Seasonality in Calorie Consumption: Evidence from Mozambique

Channing Arndt, Mikkel Barslund, José Sulemane

Discussion papers

No. 13E
2005
(revised October 2006)

National Directorate of Studies and Policy Analysis

Ministry of Planning and Development

Republic of Mozambique

The intent of the discussion paper series is to stimulate discussion and exchange ideas on issues pertinent to the economic and social development of Mozambique. A multiplicity of views exists on how to best foment economic and social development. The discussion paper series aims to reflect this diversity.
As a result, the ideas presented in the discussion papers are those of the authors. The content of the papers do not necessarily reflect the views of the Ministry of Planning and Development or any other institution within the Government of Mozambique.

The Logo was kindly provided by the Mozambican artist Nlodzy.

The authors gratefully acknowledge support from the AERC.

Contact:

Channing Arndt
Direcção Nacional de Estudos e Análise de Políticas (DNEAP)
Ministério de Planificação e Desenvolvimento
Av. Ahmed Sekou Touré nº 21, 7º andar
Maputo, Moçambique
Tel: (+258) 2 1 499442
Fax: (+258) 2 1 492663
Web: www.mpd.gov.mz
Email: channingarndt@gmail.com

José Sulemane
International Monetary Fund
And
Studies and Policy Analysis Division
Ministry of Planning and Development
Mozambique

Mikkel Barslund
Development Economics Research Group (DERG)
University at Copenhagen

Seasonality in Calorie Consumption: Evidence from Mozambique

Abstract

This paper analyzes seasonality in calorie consumption in Mozambique using data from a survey of nearly 5,000 rural households. The survey is well suited for analysis of seasonality as it contains detailed records of household consumption and was implemented throughout a full calendar year with interviews beginning shortly after harvest. The extent of seasonality in consumption varies dramatically by region. The Central provinces exhibit identifiable seasonal patterns and the variation in calories is pronounced. On the other hand, no identifiable seasonal patterns exist for households in the South and evidence for seasonality in the North is weak. These results correspond with regional differences in the degree of dependence on maize and sorghum as a staple food. Efforts to link the magnitude of seasonality with underlying determinants yielded no robust results even in the central region.

Seasonality in Calorie Consumption: Evidence from Mozambique

Introduction

Food security is at the core of many development policies, and seasonal fluctuations in the amount and quality of food consumption is a key component of food security. Accordingly, concerns about seasonal fluctuations in food intake go well back in time (see, for example, Miracle (1961)). Nevertheless, despite longstanding recognition of the importance of the issue, empirical evidence on seasonality of food consumption remains relatively thin, particularly in African contexts. Data demands form part of the reason for the relative paucity of studies. Analysing seasonality in calorie intake requires that the survey cover at least a full agricultural season. Further, the survey instrument needs to contain a careful recording of food consumption for each household in the sample for a sufficient period of time to provide a reasonable measure of average daily calorie intake. In many household data sets, the concentration of interviews of households in certain periods of the year precludes analysis of seasonality.

This paper documents the extent of seasonality in calorie consumption at the household level in Mozambique using a recent nationwide household consumption survey covering 8,700 households in rural and urban areas. We focus on the nearly 5,000 rural households sampled since concerns about seasonal fluctuations in consumption are most acute for rural households. The survey sample design explicitly considered seasonality. As such, the survey was implemented throughout a full calendar year with the first interviews beginning shortly after harvest. In addition, detailed records of household consumption were kept for a period of a week. As a result, the data set appears to be particularly well suited to consider the issue of seasonality in the context of a poor African economy.

The article is structured as follows. Section 2 contains a review of literature focusing on attempts to measure seasonality in calorie consumption in sub-Saharan African contexts.[1]

The data set and data collection procedures are described in greater detail in section 3. Section 4 provides summary descriptive statistics. Section 5 presents the methodology employed for analysing seasonal consumption, and section 6 presents results. Section 7 concludes and advances suggestions for future research.

Existing Literature

Reardon & Malton (1989) study households in two villages in Burkina Faso over the course of a year. They divide their sample into three categories according to asset wealth. Working with adult equivalents and looking at intervals of two months, they find that peak per person calorie intake is some 15 and 41 percent, for village one and two respectively, above the leanest period for the poorest households in each village. For the households in the middle of the wealth spectrum the variation is 41 and 9 percent respectively. The richest households faced an approximate 28 percent differences in both villages over the year. While the differences between peak and trough are significant it is not clear if the extreme periods are significantly different from a yearly mean daily calorie intake per adult equivalent.

Dercon and Krishnan rely on interviews concentrated at three points in time over an 18 month period for a sample of 1450 households over an 18 month period. They find that the interview period occurring shortly after harvest results in significantly lower poverty rates reflecting significantly higher consumption. The analysis focuses on the value of real consumption as opposed to calories.

Longhurst & Lipton (1989), using data from 1971, illustrate seasonality in three villages in Northern Nigeria using bimonthly intervals. From the low season in December/January, calorie intake rises by 26 percent to a peak in the April/May period. Kumar (1988) reports changes in bimonthly average calorie intake in Zambia for the 1980/81 season of approximately 35 percent from the lowest level in June/July to the highest level in December/January. Kumar employs a sample of about 250 households from a specific region in Zambia. Similarly, based on a survey of 200 households in Gambia in the 1985/86 season, Von Braun (1988) finds variation in calorie consumption of 15 percent from the rainy season to the dry season for the poorest households (the group with the biggest variation between the two seasons). The numbers reported do not allow an assessment of the statistical significance of this difference.

To summarize, most existing attempts to measure seasonality in calorie consumption in Africa rely on relatively small samples from specific regions.[2] These small sample sizes and regional peculiarities limit the ability to draw general conclusions about the extent and nature of seasonality in consumption at broader scales. Furthermore, it is important to point out that seasonal variation in calorie intake does not necessarily indicate problems of under nutrition and malnourishment. As illustrated in Lawrence et al. (1989) some variation in calorie intake throughout the year is to be expected due to changes in natural metabolism and activity levels. For example, periods of the year associated with strenuous activity, such as the planting period, may well be associated with increased calorie consumption relative to an annual mean. Similarly, relatively slack periods may be associated with reduced calorie consumption.

Data

The 2002-03 household survey (IAF) contains detailed information on consumption for a random sample of 8,700 households in Mozambique. Full documentation of all aspects of the implementation of the 2002-03 IAF surveys is available from the National Institute of Statistics (INE 2004). Here, we provide a brief summary of the basic features of the 2002-03 survey. The sample of 8,700 households represents the nation, rural and urban zones, and each of the ten provinces plus Maputo City. The interview period for each household lasted for one week. During this time, three household visits were programmed in order to administer questionnaires on general characteristics of the household, daily expenses and home consumption, possession of durable goods, gifts and transfers received, and other expenses that tend to occur with lower frequency than daily expenditures, such as school fees or purchases of clothing. While the programmed number of interviews with each household was three, in many cases enumerators visited their assigned households every day in order to fill out the daily expense and home consumption questionnaire.[3]

As indicated above, a key feature of the 2002-03 IAF was an explicit attempt to be representative in time as well as space. Data collection took place over the space of a year with data collection beginning in July 2002 and finishing in June 2003. This one-year period was divided into quarters. For each sub-group of the population the survey was designed to represent, one quarter of households were interviewed in each period. This is a more travel intensive method of collecting data since it can involve returning to similar locations multiple times over the course of a year. However, the advantages in the Mozambican context are compelling. In particular, prices for agricultural products, which represent the large bulk of expenditures for poor households, often vary from simple in the post-harvest period to double or triple in the pre-harvest period. These price variations could have substantial implications for the welfare and behavior of households.[4]

The IAF data set is generally considered to be of relatively high quality. We consider the quality of the temporal representation below. As mentioned earlier, most studies either use data collected at few temporally different points (i.e. dry and wet season). The IAF data set, on the other hand, consists of a relative large sample for each month of the year. Table 1 shows the sample composition on the month of interview for the three different regions (North, Center, and South) of Mozambique for rural households. Even disaggregated by month and region, the sample still contains more than 100 households in each cell except for the month of June 2003 and a few cases in the South.

Households sampled at different times during the year naturally leads one to ask if there exist systematic differences in household characteristics related to the time of interview. A number of reasons could underlie systematic variation in household characteristics by season (other than improper sampling). For example, seasonal migration between rural and urban zones might result in smaller household sizes when rural labour demands are low. Similarly, if men are more likely to migrate than women, one would expect to find more households headed by women in the post harvest (migration) season.

Table 2 shows the mean of basic household characteristics including household size, gender of household head, and age of household head for the sample distributed by month. Only the household size in July is significantly different from the mean at a 5 percent level. The larger mean household size is not matched by a correspondingly lower household size in urban areas, suggesting that if any movement of people from urban to rural areas in July takes place it is not picked up in the data. We conclude that the sample is sufficiently homogenous to consider the issue of seasonality in calorie intake.

While the data set is relatively well suited to the task of analysing seasonality, it is not perfect. For instance, due to data limitations, we do not consider intra-household allocation issues. These are clearly important as pointed out in a growing body of literature (see for example Chiappori (1988, 1992), Chiappori & Bourguignon (1992), Browning *et al* (1994)). Lacking data on intra-household allocations, the results presented here can be interpreted as a lower bound on the fluctuations the worst off individual member of a given household might face. For example, if bargaining power differs across members, some members might be able to maintain food intake despite declines in aggregate availability; however, aggregate availability limits would then dictate that remaining members must curtail consumption more than the average.

Maize Prices and Calorie Consumption

Figure 1 illustrates maize prices through time. The Figure depicts two series: a national average series, which is a simple average of available provincial price observations, and a price series from Sofala province, which is in the central region. Both series are in nominal local currency terms. The Sofala and the national series are qualitatively similar. Both illustrate substantial intra-seasonal variation in prices. The price peak typically occurs in January or February even though the primary maize harvest typically begins two to three months later. The early peak is due to the appearance of other crops, not least green maize, which is consumed directly. The price trough normally occurs in May or June.

As indicated earlier, intra-seasonal price swings are substantial. Using the Sofala series, from trough to peak within a single marketing year, maize prices usually increase by a factor of at least two and, in one instance, increased by a factor greater than four. These price swings are potentially important as maize is the largest single source of calories for the large majority of the population.

Table 3 presents mean calorie consumption per capita by month. Figure 2 builds upon Table 3 and shows deviations from the yearly mean calorie consumption for each month together with the 95 percent confidence interval. The solid line in Figure 2 is a fitted second degree polynomial. The picture emerging from Figure 2 is roughly consistent with the observed maize price patterns. As might be expected from the price data, January and February are lean months while consumption during the harvest months of May and June is relatively high. The high value in October corresponds with the initiation of the planting season.

The data presented in Figure 2 can be interpreted in at least two ways. At the national level for rural households, the difference in calorie consumption in January (the trough) and October (the peak) is large and statistically significant, indicating substantial seasonality in consumption. On the other hand, only one month, October, is statistically significantly different from mean annual consumption, indicating relatively little movement away from the average. These tendencies are investigated in more detail in the following sections. The approach for more detailed analysis is presented first.

Methodology

The purpose of our investigation of seasonality in rural Mozambique is twofold. We want to examine the extent and magnitude of seasonality in Mozambique and we seek to identify determinants of vulnerability to seasonality at the household level. We propose two different strategies to shed light on these objectives.

Extent of seasonality

As discussed in the data section, we believe that the sample composition is fairly similar in each month, thus, enabling us to obtain an estimate of average per capita calorie consumption by averaging all observations in a given month as in Table 3 and in Figure 2. However, in order to take into account differences in the sample composition and possibly to obtain more precise estimates of the variation in monthly calorie consumption, we specify the following regression model:

(1) $$\log(calpc_i) = \alpha + \beta \cdot month_i + \gamma \cdot region_i + \delta \cdot hhcontrols_i + \varepsilon_i,$$

where $calpc_i$ is calorie consumption per person in household i and $month_i$ is a vector of monthly dummy variables. $region_i$ is a vector of regional (province) dummies. The vector $hhcontrols_i$ contains a series of household control variables. The household control variables include: household non-food expenditure, household composition, household size squared, dummy variables indicating presence of literate female and literate male in the household, household employment in agriculture, the dependency rate, presence of a market and village accessibility (by road). After controlling for other factors, the main interest is in the estimates of the monthly dummy variables. We estimate (1) for the full sample of rural households and for the three regions: South, Center, and North.

Household determinants of the magnitude of seasonality

The goal in this section is to pinpoint factors related to the size of the seasonal variability – the amplitude of the swing from the lean to the good season. A straightforward way would be to augment equation (1) with interaction terms between the monthly dummies and any variables thought to be related to household ability to smooth calorie consumption during the year. However, since each variable added would generate another 12 interaction terms, this approach has limitations.

Instead, we parameterise the shape of the seasonality. In general, we specify the following regression model:

(2) $$\log(calpc_i) = \alpha + \beta \cdot level_i + \delta \cdot amplitude_i \cdot f(day_i, start_i) + \varepsilon_i \ ,$$

where $level_i$ is a vector of household, commune and/or region specific factors influencing the (average) level of calorie consumption. In principle this would be the region and household level controls specified in equation (1). Variables thought to affect the amplitude or swing of the seasonal cycle are included in the vector $amplitude_i$. This might include commune, district and region specific variables as well as variables at the household level. Each element in the amplitude vector is multiplied by a function, *f*, having a value determined by household *i*'s location in the season, where day_i, the day of the interview (January 1st is set equal to one) and *start* indicates households *i*'s location in the agricultural cycle. The function, *f*, is approximated using the *sin-function* in the interval from 3/2pi to 7/2pi.[5] The trough in the agricultural season is permitted to vary between the North, Center and South. An implicit assumption imbedded in equation (2) is that the variables in the amplitude vector have the same relative effect throughout the agricultural cycle.

The main assumption behind this approach is that all households face the same form of seasonality, however, the timing and amplitude can be region and household specific. In particular, this permits investigation of the relationship between household characteristics and the magnitude of the seasonal cycle. The specification also permits, for example, analysis of whether infrastructure investment in rural areas dampens seasonality.

The functional form of *f* is specified as follows:

(3) f(day, start)=sin[3/2pi+(day+dr1+dr2+dr3)*2pi/365]/2+1/2

where dr1-dr3 are regional dummies allowing for different start dates of the cycle. Day is day of year (i.e. January 1st equal one). Since the sin function is cyclical with periods of 2pi the regional dummies are only identified up until multiplies of 365. The function, *f*, takes values in the interval [0,1]. Thus, for a given household, the subpart of equation (2) defined as $\alpha+\beta*level_i$ would be the expected level of calorie consumption in the leanest period.

The error term follows, by assumption, a normal distribution with mean zero and unknown variance facilitating estimation via maximum likelihood. Survey design effects and clustering of the data are accounted for by assuming independence of the error term between but not within clusters.

Estimations and Results

For the estimation, the sample is restricted to those rural households with calorie information for the entire amount spent on food (about 95 percent of observations). In order to remove outliers and extreme observations, we further trim the sample by removing the 5 percent highest and lowest observations on calorie intake in each month. This trimming procedure is also performed for specific sub-samples of the data (such as the Northern region).

Existence of seasonality

To spell out regional differences we estimate equation (1) on four different samples – one for the North, Center, and South of the country and one for the full rural sample. Table 4 presents the results. Before turning to the issue of seasonality, estimates of the other explanatory variables are briefly discussed. Excepting the Central sub-sample, the quadratic specification of log non-food consumption is significant implying a decreasing income elasticity of calorie consumption. This finding is well established in the literature (Deaton & Paxson 1998, Subramanian & Deaton 1996 and Abdulai & Aubert 2004). With respect to household size, one additional member in the household decreases calorie consumption per capita holding per capita expenditure fixed. While this is harder to reconcile theoretically (see Deaton & Paxson 1998 for a discussion), it is commonly found in empirical studies.

Despite controls for income and other household characteristics, female headed households consume on average fewer calories, although this is only significant in the Central region. There is only a very weak effect of education and literacy, and it generally has the opposite sign of what one would expect a priori. In the North, being employed in the agricultural sector (the large majority of the sample) has a strong negative effect.

Turning to the estimated monthly dummies which represent seasonality, note that, due to the logarithmic specification, the coefficients are (approximate) percentage deviations from January calorie consumption. As is often the case in Mozambique, the South is distinct from the Central and Northern provinces. In the South, the coefficients on the monthly dummies are generally smaller and often differ in sign relative to the Center and the North. The Center and North of the country have similar coefficients to some degree of magnitude, notable exceptions being the months of March and April.

Figure 3 shows a panel of four figures illustrating the estimated monthly dummies together with a second degree polynomial fit. The Figure reveals no consistent pattern of seasonality in the Southern region of rural Mozambique. In Central Mozambique, calorie consumption is lowest in January and February, increasing until post harvest in August and then decreasing towards the end of year. As Figure 3 illustrates, there is a marked seasonal pattern in the four provinces of Central rural Mozambique. Also, it is worth noting the size of the coefficients. Similar to the results from Figure 2, around 40 percent more calories are consumed in good months compared to January and February. Seasonal patterns are less clear in the North. The point estimate for January is the lowest value as in the Center, but the estimates for the immediate post-harvest months do not differ significantly from the January trough. Notably, October, the primary planting month, has a very high value likely reflecting energy needs during this strenuous period.

The full sample illustrates a mix of the three regions. While there clearly are signs of some seasonality in the country as a whole, it is important to keep in mind that this disguises significant regional differences. The Centre region manifests significant seasonal variation. This corresponds with the highest degree of dependence on maize and sorghum in the diet. The cost share of maize and sorghum (grains and derived products) in total food expenditure for rural dwellers living at or below the poverty line is approximately 31% for Sofala and Zambezia and 52% for Manica and Tete. The Northern region exhibits a much less pronounced seasonal pattern. At the same time, dependence on maize and sorghum in the diet is much lower. In the most populous Northern province (by far), Nampula, maize and sorghum (and derived products) represent only 14% of total food costs of rural dwellers. For the South, maize and sorghum represent even smaller cost shares. Correspondingly, no seasonal patterns emerge.

Household determinants of the magnitude of seasonality

As discussed, equation (2) contains both level and magnitude vectors. The linear combination of the magnitude vector is multiplied by the sin function. Hence, larger values of the coefficients in the magnitude vector indicate agreater amplitude of seasonality. The magnitude vector contains the same elements of levels vector except that the household demographic composition variables are collapsed into one household size variable and female and male secondary education variables are dropped.

Equation (2) hinges upon the existence of a stable seasonal pattern. As a result, we confine estimations for Equation (2) to the Central region. Various additional criteria on the final sample were imposed. For the results presented, we limit our focus to households consuming between 1,500 and 3,000 calories per capita per day. Clearly, in terms of issues of food security and poverty, households consuming less than 1,500 calories are equally - if not more – important. However, an unknown and potentially large proportion of these households may be suffering from the effects of negative shocks not related to seasonality thus potentially adding considerable noise to the data. Households consuming more than 3,000 calories a day are likely to be well-off households whose calorie consumption does not fluctuate seasonally. Finally, we exclude households with household size greater than 10. The analysis, thus, focuses on households in the Central region who live relatively near the poverty line and are of roughly average size. This criterion yields a sample of 651 households.

The change in the definition of the sample is likely to affect the seasonal magnitude but the pattern should remain relatively unchanged. Figure 4 illustrates seasonality in the logarithm of per capita calorie consumption for the reduced sample. Peak season (June, July average) calorie consumption is about 10 percent higher than the trough (January, February average). As low calorie consuming households are more likely to have been left out of the reduced sample in lean months – and similar for high calorie consuming household in peak months, we interpret this number as a lower bound. The sample size is approximately equally distributed over the year.

Table 5 shows Equation (2) estimated with nine different configurations of the variables. Regression 1 in Table 5 shows Equation (2) estimated with the full set of variables. Regressions 2 to 9 show various specifications of the magnitude vector. These are presented in an attempt to gauge the robustness of total consumption and household size in the magnitude vector.

Regression 2 includes only a constant in the set of magnitude variables. The implicit assumption is that seasonality is not affected by household characteristics. The coefficient has the expected sign and is significantly different from zero. The value corresponds to a seasonal peak around 10 percent higher than the lean season level, which is consistent with the average reported above. By calculating the predicted value of the lean season level and comparing it to the average level in January and February in the sample, we can get an idea of how well the model predicts lean season calorie consumption. The estimated and predicted levels of calorie consumption per capita are respectively 2,138 and 2,055 calories per capita per day.

Results from the other regressions often provide the expected signs on effects; however, these effects are rarely statistically significant. For example, regressions 3 and 4 investigate the effect on the magnitude of seasonality of household size and higher total non-food consumption. As expected, the point estimate for the coefficient on non-food consumption is negative indicating a dampening effect on the magnitude of seasonality. The linear specification in Regression 3 indicates a (significant) negative coefficient on non-food consumption. For the quadratic specification in Regression 4, the turning point occurs at very low levels of non-food consumption but statistical significance is lost. Regressions 5 to 9 keep the total consumption and household size variable in the specification and test the behaviour of other potential variables of interest.

According to point estimates, existence of a road (Regression 5) and being employed in agriculture (Regression 9) have a negative effect on the magnitude of the seasonal swings in calorie consumption. Female headed households are better at smoothing consumption over the year (Regression 6) than their male equivalents. Note that including the female dummy in the magnitude vector causes the sign in the level vector to change. In terms of smoothing consumption over the season, having a literate male in the household is more effective than having a literate female (Regression 7). Note again that the literate male coefficient in the level vector changes sign. Finally, Regression 8 explores the effect of the dependency ratio on the seasonal variation in calorie consumption. A higher dependency ratio causes larger variation in calorie consumption over the season.

These effects, while mostly logical, are not statistically significant. Less restricted samples of households in the Central region (e.g., broader ranges of calorie consumption and larger household sizes permitted) yielded the same qualitative results. Overall, despite careful analysis as well as attempts to focus on a population where seasonal patterns in consumption are most likely to reveal themselves, no robust determinants of seasonality are identified.

Conclusions and suggestions for future research

The analysis presented above leads to the following conclusions:

- Seasonal patterns of calorie consumption for rural households in Mozambique differ by region. Calorie consumption of rural households in the Central provinces exhibit identifiable seasonal patterns and the variation in calories is pronounced. On the other hand, no identifiable seasonal patterns exist for households in the South. The evidence for a well-defined seasonal trend in calorie consumption in the North is weak. These results correspond with regional differences in the degree of dependence on maize and sorghum as a staple food.
- For the Central region, the consumption pattern tends to roughly follow the seasonal pattern for prices for the primary staple, maize. When maize prices are

high, total calorie consumption tends to be low. At the same time, lower maize price periods tend to be associated with above average consumption.

- Some of the variation in calorie consumption appears to be related to the work load in the period in question. For example, calorie consumption during the planting season tends to be high in the North in particular.
- Determinants of seasonality are difficult to ascertain. Even for the Central provinces, where seasonal patterns in calorie consumption reveal themselves clearly, no robust determinants of seasonality in calorie consumption are identified.
- While seasonal patterns are pronounced in the Central region, the majority of the rural population (those who dwell in the South and North) appear to be able to smooth consumption reasonably efficiently over the agricultural season.

A promising area for future research involves examination of the evolution of food consumption throughout the marketing season. Does the food basket vary substantially by season? Are those regions where calorie consumption smoothing tends to be relatively successful associated with greater or lesser shifts in the food basket over the course of the season? Answers to these questions would help to inform policies for stabilizing consumption such as the choice between broadening the number of crops produced and/or augmenting storage capability for rural dwellers.

References

Abdulai, A. & Aubert, B. (2004). 'Nonparametric and parametric analysis of calorie consumption in Tanzania', *Food Policy*, Vol. 29, No. 2, pp. 113-129.

Behrman, J.R. & Deolalikar A.B. (1989). 'Seasonal Demands for Nutrient Intakes and Health Status in Rural South India'. In D. E. Sahn (ed.) *Seasonal Variability in Third World Agriculture*. John Hopkins University Press, USA.

Chiappori, P.A. (1992). 'Collective labour supply and welfare', *Journal of Political Economy*, 100, pp. 437-67

Bourguignon, F. & Chiappori, P.A. (1992). 'Collective models of household behaviour: an Introduction', *European Economic Review* 36, pp. 355-65

Bourguignon, F., Browning, M., Chiappori, P.A. & Lechene, V. (1994). 'Incomes and Outcomes: Structural Model of Intra-Household Allocation', *Journal of Political Economy,* pp. 1067-97.

Deaton, A. (1997). '*The Analysis of Household Surveys – A Microeconometric Approach to Development Policy*', John Hopkins University Press, World Bank.

Deaton, A. & Paxson, C. (1998). 'Economies of Scale, Household Size, and the Demand for Food', *Journal of Political Economy*, Vol. 106, No. 5, pp. 897-930.

Dercon, S. & Krishnan, P. (2000). 'Vulnerability, Seasonality, and Poverty', *Journal of Development Studies,* Vol. 36, No. 6, pp. 25-53

Dostie, B., Haggblade, S. & Randriamamonjy, J. (2002). 'Seasonal poverty in Madagascar: magnitude and solutions', *Food Policy*, Vol. 27, pp. 493-518.

Guyer, J. (1989). 'From Seasonal Income to Daily Diet in a Partially Commercialized Rural Economy (Southern Cameroon)'. In D. E. Sahn (ed.) *Seasonal Variability in Third World Agriculture*. John Hopkins University Press, USA.

Handa, S. & Mlay, G. (2004). 'Food Consumption Patterns, Seasonality, & Market Access in Mozambique'. Working Paper, obtainable from http://www.unc.edu/~shanda/research/market_access_handa_mlay_fp_v2.pdf.

INE (Instituto Nacional de Estatistica). (2004). 'Inquérito aos Agregados Familiares: 2002-03', Maputo.

Kumar, S.K. (1988). 'Effect of Seasonal Food Shortage on Agricultural Production in Zambia', *World Development*, Vol. 16, No. 9, pp. 1051-1063.

Lawrence, M., Lawrence, F., Cole, T.J., Coward, W.A., Singh, J. & Whitehead, R.G. (1989). 'Seasonal Pattern of Activity and Its Nutritional Consequence in Gambia'. In D. E. Sahn (ed.) *Seasonal Variability in Third World Agriculture*. John Hopkins University Press, USA.

Longhurst, R. & Lipton, M. (1989). ‘The Role of Agricultural Research and Secondary Food Crops in Reducing Seasonal Food Insecurity’. In D. E. Sahn (ed.) *Seasonal Variability in Third World Agriculture*. John Hopkins University Press, USA.

Pinstrup-Andersen, P. & Jaramillo, M. (1989). ‘The Impact of Drought and Technological Cahnge in Rice Production on Intrayear Fluctuations in Food Consumption: The Case of North Arcot, India’. In D. E. Sahn (ed.) *Seasonal Variability in Third World Agriculture*. John Hopkins University Press, USA.

Reardon, T. & Matlon, P. (1989). ‘Seasonal Food Insecurity and Vulnerability in Drought-Affected Regions of Burkina Faso’. In D. E. Sahn (ed.) *Seasonal Variability in Third World Agriculture*. John Hopkins University Press, USA.

Subramanian, S. & Deaton, A. (1996). ‘The Demand for Food and Calories’, *Journal of Political Economy*, Vol. 104, No. 1, pp. 133-162.

Tschirley, D.L. & Weber, M.T. (1994). ‘Food Security Strategies Under Extremely Adverse Conditions: The Determinants of Household Income and Consumption in Rural Mozambique’, *World Development*, Vol. 22, No. 2, pp. 159-173.

Von Braun, J. (1988). ‘Effect of Technical Change in Agriculture on Food Consumption and Nutrition: Rice in a West African Setting’, *World Development*, Vol. 16, No. 9, pp. 1083-1098.

Tables

Table 1. Number of Household Interviewed

Month	*Total Rural*	*North*	*Central*	*South*
Jan 03	402	138	174	90
Feb 03	348	117	123	108
Mar 03	426	138	162	126
Apr 03	393	96	171	126
May 03	408	156	153	99
Jun 03	171	72	54	45
Jul 02	502	126	241	135
Aug 02	351	135	117	99
Sep 02	441	135	153	153
Oct 02	429	126	195	108
Nov 02	414	153	153	108
Dec 02	410	102	228	80
Total	4,695	1,494	1,924	1,277

Table 2. Summary Statistics

Month	*Household size*	*Age of head*	*Female headed households (%)*
Jan 03	4.6	43.1	26
Feb 03	5.0*	44.3	26
Mar 03	5.0*	43.5	28
Apr 03	4.6	43.4	28
May 03	4.6	45.6*	24
Jun 03	4.7	44.5	23
Jul 02	5.1**	43.3	29
Aug 02	4.5*	44.7	29
Sep 02	4.8	44.8	28
Oct 02	4.8	42.8	29
Nov 02	4.5*	43.7	25
Dec 02	4.8	43.3	23
All	4.7	43.9	27

Notes: ** / * denotes significant difference from the mean at respectively 5 and 10 percent. Based on two-tailed T-test.

Rural sample only.

Table 3. Mean Household Calorie Consumption

Month	*Estimate*	*95 percent confidence interval - upper*	*95 percent confidence interval - lower*
Jan 03	1.98	2.28	1.67
Feb 03	2.13	2.59	1.67
Mar 03	2.32	2.55	2.08
Apr 03	2.12	2.41	1.84
May 03	2.33	2.51	2.15
Jun 03	2.33	2.73	1.92
Jul 02	2.1	2.36	1.84
Aug 02	2.25	2.5	2.01
Sep 02	2.24	2.44	2.05
Oct 02	2.62	3.0	2.24
Nov 02	2.27	2.52	2.02
Dec 02	2.23	2.53	1.93

Error! Not a valid link.

Error! Not a valid link.

Error! Not a valid link.

Error! Not a valid link.

Figures

Figure 1. Maize Price Series

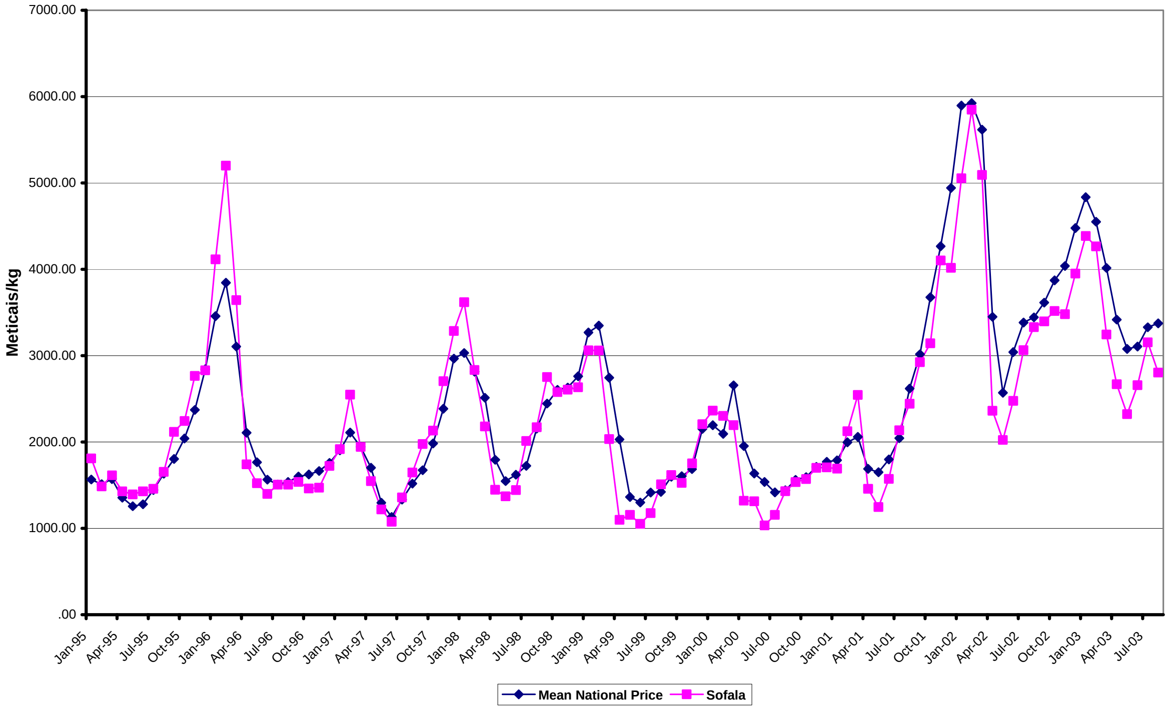


Figure 2. Deviations from Year-Mean in the Logarithm of Calorie, 2002-03

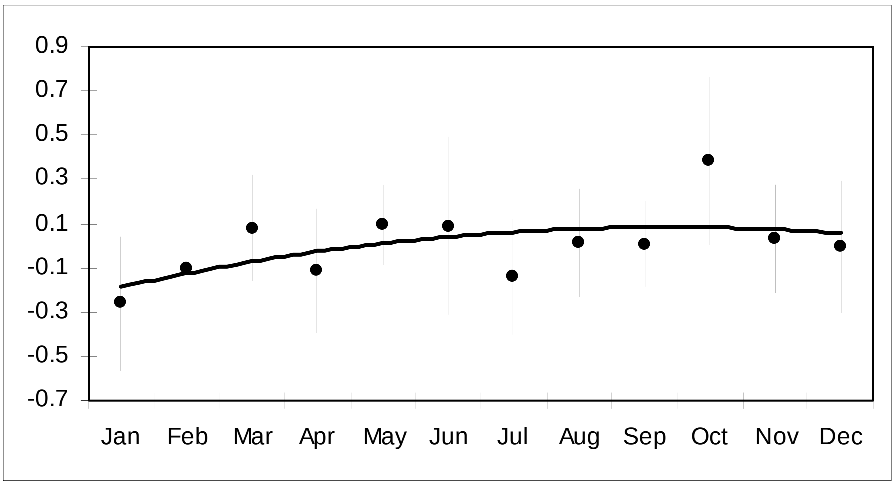
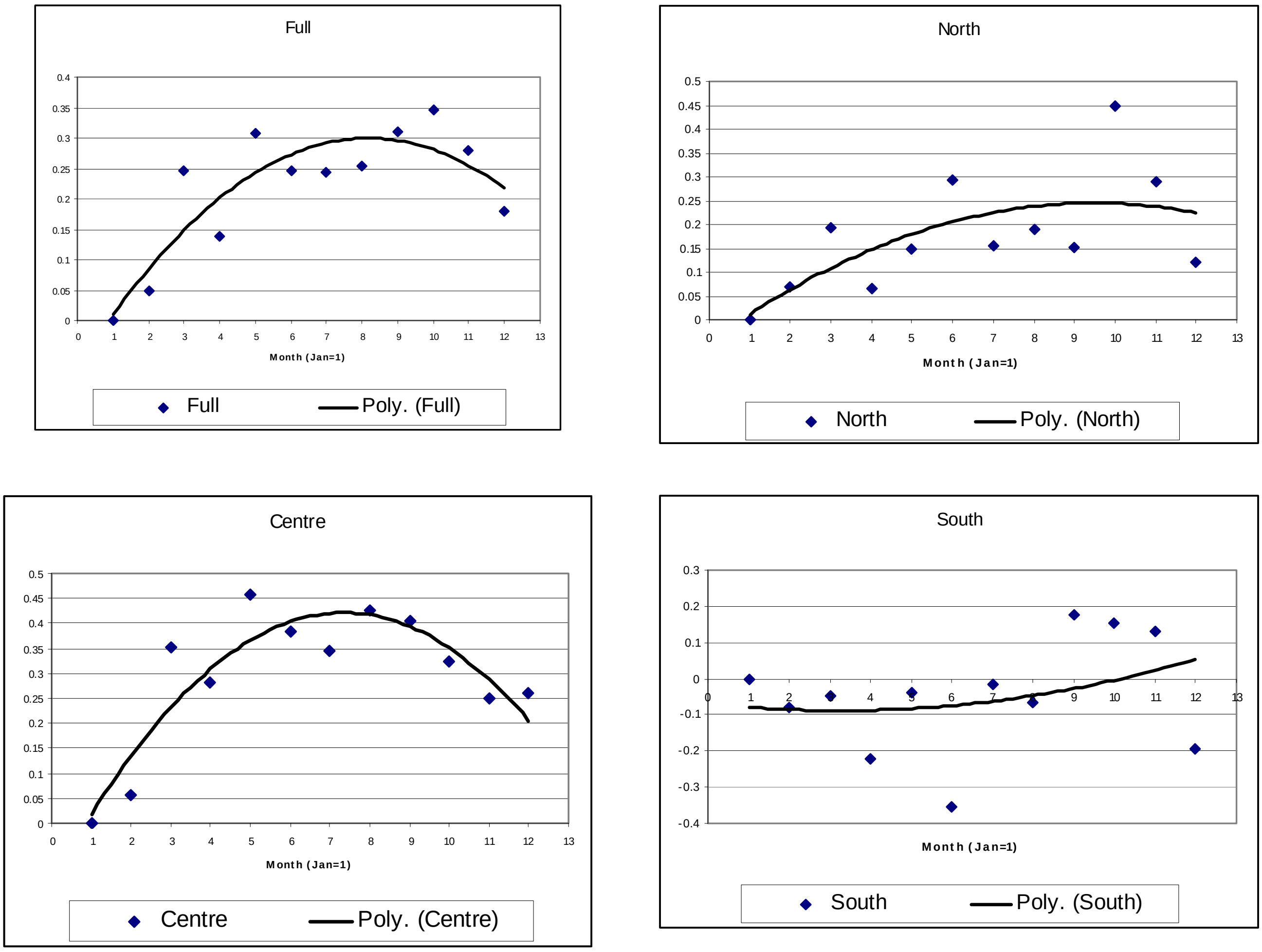
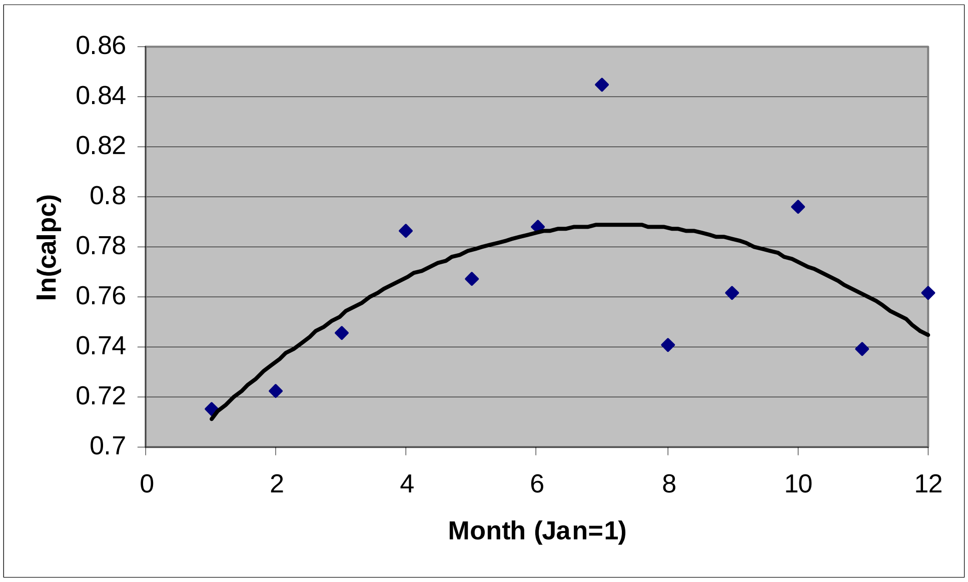


Figure 3. Estimated Monthly Dummies Equation (1)



Note: Estimations done on relevant sub-samples with provincial dummies.

Figure 4. Log of Calorie Consumption Per Capita for Sample Used in Equation (2)



Note: The line represents a quadratic trend.

Endnotes

[1] Examples of studies of seasonal fluctuations in household food intake in Asian countries using nationally representative data sets include Pinstrup-Andersen & Jaramillo (1989) and Behrman & Deolalikar (1989).

[2] Dostie, Haggblade & Randriamamonjy (2002) rely on demand models and price data to simulate seasonality.

[3] A verification survey of 78 households was undertaken. Of these, the large majority indicated that they had been interviewed three or more times. Three households indicated that they had only been interviewed once.

[4] The approach also has the advantage of relying on a reduced number of enumerators for a longer period of time. This reduces enumerator training needs and allows selection of higher quality enumerators.

[5] Keeping in mind that: sin(3/2pi)=–1, then increasing until 5/2pi, where sin(5/2pi)=1. Thereafter decreasing such that sin(7/2pi)= −1. Of course, given the cyclical behaviour of the sin function it makes no difference which interval we use as long as it has length 2pi and start where sin() is equal to −1.