Seasonality in the Costs of Nutritious Diets and in 21 Regions of Tanzania
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Introduction

Tanzania, one of the poorest countries in the world, is suffering from significant nutrition and poverty issues. Seasonality in food prices may significantly affect individuals and households’ food intake and further threaten nutrition security for the poor, due to low diversification and limited ability to smooth food consumption through food substitution over time (Brinkman et al., 2010; Bouis, Eozenou and Raham, 2011; Green et al., 2013; Kaminski et al., 2016). Market infrastructure, referring to roads and electrification, may boost food transportation, storage and trading, which then effectively close the spatial and temporal price gaps of foods (Minten and Kyle, 1999; Regolo, Portugal-Perez and Brenchton, 2014; Shively and Thapa, 2017).

However, seasonality in food prices is much understudied and the few studies were only focused on key staple crops and commodities, rather than the cost for a diet.

Objectives

To our knowledge, this paper is the first study of seasonality that systematically examined the magnitude and timing of seasonal variations in the costs of nutritious diets. Using a least-cost diet as the benchmark allows us to compare seasonality in the cost of nutrients beyond calories, measuring their affordability for the poorest and most at risk of malnutrition. Applying monthly prices of 49 food items in Tanzania over 5 years (2011 to 2015), we isolated and visualized the seasonal variation of CoNA in Tanzania and all its 21 mainland regions, and also compared with the spatial patterns of key potential determinant factors.

Methods

1. Cost of Nutrient Adequacy (CoNA) and Cost of Calorie Adequacy (CoCA):
   - 18 nutritional constraints for CoNA: 17 nutrients + 1 energy need
   - $\text{CoNA} = \min_{i,t} c_{i,t} + q_{i,t} \times q_{\text{EAR}_{j,t}}$, where $\sum_{j} q_{j,t} = E$
   - $\text{CoCA} = \min_{i,t} c_{i,t} + q_{i,t} \times q_{\text{EAR}_{j,t}}$, where $\sum_{j} q_{j,t} = E$
   - Where $n_{i,t}$ is nutrient content of food $i$ of nutrient $j$
   - EAR is nutrient requirement of nutrient $j$
   - $n_{i,t}$ is the dietary energy of food $i$, and $E$ is dietary energy - 2,000kcal per day

2. Seasonality in CoNA and CoCA
   - Seasonality in Indices: $I_{i,t} = a + \beta \times (m_{t} + b \times c_{t}) - y_{t} Y_{t} + \epsilon_{t}$
   - Where $C_{t}$ is the cost of food $i$ in region $k$ at time $t$ in a monthly time series
   - $I_{t}$ is the index of CoNA and CoCA in region $k$ at time $t$
   - $a$ and $b$ measure the magnitude of seasonality
   - $\omega$ is a constant equal to 1/12 indicating 12 months per annual cycle
   - $Y_{t}$ and $R_{t}$ are fixed effects for crop years and regions
   - $\beta$ controls for quadratic time trends

Results

Figure 1. Seasonal Variation of Cost of Nutrient Adequacy (CoNA) and Cost of Calorie Adequacy (CoCA) in Tanzania, 2011-15

Figure 2. Seasonal Variation and Peak Time of Cost of Nutrient Adequacy (CoNA) over 21 Regions in Tanzania, 2011-2015

Figure 3. Seasonality Intensity of Cost of Nutrient Adequacy (CoNA) in Tanzania

Figure 4. Regional variation of Tanzania in Road and Population Density and Electrification

Results (cont’d)

Conclusions

This paper introduced a novel combination of techniques to measure seasonality in an overall diet costs in Tanzania. Three important findings were found.

First, assuming that people may perfectly substitute diets to minimize their food expenditures according to foods’ prices and nutritional attributes, they may still be exposed to significant seasonal cost variations in Tanzania. In the real world, people are possible to be suffered from even higher and stronger seasonal costs due to consumers’ dietary preferences. However, seasonality in the least cost of caloric adequate diet is not identified.

Second, high level of CoNA seasonal gap is found in remote regions, such as Kigoma, Kilimanjaro, Iringa and Lindi, which may make substantial economic burdens to the local poor. It may also imply that seasonality should be considered as a major issue in policy making to address nutrition security problems.

Last, multiple factors related to food supply and demand may jointly determine the regional seasonality intensity. We find that the connection between regional distributions and CoNA seasonality and determinant factors are mixed. Further investigation using special regression method is highly needed to investigate specific impacts of such factors.