Seasonality in local food markets and household consumption in Africa

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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...)

(TZ 2008, MWI 2010, UG 2009)
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 (e.g., Arusha) and time-varying seasonality specification

\[
\ln p_{mt} = \sum_{j=1}^{k} \gamma_{mj} \ln p_{m_{t-j}} + \mu_{mt} + s_{mt} + \varepsilon_{mt}
\]

\[
\mu_{mt} = \mu_{mt-1} + \delta_{mt} + \nu_{mt}
\]

\[
\delta_{mt} = \delta_{mt-1} + \nu_{mt}
\]

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

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

\[
\ln c_{it}^{f/nf} = \beta_{i}^{f/nf} X_{i} + M_{it}^{f/nf} + s_{it}^{f/nf} + \varepsilon_{it}^{f/nf}
\]

- 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

\[ G^{f/nf} = \max\{M_{t}^{f/nf}\} - \min\{M_{t}^{f/nf}\} \]

• 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

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

% change monthly deviation from annual cons. average

% change monthly deviation from annual price average

National food cons. National non food cons. Staple price index
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