Price trends and income inequalities: will Sub-Saharan-Africa reduce the gap?

Francesco Caracciolo and Fabio Gaetano Santeramo

University of Naples "Federico II"

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Abstract

During the past decade, commodities prices have risen substantially and the trend is likely to persist as attested by recent OECD-FAO projections. The recent debate has not reached a clear consensus on the effects of this trend on poverty and income inequality in LDCs, thus complicating the policy planning process. Our paper aims at analyzing the likely welfare and income inequality impacts of food price trends in three Sub-Saharan countries, namely Tanzania, Ghana and Ethiopia. Moreover, we test the statistical significance of changes in income inequalities. Despite Tanzania is not affected, we find that price changes tend to exacerbate the income inequalities in Ethiopia and Ghana, especially for specific groups of households: the policy implications are relevant. Finally, our paper underlines the relevance of statistical inference in analysis on income inequalities, to conclude on welfare and inequalities effects of food price movements.

Keywords:

Sub-Saharan-Africa, Price effects, Welfare, Income inequality, Generalized Entropy

JEL: D31, O12, Q12

<u>Contact information</u>:

Francesco Caracciolo, francesco.caracciolo@unina.it ; Phone: +39 – 081 2539084
Fabio Gaetano Santeramo, fabiogaetano.santeramo@unina.it ; Phone: +39 – 081 2539084

Dipartimento di Economia e Politica Agraria, Università degli Studi di Napoli Federico II,
Via Università, 96, 80055 Portici (Napoli) – Italy

Introduction

The international food price surge we have observed in recent years does not seem to fade out. It results in a widespread concern about future evolution of commodities markets with an increasing level of alarm from international institutions, and it becomes an important challenge for developing countries. Every year OECD and FAO (2010) forecast food price patterns: the majority of academic scientists discusses actively on the possible consequences and effects on households' welfare and poverty (e.g. Rapsomanikis and Sarris, 2008; Kwenda, 2010; Shimeles, 2011), while several scholars have focused on vulnerability assessments (e.g. Meade *et al*., 2007; Rasmus and Niels, 2009) as well as on nutritional impacts (e.g. Jensen and Miller 2008; Ecker and Qaim, 2011; D'Souza and Jolliffe, 2012).

With regard to the major agricultural commodities, it may be observed that the international wheat[1] price, which up to 2005 is constantly below $200/ton, in early 2008 exceeded $400, and in July 2012 was over $320/ton. By contrast, in July 2012 the maize[2] price reached $320/ton, well above the previous historical maximum of $275/ton in June 2008 (Figure 1). A leading idea among economic analysts is that, at least until 2020, most agricultural commodities will be significantly and steadily more expensive than they were in the past decade (OECD/FAO, 2012). Price dynamics affecting most agricultural commodities since 2007-2008 are due to occasional events that have become structural over time[3].

FIGURE 1 ABOUT HERE

In a scenario in which international markets evolve continuously and forecasts are rather difficult, questions related to the growth of agricultural prices and socio-economic disparities among geographical areas have rekindled debates that had been forgotten in recent years, gaining the headlines around the world. Although much has been debated at macro level, it seems that the (still uncertain) consequences of a food price spike at the household level can be dramatic and heterogeneous. Quantifying the extent and magnitude of these effects is a still open question. The impacts of agricultural price changes on poverty may be discordant and their magnitude are likely to be different depending on many aspects under consideration (Wodon *et al.*, 2008) : macroeconomic dynamics, agricultural commodity peculiarities, distribution of net food buyers and net food sellers among low-income families (Aksoy and Izik-Dikmelik, 2008), the length of the economic period. For instance, Ivanic and Martin (2008) have suggested that higher food prices could result in an increase of poverty in Nicaragua, Zambia, Pakistan and Madagascar, and in a decrease of poverty in Peru and Vietnam. According to Sarris and Rapsomanikis (2009), food price rises would increase the number of food insecure people in Zambia, Malawi and Uganda. Similar results have been showed by Ul-Haq *et al*. (2008) for Pakistan, while Polaski (2008) suggests positive effects on high food prices for the poorest households in India.

Undertainding the effects of price changes on households is still open to debate, despite some lessons from the recent literature can be already drawn. Whether high or low levels of food prices are bad for the poor, is an issue which depends on their initial conditions (Aksoy and Hoekman, 2010). In particular the impact of changes in food prices on households welfare depends on the their income sources, volume of agricultural production and sales price[4], as well as on the households adaptability to (temporary) price volatility caused by unexpected good, bad harvests, or global economic shocks. Actually, a vast majority of the poorest people in developing countries depends on agriculture, therefore higher prices can have major implications for poverty reduction (Hertel and Winters, 2006) and, in some circumstances, food price increases may improve the livelihood of some poor households (Aksoy and Izik-Dikmelik, 2008). Hence, in order to investigate the potential benefits as well as risks related to price-changes, empirical analyses at micro-level are recommended (Ivanic and Martin, 2008; Duclos and Verdier-Chouchane 2011).

From an empirical point of view, policy analysis exercises may be sensitive to economic assumptions. Key variables such as income distribution, inequalities and welfare measures are generally treated as deterministic indexes even though they are computed from a sample of households. Indeed, we cannot exclude that a source of uncertainty on the effects of food price changes on economic welfare and income distribution may be due to the stochastic nature of the underlying information. In particular, the impact of food price changes on income distribution should be assessed providing measures of indexes' variance, so as to avoid any misleading inference due to a large uncertainty around the point estimates, taking correctly into account the complex sample design of the survey (Kish and Frankel, 1974).

The present paper addresses explicitly the latter drawback. The purpose of the paper is twofold: first, it aims at providing an assessment of the impacts of food price trends on income inequality in Sub-Saharan Africa; secondly, it aims at exploring the relevance and the role of taking into account the statistical properties of inequality indexes. The analysis of welfare impacts of price changes in Sub-Saharan Africa is conducted through compensating variation. We estimated Generalized Entropy indexes, so asto assess the income distributional effects and to provide inference on statistical changes in income inequality. The study has been set on three countries, namely Tanzania, Ghana and Ethiopia. Focusing on such heterogeneous countries with respect to GDP, income distribution and poverty, we benefit from a natural framework to exploit the impacts of price changes on income inequality. The analysis is conducted using household surveys (HHS) and taking into consideration the main staple foods in the selected countries' diet and agricultural production. Our paper contributes to provide evidences on the expected welfare and income inequality effects of price changes in Sub-Saharan Africa by deepening on the relevance of taking into account the statistical inference of income distribution changes for (more efficient) policies planning.

The remainder of the paper is as follows: sections 2 is dedicated to the countries description; in section 3 we describe the households survey data, the methodological approach and the results of the analysis of welfare changes; section 4 is devoted to presenting the methodology and results of the analysis on income redistribution; the last section, summarizing the main findings, provides conclusive remarks and policy implications.

Countries description

Poverty and inequality are endemic in Sub-Saharan countries where commodity price volatility remains a deep concern (Wodon and Zaman, 2010). Sub-Saharan Africa provides also interesting evidence of the cross-country heterogeneity in terms of economic and social-cultural structure as well as in policy solutions developed to address hunger and social inequality issues. Such country-specific dimensions may have significant influence on the welfare implications of food price changes. Due to the above mentioned reasons, the analysis was performed focusing on three different countries: Ethiopia, Tanzania, and Ghana. These countries have been chosen according to the Global Hunger Index[5] (Wiesmann, 2004; IFPRI, 2010): we selected the first country within the "alarming" hunger problem group (Ethiopia), the second within the "serious" group (Tanzania) and the latter within the "moderate" hunger problem group (Ghana). The set of analyzed countries cannot be considered fully representative and exhaustive of the regional differences; however, we believe that it suffices in providing interesting results to conclude on the effects of price changes in Sub-Saharan Africa.

TABLE 1 ABOUT HERE

Table 1 provides basic macro statistics of the investigated countries. In Ethiopia and in Tanzania, agriculture and livestock production are definitely the main constituents of the national economy and in particular of the rural population which relies on small-scale farming. Differently, Ghana was recently declared a middle-income country, moving away from a totally agricultural-dependent economy.

Since 1993 Ethiopia doubled its harvested area of maize moving from 838,450 hectares to 1,768,122 hectares (FAOSTAT, 2009). Maize and wheat are the main crop for local food consumption as share of the Dietary Energy Supply (DES): the former is largely consumed in rural and urban areas, while the latter is mainly consumed in urban areas. Although food security indicators are improving more and more, poverty rates are still high, such that Ethiopia registers one of the highest GHI value in Africa. Despite the recent development, in Tanzania the contribution of the agricultural sector still accounts for a large part of the GDP (45.7%, 2007). Maize and its derivates account for one-third of total dietary energy supply, while rice is the second crop for production and consumption. Among the selected countries, Ghana has been the most beneficial from the economic liberalization since the early nineties, particularly in terms of agricultural trade. Since the last decade, the primary sector contributes for less than 40 per cent to the national GDP, despite half of the households still live in rural areas (Diao and Sarpong, 2011). The share of maize, wheat and rice account only for 17 per cent of the DES: maize is nevertheless the main staple food in rural areas, and rice is one of the main commodities for consumption in urban areas.

Welfare impacts of price changes

Methodology

A common approach to assess the impacts of price changes is to compute money-metric measures of welfare changes. Given the indirect utility function $V(p; y, \pi)$, the welfare effects of price changes can be measured through a compensating variation measure (Mghenyi *et al*., 2011):

$$V[p^0; y + \pi(p^0)] \equiv V\{p^1; (1 - m)[y + \pi(p^1)]\} \quad (1)$$

where p^0 and p' are prices at initial and new level, y is the household income deriving from all sources, except from the good for which a price change is hypothesized, π represents the profit function depending on price changes, while m is the ex post income change necessary to leave the original level of the household's utility unchanged. The variable m represents the *i-th* household change in welfare due to a price change of the *j-th* good and it depends on consumption and production shares, prices and income elasticities, risk aversion and price changes:

$$m_{i,j} = f(s_{i,j}{}^s, s_{i,j}{}^c, \varepsilon_j{}^s, \varepsilon_j{}^c, \eta_j, R_i, \lambda_j) \quad (2)$$

where $s_{i,j}^s$ and $s_{i,j}^c$ represent the shares of production and consumption of household i for the *j-th* good, ε_j^s, ε_j^c and η_j are the aggregate own price elasticities of supply and demand and the income elasticity of the *j-th* good, R_i represent the household's coefficients of relative risk aversion (RRA) and $\lambda_j = \left(\frac{P_j^1 - P_j^0}{P_j^0}\right)$ are the *j-th* post-change percentage price changes, based on market clearing prices. In order to consider a reasonable and realistic scenario of price changes per crop and per country, time-series projections of the 2011-2020 OECD - FAO Agricultural Outlook have been included. Food price changes at country level (macro level) are therefore exogenous and obtained tout court from AGLINK-COSIMO[6]. In particular, the baseline P_j^0 are observed in 2011, whilst P_j^1 refer to the forecasted prices in 2020. As concerns elasticities parameters (η_j ,ε_j^s and ε_j^c), we consider a range of values from several empirical studies (e.g. Teklu, 1996, Danielson, 2002; Seale *et al*., 2003; Thiele, 2003; Abdulai and Dominique, 2004). The bundle of goods included, for each of the considered country, contains wheat, maize (including other cereals), and rice. Following Myers (2006) and Mghenyi *et al*. (2011), we compute the individual welfare change $m_{i,j}$ by taking its second-order Taylor series approximation:

$$m_{i,j} \approx (s_{i,j}^s - s_{i,j}^c)\lambda_j - \tfrac{1}{2}[s_{i,j}^s\varepsilon_j^s - s_{i,j}^c\varepsilon_j^c]\lambda_j^2 + \tfrac{1}{2}\left\{(R_i - \eta_j)\left[(s_{i,j}^c)^2 - 2s_{i,j}^c s_{i,j}^s\right] + R_i(s_{i,j}^s)^2\right\}\lambda_j{}^2 \qquad (3)$$

The first term represents the short-run effect of price changes, depending on production values cleaned out by consumption. The second term (in square brackets) represents the long-run effect which relies on household adaptation strategies. The third term is the indirect effect of price changes weighted by household's income elasticity and risk aversion. The weighted sample mean of the welfare change ($M = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_i m_{i,j}}{\sum_{i=1}^{h} w_i}$) are calculated for each population subgroup and for the total population by summing over the h households and the n goods the (partial) welfare changes and by dividing by the sum of sample weights (w_i). Moreover, in order to assess whether risk aversion would influence welfare (re)distributional changes, we adopt an expo-power utility function (Saha, 1993; Moschini and Hennessy, 2001; Serra *et al*., 2006) of household's income ($y_i + \pi_i(p^1)$) to compute welfare changes under decreasing relative risk aversion (DRRA). Therefore we assume high-income households are (relatively) less risk averse[7]. According to Ogaki and Zhang (2001) poor households tend to be not willing to face any risk: thus, the RRA coefficient would be a decreasing function of wealth[8].

The effects of price changes on households' welfare may be threefold (Aksoy and Hockman, 2010). Firstly, they might affect household food expenditure and diet composition depending on demand elasticity; secondly, they might influence returns from farming as much as the household is directly engaged in the agricultural activities; lastly, demand for labor and wages in agricultural sector might be affected. Moreover, food price changes might increase or decrease investments in agricultural sector and changing farm productivity.

Survey data description

Statistically representative samples of households are used to distinguish among different household types and evaluate how their incomes respond to changes in prices. Given the critical relevance of data timeliness, we put much effort to investigate the most recent and freely available data; the datasets employed here are derived from rather homogeneous, nationally representative household surveys, prepared to study households' living conditions and poverty issues in developing countries. For Ethiopia, data are collected from the survey conducted by the Central Statistical Agency and disseminated in August 2005. The dataset contains 25,917 households and covers both the urban and the sedentary rural parts of the country (CSA, 2007). In Tanzania, the data come from the 2000-2001 Tanzanian Household Budget Survey (HBS), conducted by the National Bureau of Statistics. It covers more than 22,000 households across all the twenty regions of Tanzania mainland (NBS, 2001). The Ghana Living Standards Survey IV was carried out in 1999 by the Ghana Statistical Service (GSS), in collaboration with the World Bank. The survey ensures representative statistics at the provincial level, including a sample of 5,988 households[9].

The information have been made as much comparable as possible across countries and years. In some circumstances, the standardization process led to non-perfectly comparable concepts (for example, periods of recall ranges from one week in some countries to one year in others, to calculate agricultural incomes or food expenditures), while the most sensitive data homogenization process has concerned the categorization of the produced and consumed food items, between aggregated food categories (wheat, maize and rice), and the agricultural and food items included in each HHS.

As already stated, changes in income inequality depend on specific household characteristics, such as sources of income and relative diversification, dependence on the production and sale of agricultural products, and the degree to which the household is a net purchaser of food products. Households decomposition in different mutually exclusive sub-groups provides insights into the redistributional effects of price changes among the various homogeneous classes of households (Mulenga and Van Campenhout, 2008). In our study, households have been divided in homogenous groups by income sources and labour allocation, according to a largely adopted criterion (Hertel *et al*., 2007). The six households groups are distinguished on the basis of the main households income sources:

a. Agricultural enterprises (divided in small and large scale farmers[10]);
b. Non-agricultural enterprises;
c. Labour and wages;
d. Transfer (household remittance income or public transfer);
e. Diversified source of income for households in rural areas;
f. Diversified source of income for households in urban areas.

Welfare changes

Equation (3) was applied to compute welfare changes due the price trends. Household data have been weighted, in order to be statistically representative of the analyzed countries.

TABLE 2 ABOUT HERE

Table 2 reports parameters values. Supply elasticities range from 0.28 to 0.85, coherently to previous researches on supply response in Africa. Demand elasticities suggested by previous researches span from -0.65 to -0.98, depending on country and commodity, and estimates of income elasticities range from 0.39 to 1.24[11]. Price changes (λ_j), calculated from OECD-FAO forecasts, indicate prices will rise in all but one case: the price of rice in Tanzania is forecasted to slightly fall. In all other cases, ex-post price changes are around 0.5. Consumption and supply shares are calculated for each country and commodity: wheat, maize and rice are the main sources of calories and/or the main source of income in agriculture. Lastly, the coefficients of relative risk aversion are computed through the expo-power function and normalized in order to range from zero to 3 (Meyers, 2006).

TABLE 3 ABOUT HERE

Results on welfare effects of price changes are reported in table 3. In all cases the model forecasts an overall negative welfare change. The results are particularly negative for Ethiopia (-38.3%), the country with the lowest income levels and the largest dependency on agriculture. The welfare in Tanzania is slightly affected (-2.1%), while for Ghana we assessa -10% welfare change on average.

Household's area of residence (urban or rural) and income diversification leads to social welfare effects in different directions and to differing degrees. The reason for this distinction lies in the fact that net consumers of agricultural products are concentrated in urban centres, while in rural areas - where there is a greater number of poor families and few occupational alternatives - the category of producers-consumers is concentrated. Secondly most of the benefits fall on the producers with the largest agricultural production -and most likely with the higher income (Mellor, 1978).

In order to empirically investigate the income (re)distributional changes, new income levels (t_1) are computed by applying the welfare changes to the baseline. A preliminary graphical analysis through kernel densities shows that income changes are rather minimal for Tanzania and Ghana (Figure 2). On the contrary, the income distribution in Ethiopia shifts on the left, coherently with our previous results.

FIGURE 2 ABOUT HERE

As far as households strata are concerned, increases in price levels should benefit producers and penalize consumers. Such a statement is true for Tanzania, where large agricultural enterprises' gain is around 5 percent (Table 3). Moreover, large and small agricultural farmers, accounting respectively for 12 percent and 18 per cent of the total population, are the only winners. In Ethiopia and Ghana, on the contrary, small agricultural enterprises - accounting respectively for 48 per cent and 28 per cent of the total population - are big losers.

In general, households receiving transfers, which represent a small proportion of the total population, face substantial losses (-7% in Tanzania, -45% in Ethiopia and -16% in Ghana). Such negative outcomes are probably due to the independency of their income sources from agriculture, while their consumption expenditure is largely affected by staple food prices changes. A further difference to be highlighted is the impact on households with diversified income sources and classified as rural or urban: the former are penalized in Ethiopia, the latter in

Tanzania, while in Ghana both categories seem less penalized by food price changes.

Income (re)distribution and inequality indexes

Methodology

Welfare changes, measured through a compensating variation formula, suggest that price changes are not neutral in Sub-Saharan Africa. From a policy perspective, welfare changes in Least Developed Countries (LDCs) are important for poverty and income inequalities implications[12] (Peters, 2006). In this section, we investigate the latter issue by referring to a broad class of inequality indexes: the Generalized Entropy (GE) and the Atkinson indexes. Those statistics, widely adopted in analyses of economic inequalities (see Cowell 2000 for a survey), are able to provide a measurement of income distribution under different assumptions of inequality aversion and provide similar results to newer measures of inequality (Zhang and Kanbur, 2001). The GE index is given by:

$$I_{GE}^{\alpha}(F) = \frac{1}{\alpha^2-\alpha}\int\left[\left[\frac{y}{\mu(F)}\right]^{\alpha} - 1\right]dF(y) \qquad (4)$$

where F and $\mu(F)$ are respectively the income distribution function and the mean income, y represents the individual income in the baseline period or in period one, and $\alpha \in (-\infty, +\infty)$ is a parameter indicating the sensitivity of GE to upper or lower tails of distribution: for > 0, the index is very sensitive to distributional changes affecting the upper tail (that is high income households); for $\alpha < 0$, the index is sensitive to changes in the lower tail (that is low income households). The Atkinson index is as follows:

$$I_{A}^{\varepsilon}(F) = 1 - \frac{1}{\mu(F)}\left[\int y^{1-\varepsilon}dF(y)\right]^{\frac{1}{1-\varepsilon}} \qquad (5)$$

where $\varepsilon \geq 0$ represents the relative inequality aversion[13], and it is ordinally equivalent to the GE index if $\alpha = 1 - \varepsilon$. In particular, the two indexes can be transformed into one another through a simple formula: $I_{GE}^{\varepsilon}(F) = \frac{[1-I_A^{\varepsilon}(F)]^{\alpha}-1}{\alpha[\alpha-1]}$. The two indexes rely on axioms which ensure several desirable properties such as the principle of transfers, decomposability and the income homogeneity[14].

Price changes might have controversial impacts on income distribution in terms of sign and magnitude and is well known that inequality indexes can be largely affected by organization of surveys data (for example clustering, weighting, and so forth). Hence, following Biewen and Jeankins (2006), GE indexes and their variability are estimated in order to perform robust inference. This approach allows to test for statistical differences of inequality changes from the baseline period to period one (post-forecasts price changes) taking correctly into account the survey design complexity. In particular, the approach consists in computing GE (or Atkinson) indexes through the sample estimation of two statistics in which they can be decomposed, $U_{\alpha} = g(wy^{\alpha})$ and $T_{\alpha} = g(wy^{\alpha} ln(y))$ with w being the sampling weight, in order to estimate the variance of $\hat{I}$:

$$\widehat{var}(\hat{I}) = \sum_{i=1}^{n} \left(\sum_{j=1}^{m_i} w_{ij} \widetilde{s_{ij}} - \frac{\sum_{i=1}^{n} \sum_{j=1}^{m_i} w_{ij} \widetilde{s_{ij}}}{n} \right)^2 \qquad (6)$$

where $\widetilde{s_{ij}^{GE}} = \frac{1}{\alpha} \hat{U}_{\alpha} \hat{U}_1^{-1} \hat{U}_0^{\alpha-2} - \frac{1}{\alpha-1} \hat{U}_{\alpha} \hat{U}_1^{-\alpha-1} \hat{U}_0^{\alpha-1} y_{ij} + \frac{1}{\alpha^2-\alpha} \hat{U}_0^{\alpha-1} \hat{U}_1^{-\alpha} (y_{ij})^{\alpha}$, n is the number of subgroups and m_i the number of sampled individuals in subgroup i. The expression largely simplifies as $\alpha \to 0$ (MLD index) or $\alpha \to 1$(Theil index). The link among (4), (5) and (6) is evident from the formulas expressing the Atkinson and the Generalized Entropy indexes as functions of $U_{\alpha} = f(y^{\alpha})$ and $T_{\alpha} = f(\log(y) \cdot y^{\alpha})$ statistics, where f is a composite summation over individuals, clusters and strata. For simplicity, only the formula valid for $\alpha \in \mathbb{R}\backslash\{0,1\}$ is reported:

$$I_{GE}^{\alpha} = \left(\frac{1}{\alpha^2-\alpha}\right)[U_0^{\alpha-1}U_1^{-\alpha}U_{\alpha}^{-1}] \quad (7)$$

The GE index is a general formula for measuring the redundancy in data (e.g. the order of entropy): the higher the index, the higher the inequality. In order to derive statistical inference on income distributional changes, the GE indexes and their standard error are estimated, computing z-ratios tests of statistical significance[15] with $GE_{t_0}(\alpha) = GE_{t_1}(\alpha)$ under the null hypothesis.

A fundamental property of income distribution analysis is the decomposability of the indexes, that is indexes can be decomposed by income source or population sub-groups (Theil 1979). The former has been applied in several studies aimed at understanding the determinants of income inequality (*cfr*. Adams and Jane, 1995; Bellù *et al.*, 2006; Ngepah, 2011), while the latter is more related with socio-demographical aspects: in other terms the former is a positive approach, the latter a normative one. We adopted an income inequality decomposition by income source to provide evidence of the different – and sometimes opposite – internal dynamics in income redistribution that lead to global results.

The inequality indexes are decomposed in "within" and "between" groups GE indexes to deepen the analysis of income (re)distributional dynamics in terms of internal inequalities. In order to evaluate "between" groups fraction, the index is computed to each subgroup average value, weighted by $\omega(p_j, s_j) = p_j^{1-\alpha}s_j^{\alpha}$, where p and s represent respectively the population and income proportion of the *j-th* population subgroups. The changes in "within" and "between" GE indexes have been tested for statistical significance through a bootstrapping procedure with 10.000 replications.

Results

The GE indexes are calculated assuming different values of α, particularly -1, 0, 1 and 2. The $GE(\alpha)$ percentage changes from period 0 to period 1 are evaluated under DRRA. Moreover the z-ratios tests are provided indicating the statistical significance of such changes with respect to the baseline period.

TABLE 4 ABOUT HERE

Results in table 4 show that the values of indexes increase from t_0 to t_1, interpreted as an increase in income inequalities. Moreover, the largest the redistributional effects are observed for $\alpha=-1$ and $\alpha=2$, that is for indexes weighting heavier the distributional changes affecting low or high income households. However, it is crucial to underline that, when standard errors are taken into account, the situation is quite different: changes in $GE(\alpha)$ computed for Tanzania and Ghana are statistically not significant (we fail to reject the null hypotheses at 5% level) while for Ethiopia we reject the null hypotheses for all $GE(\alpha)$[16]: in such cases the index changes are statistically significant, allowing to conclude that price changes have an effective income redistribution role.

To sum up, despite the computed $GE(\alpha)$ indexes increase from t_0 to t_1, suggesting that price changes would increase income inequalities, the statistical inference casts doubts in two out of three countries. In particular, we observe that only for Ethiopia the inequality changes are statistically significant.

FIGURE 3 ABOUT HERE

In figure 3 we present the Lorenz Curves of income distributions observed in t_0 and forecasted for t_1. The income distributions in Tanzania and Ghana seem not to be affected by price changes as the Lorenz Curves in t_0 and t_1 are almost overlapped. On the contrary, the Lorenz Curves related to Ethiopia and computed in t_0 and t_1 are significantly different: the curve in t_1 is farer from the 45° degree line, that is the income distribution will tend to be more unequal. Finally, the confidence intervals for t_0 and t_1, computed following Beach and Davidson (1983), do not overlap, thus suggesting the shift would be significative in statistical terms.

A second step of the analysis on income redistribution consisted in decomposing the inequalities in the "within" and "between" groups inequalities. The decomposition of $GE(\alpha)$ indexes shows that in all cases the "within" index increase, in that the income inequalities among households belonging to the same category increase (Table 4). We found that price changes from t_0 to t_1 tend to exacerbate the inequalities among groups of households in Ethiopia and in Ghana. As far as the "between" indexes are concerned, we observe negative changes for Tanzania and Ghana, while the opposite is true for Ethiopia. However, such changes are statistically not significant for Tanzania and Ghana, while they are statistically significant only for Ethiopia[17].

These findings are coherent with previous results from z-ratios tests: in Ghana, the different dynamics related to income redistributions "within" and "between" categories seem to balance each other, thus aggregate changes in $GE(\alpha)$ indexes are statistically not significant; in Ethiopia, inequalities are increased both "within" and "between" categories, and indeed the index changes are statistically significant. Lastly, we do not have statistical evidence to support any "within" or "between" income redistribution in Tanzania.

TABLE 5 ABOUT HERE

Conclusive remarks

The agricultural commodities prices surge observed during the past decade as attested by OECD-FAO data and projections pushed prices to higher levels with respect to the nineties, a situation that is expected to persist in the medium-term. Despite the impacts on developing countries and LDCs have been largely analyzed, the literature has not reached a consensus on the potential effects on income inequality. The effects might be rather heterogeneous depending on the countries and households characteristics, and hard to be generalized. This paper presents an empirical analysis of the impacts of expected food price changes on welfare and income inequalities in three heterogeneous Sub-Saharan Africa countries differing largely for GDP, income distribution, poverty and hunger levels. The study focused on Ethiopia, Tanzania, and Ghana taking into account the main staple foods for consumption and production. Following Mghenyi et al. (2011) we computed the compensating variation and estimated the expected impacts on income distributions. The latter issue has been addressed through the Generalized Entropy indexes, applying the Biewen and Jenkins (2006) approach to derive inference on the statistical significance of GE index changes.

Our findings are twofold: on one hand, our analysis shows how price trends will tend to harm Sub-Saharan Africa in terms of welfare losses, the extent of which depends largely on the economic structure, and on households' characteristics. In particular, price trends are likely to exacerbate intra-groups inequalities: this result suggest that the future agenda of welfare policies in Ghana and Ethiopia should include interventions to promote the convergence across household groups. On the other hand, we contribute in showing the relevance of taking into account the statistical inference of income distribution indexes when sample data are used. In particular, our results highlight the weakness of results from GE(α) indexes computation when statistical inference is not taken into account. A correct data analysis is a fundamental step for policy planning: as we have shown simple computations might not suffice as basis for policy decisions.

Notes

1. USDA, Wheat (US No.2, Soft Red Winter Wheat , US Gulf (Tuesday)), monthly average
2. USDA, Maize (US No.2, Yellow, U.S. Gulf (Friday)), monthly average
3. For example Mitchell (2008) shows how political support of biofuels contributed to establish a close link among prices of agricultural commodities, and trend in crude oil prices.
4. In particular the impact is different for net-buyers and net-sellers, that is if the household consumption overcomes or not the production of agricultural products.
5. The Global Hunger Index (GHI) is a multidimensional statistical tool, used to describe the hunger situation of a country. It ranks countries on a 100 point scale, with 0 being the best score ("no hunger") and 100 being the worst.
6. AGLINK-COSIMO projections 2011-2020 are available from OECD-FAO Agricultural Outlook 2011-2020 website. AGLINK-COSIMO is a recursive-dynamic, partial equilibrium, supply demand model of world agriculture, developed by the OECD and FAO Secretariats in close co-operation with member countries and some non-member economies, covering in total 39 agricultural primary and processed commodities and 52 countries and regions.
7. The expo-power function is flexible and allows to assume decreasing, constant and increasing relative risk aversion depending on values of the parameter α. As implies decreasing RRA, following Saha (1993) we set the parameters α equal to 0.5 while β=0.1.
8. A sensitivity analysis under increasing and constant relative risk aversion shows that results are not sensibly affected by such an assumption.
9. Although the survey has been conducted more than a decade ago, it is important to stress that the paper relies mainly on the relevance of statistical inference and the point estimates are currently out of the scope of our investigation.
10. The classification of small scale farmers sub-group was based on both the net-income and crop land rules among the households in the "agricultural enterprises" group (Lund and Price,1998; Kirsten and Van Zyl, 1998).
11. A sensitivity analysis, assuming a range of elasticities values from -1.03 to -0.42 for ε_j^c, from 0.55 to 1.27 for η_j, and from 0.13 to 0.72 for ε_j^c, shows that the main implications of our results are not affected by parameters choice.
12. A vast literature investigated the relevance of income inequality relies on economic growth (for example Kuznets, 1955; Klasen, 2008; Odedokun and Round, 2004; Davis and Hopkins, 2011;).
13. For $\varepsilon \to 0$ the index is very sensitive to distributional changes affecting the upper tail, for $\varepsilon \to 1$ the index is sensitive to changes in the lower tail.
14. *Cfr.* Cowell (2000) for a complete survey on the properties of inequality indexes.
15. *Cfr.* Biewen and Jeankins (2006) for further details.
16. We consider the statistical significance at 5% level, that is |z| < 1.6 implies we cannot reject the null hypothesis $H_0 : GE(\alpha)|_{t_0}=GE(\alpha)|_{t_1}$
17. We consider the statistical significance at 5% level, that is |z| < 1.6 implies we cannot reject the null hypothesis $H_0 : GE(\alpha)|_{t_0}=GE(\alpha)|_{t_1}$

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Figures and tables

Figure 1. International prices of Staple Commodities, 2000-2012

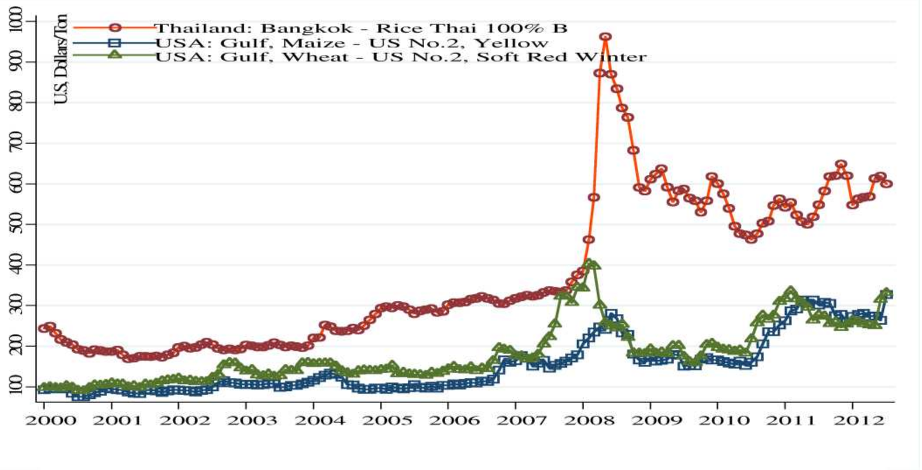
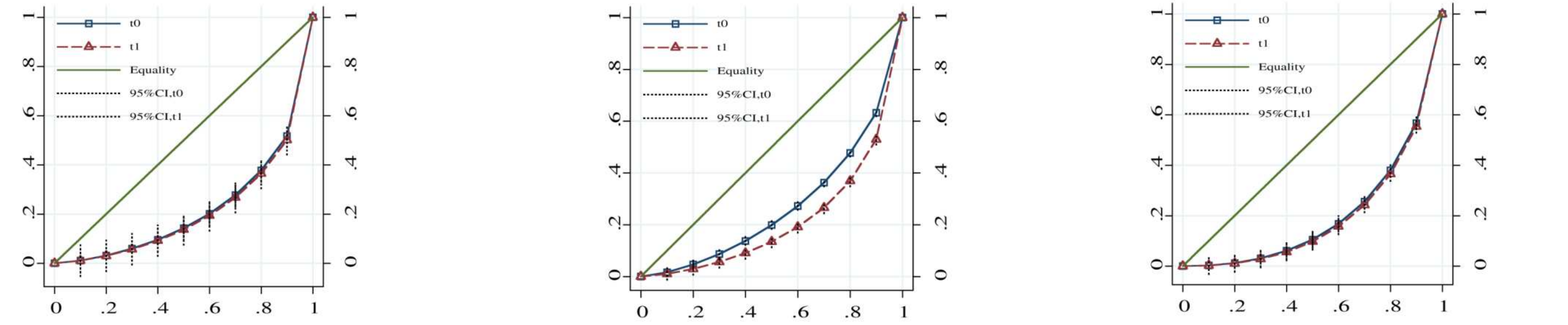


Figure 2. Lorenz curves in t_0 and t_1

Tanzania	*Ethiopia*	*Ghana*



Vertical and horizontal axis represent respectively "Cumulative income share" and *"Cumulative population share".*

Figure 3. Kernel densities of logarithmic per household income in t_0 and t_1

Tanzania	*Ethiopia*	*Ghana*

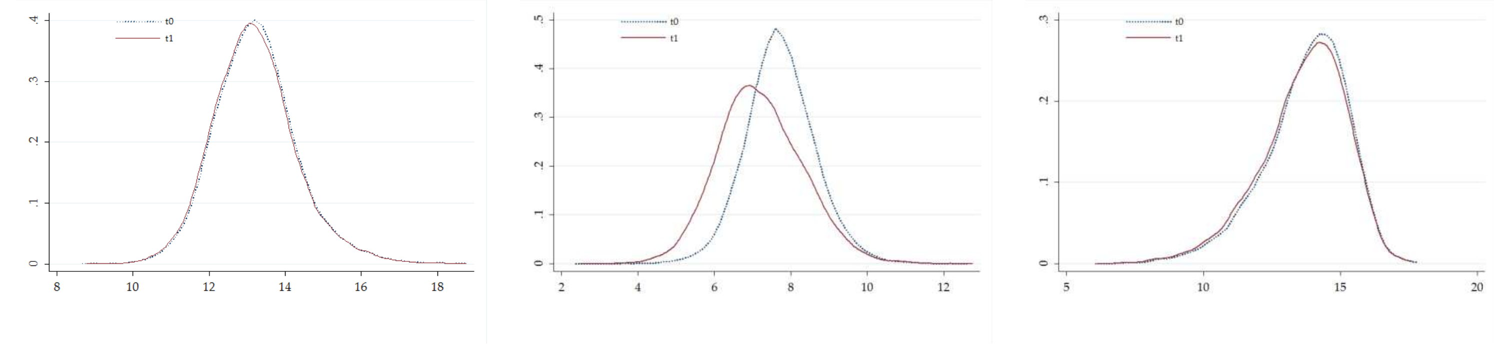


Table 1. Basic figures for selected developing countries

	Tanzania	**Ethiopia**	**Ghana**
Population (,000)	40,134	76,645	22,393
Density of Population / Km^2	45	77	98
Rural population %	75.4	83.0	51.5
Agricultural land (1000ha)	10,800	14,329	7,017
Share of agricultural labour force in total labour force	77.9	79.4	55.5
AGR. Share of GDP	45.7	46.9	35.7
DGP per capita USD	509	353	1118
Poverty (HCR)	35.7	44.2	28.5
Gini of income	34.6	30.0	43.0
Global Hunger Index	20.7	29.8	10.0
Dietary energy supply (DES)	2,020	1,950	2,850
Maize, wheat and rice consumed as share in DES	41.0	49.5	17.3

Table 2. Parameters

	Wheat			Maize			Rice		
	Tanzania	Ethiopia	Ghana	Tanzania	Ethiopia	Ghana	Tanzania	Ethiopia	Ghana
ε^c	-0.77	-0.98	-0.65	-0.77	-0.75	-0.65	-0.77	-0.87	-0.65
ε^s	0.52	0.28	0.38	0.52	0.51	0.38	0.52	0.85	0.38
η	0.68	0.78	0.80	0.68	0.92	0.70	0.68	0.39	1.24
λ	0.40	0.59	0.43	0.47	0.62	0.46	-0.07	0.68	0.17
$\overline{s^c}$	0.032	0.066	< 0.001	0.096	0.515	0.225	0.065	< 0.001	0.025
$\overline{s^s}$	0.063	0.017	< 0.001	0.004	0.098	0.029	0.000	< 0.001	0.012

Table 3. Compensating variation measure of the welfare effect

	Tanzania	Ethiopia	Ghana
Tot	-0.021	-0.383	-0.104
Agric. Small	0.004	-0.440	-0.119
Agric. Large	0.046	-0.137	-0.068
Non Agricultural	-0.051	-0.445	-0.117
Labour	-0.05	-0.299	-0.111
Transfer	-0.071	-0.448	-0.163
Rural diversified	-0.024	-0.431	-0.063
Urban diversified	-0.044	-0.272	-0.064

Table 4. Inequality indexes estimation results

	t_0		Tanzania	t_1		
	Estimate	Std.Err.		Estimate	Std. Err.	H_0 (z)
GE(-1)	0.963	0.071		1.028	0.098	0.54
MLD	0.622	0.042		0.656	0.057	0.48
Theil	0.861	0.094		0.949	0.149	0.50
GE(2)	4.065	0.824		5.637	1.878	0.77
	t_0		Ethiopia	t_1		
	Estimate	Std.Err.		Estimate	Std. Err.	H_0 (z)
GE(-1)	0.579	0.019		1.049	0.0290	13.5
MLD	0.390	0.010		0.628	0.014	13.7
Theil	0.466	0.026		0.755	0.036	6.48
GE(2)	1.400	0.266		2.879	0.669	2.06
	t_0		Ghana	t_1		
	Estimate	Std.Err.		Estimate	Std. Err.	H_0 (z)
GE(-1)	5.490	0.441		6.276	0.507	1.17
MLD	0.846	0.022		0.899	0.023	1.68
Theil	0.667	0.026		0.704	0.026	1.00
GE(2)	1.125	0.094		1.208	0.099	0.61

Table 5. Inequality indexes decomposition

	Tanzania (*within*)					**Tanzania** (*between*)				
	t_0		t_1			t_0		t_1		
	Estimate	Std.Err.	Estimate	Std. Err.	H_0 (z)	Estimate	Std.Err.	Estimate	Std. Err.	H_0 (z)
GE(-1)	0.876	0.080	0.951	0.106	0.56	0.086	0.019	0.077	0.018	-0.38
MLD	0.538	0.050	0.583	0.065	0.54	0.084	0.018	0.073	0.017	-0.43
Theil	0.776	0.102	0.876	0.153	0.54	0.085	0.019	0.073	0.018	-0.46
GE(2)	3.976	0.809	5.562	1.755	0.82	0.089	0.021	0.075	0.021	-0.45
	Ethiopia (*within*)					**Ethiopia** (*between*)				
	t_0		t_1			t_0		t_1		
	Estimate	Std.Err.	Estimate	Std. Err.	H_0 (z)	Estimate	Std.Err.	Estimate	Std. Err.	H_0 (z)
GE(-1)	0.479	0.019	0.809	0.022	11.3	0.100	0.005	0.240	0.011	12.1
MLD	0.290	0.009	0.405	0.009	9.00	0.100	0.004	0.223	0.009	12.4
Theil	0.362	0.027	0.526	0.035	3.74	0.105	0.005	0.229	0.010	11.7
GE(2)	1.285	0.292	2.619	0.742	1.67	0.115	0.006	0.260	0.013	10.3
	Ghana (*within*)					**Ghana** (*between*)				
	t_0		t_1			t_0		t_1		
	Estimate	Std.Err.	Estimate	Std. Err.	H_0 (z)	Estimate	Std.Err.	Estimate	Std. Err.	H_0 (z)
GE(-1)	5.419	0.384	6.212	0.440	1.36	0.071	0.011	0.064	0.010	-0.45
MLD	0.780	0.016	0.839	0.017	2.51	0.066	0.009	0.060	0.009	-0.44
Theil	0.604	0.019	0.646	0.020	1.53	0.063	0.008	0.058	0.008	-0.41
GE(2)	1.063	0.080	1.151	0.085	0.75	0.062	0.008	0.058	0.008	-0.37

Appendix

Table A.1. Household survey collected for micro-simulation

Country	Commodities considered in the study	HHS Survey for simulation at micro level	Year and sample size
Tanzania	Wheat, Maize, Rice	Household Budget Survey 2001 (National Bureau of Statistics UNITED REPUBLIC OF TANZANIA)	2001 - 22,178 households
Ethiopia	Wheat, Maize, Rice	Welfare Monitoring Survey 2000-2001 (WMS) CSA - Central Statistical Agency of Ethiopia	2000 - 25,917 households
Ghana	Wheat, Maize, Rice	The Ghana Living Standards Survey IV (GLSS)	1999 - 5,988 households

Table A.2. Tanzania household groups survey statistics

Variables	Agric. Small	Agric. Large	Non Agricultural	Labour	Transfer	Rural diversified	Urban diversified	Total
Sample cases	2,637	1,457	6,748	3,799	630	2,812	3,821	21,904
N° household (Population)	1,207,682	763,418	1,431,832	675,699	134,376	1,876,510	319,633	6,409,150
Share of population	18.84	11.91	22.34	10.54	2.1	29.28	4.99	100
Household Head Average Age	44.24	45	42.08	39.05	50.39	44.73	44.94	43.61
Average Household size	4.57	6.15	4.95	4.33	3.57	5.05	4.96	4.95
%of rural Household	94.15	96.37	63.84	41.86	67.87	100	0	78.60
Food Expenditure /total Exp	56.63	51.86	57.48	63.87	50.04	51.96	56.66	55.51
Income (LCU)	395,654	486,656	794,910	1,106,055	455,369	323,474	1,055,300	675,015
Food Expenditure (LCU)	220,622	258,840	402,812	503,416	308,355	261,881	542,879	325,681

Source*: Authors calculations based on Household Survey data, Household Budget Survey 2001 (National Bureau of Statistics UNITED REPUBLIC OF TANZANIA)*

Table A.3. Ethiopia household groups survey statistics

	Agric. Small	Agric. Large	Non Agricultural	Labour	Transfer	Rural diversified	Urban diversified	Total
Sample cases	9,241	3,080	4,726	3,523	1,414	2,383	1,318	21,904
N° household (Population)	5,527,590	1,648,678	1,531,798	808,659	408,632	1,250,738	245,961	11,422,057
Share of population	48.39	14.43	13.41	7.08	3.58	10.95	2.15	100
Household Head Average Age	44.15	43.58	42.8	39.25	50.33	44.1	47.04	43.82
Average Household size	4.81	5.88	4.36	4.37	3.65	4.77	5.08	4.83
%of rural Household	99.32	97.5	58.81	38.15	52.01	100	0	85.54
Food Expenditure /total Exp	75.51	73.71	69.04	66.82	69.73	71.26	64.25	72.85
Income (LCU)	920	4,727	2,448	4,868	2,181	1,504	5,342	2,798
Food Expenditure (LCU)	1,624	2,551	1,803	1,966	1,480	1,674	2,265	1,820

Source*: Authors calculations based on Household Survey data, 2001 Welfare Monitoring Survey 2000-2001 (WMS) CSA - Central Statistical Agency of Ethiopia*

Table A.4. Ghana household groups survey statistics

	Agric. Small	Agric. Large	Non Agricultural	Labour	Transfer	Rural diversified	Urban diversified	Total
Sample cases	1473	900	1255	894	57	331	123	5,033
N° household (Sample)	1,434,027	820,566	1,344,994	981,402	51,997	348,167	130,365	5,111,516
Share of sample	28.05	16.05	26.31	19.2	1.02	6.81	2.55	100
Household Head Average Age	45.32	49.79	42.59	40.48	65.35	46.58	45	44.67
Average Household size	4.71	4.73	4.14	4.01	3.74	5.13	5.29	4.46
%of rural Household	83.62	89.06	52.25	39.23	30.58	100	0	66.16
Income (LCU)	1,433,773	1,687,860	3,384,123	2,743,919	1,452,022	2,620,906	4,015,723	2,386,200
Food Expenditure (LCU)	851,634	909,024	1,463,844	1,843,087	1,658,646	992,319	1,530,826	1,247,409

Source*: Authors calculations based on Household Survey data, 1999, The Ghana Living Standards Survey (GLSS)*

Table A.5. Comparison of demand elasticities for maize wheat and rice.

Country	*Source*	*Category*	*Own price*	*Expenditure*
Ghana	Alderman, 1992	Maize	-0.43[d];-.87[d]	
Ghana	Alderman, 1990	Cereals		0.69[b];0.91[c]
Ghana	Alderman, 1990	Maize		0.60[b];0.79[c]
Ghana	Alderman, 1990	Rice		1.27[b];1.20[c]
Tanzania	Seale et al., 2003	Bread and cereal	-0.50	0.62
Tanzania	Abdulai and Aubert, 2003	Cereals and pulses	-1.03	0.74
Tanzania	Teklu, 1996	Maize		0.80[b];0.55[c]
Ethiopia	Shimeles, 1993	Food		0.96[b];0.80[c]
Ethiopia	Tafere et al., 2010	Wheat	-0.98[a]	0.78
Ethiopia	Tafere et al., 2010	Maize	-0.75a	0.92
Ethiopia	Tafere et al., 2010	Teff	-0.89a	1.69
Kenya	Seale et al., 2003	Bread and cereal	-0.47	0.58
Malawi	Seale et al., 2003	Bread and cereal	-0.48	0.59
Zambia	Seale et al., 2003	Bread and cereal	-0.48	0.59
Zimbabwe	Seale et al., 2003	Bread and cereal	-0.42	0.51

[a]*compensated;* [b]*rural households;* [c]*urban households;* [d]*authors consider two different area.*

Table A.6. Comparison of agricultural products supply elasticities.

Country	*Source*	*Category*	*Supply Elasticity*
Ghana	Thiele, 2003	Agriculture	0.38[a]
Tanzania	Thiele, 2003	Agriculture	0.72[a]
Tanzania	McKay et al., 1999	Agriculture	0.35[b]
Tanzania	Danielson, 2002	Maize	0.32[a];0.13[b]
Ethiopia	Alemu et al., 2003	Wheat	0.28[a]
Ethiopia	Alemu et al., 2003	Teff	0.28[a]
Ethiopia	Alemu et al., 2003	Maize	0.51[a]
Malawi	Thiele, 2003	Agriculture	0.55[a]
Zambia	Thiele, 2003	Agriculture	0.19[a]

[a]Long-run. [b]Short-run