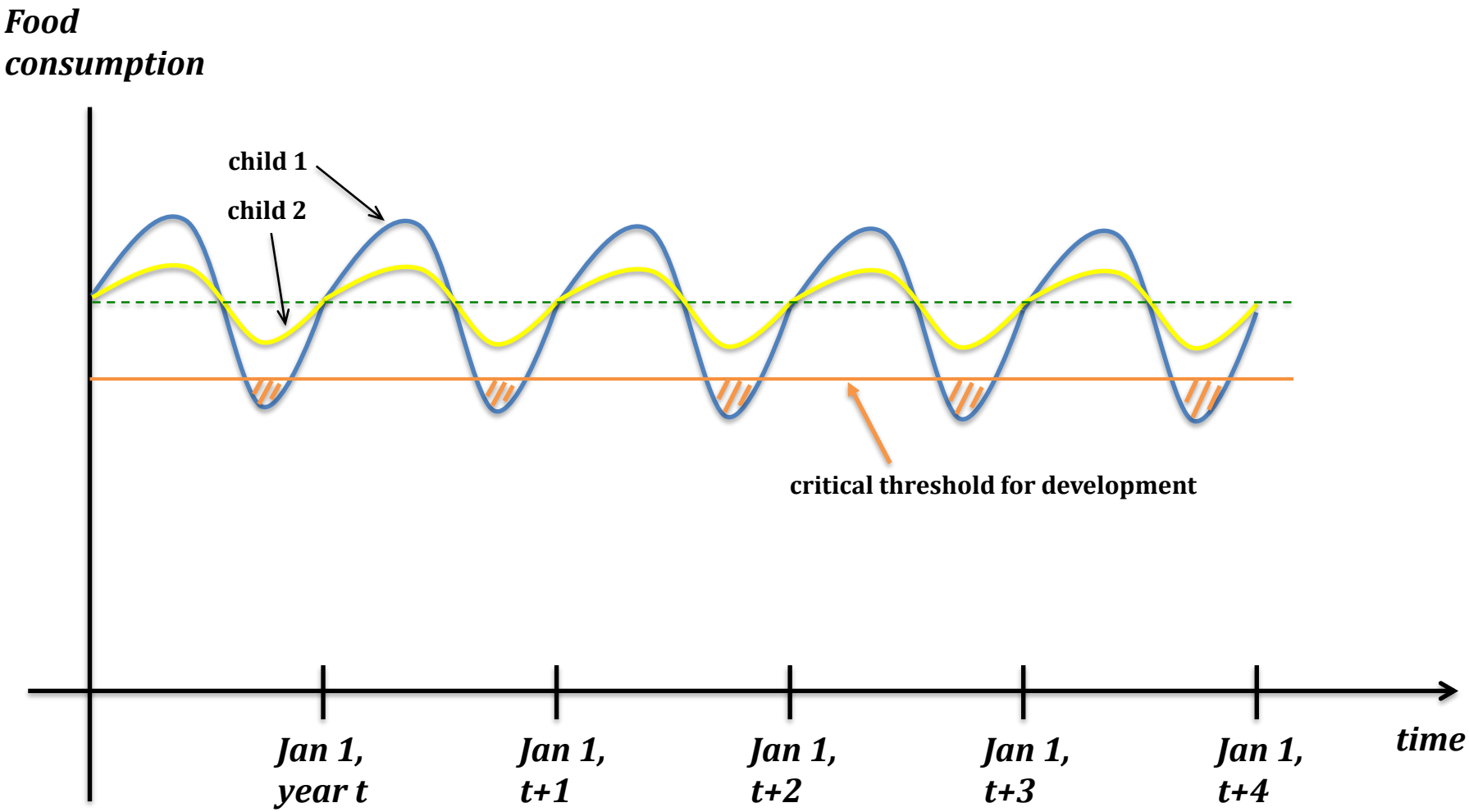
Annualizing may throw away valuable information about welfare.

> Christian and Dillon (2017): consumption seasonality affects height and educational attainment in the long run, conditional on average consumption.

Graphical intuition in Christian and Dillon (2017)



Graphical intuition in Christian and Dillon (2017)



Related literature

Various threads in the literature dealing with poverty dynamics

- Transitory poverty (Baulch 1996; Haddad and Ahmed 2003; Barrett 2005)
- Vulnerability (Dercon and Krishnan 2000; Ligon and Schechter 2003; Dercon 2006)
- Resilience (Barrett and Constas, 2014; Bene et al. 2014)
- Income instability in developed countries (Hill et al. 2013)

Also an extensive macro / time series literature on seasonality

Our contribution: explicitly model the seasonal component of consumption for developing countries and show how it is relevant for measuring welfare

Outline

Three highlights from this project:

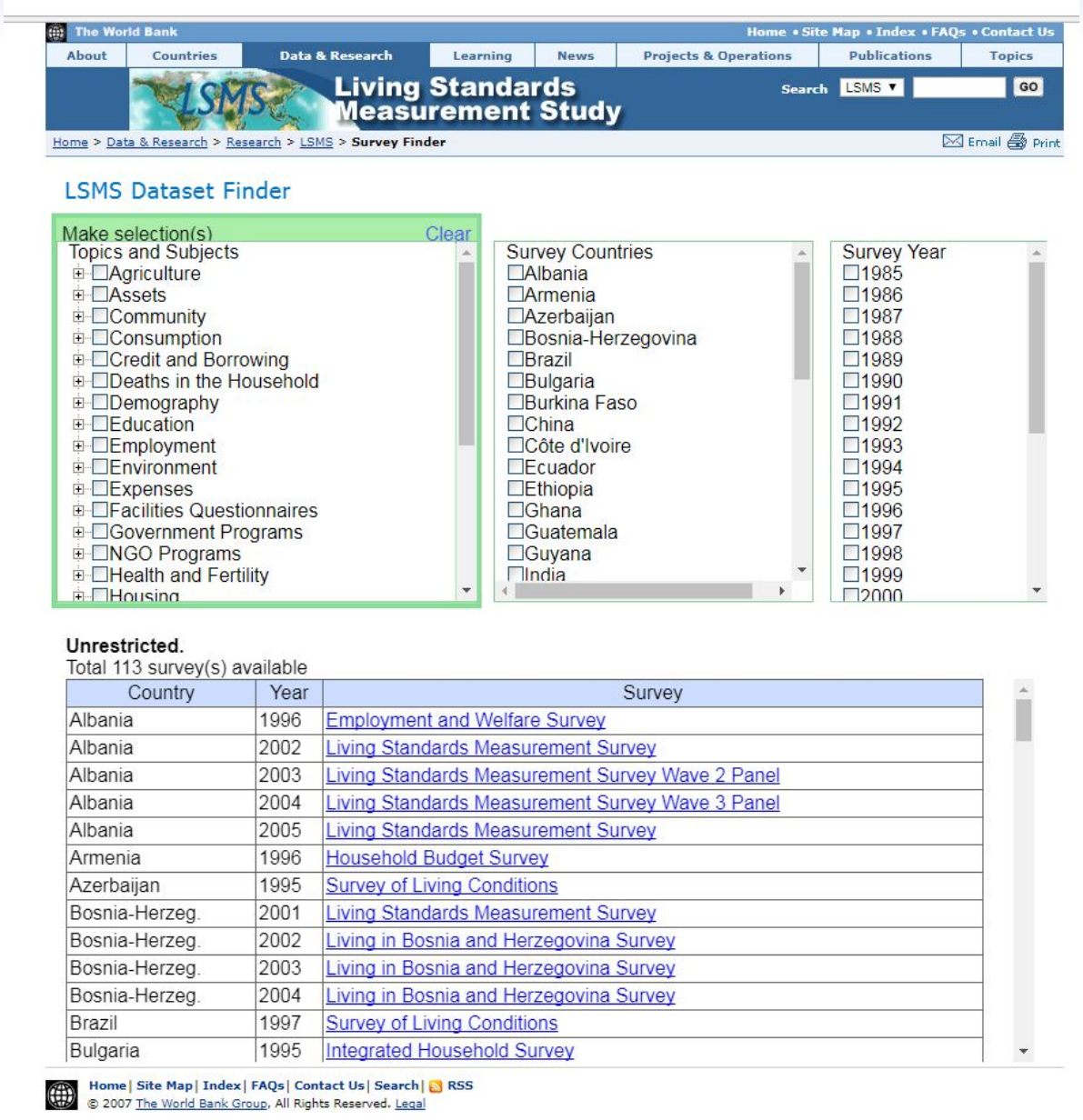
1. Motivating evidence from 12-month surveys
2. Theory: seasonality-robust generalizations of the FGT measures (Foster, Greer, Thorbecke 1984)
3. Example application of seasonal poverty measures

1. Motivating evidence from 12-month surveys

Motivating evidence

We have already seen examples of seasonality in consumption.

What are the implications for poverty measurement?



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Living Standards Measurement Study

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LSMS Dataset Finder

Make selection(s) Clear

Topics and Subjects
- Agriculture
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- Deaths in the Household
- Demography
- Education
- Employment
- Environment
- Expenses
- Facilities Questionnaires
- Government Programs
- NGO Programs
- Health and Fertility
- Housing

Survey Countries
- Albania
- Armenia
- Azerbaijan
- Bosnia-Herzegovina
- Brazil
- Bulgaria
- Burkina Faso
- China
- Côte d'Ivoire
- Ecuador
- Ethiopia
- Ghana
- Guatemala
- Guyana
- India

Survey Year
- 1985
- 1986
- 1987
- 1988
- 1989
- 1990
- 1991
- 1992
- 1993
- 1994
- 1995
- 1996
- 1997
- 1998
- 1999
- 2000

Unrestricted.
Total 113 survey(s) available

Country	Year	Survey
Albania	1996	Employment and Welfare Survey
Albania	2002	Living Standards Measurement Survey
Albania	2003	Living Standards Measurement Survey Wave 2 Panel
Albania	2004	Living Standards Measurement Survey Wave 3 Panel
Albania	2005	Living Standards Measurement Survey
Armenia	1996	Household Budget Survey
Azerbaijan	1995	Survey of Living Conditions
Bosnia-Herzeg.	2001	Living Standards Measurement Survey
Bosnia-Herzeg.	2002	Living in Bosnia and Herzegovina Survey
Bosnia-Herzeg.	2003	Living in Bosnia and Herzegovina Survey
Bosnia-Herzeg.	2004	Living in Bosnia and Herzegovina Survey
Brazil	1997	Survey of Living Conditions
Bulgaria	1995	Integrated Household Survey

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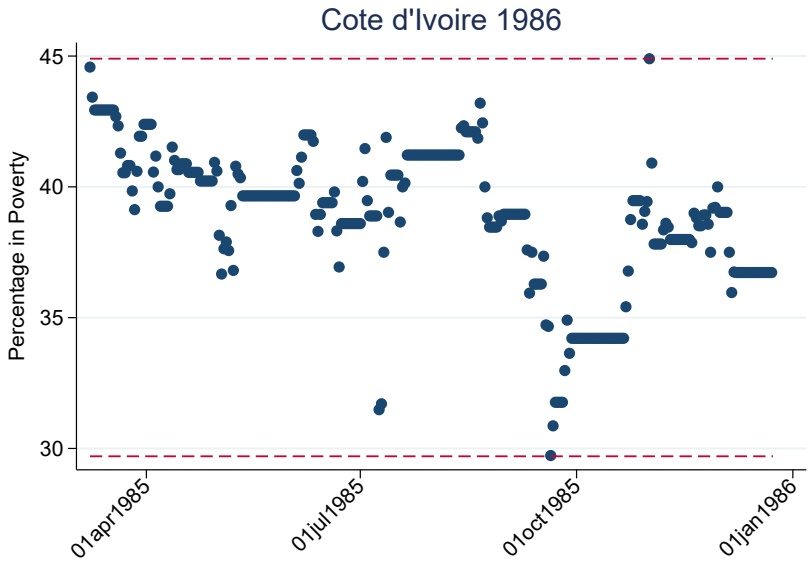
Countries with 12-month LSMS consumption surveys

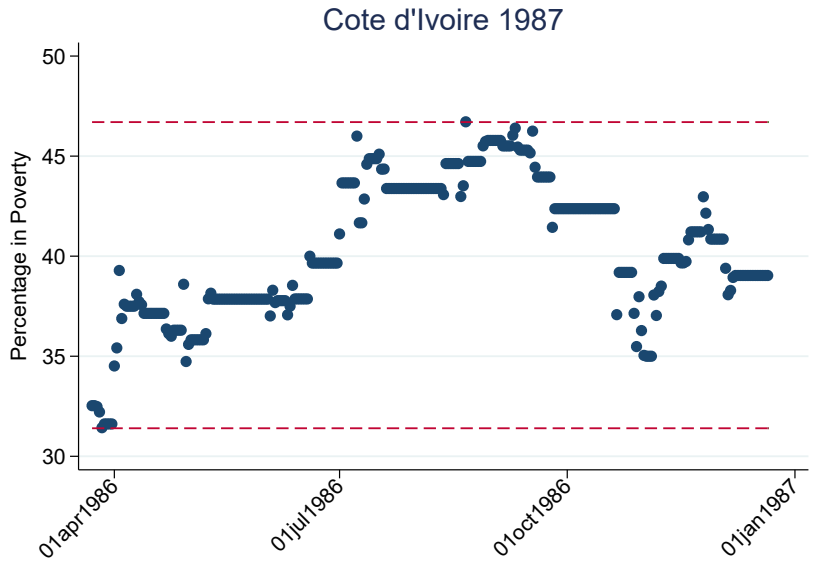
1. Cote d'Ivoire, 1986, 1987, 1988, 1989
2. Ghana, 1987, 1988, 1991, 1998
3. Malawi, 2010
4. Peru, 1985

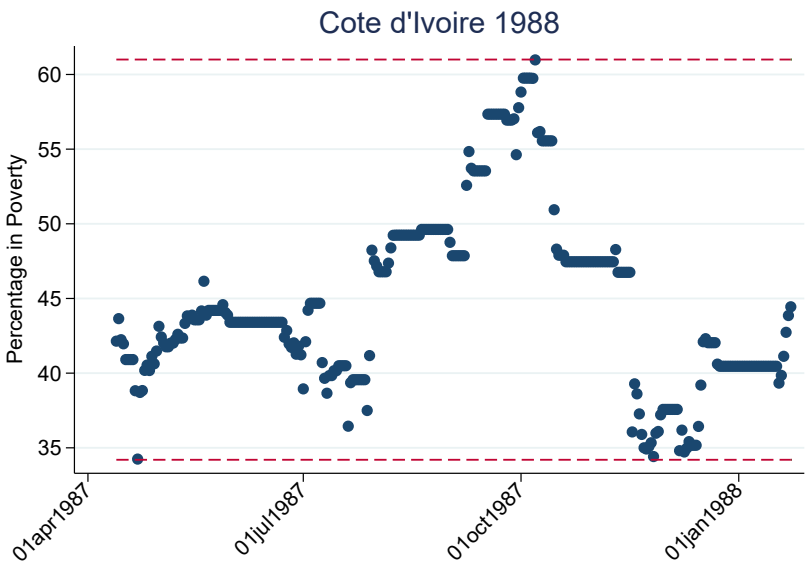
(and numerous others, yet to be analyzed)

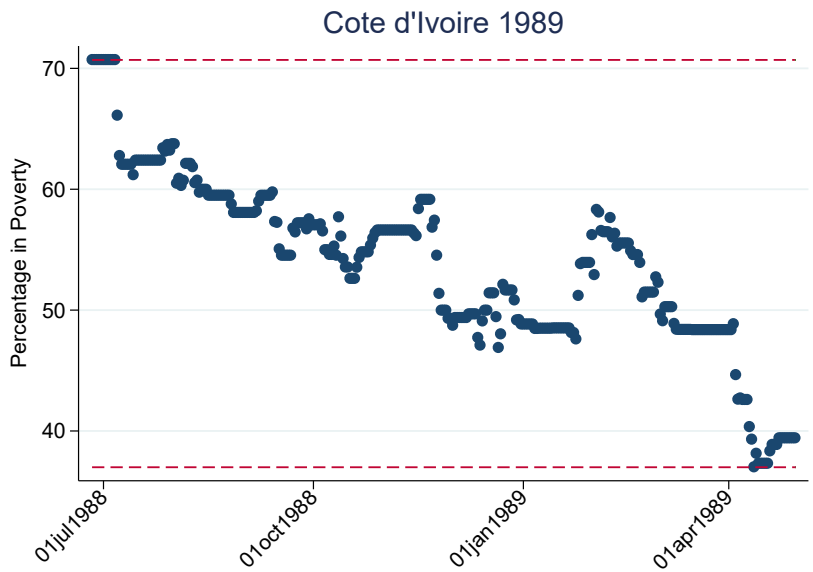
Approach: calculate the poverty rate for synthetic consumption surveys conducted during a rolling 60-day window

Cote d'Ivoire

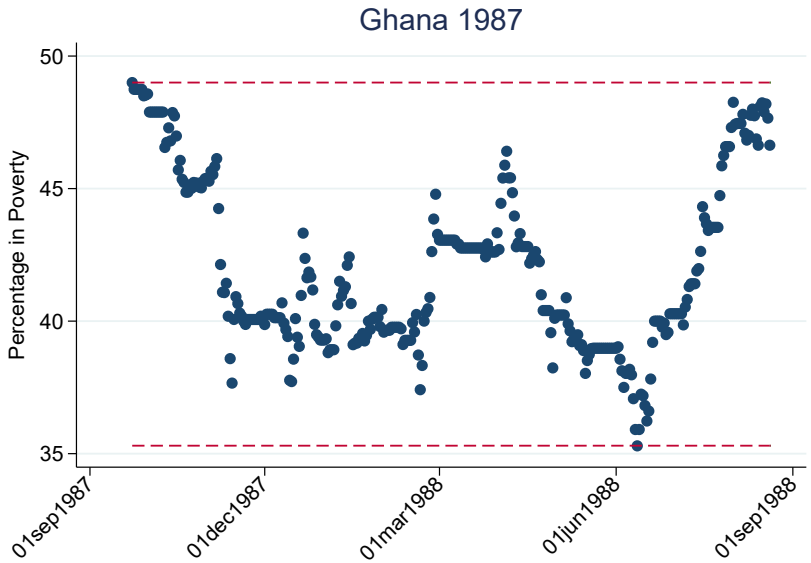


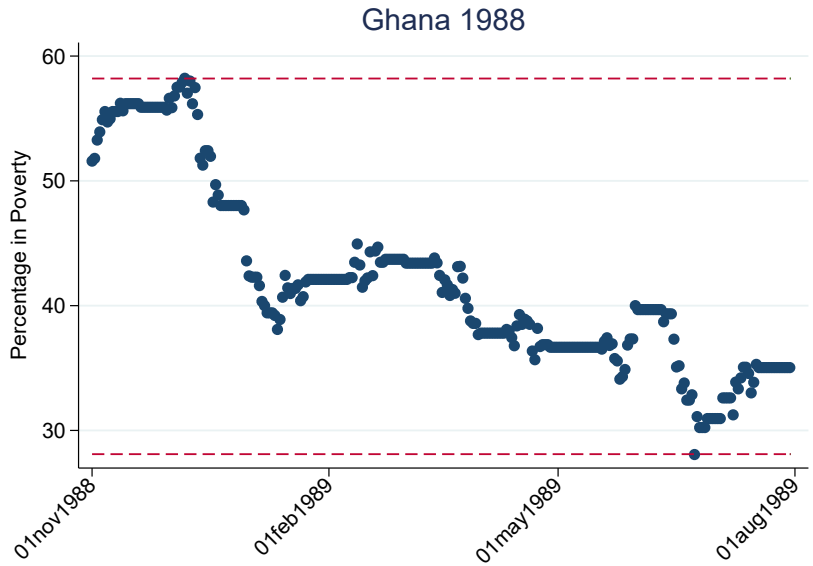


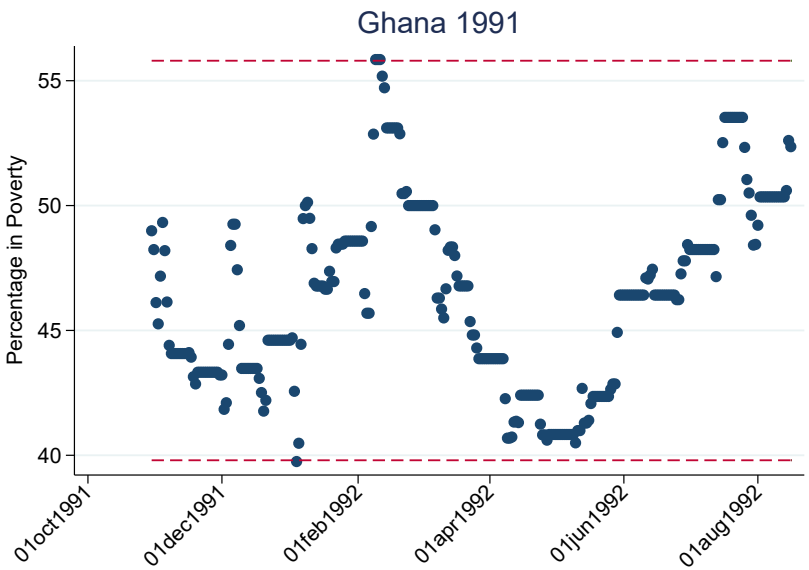


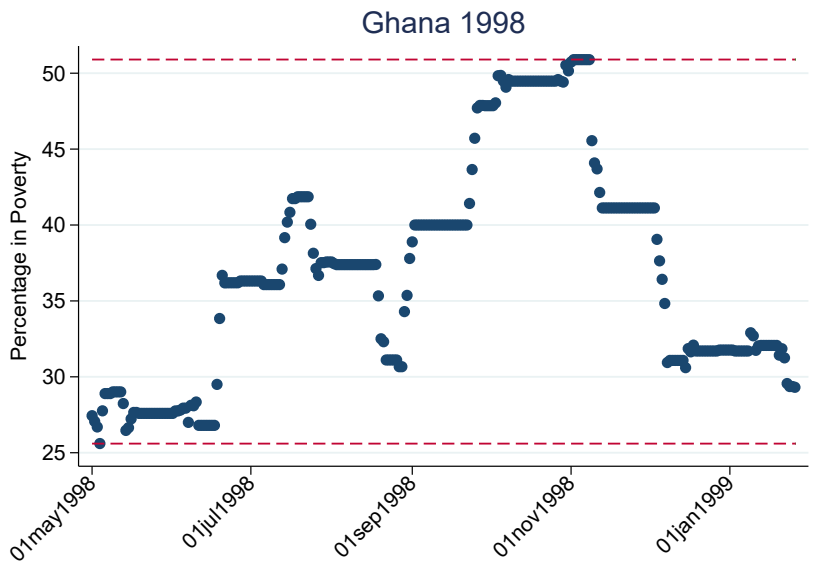


Ghana

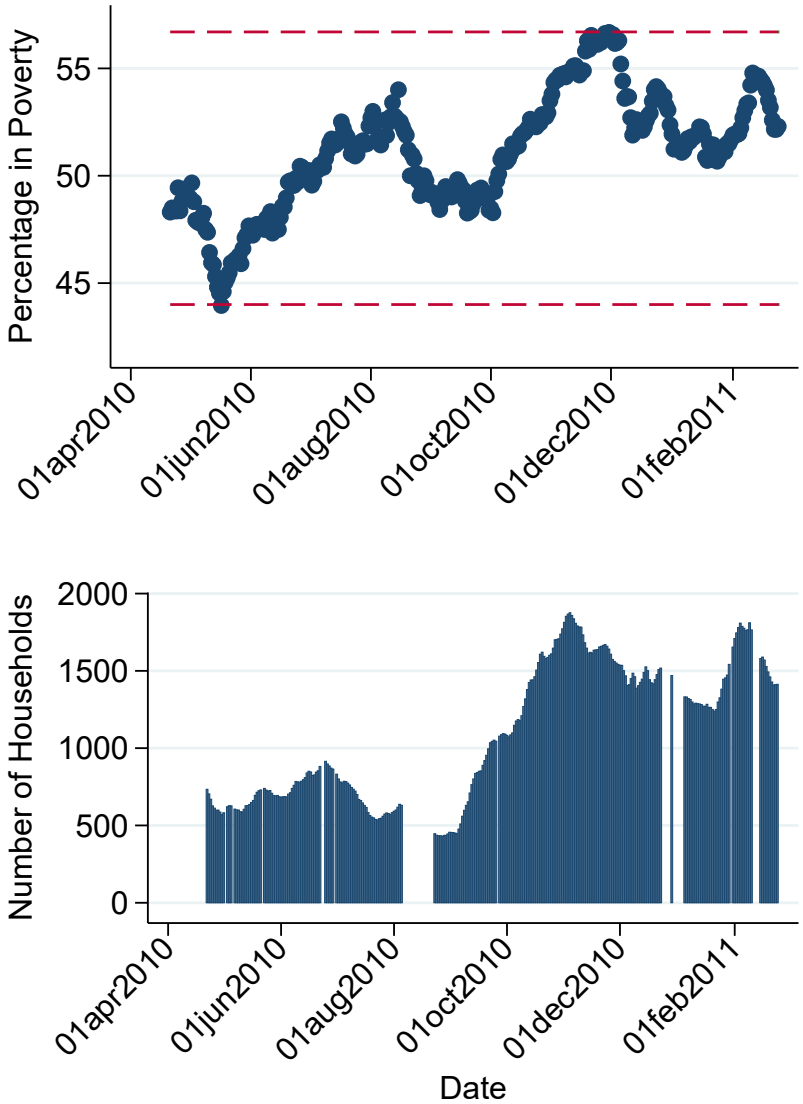

Ghana 1987
Percentage in Poverty
50
45
40
35
01sep1987
01dec1987
01mar1988
01jun1988
01sep1988


Ghana 1988
Percentage in Poverty
60
50
40
30
01nov1988
01feb1989
01may1989
01aug1989

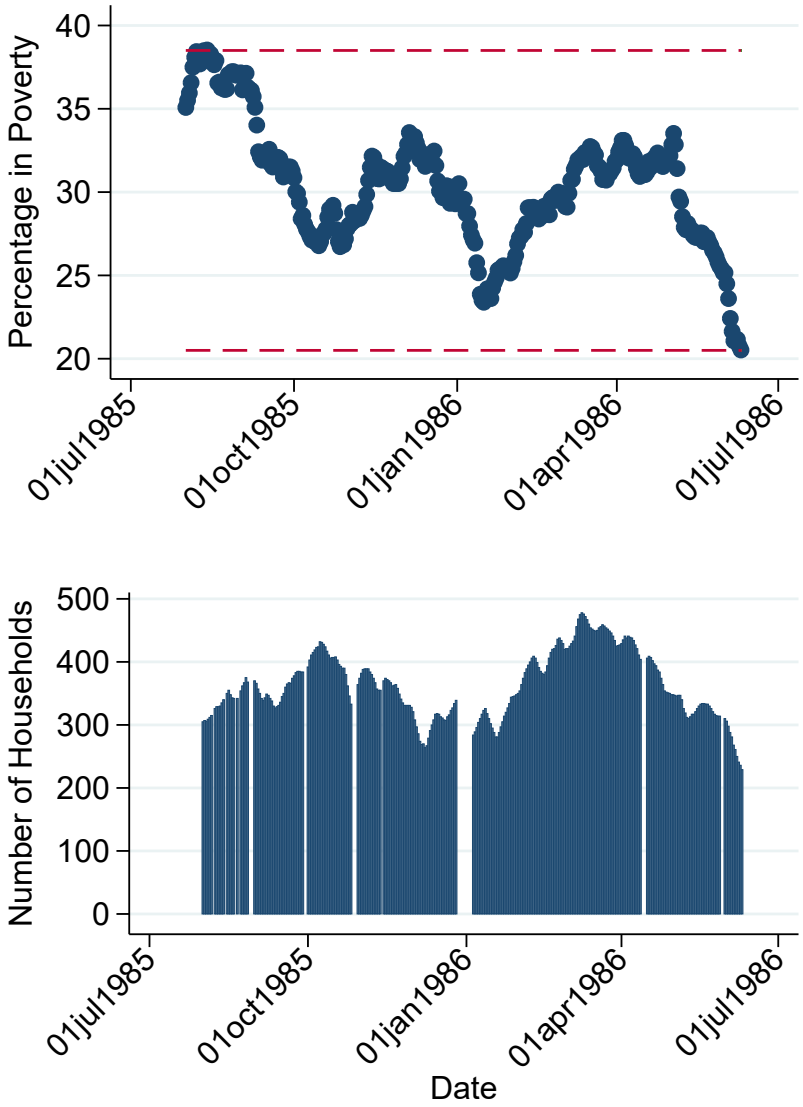

Ghana 1991
Percentage in Poverty
55
50
45
40
01oct1991
01dec1991
01feb1992
01apr1992
01jun1992
01aug1992


Ghana 1998
Percentage in Poverty
50
45
40
35
30
25
01may1998
01jul1998
01sep1998
01nov1998
01jan1999

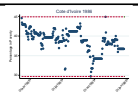
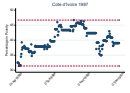
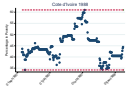
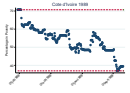
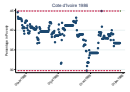
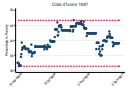
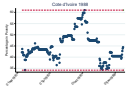
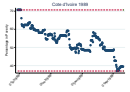
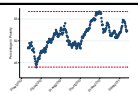
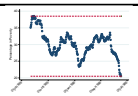
Malawi, 2010


Percentage in Poverty
55
50
45
01apr2010
01jun2010
01aug2010
01oct2010
01dec2010
01feb2011
Number of Households
2000
1500
1000
500
0
01apr2010
01jun2010
01aug2010
01oct2010
01dec2010
01feb2011
Date

Peru, 1985


Percentage in Poverty
40
35
30
25
20
01jul1985
01oct1985
01jan1986
01apr1986
01jul1986
Number of Households
500
400
300
200
100
0
01jul1985
01oct1985
01jan1986
01apr1986
01jul1986
Date

Poverty rates from rolling survey windows

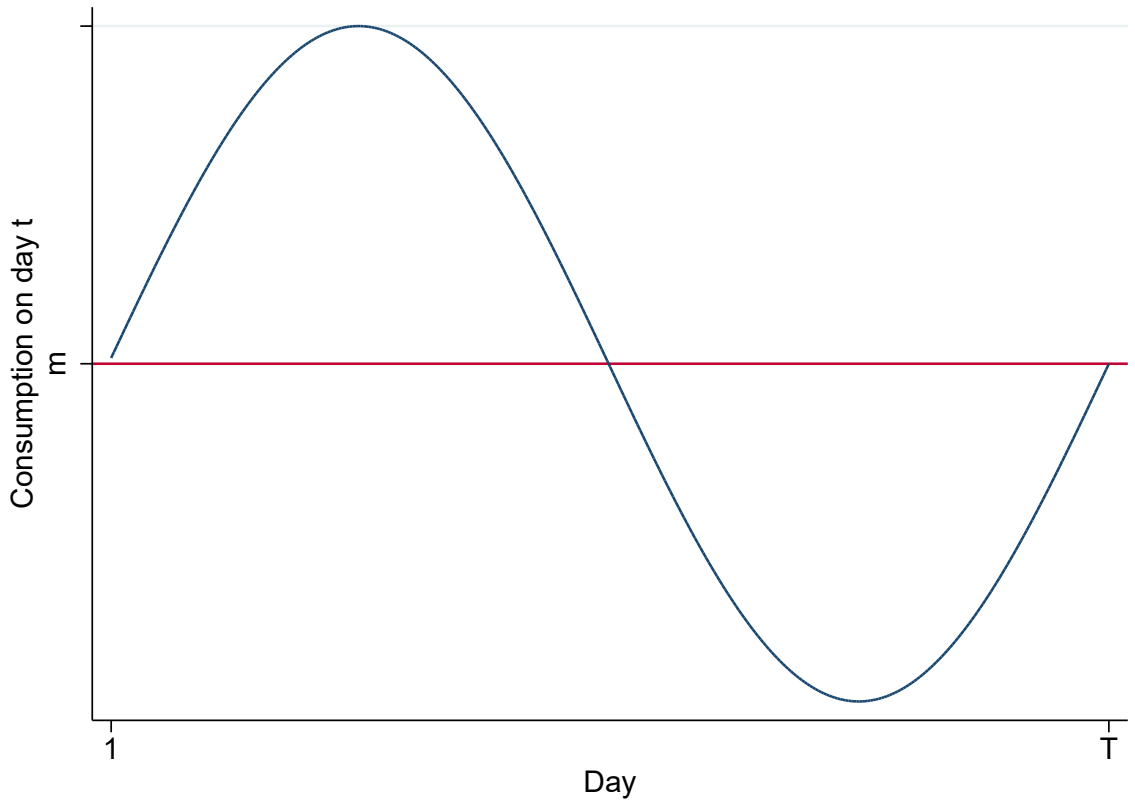
Country	Year		60-day range (%)	Using all data
Cote d'Ivoire	1986		30-45	39
	1987		32-47	38
	1988		34-61	44
	1989		36-70	53
Ghana	1987		35-49	42
	1988		28-58	43
	1991		40-57	47
	1998		26-56	34
Malawi	2010		44-57	50
Peru	1985		20-38	30

Implications for poverty measurement

- This is not an entirely unknown issue
- In many countries, successive consumption surveys are conducted at a similar time of year, improving comparability
- Yet, between-country comparisons are likely biased by differences in:
  1. Amplitude of underlying consumption cycles
  2. Start date
  3. Survey duration
- What is the solution?
  1. Space smaller consumption surveys throughout the year
     - We are working on optimal timing using the 12-month surveys
  2. Make inference from other countries about un-surveyed periods

2. Theory: seasonality-robust poverty measures

Hypothetical consumption path for an individual



Hypothetical consumption path for an individual or household

Seasonality adjusted poverty measures

Measuring variability

1. Share of the year below reference mean
2. Absolute variability
3. Absolute proportional variability
4. Squared variability
5. Squared proportional variability

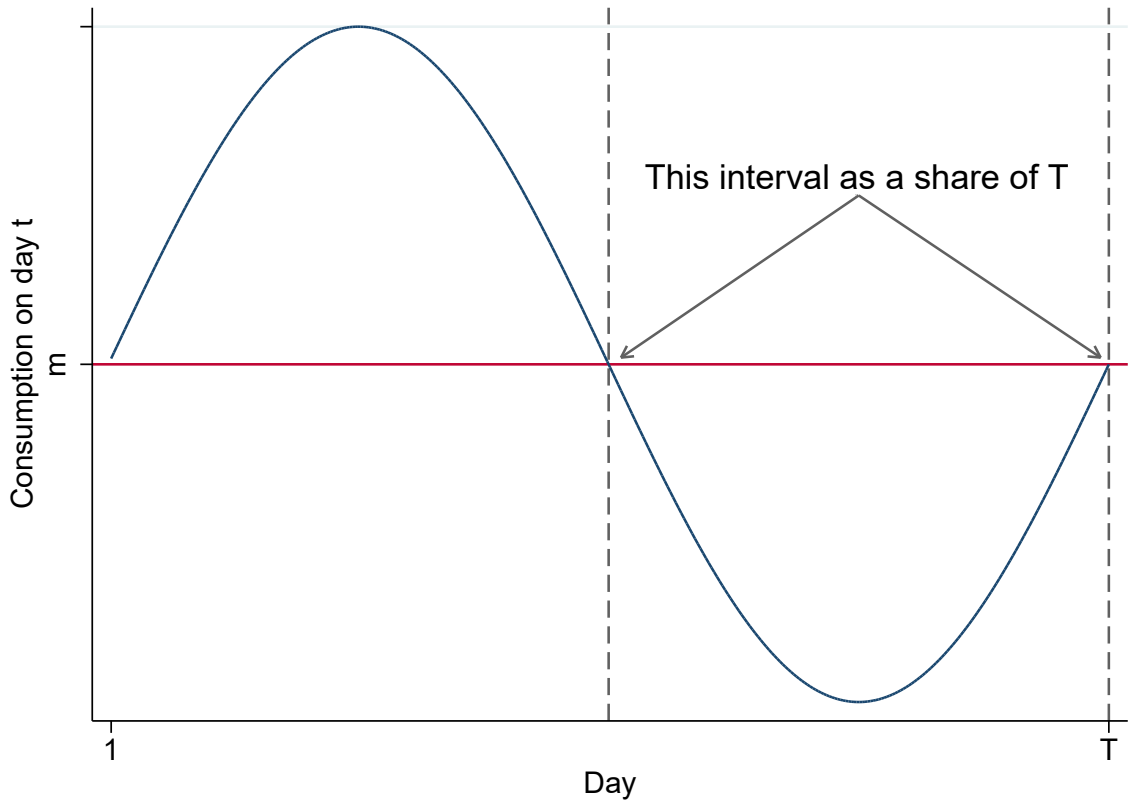
Variability around the poverty line

6. Share of year in poverty
7. Cumulative poverty exposure
8. Net poverty exposure

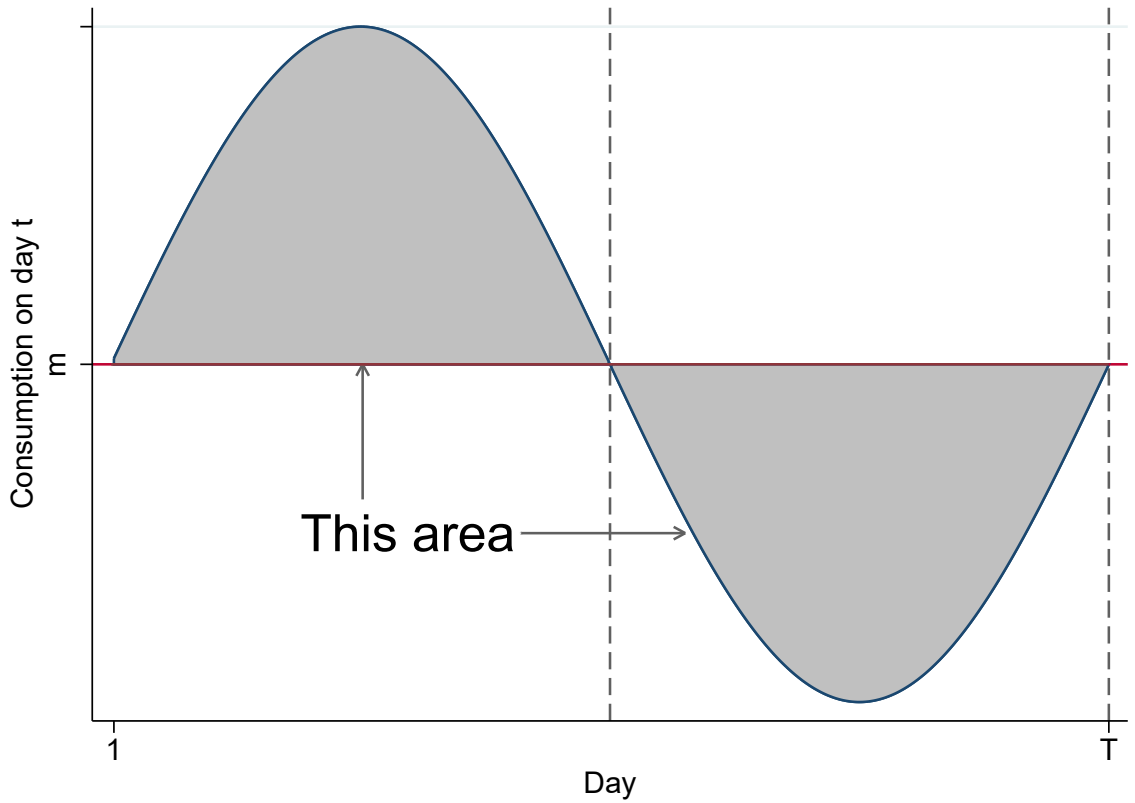
Measuring variability

1. Share of the year below reference mean: $\frac{1}{T}\sum_{t=1}^{T}\mathbf{1}(c_{it} < m)$
2. Absolute variability: $\frac{1}{T}\sum_{t=1}^{T}|c_{it} - m|$
3. Absolute proportional variability: $\frac{1}{T}\sum_{t=1}^{T}\frac{|c_{it}-m|}{m}$
4. Squared variability: $\frac{1}{T}\sum_{t=1}^{T}(c_{it} - m)^2$
5. Squared proportional variability: $\frac{1}{T}\sum_{t=1}^{T}\frac{(c_{it}-m)^2}{m}$

Share of the year below the reference mean



Absolute variability



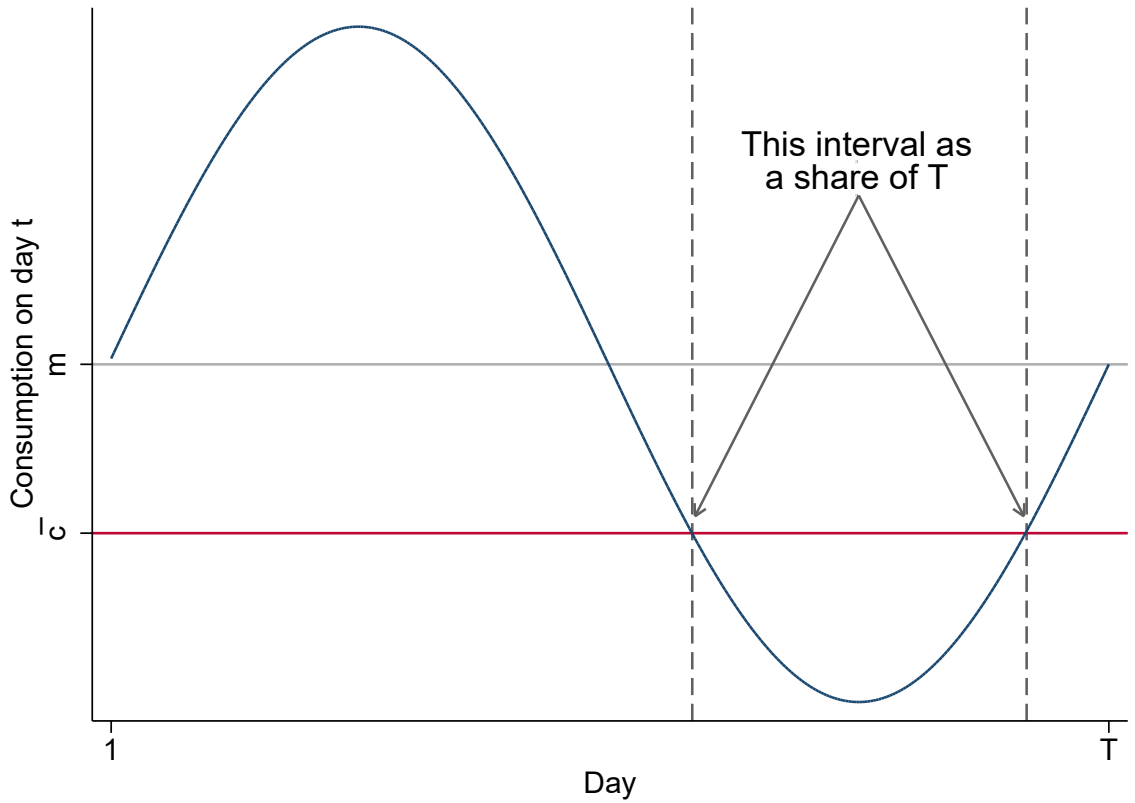
Variability around the poverty line

6. Share of the year in poverty: $\frac{1}{T}\sum_{t=1}^{T}\mathbf{1}(c_{it} < \bar{c})$

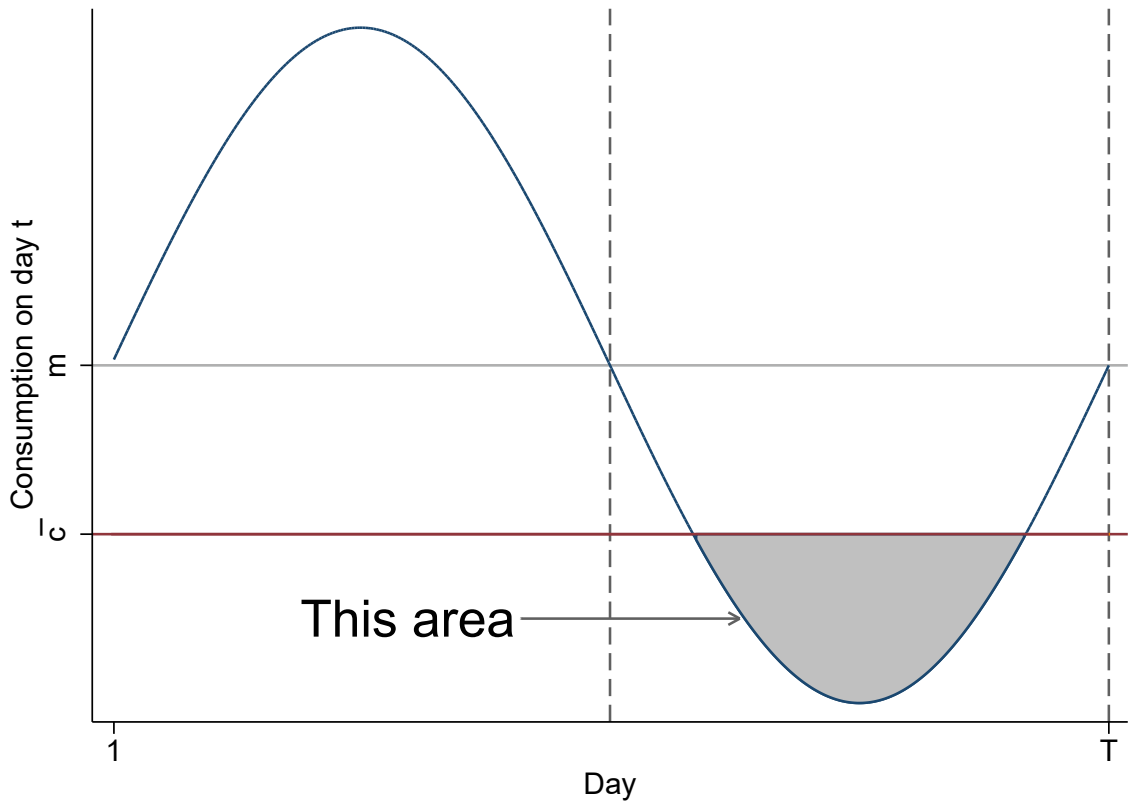
7. Cumulative poverty exposure: $\frac{1}{T}\sum_{t=1}^{T}\mathbf{1}(c_{it} < \bar{c})|c_{it} - \bar{c}|$

8. Net poverty exposure: $\frac{1}{T}\sum_{t=1}^{T}(c_{it} - \bar{c})$

Share of the year in poverty



Cumulative poverty exposure



Theory: main takeaways

- These measures are generalizations of the FGT to the daily level.
- All are fully decomposable within and across individuals.
- Burdensome data requirements: need to observe c_{it} for all i on all t.
- There are empirically tractable versions if we put some structure on survey data with enough temporal coverage

3. Empirical application

Application to survey data spanning 12+ months

- Goal is to apply the above measures when we do not observe households in high frequency
- DGP is a rolling survey of 12+ months duration that measures:
  1. Consumption
  2. Covariates associated with possible consumption seasonality
- We may see each household 1 or more times
- If survey timing is randomized, we can estimate a structural model that allows for seasonality
- Similar to first stage of estimation procedure in Christian and Dillon (2017)

A consumption model with seasonality

Consumption on day $d = 1, \ldots, 365$ can be modeled as the sum of:

- A level shifter that depends on characteristics: $X_{ydh}\phi$
- Seasonal deviations that depend on characteristics: $\Gamma(d, Z_{ydh})$
- Idiosyncratic innovations: ψ_{ydh}

$$c(d, X_{ydh}, Z_{ydh}) = X_{ydh}\phi + \Gamma(d, Z_{ydh}) + \psi_{ydh}$$

- ψ_{ydh} has mean 0 and variance σ^2_ψ
- y indexes years, h indexes households
- X_{ydh} contains trends and intercepts as needed

A consumption model with seasonality

Let the seasonality term be written as the product of two components:

$$\Gamma(d, Z_{ydh}) = \gamma(d) f(Z_{ydh})$$

$\gamma(d)$: sequence of day-specific innovations, common across HHs
$f(Z_{ydh})$: function that attenuates or exacerbates the seasonal effect

The sequence $\gamma(d)$ has mean $\overline{\gamma}$ and variance σ^2_γ

The conditional variance of $\Gamma(d, Z_{ydh})$ can be written as $\sigma^2_{\gamma h} \equiv \sigma^2_\gamma f(Z_{ydh})^2$

Structural representation of seasonality

The household-specific seasonal term can be modeled as a linear function of characteristics: $f(Z_{ydh}) = Z_{ydh}\rho$

We use a sine function representation for $\gamma(d)$, but add a parameter τ for the day on which consumption crosses its day 0 level:

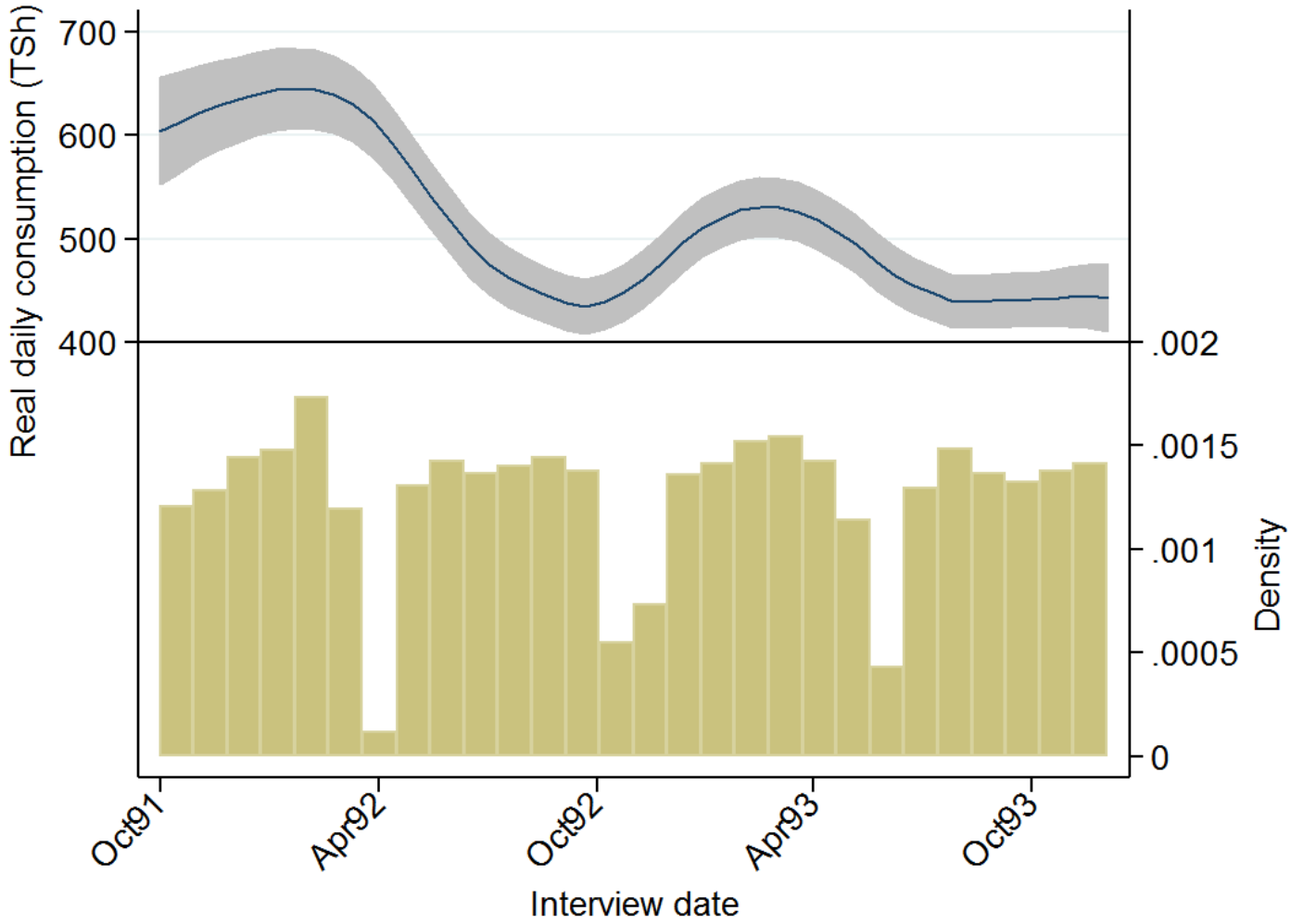
$$\begin{aligned} c_{ydh} &= X_{ydh}\phi + \gamma(d)Z_{ydh}\rho + \psi_{ydh} \\ &= X_{ydh}\phi + \left\{ \sin\left(\frac{\pi d}{\tau}\right)\mathbb{I}[d \leq \tau] + \sin\left(\pi + \pi\frac{d-\tau}{365-\tau}\right)\mathbb{I}[d > \tau] \right\} Z_{ydh}\rho + \psi_{ydh} \\ &= X_{ydh}\phi + w(d,\tau)Z_{ydh}\rho + \psi_{ydh} \end{aligned}$$

We estimate $(\hat{\phi}, \hat{\rho}, \hat{\tau})$ via ML and then project $\hat{c}_{ydh}$ for every household on every day

Data

- 28-month continuous survey in Tanzania, 1991-1994
- Kagera Health and Development Survey (KHDS)
  - Includes 4 rounds every $\sim$6 months
  - 912 households and 6,204 individuals
  - 50 villages in the Kagera region of northwest Tanzania
  - Wide range of health, demographic, economic topics
- Consumption is measured as the real value (TZS) of consumption per adult equivalent
- We use a \$1.25/day poverty line

Time path of consumption

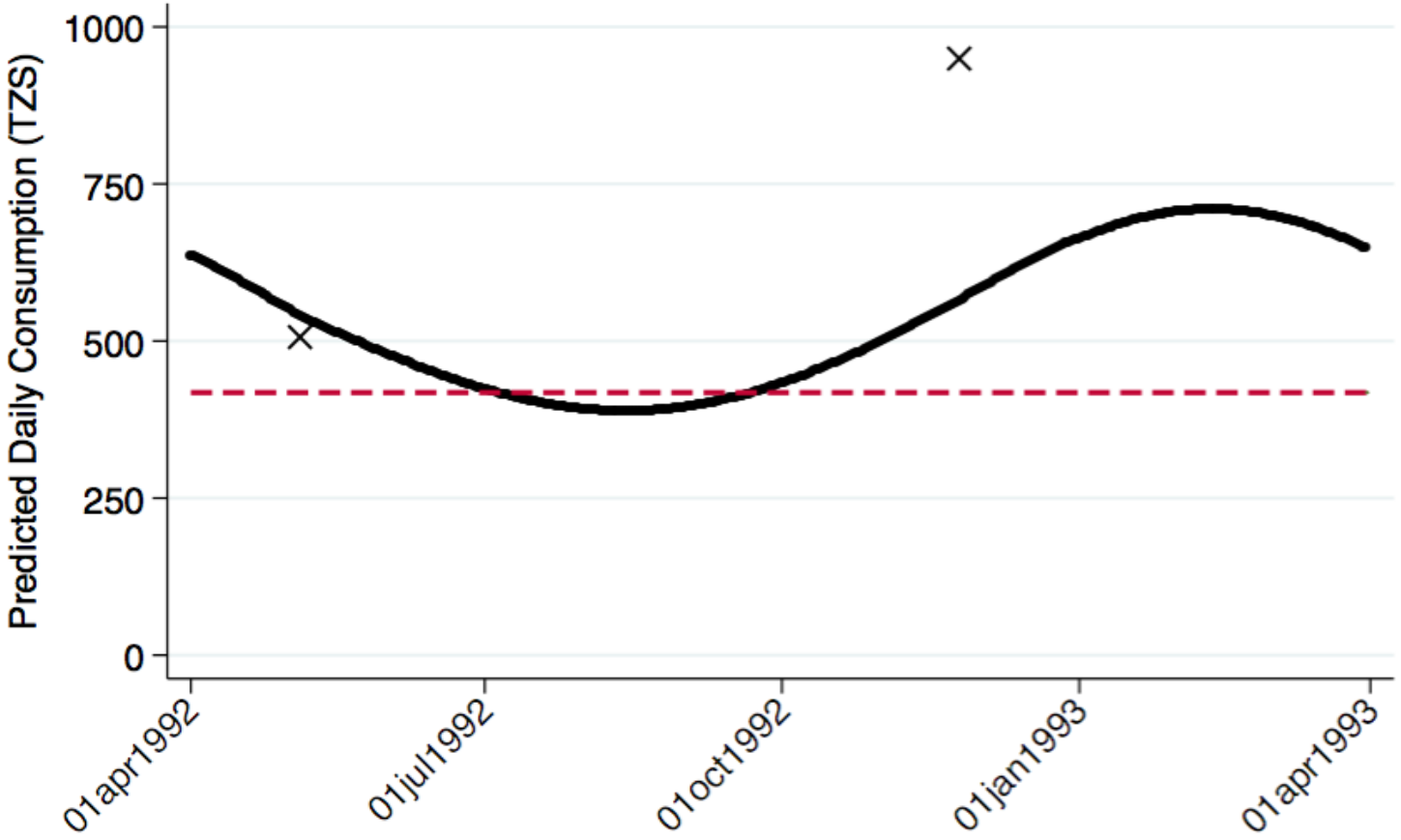


Covariates for consumption model

Table 1: Household summary statistics from 4 rounds of KHDS 1, 1991-1994, pooled

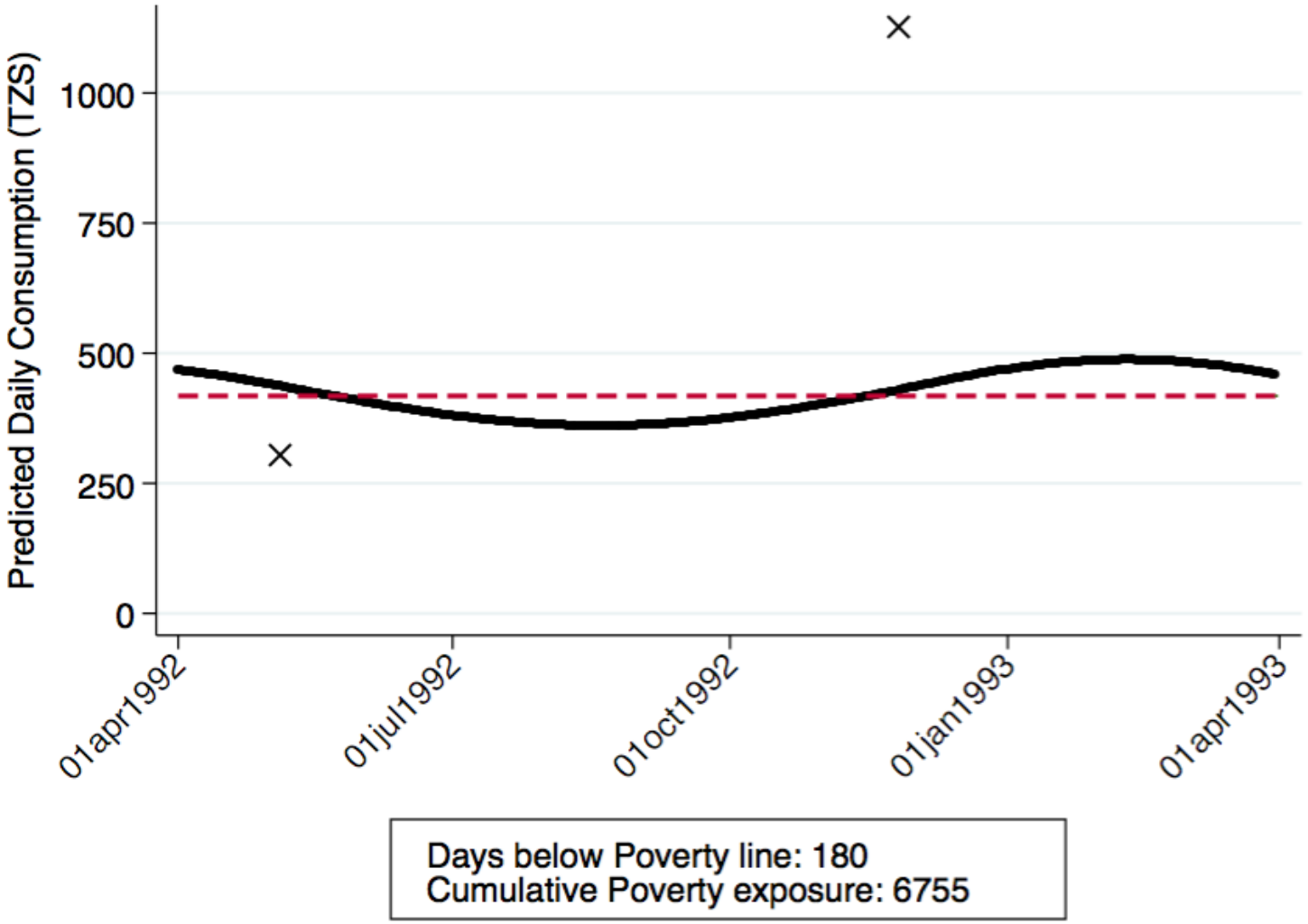
Variable	Mean	Standard deviation
Head is male (=1)	0.72	0.45
Head age (years)	49.46	16.96
Head education (years)	4.07	3.20
Head can read (=1)	0.72	0.45
Head basic math (=1)	0.72	0.45
Asset index	-0.01	0.97
Acres owned	5.02	27.64
Value of agricultural capital (TZS)	5928.01	67034.83
Has non-farm business (=1)	0.40	0.49
Tropical livestock units	1.45	7.29
Household size, number	6.81	3.53
Household size, adult equivalents	4.66	2.45
Muslim (=1)	0.12	0.32
Catholic (=1)	0.60	0.49
Christian (=1)	0.24	0.43
Haya ethnicity (=1)	0.63	0.48
Hangaza ethnicity (=1)	0.13	0.33
Speaks Swahili (=1)	0.91	0.29

Results: example households

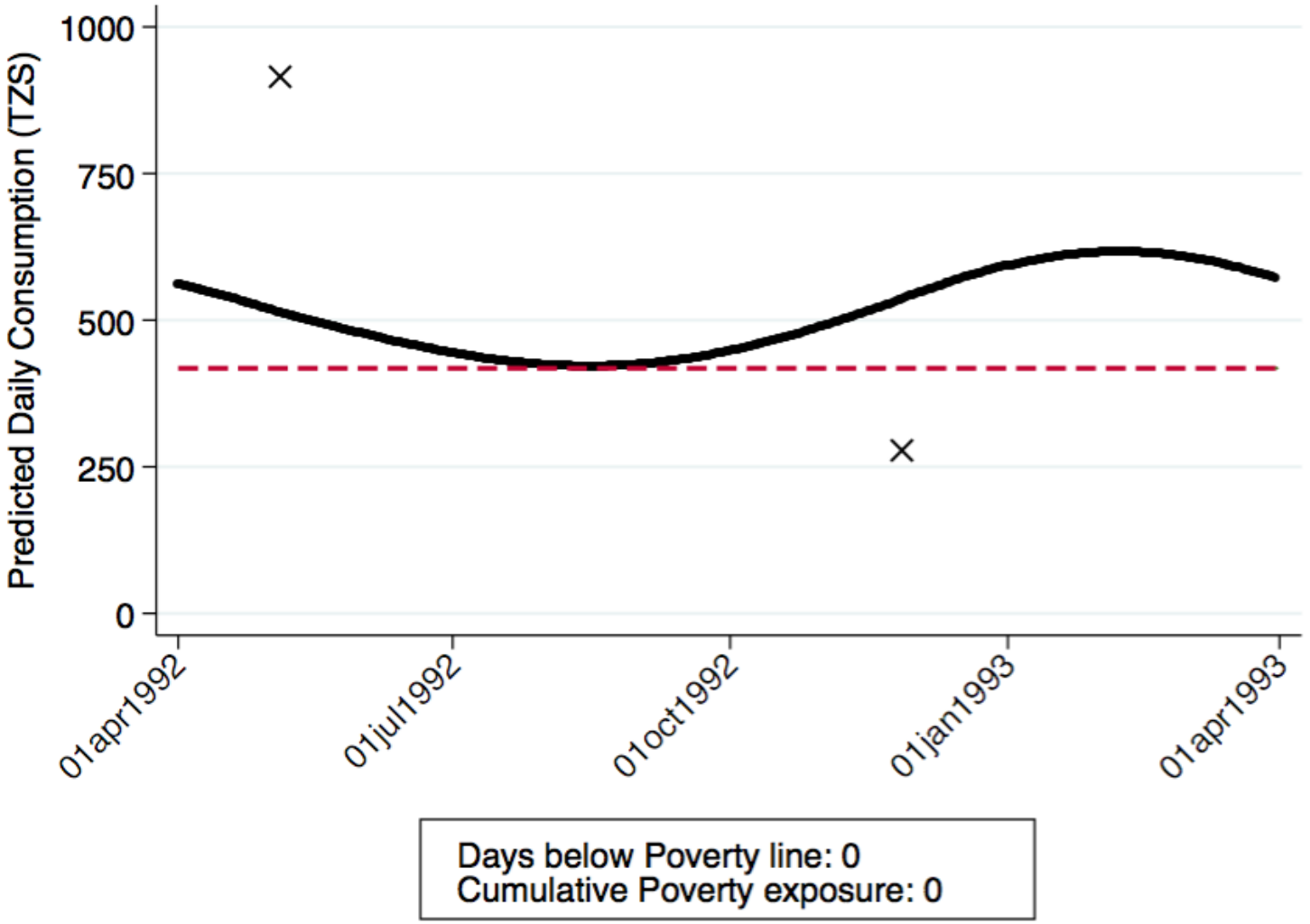


Days below Poverty line: 80
Cumulative Poverty exposure: 1597

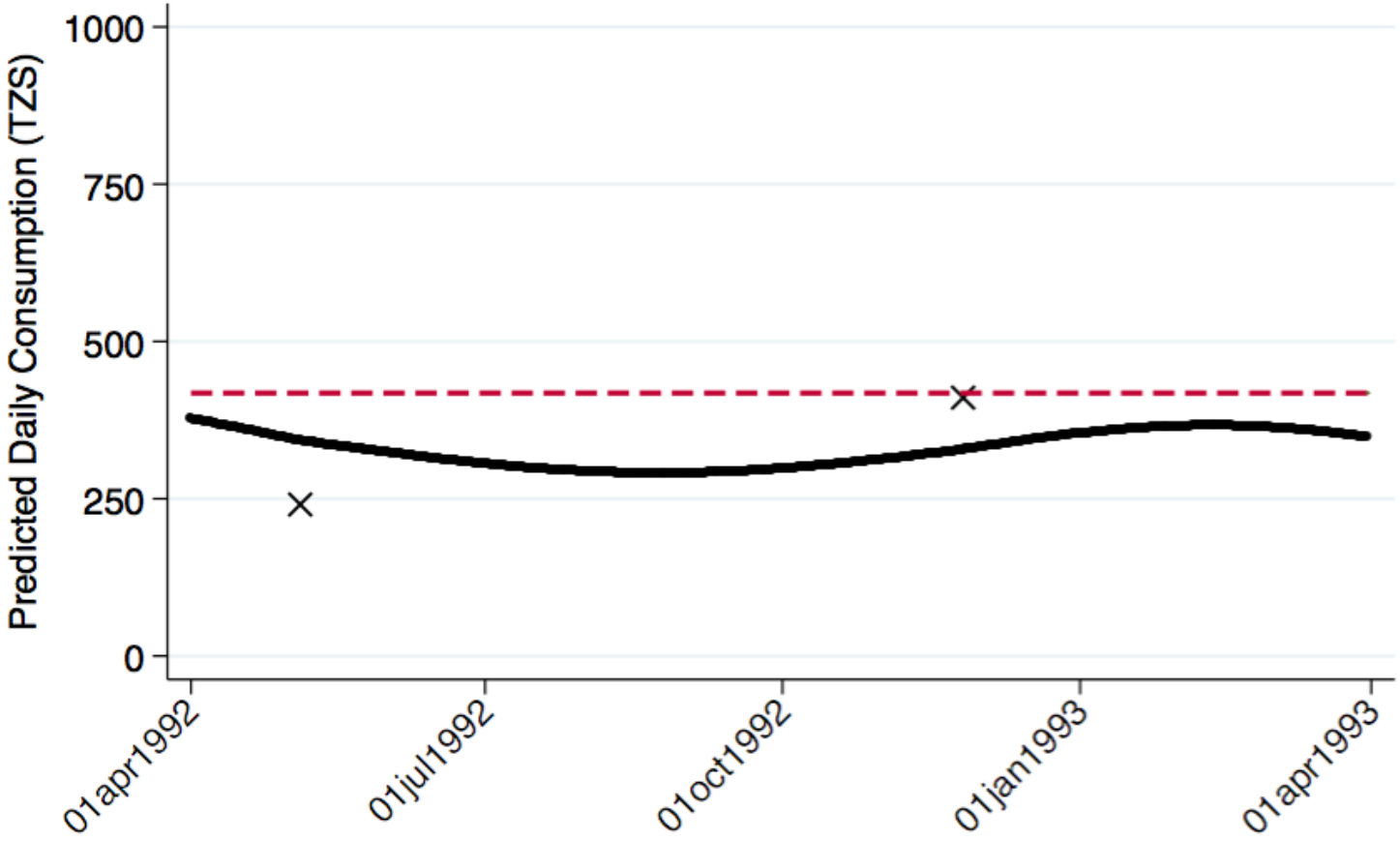
Results: example households



Results: example households

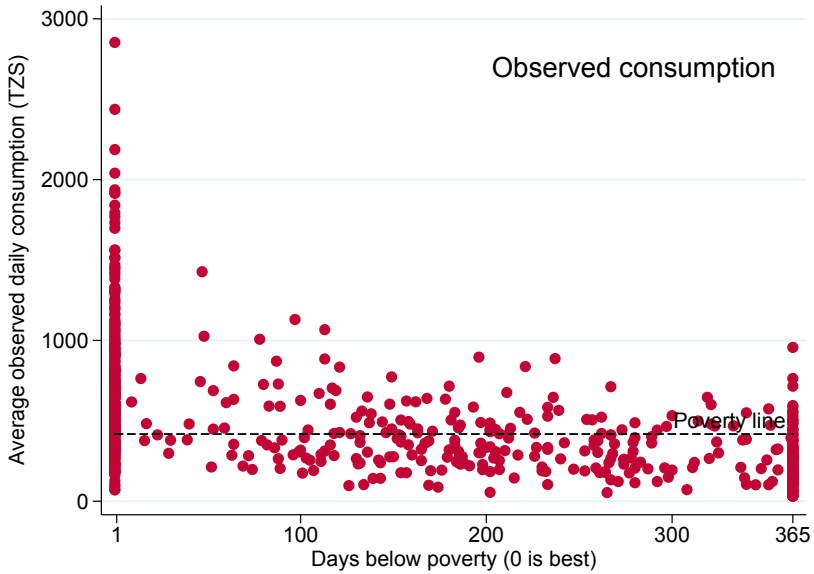


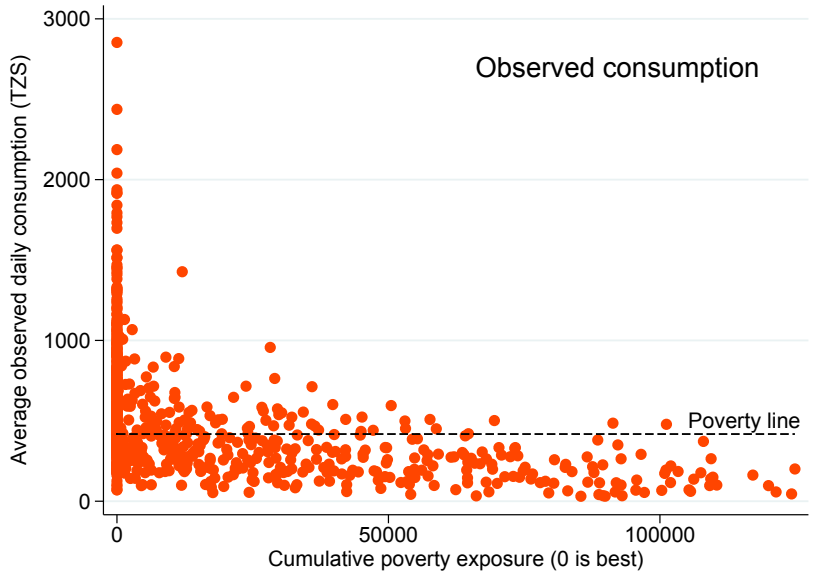
Results: example households

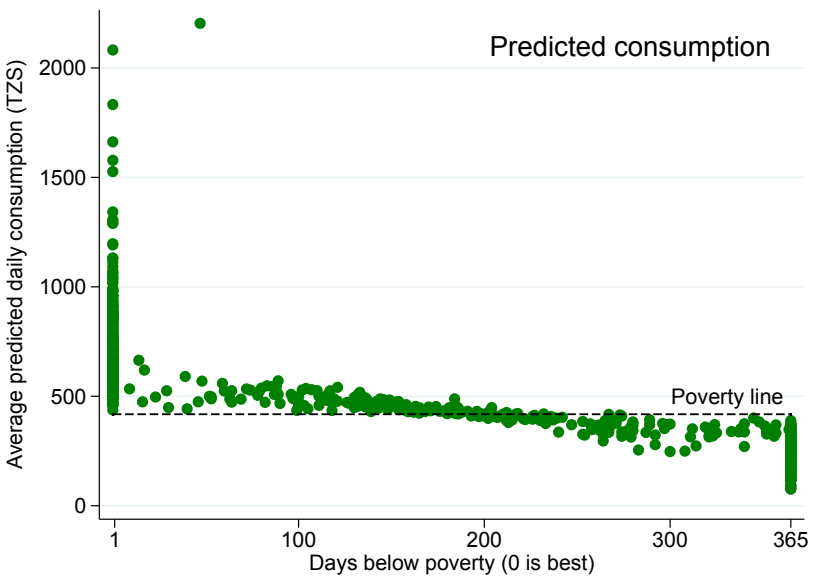


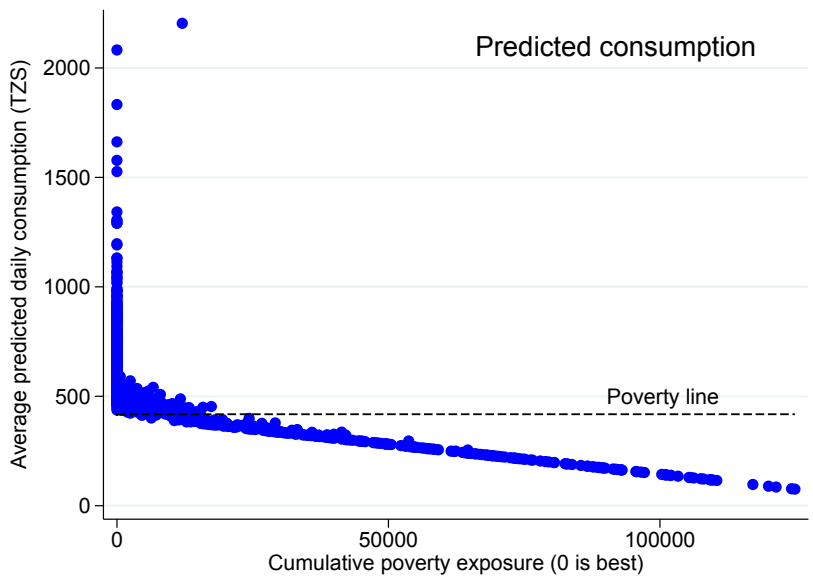
Days below Poverty line: 365
Cumulative Poverty exposure: 32822

Comparing poverty measures (levels)

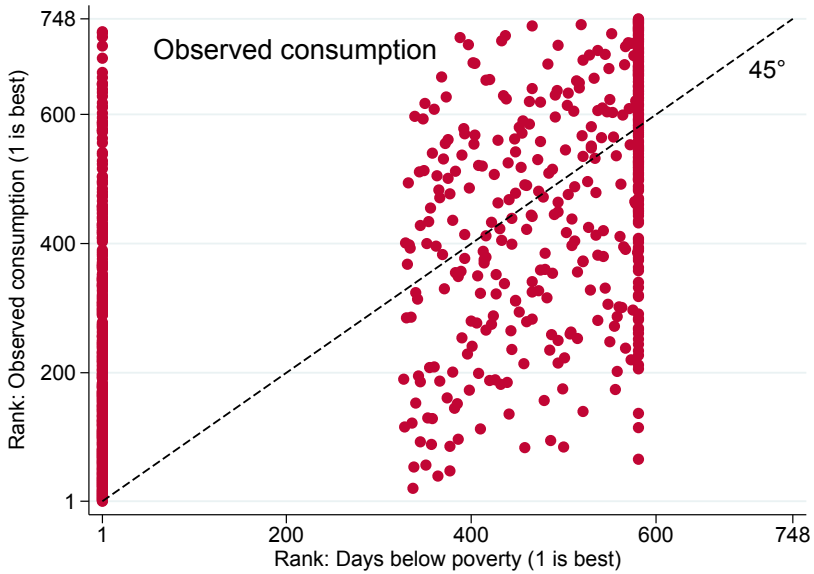


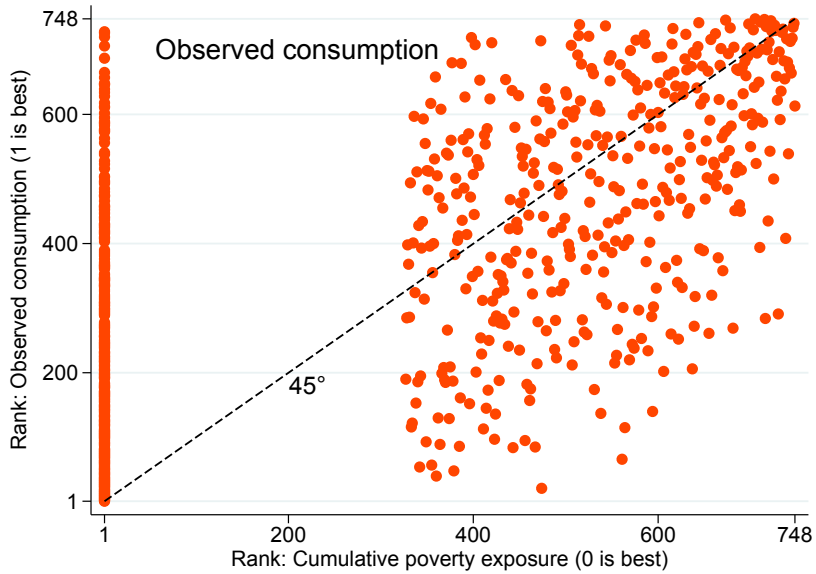


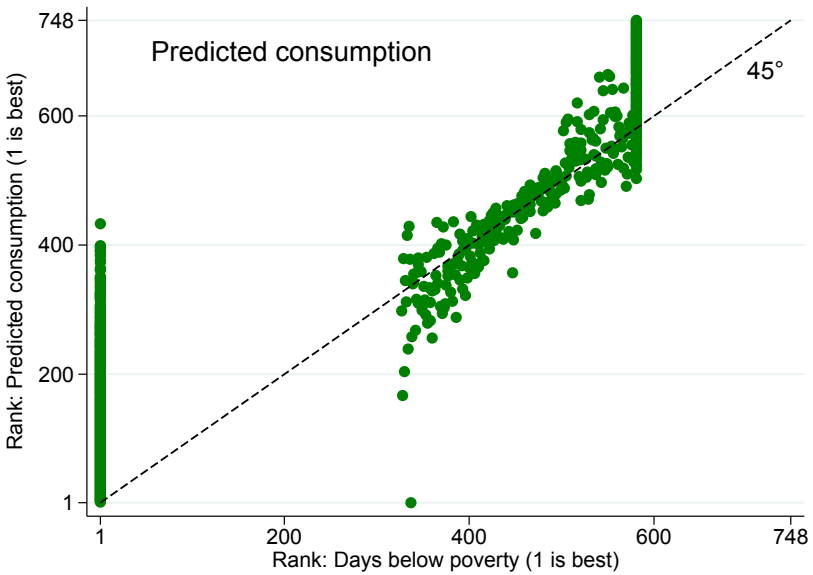


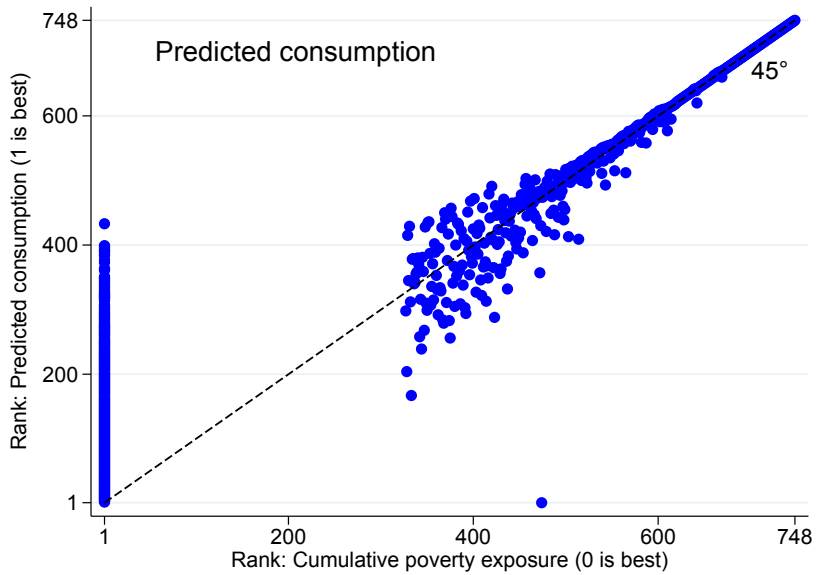


Comparing poverty measures (ranks)









Summary and conclusions

- Consumption surveys covering $<$12 months may misrepresent poverty
- Bias in within-country changes over time may be mitigated if timing is consistent
- But between-country comparisons likely suffer from unknown degrees of bias
- Seasonality-robust poverty measures are tractable, if data cover enough seasons
- Work is ongoing on both theoretical and empirical aspects of the project

Thanks. Comments welcome.

Paul Christian. pchristian@worldbank.org.
Brian Dillon. bdillon2@uw.edu.
Ben Glasner. bglasner@uw.edu.