Seasonality in local food markets and household consumption in Africa

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AGRICULTURE
IN AFRICA
TELLING FACTS
FROM MYTHS

What is seasonality and how does it come about?

- **Seasonality:**
  - Regular intra-annual variability at predetermined time periods/months, i.e. "the deterministic part of volatility"
  - Repeated patterns within a year can remain constant or change over time

- **Regular drivers of seasonality in prices**
  - Seasonality in production – production cycles/AEZs
  - Seasonality in demand

➔**Some minimal seasonality in prices is expected given storage and capital costs**

- **Others drivers**
  - Role of marketing & transaction costs (limited spatial arbitrage)
  - Market structure
  - Marketing behavior of farmers in response to liquidity constraints (sell low, buy high) and credit constraints

- **Why does it translate in seasonality in welfare (food and non-food)?**
  - Lack of non-seasonal or counter-seasonal income-generating activities (e.g. migration)
  - Lack of other coping mechanisms (self and community insurance)
  - Depends on degree of food-non food substitution elasticity and absolute price levels

Conventional wisdoms

- Seasonality in prices has been much studied and was considered to have substantial welfare effects, (Sahn, 1989; Reardon, 1997; Dorward et al 2004)
  - **Eg severe acute malnutrition in Niger –WHZ- bw 1% -4% (harvest-hungry seasons) (ACF, Araujo-Bonjean)**
- Seemingly considered less important today?
  - Agricultural markets are more integrated today than in the nineties
  - Little studied/discussed during the past 15 years (except Devereux 2009)
  - Poverty studies often do not correct for it – some recent studies do and find significant effects (e.g. Dercon & Krishnan 2000)
- Still an issue?
  - Markets are well integrated within countries, but much less across borders; and subject to significant amount of volatility (after liberalization policies of the 90s-2000s) : seasonality is a key ingredient of volatility in SSA
  - Also market integration does not exclude price seasonality if correlated production cycles across space
  - Many studies only covering certain markets in certain areas (publication bias)
  - Renewed interest (Devereux, 2009)?
  - **Exploring both price and consumption seasonality more systematically**

Our contribution

- **Rigorous discussion and construction of seasonality measures**
  - Depart from the development micro literature (abstracting from time series analysis / cursory treatment)
  - Unconditional & Conditional
  - Bring in insights from finance and public health literature

- **Updated and enlarged evidence basis (across countries and regions)**
  - Three ESA countries (UG, TZ, MWI)
  - Seasonality measures of agricultural monthly prices series (2000-2013) in 869 markets in total
  - Seasonality measures of both food and non-food consumption in the same countries

- **Link food market price & household consumption behavior (juxtaposition) + disaggregated / heterogeneity analyses**

Our data

- **Market prices: construction of 13 years of monthly-based time series**
  - Staples, some fruits and vegetables + pulses, some processed products
  - Both wholesale and retail market levels
  - For the main consumption centers in each country (868 markets in total)
  - Imputation of missing values

- **LSMS-ISA data at the household level (TZ 2008, MWI 2010, UG 2009)**
  - Around 3,000 hhs in UG and TZ; 12,000 in MWI
  - Cross-section data but collected over more than 13 months in each region with about equal sub-sample slices in each month (no repeated observations over time)
  - Food and non-food expenditure data available (spatially deflated but not intra-annually) as well as rich set of co-variates (hh income and assets, education, size, labor market status of the hh head, AEZ…)

Our findings

Seasonality in food prices & expenditures remains pervasive

- **25% seasonal mark up in maize price; abt 10-15% for staple food price index**
- **40-45 % seasonal mark up in food consumption and an even larger 65-70% seasonal mark up in non-food consumption**
- **Strong heterogeneity across locations and sub-samples between and within countries (e.g. urban vs. rural households)**
- **Price and expenditure seasonality seem linked in the annual cycles**
  - **Food and non-food cons seasonal patterns inversely follow staple price seasonal patterns but heterogeneously across and within countries**
  - **Uganda cons. seasonality =5* price seasonality measures but Malawi is eq. to 1/2**
- **Policy implications**
  - **Understanding excess price seasonality**
  - **Intra-annual consumption smoothing remains a challenge**
  - **More attention to intra-annual timing of surveys needed in poverty measurement and analysis**

Seasonality measures

- **Seasonality measures**
  - Based on seasonal (monthly) factors
  - A gap measure between the extreme month effects – a range value for the amplitude of the seasonal cycle
  - Intra-annual standard deviation for measuring the extent of intra-annual variability
  - A gini as an overall inequality measure

- **Unconditional vs conditional**
  - Unconditional: based on the average month values of the sample
  - Conditional: based on seasonal factor estimates after modelling

➔ **This presentation: focus on conditional, gap estimates**

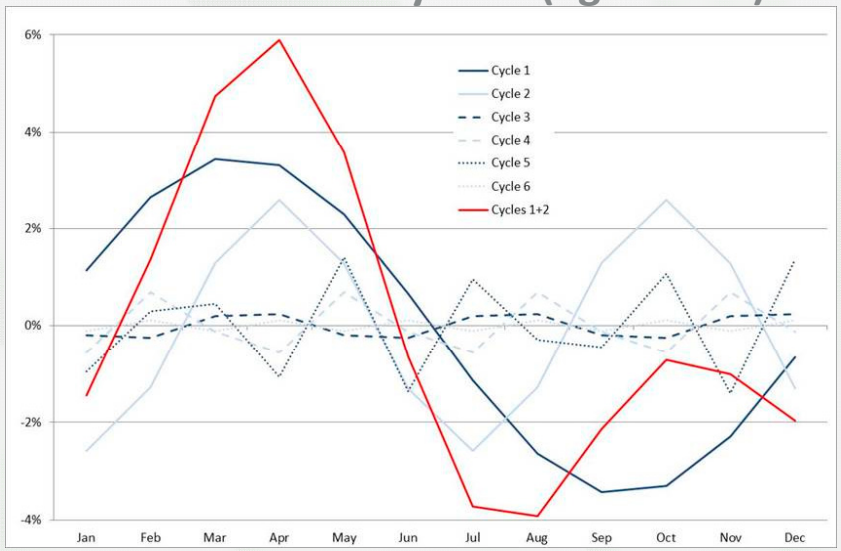
Empirical methodology : estimations

– **Price time series: a flexible de-trending ARIMA model with multi-cyclical (eg Arusha) and time-varying seasonality specification**

$$\ln p_{mt} = \sum_{j=1}^{k} \gamma_{mj} \ln p_{mt-j} + \mu_{mt} + s_{mt} + \varepsilon_{mt}$$

$$\mu_{mt} = \mu_{mt-1} + \delta_{mt} + \nu_{mt}$$
$$\delta_{mt} = \delta_{mt-1} + \upsilon_{mt}$$

$$s_{mt} = \sum_{j=1}^{6} \sigma_{jmt} \quad \text{where} \quad \sigma_{jmt} = \alpha_{jm} \cos\left(\frac{jt\pi}{6}\right) + \beta_{jm} \sin\left(\frac{jt\pi}{6}\right)$$



– **Household consumption: OLS regression with household and geographic controls + month dummies**

$$\ln c_{it}^{f/nf} = \boldsymbol{\beta}^{f/nf} \mathbf{X}_i + \mathbf{M}_{\mathbf{t}}^{f/nf} + s_{it}^{f/nf} + \varepsilon_{it}^{f/nf}$$

- **Specification issues on survey weights and strata and regional controls – use several specifications as robustness checks for the seasonality measures**
- **Applied to national and sub-national samples to derive aggregate, disaggregate, and reaggregated conditional seasonal factors – the month dummy coefficients**

Empirical methodology: conditional seasonality measures

- Price gap (weak principle of transfer)

$$g_m = \max\{s_{mt}\} - \min\{s_{mt}\} \approx \sqrt{\alpha_m{}^2 + \beta_m{}^2}$$ (when the 6-month cycle predominates)

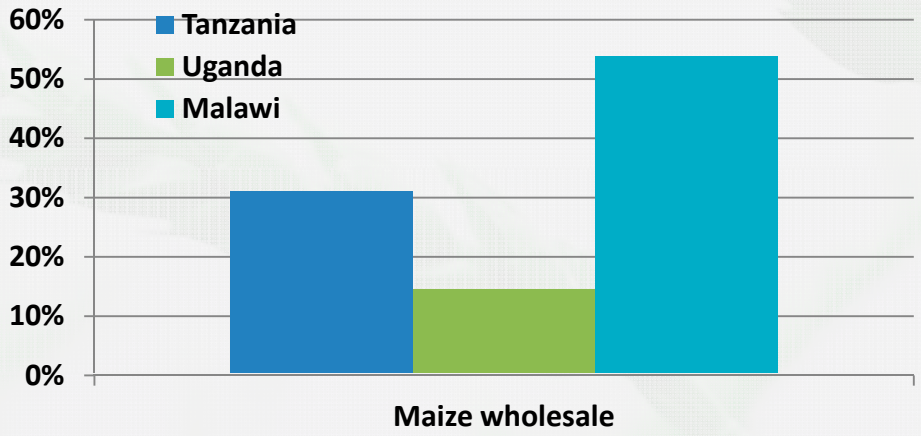
- Expenditure gap

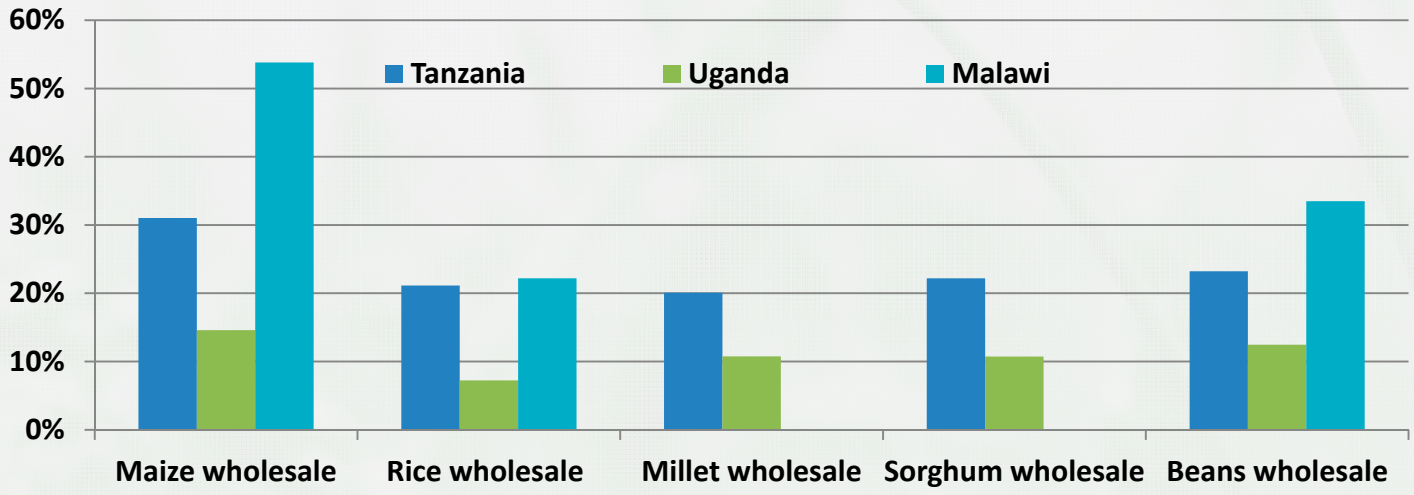
$$G^{f/nf} = \max\{\mathbf{M}_t^{f/nf}\} - \min\{\mathbf{M}_t^{f/nf}\}$$

- Seasonal gini in expenditures = seasonal inequality of consumption levels
  - **To what extent would seasonal inequality be reduced, on average over time, by a transfer of consumption from a high to a low month?" (principle of transfer)**
  - **Can be approximated as equal to 0.2G when the 6-month cycle predominates**

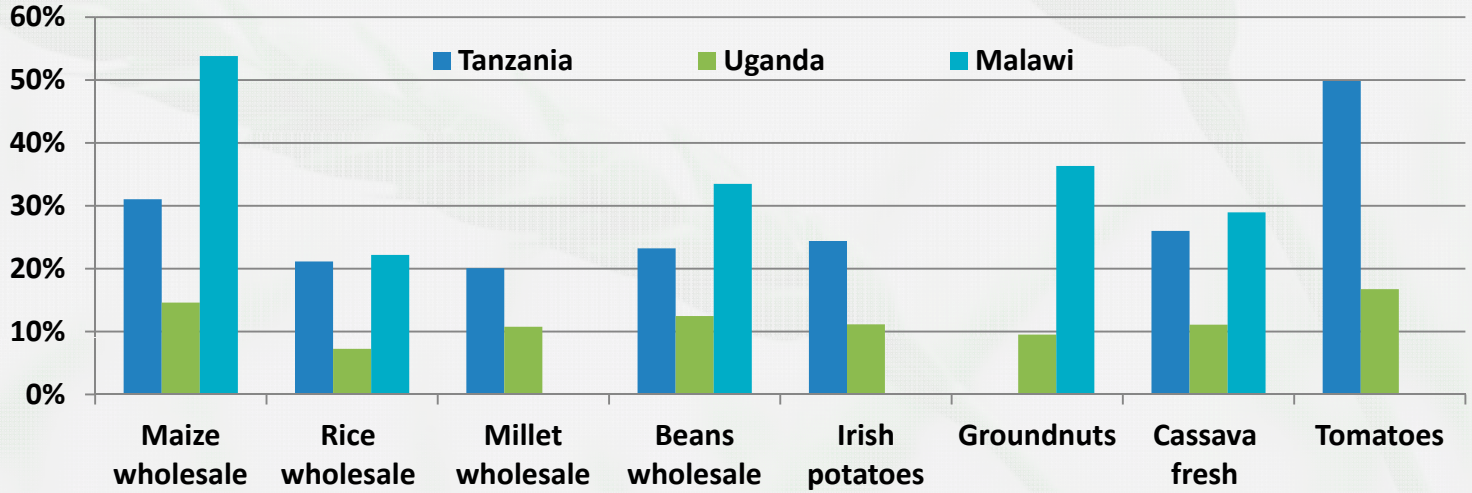
$$Gini = \frac{\sum_{t=1}^{12} t\bar{C}\left(1+M_t\right)}{6\sum_{m=1}^{12} \bar{C}\left(1+M_t\right)} - \frac{13}{12} = \frac{1}{72}\sum_{t=1}^{12} t\left(1+M_t\right) - \frac{13}{12} = \frac{1}{72}\sum_{m=1}^{12} t\left(1+M_t\right)$$

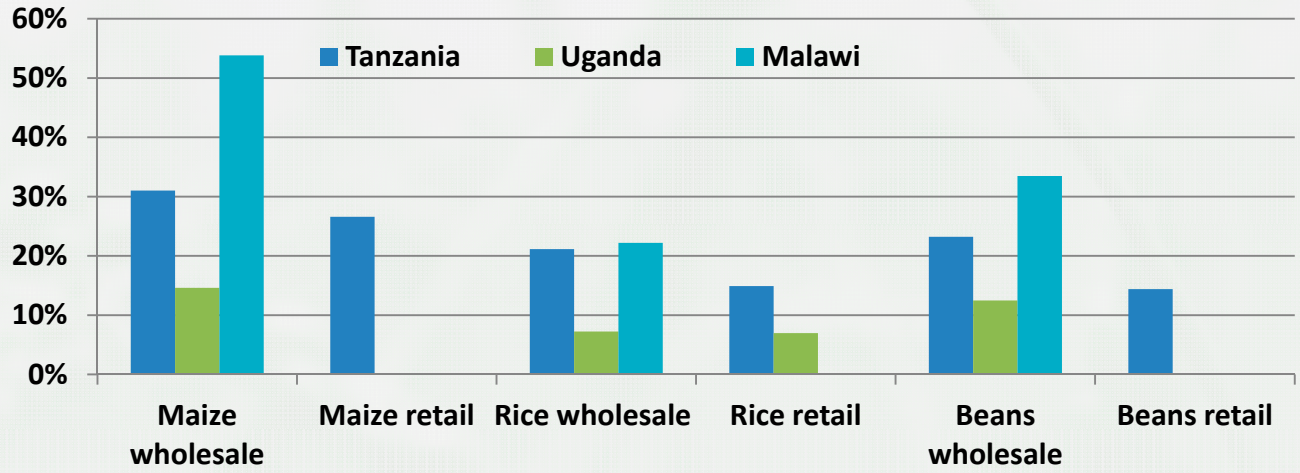
Findings – wholesale maize seasonal price gap between 15 (UG) and 50% (MWLI) on average; higher than rice, sorghum and millet





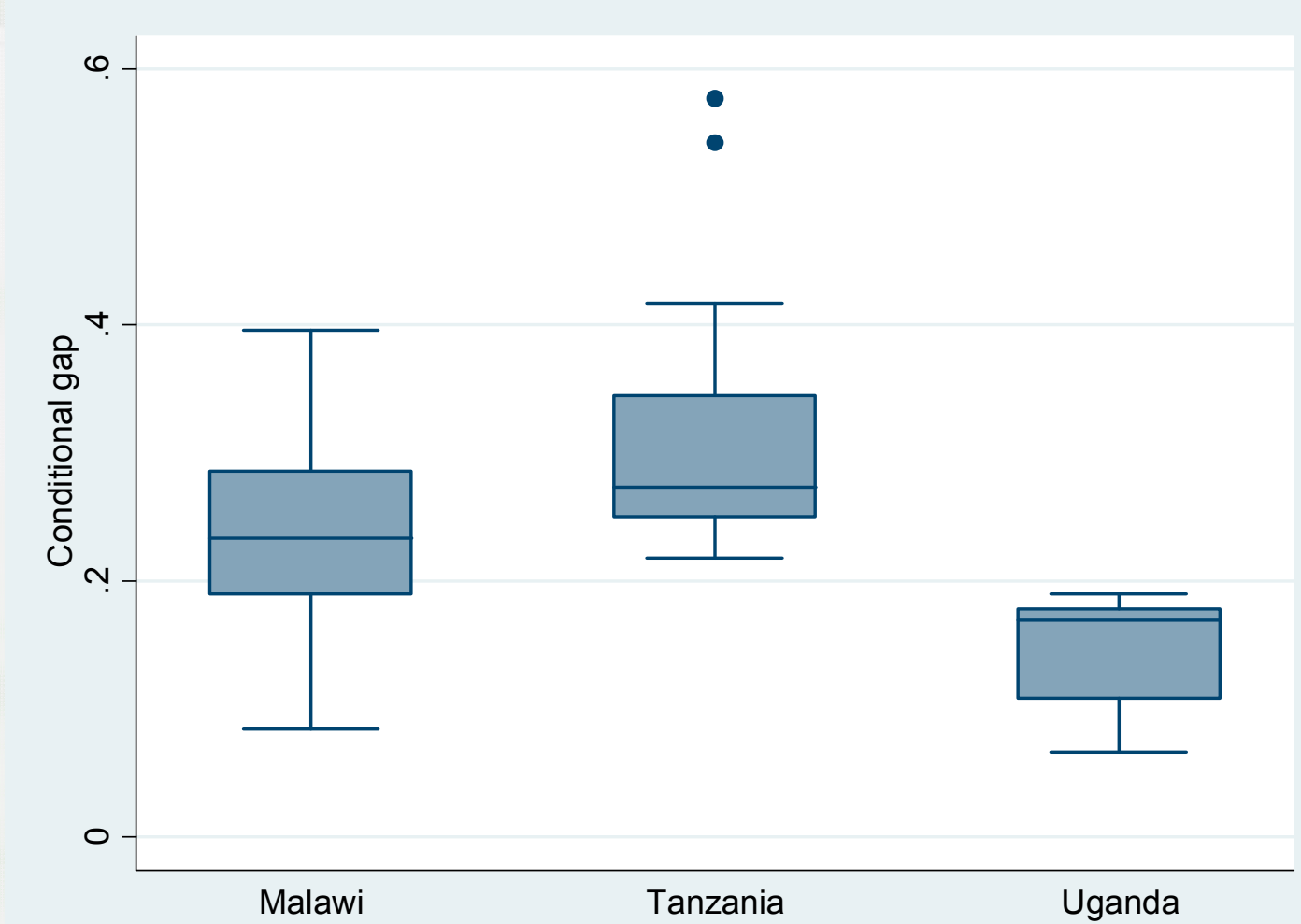
Findings- vegetable prices have highest gaps, cassava and groundnuts are of intermediate levels, wholesale > retail, and consistent ranking across countries



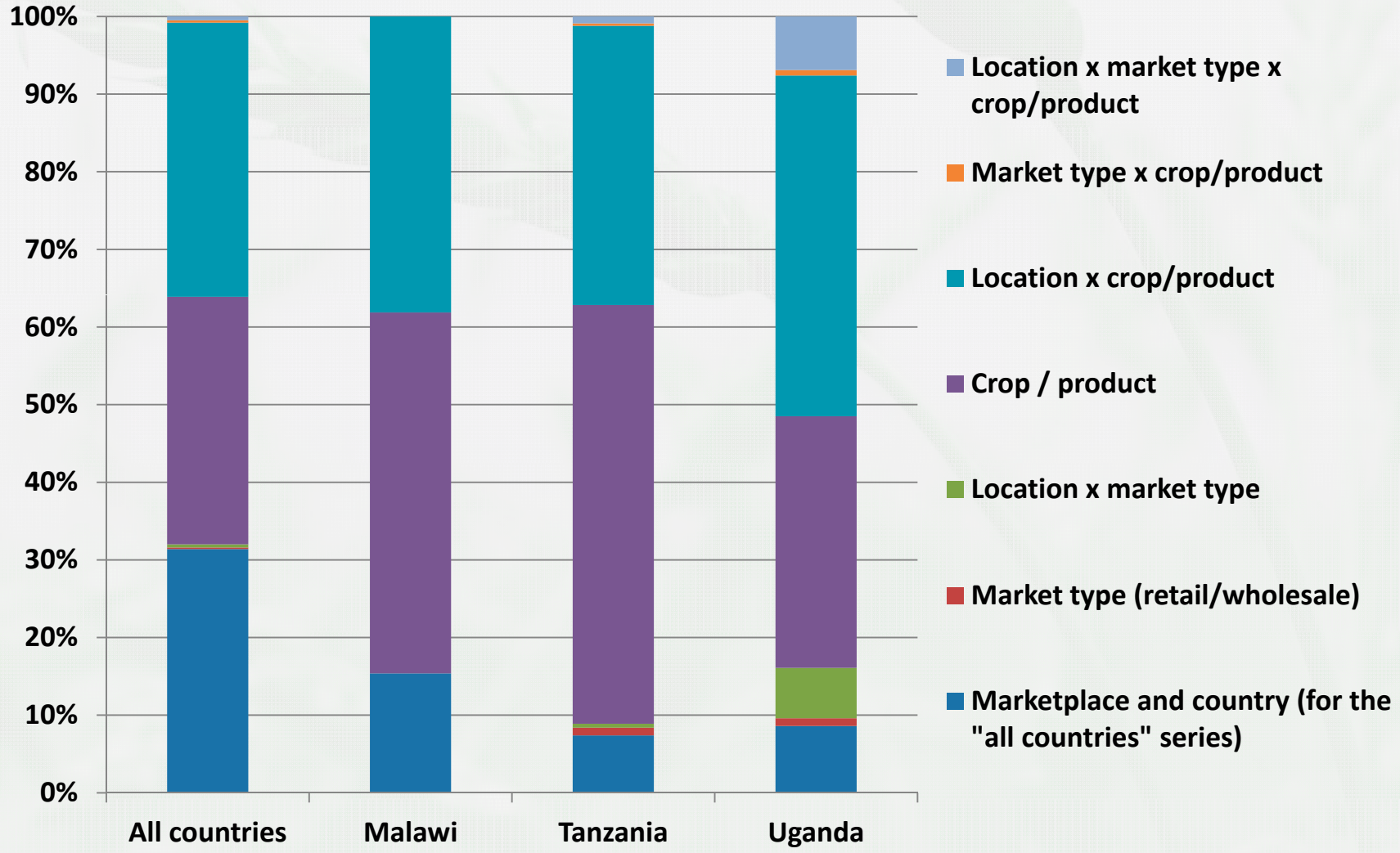


…but substantial within-country heterogeneity

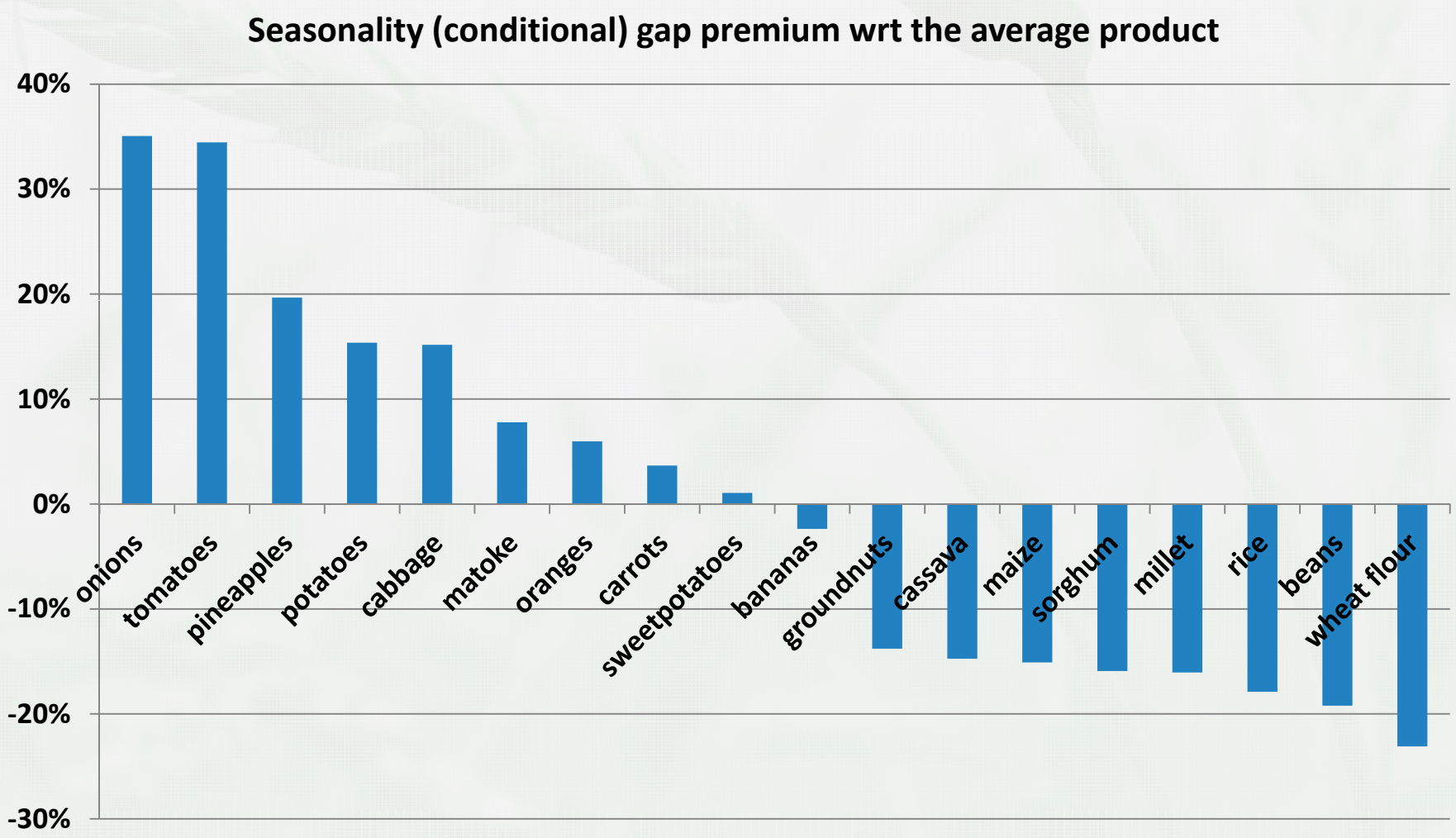
Wholesale maize seasonal conditional price gap (2000-2013) across markets



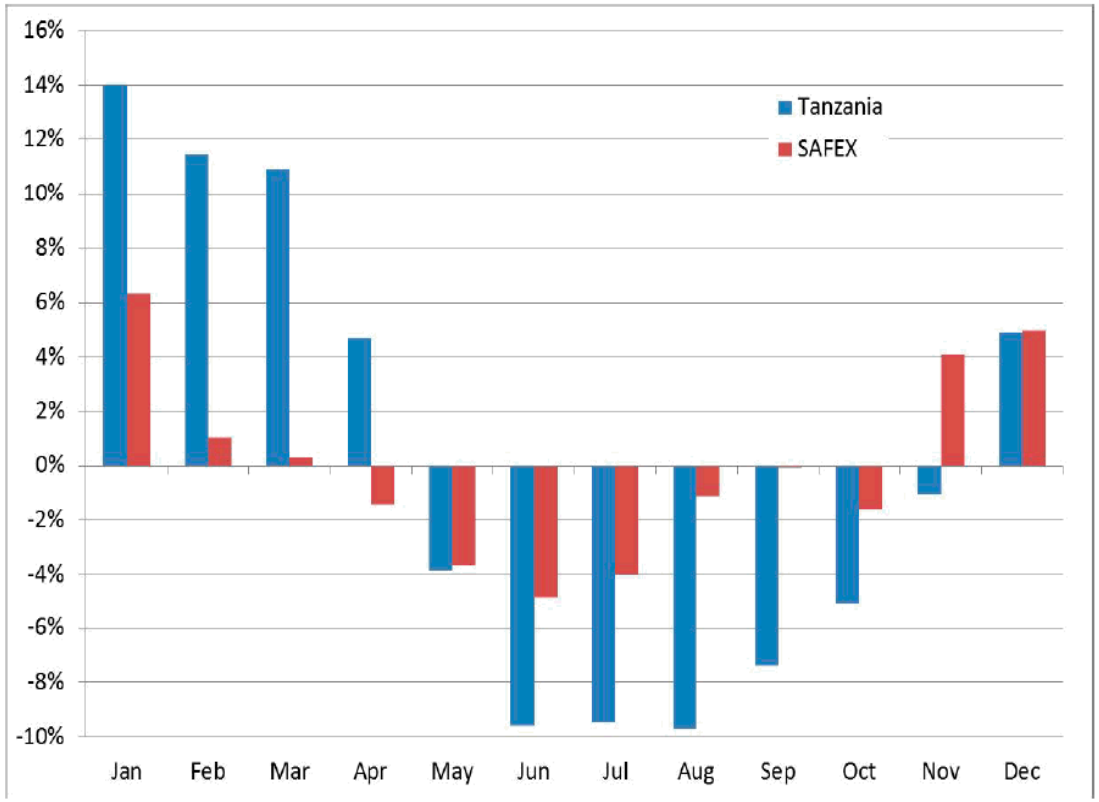
Decomposition of price conditional seasonal gaps (anova)



Seasonality price gaps are consistent with expectations



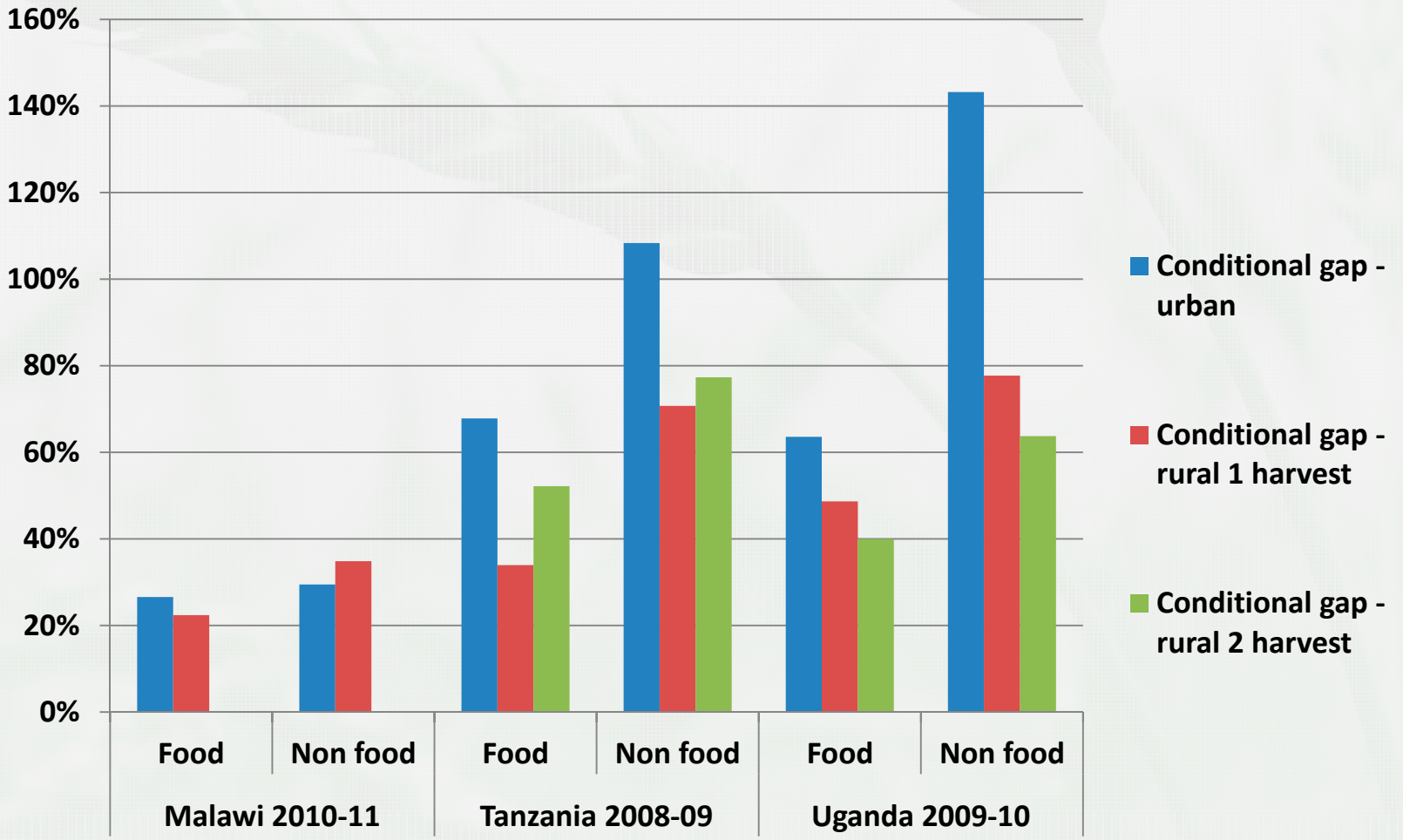
Benchmarking: SAFEX vs. Tanzania maize price indexes



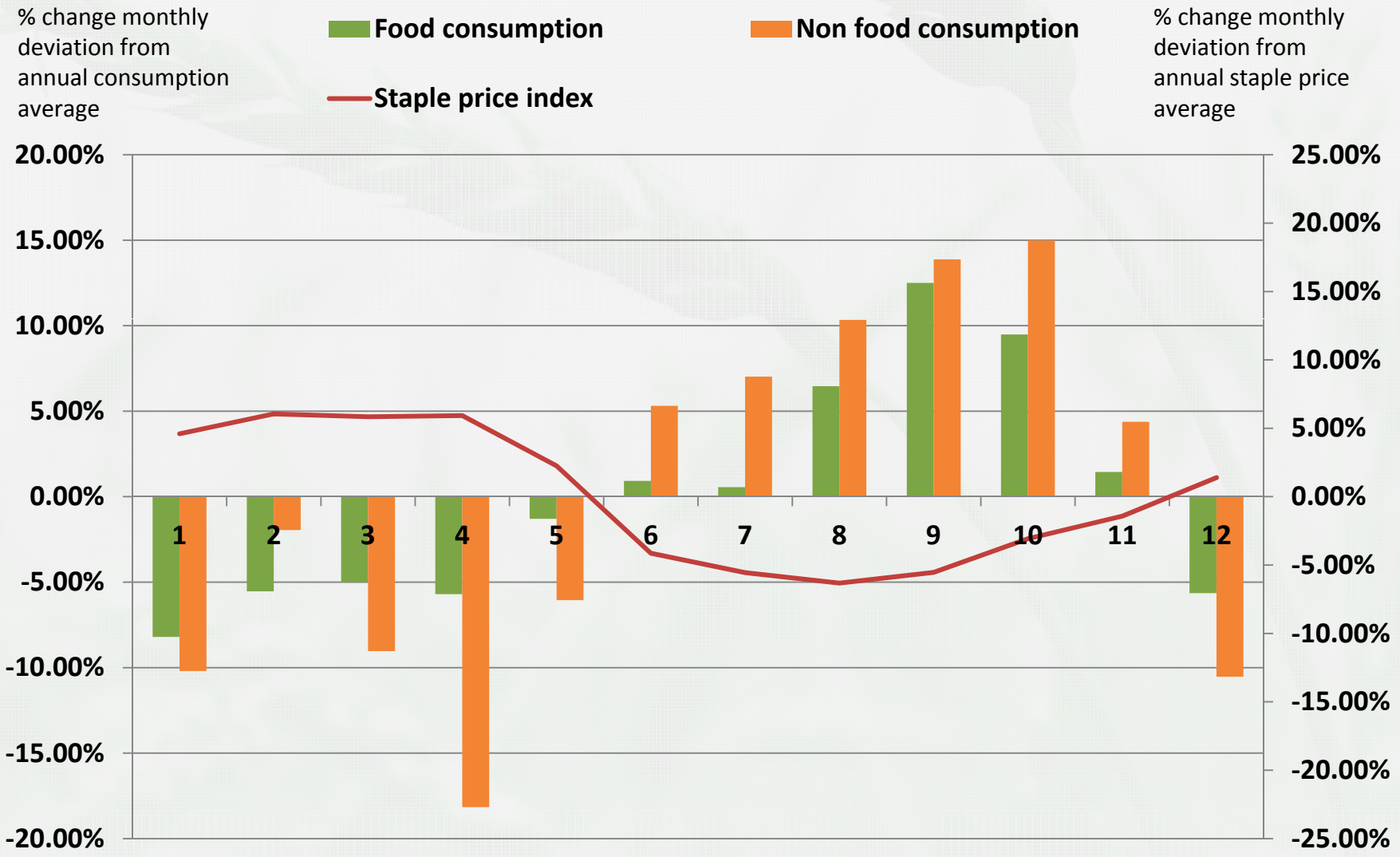
- SAFEX : Africa's agricultural commodity index and commodity prices on the Johannesburg stock exchange
- Tanzania: national average prices (wholesale)

- **Seasonal range from trend is two times higher in TZ on average**
- **In some exceptional years, this is way above, especially for some months**
- **Robust to various trend estimates and ARIMA specifications**

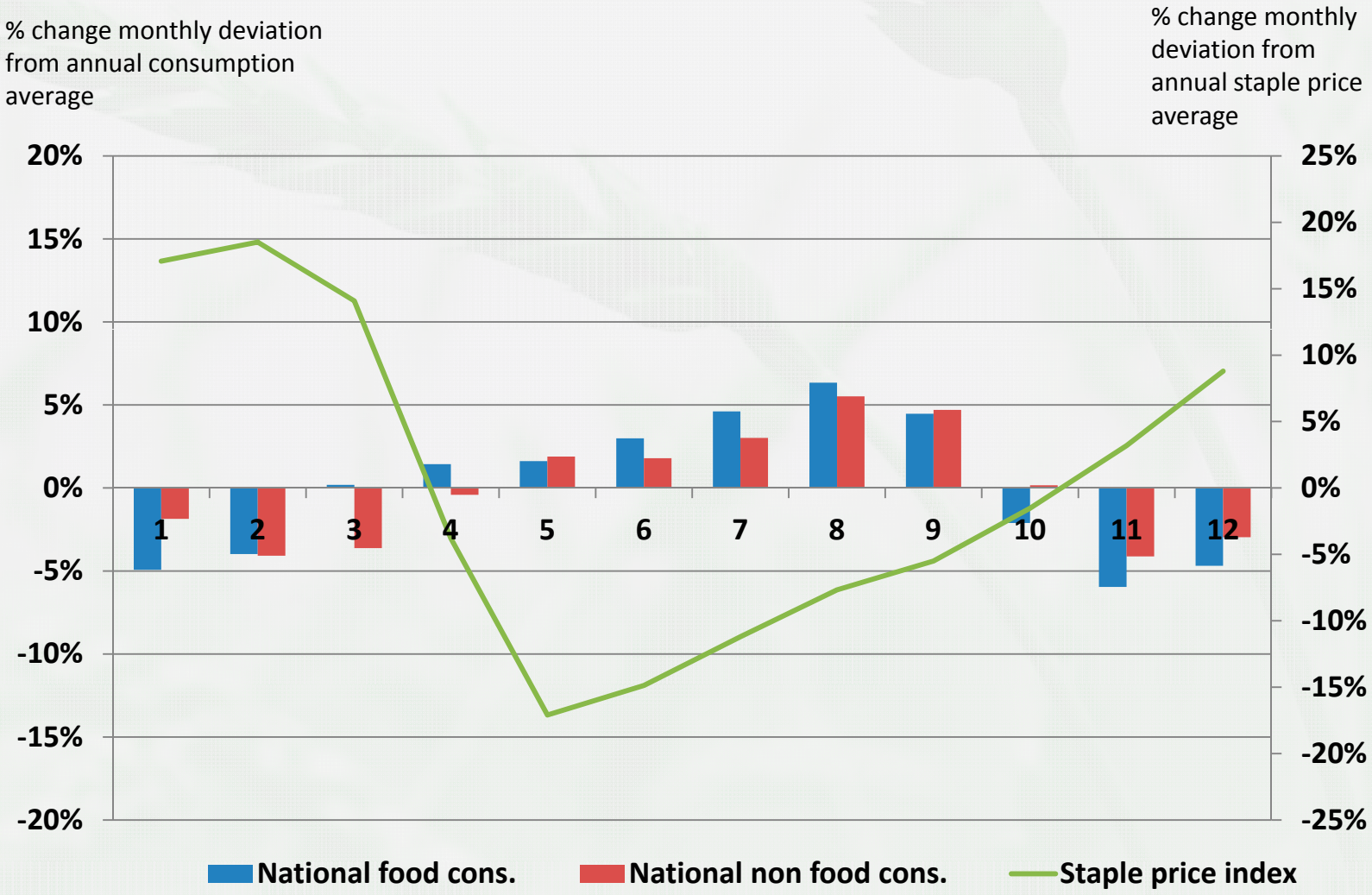
Consumption seasonality (conditional): urban>rural, non food > food, Malawi < TZ < UG



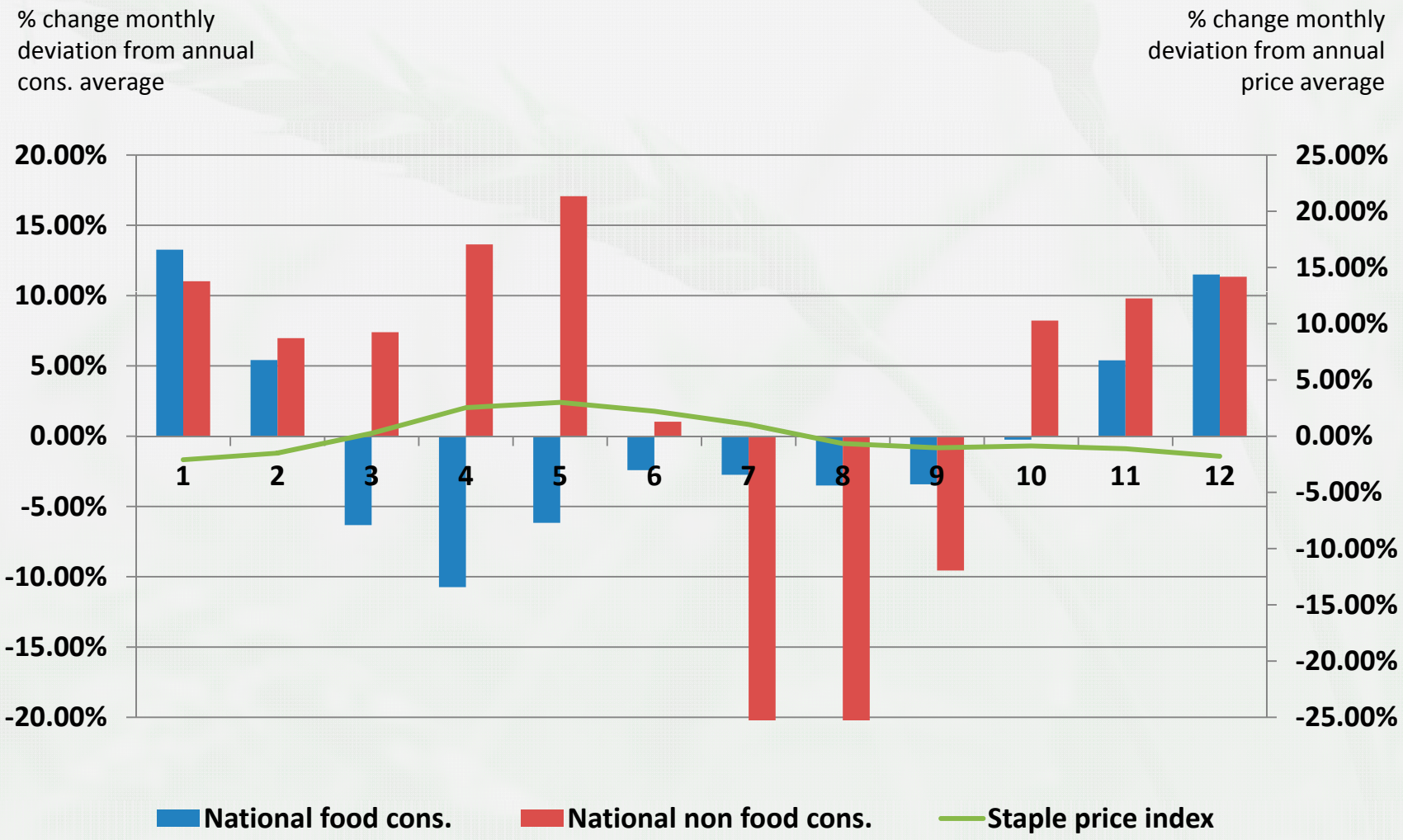
Consumption seasonality tracks staple price seasonality; Pattern more pronounced for non-food than food exp- TZ



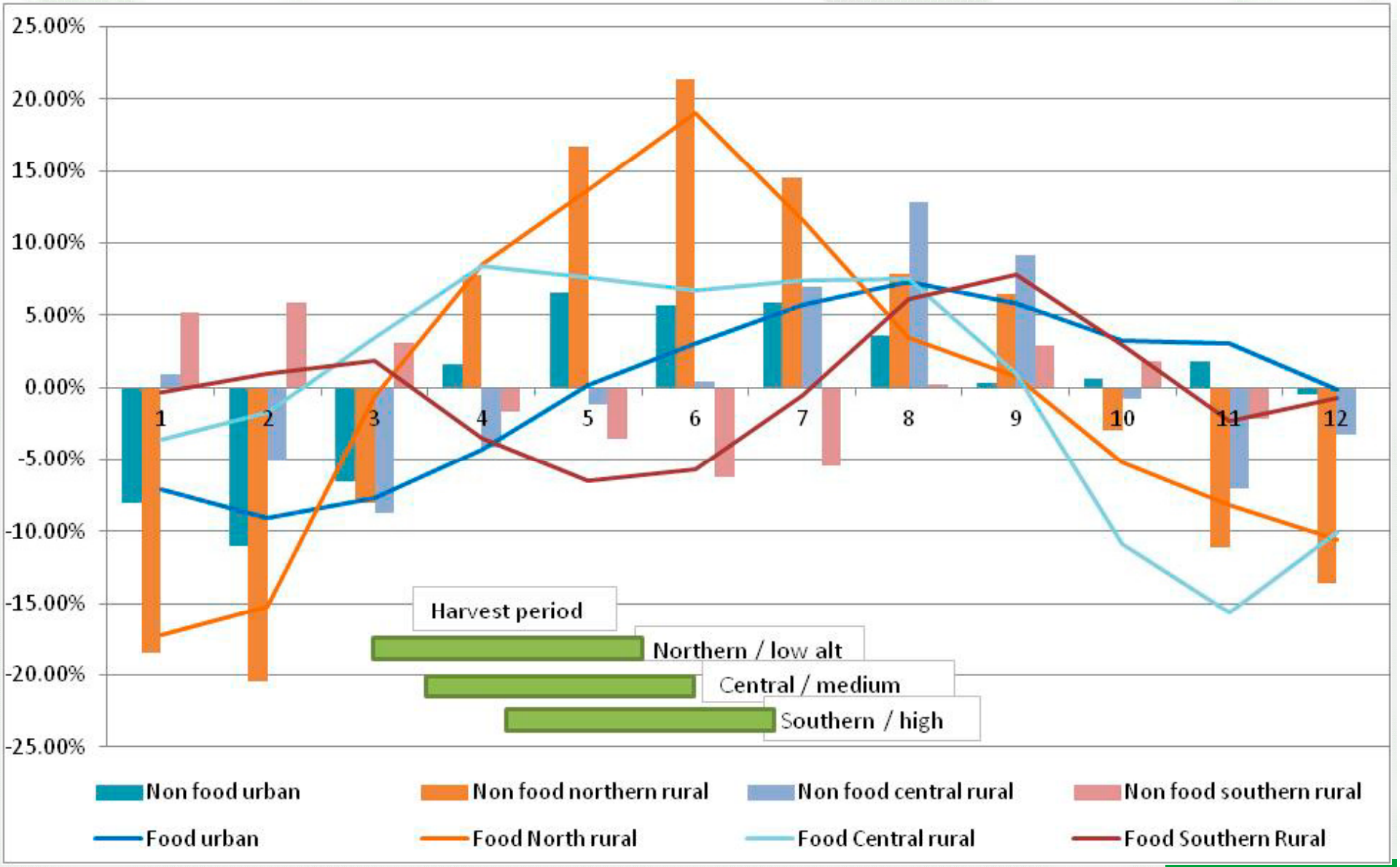
Consumption seasonality tracks staple price seasonality; Equivalent non-food & food pattern, less sensitive to prices- MLWI



Food / non-food intra-annual substitution but highest food consumption sensitivity to prices- UG



Disaggregated results / heterogeneous seasonality – MLWI



Conclusion

- **Seasonality still permeates African agriculture and livelihoods (also in people's food consumption) :**
- **On markets**
  - Significant price gaps - 25% for maize -, consistent across countries + higher seasonality for wholesale vs. retail markets, especially for staples
  - Well correlated with the crop calendars / production cycles
  - Heterogeneity in price gaps explained chiefly by the type of crop/ product, and then in combination with locations (but very small pure location effects)
- **To the households:**
  - High sensitivity of consumption to the month dummies, rural<urban
  - Food and non-food move together (or with a lag) but food < non-food fluctuations
  - Correlated with the seasonality in markets (and timing)
  - ➔ suggestive that staple price seasonality translates into expenditure seasonality
- **Implications**
  - Timing of consumption data collection still key for poverty calculations
  - Important agenda to better understand reasons for food price seasonality
  - Not only inter annual, but also intra-annual food consumption smoothing deserves more analytical and policy attention