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Seasonality in Food Prices and the Cost of a Nutritious Diet in Tanzania

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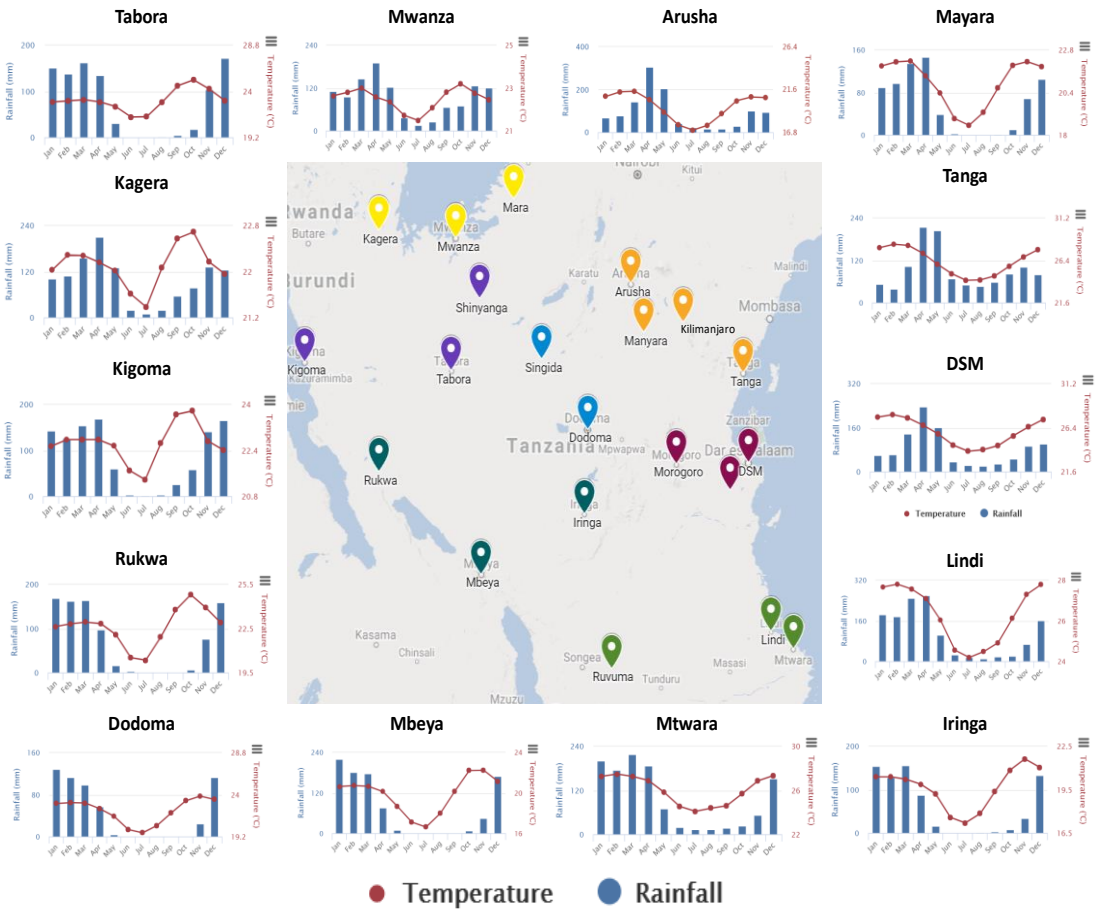


Introduction

- **Tanzania, a large country in east Africa, facing both economic and nutrition challenges**
  - **68%** of the population living below poverty line of $1.25
  - **42%** of children under 5 were stunted in 2010
  - Anemia: **59%** among children, and **41%** among women

- **Rising food prices may further threaten nutrition security**
  - Reduce access to (nutritious) foods with greater effect on food consumption /nutrition and health status in lower-income countries/HHs (Green *et al.*, 2013; Brinkman *et al.*, 2010)

Introduction (cont'd)

- **Seasonality is a key predictable component of food price variations**
  - Tanzania: seasonal fluctuations in food market prices and food consumptions (Kaminski et al. 2016)
  - Africa: seasonality for maize and rice is **2.5-3x** larger than in the international markets (Gilbert et al. 2017)
- **Previous work on wholesale prices of major staples in single markets or food expenditure**
  - We compare seasonality in food prices of all major food groups
  - Challenges: upward bias if using common dummy variable method
    - Period is usually short (usually only 5-6 years)
    - Seasonal patterns are absent or unclear

Introduction (cont'd)

- **How about the cost of diets considering food substitutions?**
  - **The least cost diet method** for many specific uses
    - Stigler (1945) linear programing to compute least-cost diets
    - USDA Thrifty Food Plan for US nutrition assistance program (USDA 2017)
    - SCUK Cost of Diet tool (2009) and Optifood (2012)
    - Allen (2017) in AER to measure global poverty
  - We follow the Cost of Nutrient Adequacy (Masters et al. 2018) and distinguish **longer-term health vs immediate energy needs**
    - Cost of Nutrient Adequacy, **CoNA**
    - Cost of Caloric Adequacy, **CoCA**

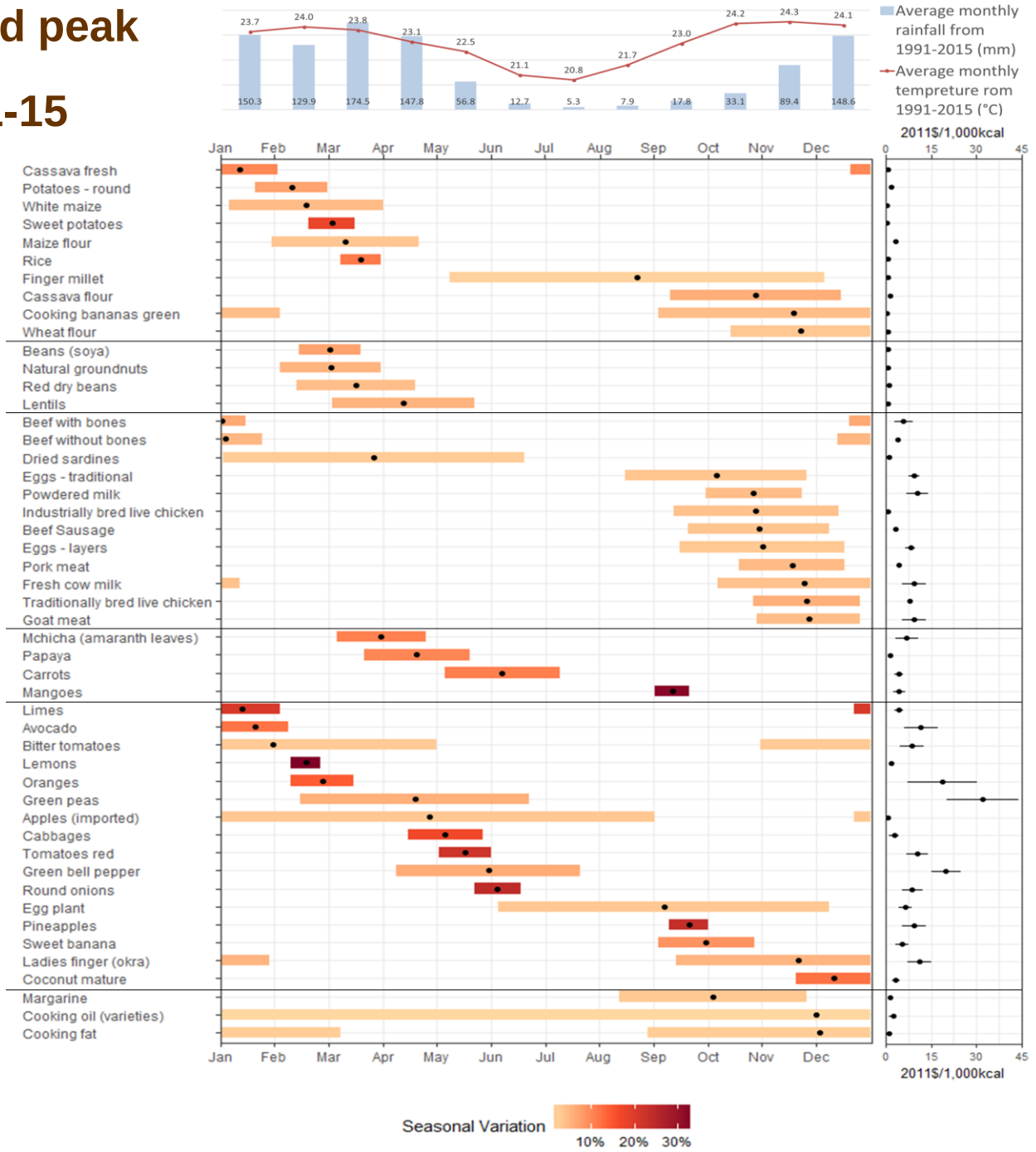
Methods and Data

- **Least cost diet method for both CoNA and CoCA**
  - Cost of Nutrient Adequacy (CoNA)
    - $\min C_{kt} = \min \sum p_i x q_i$, where $\sum n_{ij} x q_i \geq EAR_j$ and $\sum n_{ie} x q_i = E$
  - Cost of Caloric Adequacy (CoCA)
    - $\min C_{kt} = \min \sum p_i x q_i$, where $\sum n_{ie} x q_i = E$
- **Harmonic/trigonometric model for seasonal component of month-to-month changes**
  - Individual foods
    - $\ln(C_{ikt}) = \alpha_0 + \beta_s \sin(2\pi\omega t) + \beta_c \cos(2\pi\omega t) + \beta_t T(t) + \gamma_j Y_j + \theta_k R_k + e_{ikt}$
  - Diet-cost indexes
    - $I_{kt} = \alpha_0 + \beta_s \sin(2\pi\omega t) + \beta_c \cos(2\pi\omega t) + \beta_t T(t) + \gamma_j Y_j + \theta_k R_k + e_{kt}$
  - Present the **amplitude** and **peak timing** (Naumova et al., 2007)

Methods and Data (cont'd)

- **Monthly prices for 49 foods in local markets across 21regions**
  - January 2011 through December 2015
  - Collected by field agents for the National Bureau of Statistics (NBS)
- **Food Composition Datasets**
  - National Nutrient Database for Standard Reference (USDA)
  - West African Food Composition Table (FAO)
- **EARs for 17 Nutrients from IOM**
  - Protein plus 7 minerals (Ca, Fe, Mg, P, Zn, Cu, Se) and 9 essential vitamins (A, C, E, Thiamin, Riboflavin, Niacin, B-6, Folate, B-12).

Seasonal variation and peak timing of the cost of individual foods, 2011-15



Starchy Staples

Pulses, nuts and seeds

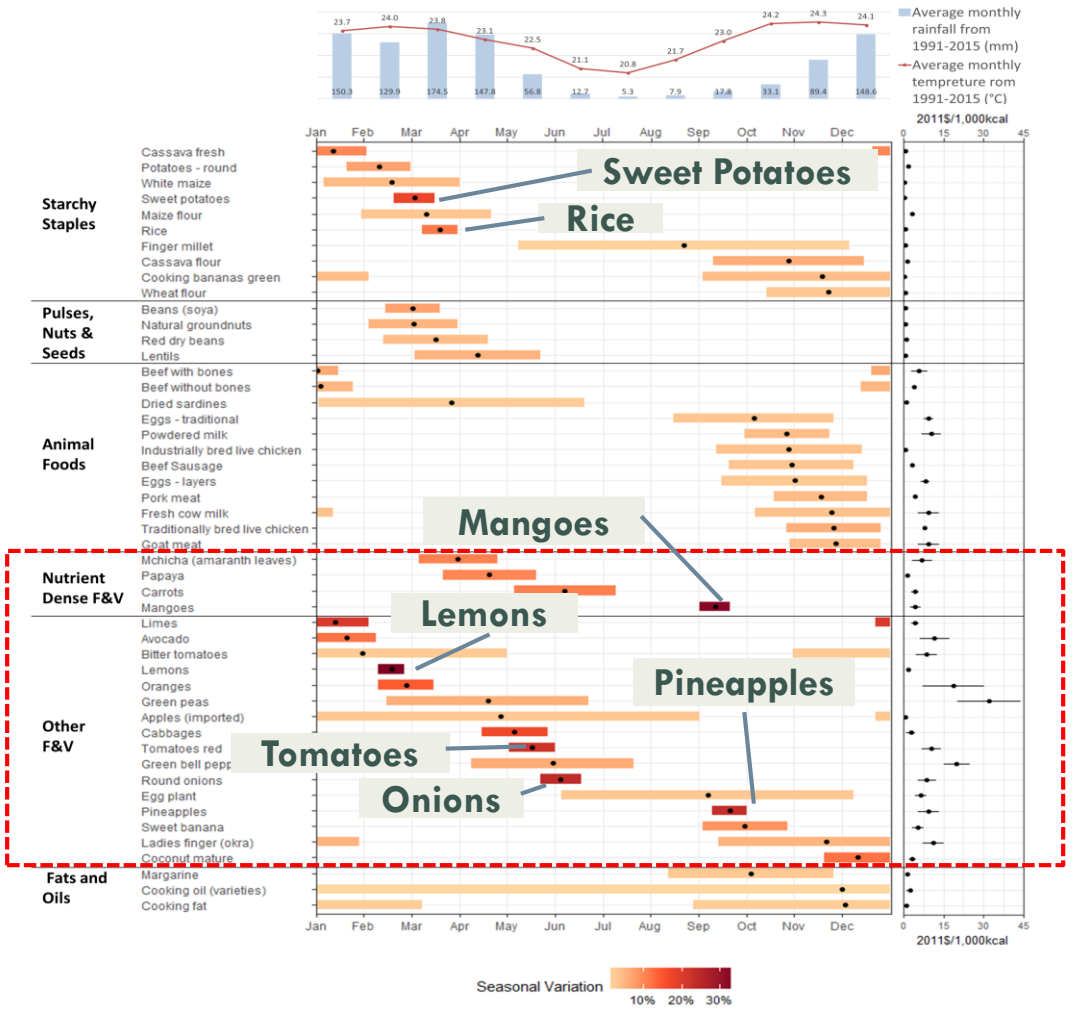
Animal foods

Nutrient dense F&V

Other F&V

Oils and fats

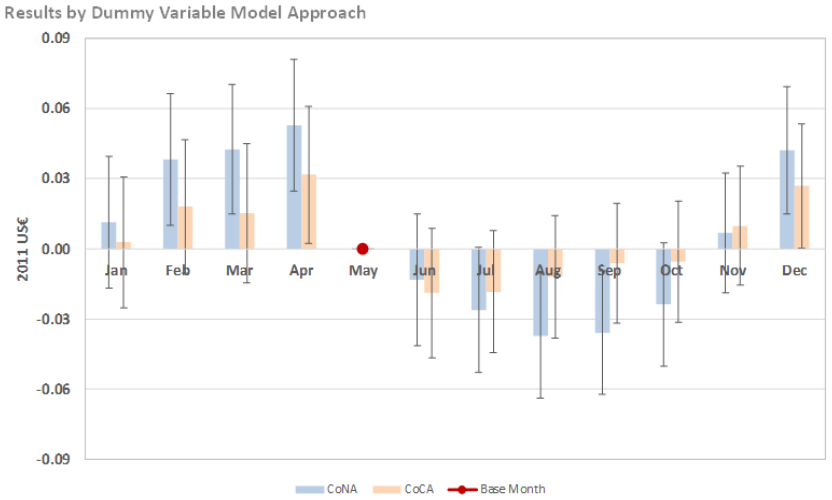
Results – Sharpest Seasonality in F&V

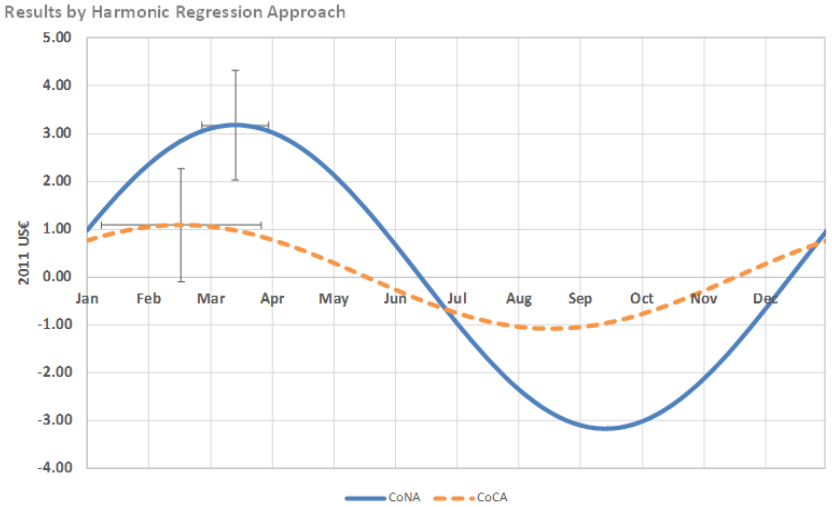


Note: data shown are 95% confidence intervals as bars for the peak timing. The color gradation shows the estimated seasonal variation in monthly price of each food item at 21 market locations across the nation. The side graph on the top shows the average monthly rainfall between 1991 and 2005, and the side graph to the right displays the average monthly price per 1,000kcal and the standard deviation of each food item. The seasonal variations for 8 food items were not significant, including finger millet, white maize, dried sardines, egg plants, apples (imported), bitter tomatoes and cooking oil (varieties) and cooking fat.

- **Significant seasonal variations in 46 of 49 foods**
  - F&V has the sharpest seasonality
  - They also have the highest food prices per calories
- **Seasonality of individual food price = seasonality of cost of diets?**

Results – Seasonal Variation of CoNA and CoCA in Tanzania, 2011-15



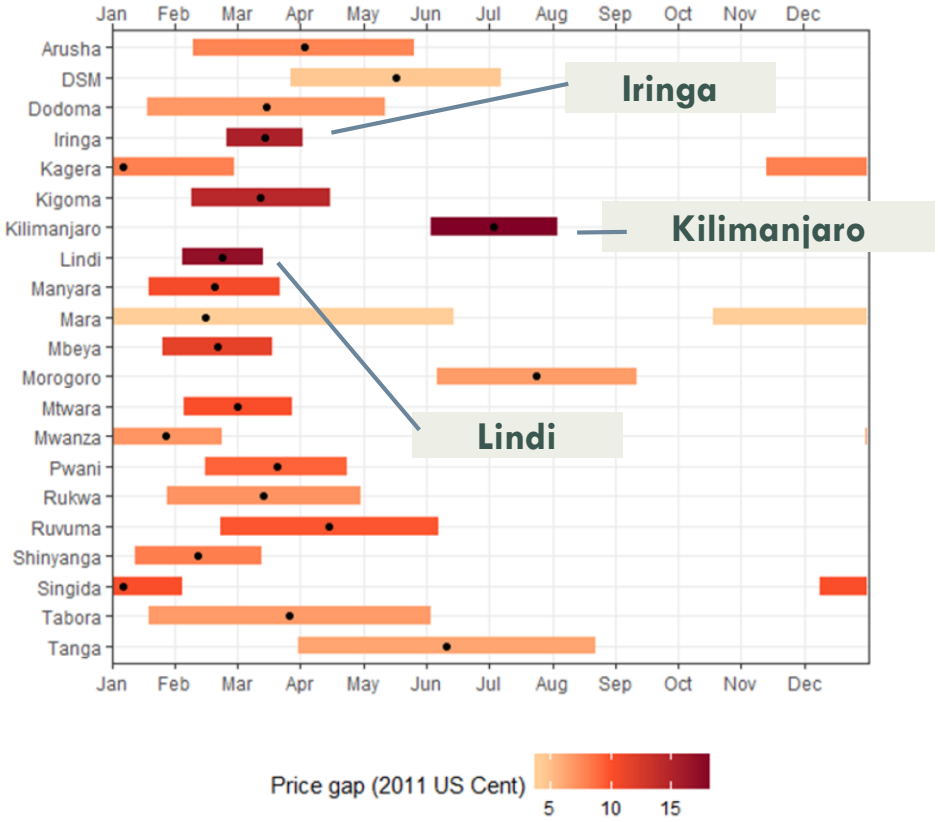


- **Clear seasonal pattern in the cost of nutrient adequacy (CoNA)**
  - People may suffer even higher costs and stronger seasonal changes to maintain a nutritious diets
- **Peak time of CoNA in March is one month later than the peak of CoCA**
  - Variation in seasonality drives fluctuations in the cost of meeting micronutrient needs through F&V

Note: error bars show 95% confidence intervals of the relevant estimates. At a significance level of 5%, dash line indicates that the seasonality of CoCA is not significant, while solid line indicates that the seasonality of CoNA is significant.

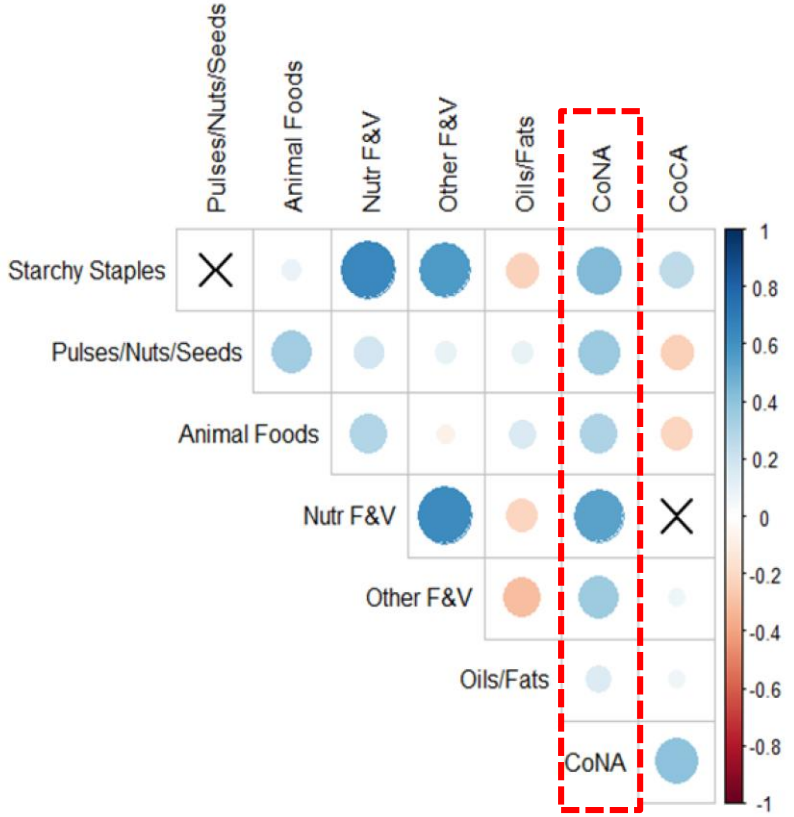
Results – Regional Variations of CoNA and the Important Role of Nutrient-Rich F&V

Fig 3. Seasonal Variation of 21 Regional CoNA indexes, 2011-15



Note: data shown are 95% confidence intervals as bars for the peak timing. The color gradation shows the estimated seasonal variation in the regional CoNA indexes. The seasonal variations for 3 regions were not significant, including Dodoma, Mara and Arusha.

Fig 4. Correlation Coefficient of Prices among 6 Food Groups and CoNA



Note: Nutr F&V is the abbreviation of Nutrient-rich Fruits and Vegetables. Other F&V is the abbreviation of Other Fruits and Vegetables. CoNA and CoCA are the indexes representing the cost of nutrient adequacy and the cost of calorie adequacy. Blue circles indicate the prices of the two food groups or indexes on horizontal and vertical directions are positively correlated, red circles indicates that they are negatively correlated at the significance level of 0.05. Nonsignificant correlation is shown as an "X" symbol in the figure.

Conclusions

- **Seasonality widely exists in retail food prices in Tanzania**
  - F&V has the most extreme seasonality, with different seasonal peaks according to the harvest timing;

- **Seasonal fluctuation has been observed in the least cost of nutritious diet in Tanzania**
  - Allowing people to substitute freely among foods as prices vary, the lowest possible expenditure needed to meet all nutrient needs has significant seasonality
  - The cost of calories as such fluctuates less predictably

Conclusions (cont'd)

- **Regional variations of CoNA is striking**
  - CoNA's seasonal peak is at the end of the rainy season in March/April with exceptions like Kilimanjaro around July
  - Price gap between annually seasonal peak/bottom prices can be over 15 US cents like Kilimanjaro
- **F&V price is a key driver of the seasonal change in CoNA**
  - Each region's cost of nutritious diets is highly correlated with seasonality in prices of its nutrient dense F&V
  - More targeted investments in market infrastructure for storage and transport of those foods among markets over time to lower and smooth the cost of nutritious diets

Limitations and Next Steps

- **Price data were collected in principal food markets in each region**
  - Seasonal scarcity at even more remote locations is likely to be even more severe, for which additional data on local prices would be needed
- **Next steps**
  - Method to be applied in other developing countries with different development status and evaluate various food systems
  - To investigate whether, or by how much, market infrastructure may affect the level and seasonality of the costs of individual foods, as well as the cost of nutritious diets

Thank you!

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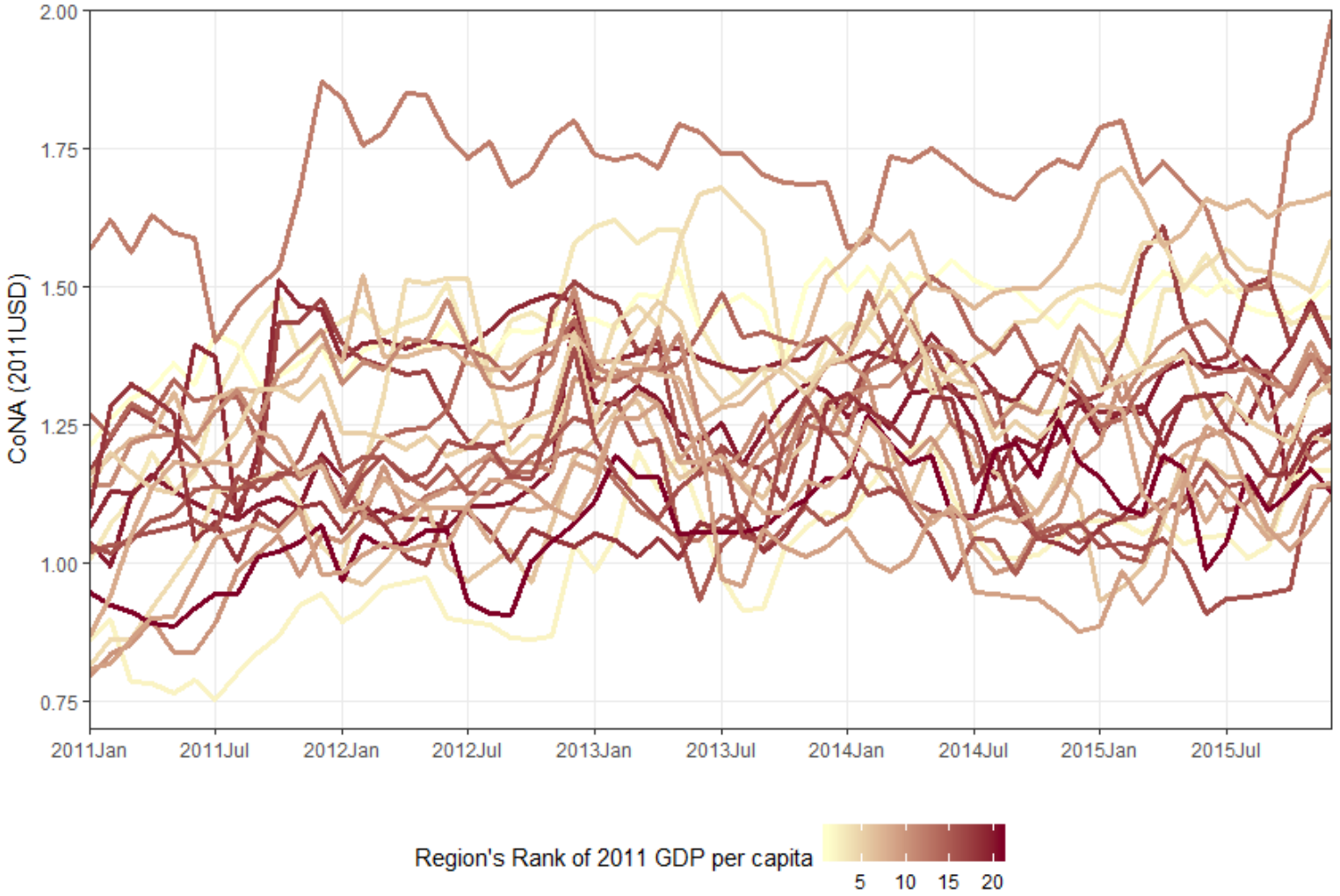
Model code and data for replication of results will be available on that project's website at **http://sites.tufts.edu/candasa**

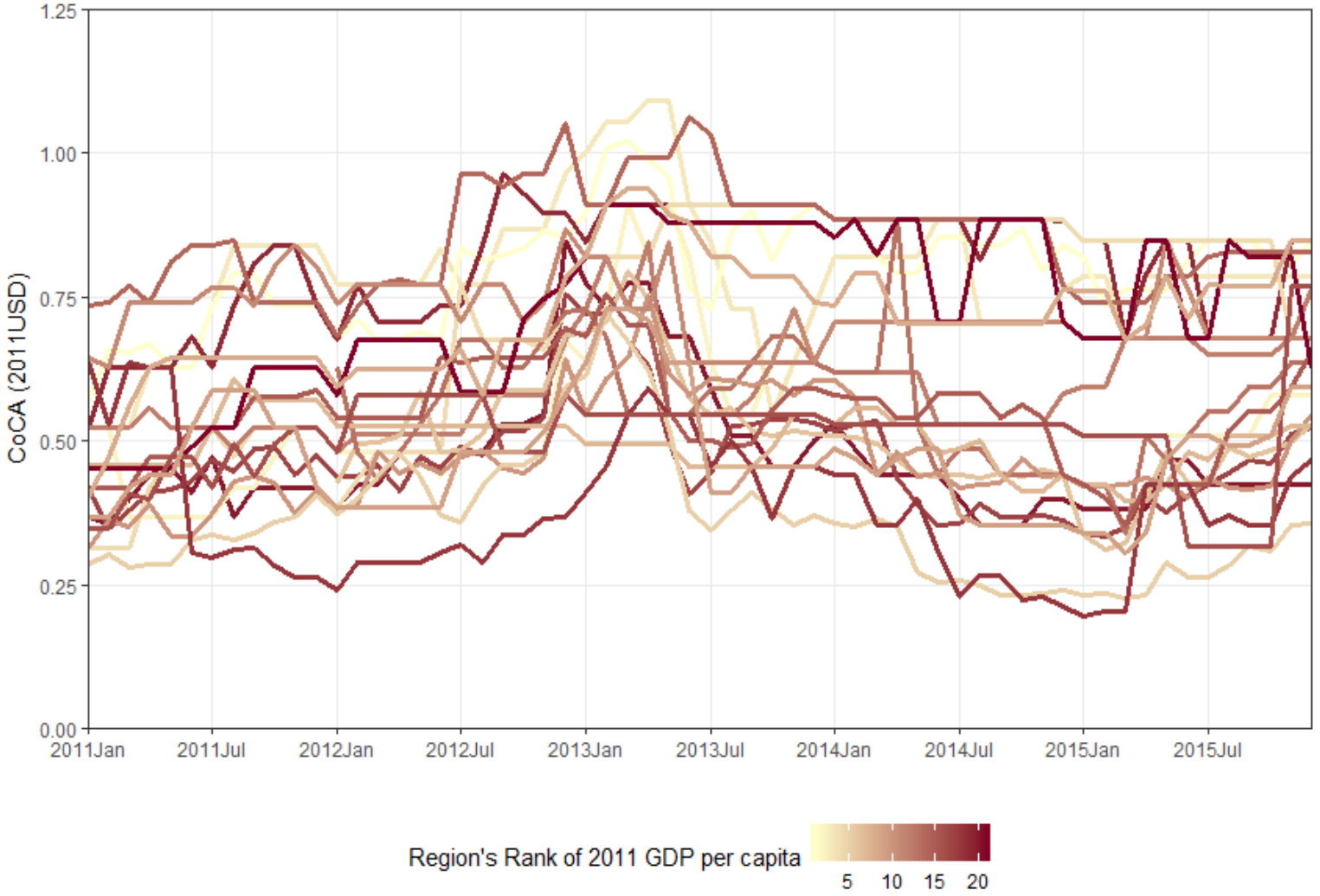
All results depend on price enumerators!

Photo: Anna Herforth, 2017

Appendix: 21 Regional CoNA Index in Tanzania, 2011-2015



Appendix: 21 Regional CoCA Index in Tanzania, 2011-2015



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