The Economic Impact of Global Food Price Increase on Africa Least Developed Countries: An Application of the Common Agricultural Policy Regionalized Impact (CAPRI) Model

Jean-baptiste Wendkouni Zongo

Dept. of Agricultural Economics, National Taiwan University, Taipei, Taiwan

E-mail: zjean_baptiste@yahoo.fr

Huey-Lin Lee

Dept. of Agricultural Economics, National Taiwan University, Taipei, Taiwan

E-mail: hlee@mail2.nccu.tw

Shih-Hsun Hsu

Dept. of Agricultural Economics, National Taiwan University, Taipei, Taiwan

E-mail: m577@ntu.edu.tw

Ching-Cheng Chang

Dept. of Agricultural Economics, National Taiwan University, Taipei, Taiwan, and Academia Sinica, Taipei, Taiwan

E-mail: emily@econ.sinica.edu.tw

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W. J.-B. ZONGO[1], H.-L. Lee[2], Shih-Hsun Hsu[*, 1], and C.-C. Chang[1, 3]

Abstract

International prices of most staple food commodities in 2008 reached a remarkable level that had not been seen since late 1970's. Food commodity prices are projected to remain on higher levels over the next decade, supported by firm demand, unfavorable weather conditions, slowing growth in global production, and expected high price of crude oil. This perspective poses not only challenges to global food insecurity but also offers opportunities for food and agricultural producers arising from the higher average prices projected for the coming decade. This paper attempted to investigate the impact of future global food price increase on 28 Africa least developed countries (LDCs) and to propose some policy instruments for tackling the impact of high food prices. Our simulation results indicate that African LDCs are adversely affected in terms of overall welfare when prices of maize, rice and wheat increase. The reduction in consumer surplus, agricultural income and tariff revenues are the key factors for the reduced overall welfare. The sectoral impact analysis reveals that total demand for wheat and rice, including both human consumption and imports, would drop as a result of substitution effect, yet maize demand could increases. In addition, African LDCs are projected to be more negatively affected than the other trade blocks such as Africa-Rest, Nigeria, South-Africa and Ethiopia. Important policy implications follow our findings. African LDCs governments could invest to develop the wheat, rice and maize sectors in order to reduce the countries' vulnerability to international shocks. Bilateral cooperation between African and Western countries should be more oriented toward transfer of technology, knowledge and managerial skills. Poor transportation could magnify import prices, and also impede the distribution of products between production zones and consumption areas within and out of the country. Improving transportation logistics and infrastructure would be helpful in reducing costs of food transportation to African LDC consumers. In addition, policies that promote for more diversified agricultural income sources, such as earnings from livestock and fishing, can help farmers withstand the unfavorable impact of agricultural price fluctuations on African LDCs.

Keywords: the CAPRI model, African LDCs, global food prices, food security, welfare analysis.

[*] Corresponding author. Email: m577tony@gmail.com
[1] Dept. of Agricultural Economics, National Taiwan University, Taipei, Taiwan.
[2] Dept. of Economics, National Chengchi University, Taipei, Taiwan.
[3] Academia Sinica, Taipei, Taiwan.

1. Introduction

International prices of most staple food commodities in 2008 reached a remarkable level that had not been seen since late 1970's. Food commodity prices are projected to remain on higher levels over the next decade, supported by firm demand, unfavorable weather conditions, slowing growth in global production, and expected high price of crude oil. This perspective poses not only challenges to global food insecurity but also offers opportunities for food and agricultural producers arising from the higher average prices projected for the coming decade.

This paper attempted to investigate the impact of future global food price increase on 28 Africa least developed countries (LDCs) and to propose some policy instruments for tackling the impact of high food prices. Unlike most conventional studies on agricultural impact of trade, we chose in this study the Common Agricultural Policy Regionalized Impact (CAPRI in abbreviation, see Britz & Witzke, 2012) modeling system as the analytical tool. The market module of CAPRI is a multi-regional partial equilibrium model for agricultural products that covers 47 primary and secondary agricultural products produced in 77 countries of 40 trade blocks in the world, among which 28 individual African countries are accounted for, and the remaining African countries being aggregated into four trade blocks—namely, Africa-Rest, Nigeria, Ethiopia and South Africa. This study is, to our knowledge, thus far the very first application of the CAPRI modeling system to assess price surge and policy impact on African LDCs.

Based on the parameters as estimated by Haniotis and Baffes (2010), we translated the projected oil price increase in the medium run (5 to 10 years) into agricultural commodity price changes in the global market. Oil price rise affects agricultural product prices in both production and demand sides. Energy is needed for fertilizer production and thus higher energy prices would push up fertilizer production costs. This would in turn lead to increases in agricultural production costs. On the demand side, as the price of crude oil increases, some crops are used as inputs for producing biofuel so as to substitute for crude oil, and thus push up the demand for grains (Mueller, Anderson and Wallington, 2011).

The paper is organized as follows. In section 2 we introduce the CAPRI model used in this study to analyze the impact on African LDCs and its benchmarking database. We describe the simulation design in section 3 and discuss the simulation results in section 4, followed by the policy insights and suggestions drawn from our simulation results. Section 5 concludes the paper.

2. CAPRI Model and Database

The CARPI model

The CAPRI (Common Agricultural Policy Regional Impact) model is a partial equilibrium model for economic impact simulations for the EU-based agriculture sector with disaggregated crop sub-sectors. The model is divided into two sub-modules: the supply module and the market module. The supply module comprises about 50 crops and animals activities, 1843 farm type models for EU25 and is mixed primal-dual profit maximization problem for the aggregate of farmers in one region at given prices for agricultural outputs and inputs and given policy incentives. The market module comprises a partial, spatial, global equilibrium model for most agricultural primary and important secondary products such as dairy products and covers 47 primary and secondary agricultural products and 77 countries in 40 trade blocks (Britz, 2007). CAPRI operates as a pair of linked partial equilibrium models which iterate to a convergent solution between EU agricultural supplies and global agricultural markets.

Our study used the market module which has been adjusted to analyze the food price increase scenario. More specifically, to get rid of exogenous prices in the model, the European supply part of the CAPRI model is coupled with a global spatial multi-commodity model based on the Armington approach. The multi-commodity model consists of a class of model written in physical and valued terms, where demand and supply quantities are endogenous and driven by behavioral functions (See next section for more details) depending on endogenous prices (Piketty et al., 2009). The African LDCs is a single aggregate trade block that groups together 28 countries in the market module in the CAPRI model, featuring supply side and demand side behavioral functions.

The supply side consists of supply of primary products and supply of selected processed products. The demand side consists of human consumption, feed and processing functions for each single or aggregated trade bloc. The supply for each product "***i***", feed and processing demand in the trade block is modeled by a supply function derived from a Normalized Quadratic profit Function. Human consumption is modeled by Generalized Leontief Expenditure Function. The parameters of these functions are derived from elasticities borrowed from other studies and modeling systems, and calibrated to project quantities and prices in the simulation year. This provides a flexible functional form. The flexible functional form combined the calibration (homogeneity of degree zero in prices, symmetry, correct curvature, additivity) on the parameter allows for a welfare analysis of the results.

The model uses a two stage Armington system in order to model substitution between country's imports, and between imports and domestic sales. For this, a

Constant Elasticity of Substitution (CES) function is used, which allows the model to capture the pure economic behavior (through the relative changes in import price and substitution elasticity), but also to take account of a ‘preference’ given to a specific origin (through shares of historical import flows). This means that trade flows are not driven solely by the difference between market prices in the two trading blocks.

In the market module, all the regional aggregates have policy instruments inter alia bilateral tariffs (specific and ad-valorem). Price distortions are based on OECD’s (Organization for Economic Cooperation and Development’s) producer and consumer support estimates and tariff protection measures are aggregated from Agricultural Market Access Database (AMAD) (Piketty et al., 2009). Bilateral agreements for the European Union are added according to the EU legislation. In both, future changes as defined in legislation are implemented in the Baseline scenario. For EU25, intervention sales and subsidized exports under World Trade Organization (WTO) commitments are explicitly represented. In the model, several dozen Tariff Rate Quotas (TQRs) worldwide are also apprehended. TRQs in the model are either allocated to specific trading partners or open to any imports. Tariffs and import under TRQs in the model are endogenous, so that the regime switches from under filled, to binding and to over-quota imports and vice versa. Resulting changes in tariffs are modeled endogenously.

The model also captures the remaining flexible levies in cereal markets and safeguards for sugar and rice for EU (Piketty et al., 2009). The land is used considered as an input into agriculture. A change in price of product (wheat, maize or rice) leads to a change in quantity of that product. The change in quantity is in turn translated into land demand change based on its yield.

Each country total demand consists of domestic demand and import and is a function of the link between the domestic price and the average import price. Similarly, countries allocate their production between domestic sales, export and changes in intervention stock. Every country or aggregated country will face international competitiveness. From the equilibrium mechanism of supply and demand and Armington mechanism in the market module, one deduces that a region will be more internationally competitive if it can increase its production and lower its price at farm gate. Countries with suitable production factors or an appropriate trade policy would have a higher import share. The cross price effect is also taken into account in the market module. Depending on the cross price elasticities, following a decrease in one product price, demand for other products will drop with falling price for a substitute.

Figure 1 shows the link between supply and market module. Iterations between supply and market module lead to the equilibrium in CAPRI model. The regional agricultural income is maximized with exogenous prices subject to several constraints (land, fertilizer need, set aside, etc.) and the regional result obtained from the maximization are aggregated and enter a small, non-spatial multi-commodity model for young animal trade. The results from the supply module on feed use and production will serve to calibrate the supply and feed demand functions of the market module in the second iteration. The market module is then solved at this stage (constrained equation system) and the resulting prices will be transmitted again to the supply module for the following iteration (Britz & Witzke, 2012).

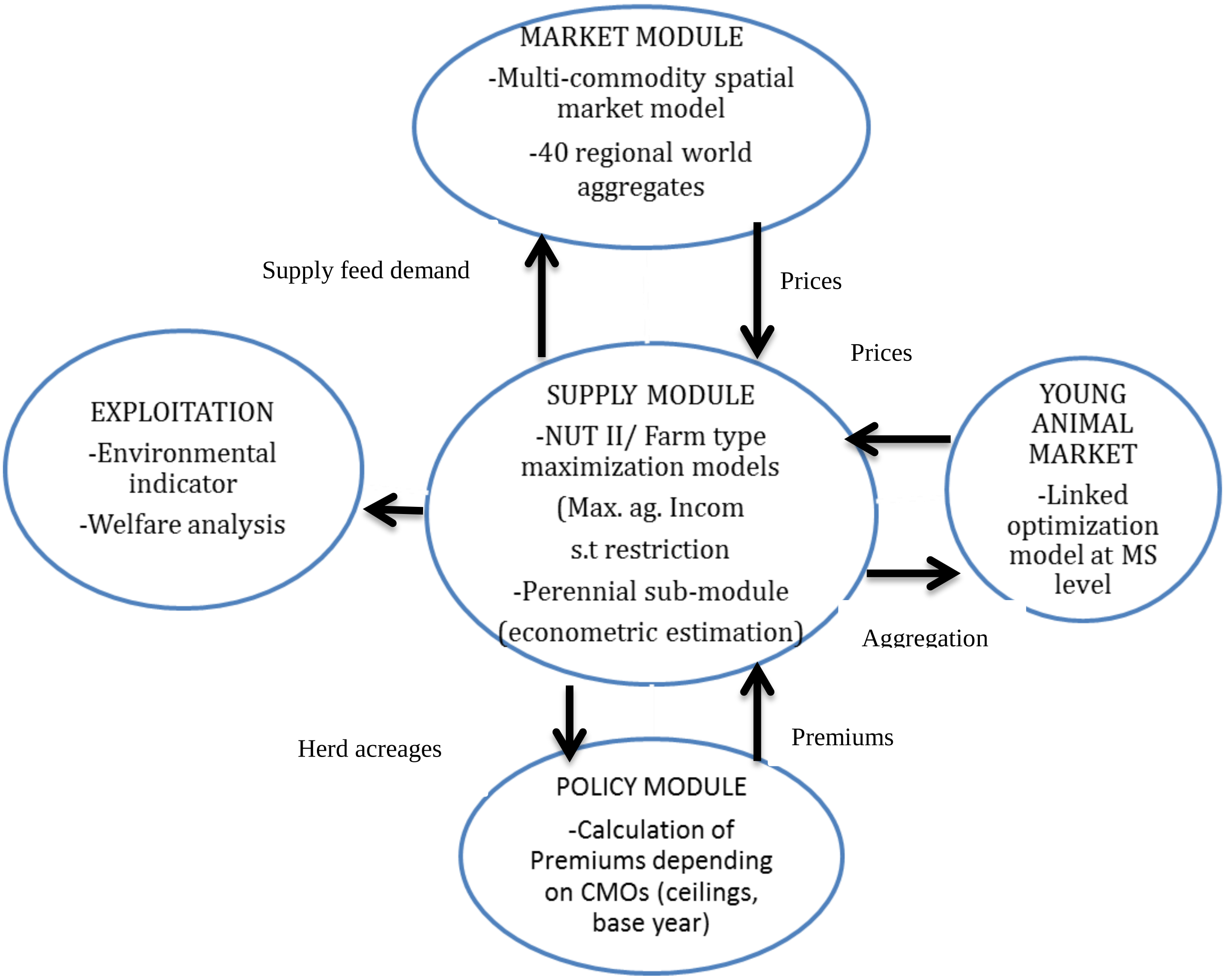

Figure 1: Link of modules in CAPRI

Source: CAPRI modeling system (Britz & Witzke, 2012)

Note: CMOs refers to Common Market Organization and MS designates Member State.

The CAPRI benchmarking Database

CAPRI data base (to the largest extent possible) is sourced via official, harmonized statistical data from EuroStat and FAOStat. The data base ensures mutually, harmonized sources of data, completeness over time and regions as well as consistency between quantities, values and prices.

The supply module covers EU27+Norway+Western Balkans+Turkey and the main elements of this module are: outputs, inputs, income indicators, activity level and secondary products. The main sources of the data are: Eurostat, specifically Eurostat crop production statistics, land use statistics, slaughtering statistics, statistics on import and export of live animals, farm and market balance statistics, Economic Account for Agriculture (EAA). In addition the missing data are completed mainly from FAOSTAT, UNSTATS. The data base at regional level is referred to the so-called NTU 2 level. In the market module, the trade data are derived from FAO. Times series have been completed to 2005 based on FAOSTAT2 project.

Table 1 shows the Armington substitution elasticities specified for pairs of agricultural product groups in the CAPRI model. We consider wheat, rice and maize being imperfectly substitutable between domestic and foreign origins through an Armington approach. Missing own-supply elasticities are set to 0.5, and the elasticity to all remaining products including the inputs is assumed to be -0.25, if not given. Table 2 lists agricultural activities covered in the CAPRI model and database.

Table 1 Substitution Elasticities for Armington CES Functions

Product	Substitution elasticity between domestic sales and imports	Substitution elasticity between import flows
Cheese, fresh milk products	2	4
Other vegetables	1.5	1.5
Other fruits	3	3
Sugar	12	12
All other products (wheat, rice, maize…)	8	10

Source: Britz and Witzke (2012).

Table 2 List of agricultural activities covered in the CAPRI database

Group	Activities
Cereals	Soft wheat (SWHE), Durum wheat (DWHE), Rye and Meslin (RYEM), Barley (BARL), Oats (OATS),Paddy rice (PARI), Maize (MAIZ), Other cereals(OCER)
Oilseeds	Rapeseed(rapeseed), Sunflower(SUNF), Soya(SOYA), Olives for oil(OLIV), Other oilseeds(OOIL)
Other annual crops	Pulses(PULS), Potatoes(POTA), Sugar beet(SUGB), Flax and hemp(TEXT), Tobacco(TOBA), Other industrial crops(OIND)
Vegetables Fruits Other perennials	Tomatoes(TOMA), Other vegetables(OVEG), Apples, pear & peaches(APPL), Citrus fruits(CITR), Other fruits(OFRU), Table grapes(TAGR), Table olives(TABO), Table wine(TWIN), Nurseries(NURS), Flowers(FLOW), Other marketable crops(OCRO)
Fodder production	Fodder maize(MAIF), Fodder root crops(ROOF), Other fodder on arable land(OFAR), Graze and grazing(GRAS)
Fallow land and set-aside	Set-aside idling(SETA), Nonfood production on set-aside(NONF), Fallow land(FALL)
Cattle	Dairy cows(DCOW), Sucker cows(SCOW), Male adult cattle fattening(BULF), Heifers fattening(HEIF), Heifers raising(HEIR), Fattening of male calves(CAMF), Fattening of female calves(CAFF), Raising of male calves(CAMR), Raising of female calves(CAFR)
Pigs, poultry and other animals	Pig fattening(PIGF), Pig breeding(SOWS), Poultry fattening(POUF), Laying hens(HENS), Sheep and goat fattening(SHGF) Sheep and goat for milk(SHGM), Other animals(OANI)

Source: Britz and Witzke (2012).

3. Simulation Design

We simulate the impact of oil price induced agricultural price surge of wheat, maize and rice for a long-run timeframe up to the year 2020. We assume in the model that all markets are perfect competitive. The impacts of the commodity prices surge are measured as the difference in results between the grain price scenario and the baseline scenario.

The baseline serves as a reference point for impact analysis with CAPRI. In other word the baseline can be used to predict the most likely future development outcome under the current policy and encompassing all future changes that have been already acknowledged in the current legislation (Britz & Witzke, 2012). In the reference scenario, the Common Agricultural Policy (CAP) reform of 2003 is implemented as it would be in 2013. This includes the implementation of decoupling and payment scheme options. It includes the chosen implementation of decoupling and payment scheme options (single farm payments, regional uniform payments or hybrid forms) for the different EU Member States, modulation of direct payments, capping of export subsidies and EU preferential trade preferences with e.g. Morocco, Turkey, the other Mediterranean countries, Chile, the least developed countries (Every But Arms (EBA) initiative: duty and quota free access) as well as African, Caribbean and Pacific countries under the Cotonou agreements. It comprises specific and ad valorem tariffs as currently applied by the different WTO members. Major developments in EU25 underlying the reference run are in-line with the latest Directorate-General for Agriculture and Rural Development of the European Commission (DG-AGRI) baseline. For the rest of the world, FAO's 2030 exercise and results from Food and Agricultural Policy Research Institute (FAPRI, 2010; 2011a; 2011b) were used as a yardstick for projection. The DG-AGRI provides every year a medium term outlook for European agricultural market, supply balance sheets (production, consumption, trade, stocks) and income for the next 7-8 years based on a series of economic models and taking into consideration short-run projections and expertise from market analysts. The OECD-FAO based also on a set of assumptions on exogenous and policy-related drivers, a collaborative expert system and a joint modeling system to provide a baseline (Blanco, 2010).

Grain price scenario is the wheat, maize and rice future price surge scenario. The objective of this scenario is to identify the major trends of the World wheat, maize and rice future prices and quantify its economic impacts on the Least Developed Countries in Africa. The measure of the impact is captured by the deviation of the consumer surplus, producer surplus and government expenditure from the baseline scenario. The determination of the commodity future prices has been the object of numerous research and approaches see, (Working (1942); Choe & Mundial (1990)), and for recent one, Haniotis & Baffes (2010). In the aim at forecasting the commodity future trends, Haniotis & Baffes (2010) used a simple econometric method to examine which factor is the most influential factor on the commodity price surge. The result showed that most commodity price respond strongly to energy price and then the energy price is the key determinant of food price. The channels through which energy prices affect other commodities prices can be classified into two mainly parts: The production side and the demand side.

On the production side, energy enters the aggregate production function as an input and thus higher energy price leads to increased production cost. Similarly, some fertilizers use energy-intensive input. On the demand side, as the price of crude oil increases, some commodities will be used as substitutes to crude oil, increasing the demand for biofuel, which in turn will drive the demand for grains up. Many researchers have attributed the strong relation between energy and non-energy price to the use of biofuels as a substitute (Mueller, Anderson, & Wallington, 2011). Our price projections are taken from Haniotis and Baffes, since not only, it provides a framework to forecast future price but also it give a pathway for understanding the link between energy prices, demand, and grain prices.

Although future path of commodity price is still uncertain, the study demonstrated a strong link between energy and commodity prices as a key factor of the longer-term behavior of commodity price (Haniotis & Baffes, 2010). Specifically, the results showed that the parameter estimate of the wheat price is 0.30 implying that a 10 percent increase in energy prices is associated with 3 percent increase in wheat price in the long term. A 10 percent increase in energy prices is accompanied by 2.7 percent increase in maize price in the long run. Similarly, a 10 percent increase in energy prices goes with 2.5 percent increase in rice prices in the long term.

Now, the majority of the expert and researchers believe that future prices of oil will be three to four times higher than this at least in the long run according to (Haniotis & Baffes, 2010). In a recent paper, economists of OECD predict the oil prices to reach $150 per barrel, with the possibility of it climbing to as high as $270 a barrel compared to $79 per barrel in 2010 (The Financial Times Limited 2013). We consider the average value of $150 and $270 which is $210. Combining Haniotis & Baffes (2010) regression results and the percentage increase in oil prices, we predict as follows the percentage changes in wheat, maize and rice future prices:

(a) prospective percentage change in wheat prices: (165%*30%)/(100%) = 50%;
(b) prospective percentage change in maize prices: (165%*27%)/(100%) = 45%;
(c) prospective percentage change in rice prices: (165%*25%)/(100%) = 41%.

These estimated crop price deviations from the baseline levels over the long run are brought into CAPRI model to simulate the impact of such crop price deviations on the African LDCs.

In the market module, prices are endogenously determined by the aggregate demand and supply in the world market of grains. To assess the impact of exogenous estimated world grain price changes in the market module, we can use an indirect method, by given the shock either to the producer sider, either to the demand side. In this study we choose the demand side specifically the Human consumption in the international market (see chapter 4 for details about human consumption). Human consumption in the market module includes all processed food products and imported food. We shock the human consumption for all regions with behavioral functions in the market module. We made several tests on demand quantity shock that will lead to the level of projected prices. An increased demand (Human consumption) for wheat, maize and rice in all regions will lead to imbalances in the market clearing equation for these products and for all regions. These imbalances can only be equilibrated again if supply and demand adjust, which will require consumer price to increase to drop the human consumption. This is not only consistent with economic theory but also with the recent studies about the driving forces behind food price spikes. In the first iteration for equilibrium in CAPRI, the regional aggregate at NTU2 level will use the higher prices derived from increased human consumption to maximize regional agricultural income subject to land, fertilizer need, set aside restrictions. From this first iteration, a new supply and feed use quantity is obtained. The new supply and feed use quantity will be transmitted to the market module to calibrate the supply and feed demand functions of the market module. The market module is then solved at this stage. The new prices generated in the market module will be transmitted to the supply module. This process will be repeated until new supply and demand equilibrium is found (Britz & Witzke, 2012). The higher consumer price will lead to higher import prices.

Figure 2 describes the mechanism by which the shock on the demand side in the international market will be transmitted to the domestic market in Africa LDCs. An increase in the human consumption from D to D'in the international market will lead to increases in commodity prices both from P1 to P2 in the international market and domestic market.

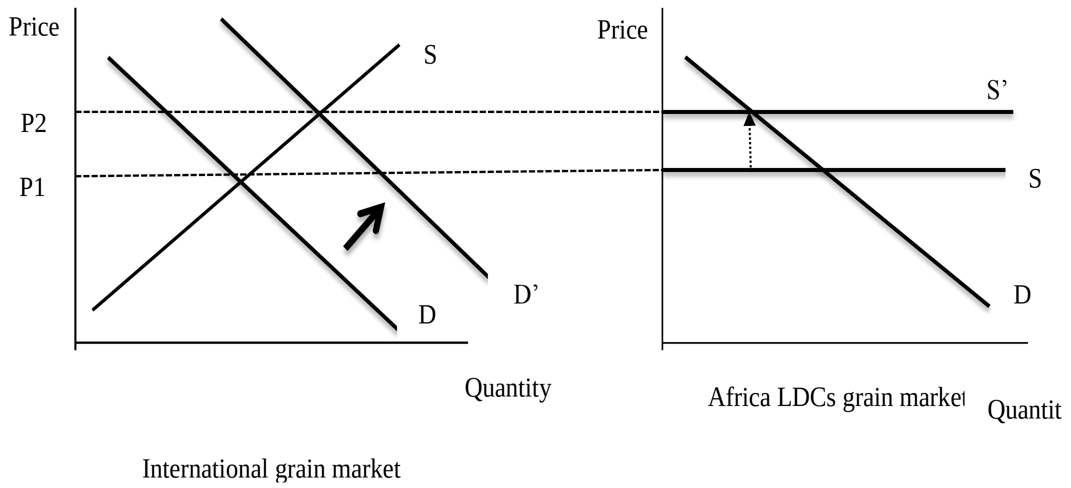

Figure 2: Demand-side shock

Note: S refers to import supply and D to import demand.

4. Simulation Results

Impact on overall welfare

CAPRI welfare measure follows the standard concept of welfare analysis. The total welfare is decomposed into the sum of the welfare gain of consumer (represented by money metric), the welfare gain of producers (represented by agricultural income), the welfare gain of the public sector (tariff revenues), the welfare gain of agro-industry (represented by profits by processing activities) and minus the welfare loss from taxpayers[1]. The money metric refers to the minimal expenditure necessary for consumers to reach the utility level of the simulation scenario at the price level of the reference scenario. Agricultural income is computed using the gross value added concept of the EAA (EUROSTAT, 2000). Costs for crop, animal, and other variable inputs, as reflected in the Economic and Agriculture Account are s from the income of agricultural producers (agricultural gross value added at market prices). Income from premiums in a respective region is added to the producers' market income (Domínguez & Wieck, 2011).

Table 3 shows the results of the baseline and grain price scenario of the simulation of wheat, rice and maize due to demand increase from human consumption. Compared to the baseline the overall welfare would decrease by 8.04% in LDCs countries in Africa following wheat, maize and rice price surge. This welfare decrease is mainly due to the decrease in consumer surplus by 17.18%, decrease in agricultural income by 6.66% and a reduction in tariff revenues by -7.24%.

An increase in wheat, maize and rice price leads to a relatively strong decrease in consumer surplus, a consequence of the importance of these crops in food diet in LDCs. Welfare gains of producers are also projected to decrease. In CAPRI modeling system, agricultural income refers to the agricultural gross value added at market prices, i.e. the difference between the agricultural output and the intermediate consumption. The drop in agricultural income may stem from the fact that most of the farmers in the LDCs countries are small scale or family farmers with faint technology. This is also explained through the decrease in domestic demand (human consumption) observed in Table 3.

We note significant growth in the profits of processing and non-agricultural activities. In CAPRI market model, the processing industries are related to the production of cake and oils from seeds, and also to the processing stage of dairy products. An increase in the price of seeds or grains leads to an increase in the market price of processed products, which in turn drive the processing margin up. However, the losses from consumers, producers and government outweigh the gains form industries leading to a decrease in the overall welfare.

[1] This part is not covered for African LDCs

Table 3: Impact grain price scenario on Overall Welfare in LDCs

	Baseline*	Scenario*	Percentage change
Consumer surplus	371132.00	307380.28	-17.18%
Agricultural Income	49151.47	45878.90	-6.66%
Tariff revenues	1234.14	1144.76	-7.24%
Profit of processing activities	-7486.26	23539.75	
• Profit of non-agricultural and land use	0.00	20042.90	
• Profit of dairies	-7940.68	683.77	108.61%
• Profit of other processing	454.42	2813.08	519.05%
• Profit of feed industry	2833.30	2802.28	-0.74%
Welfare	**414031.38**	**380758.53**	**-8.04%**

* Unit of measurement: Million Euro.

This result is consistent with our expectation and hypothesis since we expected the overall welfare to drop. It is also consistent with earlier works. Zezza et al. (2008) concluded that rising prices has a strong impact on the poverty of net food buyer and poor farmers. Boccanfuso & Savard (2011) found some mixed results for two selected LDCs countries in Africa, Senegal and Mali using CGE model. He stresses out that agricultural price increase has weakly negative impact on poverty in these regions, but leads to increases in aggregate household income.

Impact on consumers, producers and Government

In this section we present the sectorial effect on consumers, producers and tariff revenues. The results from Table 4 indicate important drops in consumer surplus. Welfare in the wheat, maize and rice market is decreasing in the scenario respectively by 64.65%, 60.54%, and 58.87%. Most of African LDCs are not self-sufficient in rice. Taking the example of three LDCs, an April 2013 report of the United States Department of Agriculture (USDA, 2013), reveals that 60% of Burkina Faso rice needs is imported, in Mali more than 50% of rice consumption is imported and in Senegal it is estimated to 55%. We note a significantly decrease in domestic demand (human consumption) by around -88.48% for wheat and import flows into Africa LDCs of both wheat and rice. Only domestic demand and import flows of grain maize are projected to increase, respectively by 0.86% and by 72.36%. This may be explained through the substitution effects. The consumers substitute wheat and rice for maize in the simulation. This is mainly due to the fact that in the international market, maize prices are lower than wheat and rice. Besides, according to the International Institute of Tropical Agriculture (IITA, 2009) maize is the most important cereal crop in sub-Saharan Africa (SSA) and an important staple food for more than 1.2 billion people in Sub-Saharan Africa.

Two other results to mention are the changes in calorie intake and in protein intake. The calorie and protein intake from wheat, maize and rice are projected to fall in the scenario. The lost from wheat is the most substantial, around -89.10%. From the food security perspectives, this result emphasizes the effects that reductions in real income caused by rising food prices could have on nutrition quality. The reduction in calorie and protein intake could lead to health issues and lessen the productivity of farmers.

On the producer side, we look at both the production and the profit changes over the scenario. Results in Table 5 show that the production of wheat and rice in Africa LDCs is projected to decrease, driven by a drop in net production, and reduction in feed and processing industries. Regarding the net production of wheat, and rice it appears that under the baseline, the production decreases in the LDCs countries in Africa by 79.87% and 16.35% respectively over the scenario. Only maize production is projected to increase slightly in LDCs countries. The most important reduction is observed in wheat. The slight increase in maize production 0.10% may stem from the substitution effects earlier mentioned. Farmers have more incentives to produce more maize since domestic demand for maize increase through the substitution effects. Similarly, maize processing and feed use production will increase over the scenario.

The agricultural profits for the three products drop, however, feed and processing industries will experience important increase in profits for all the three products. In general, crop production is projected to drop under price increase scenario in LDCs, except for maize. It is worth mentioning two other factors that may account for long term reductions in production and profits. The first factor is the price of fertilizers and other input that generally rise following the period of food price increase. Secondly, the degrading of weather conditions within the LDCs countries accounts for the reduction of agricultural production.

Recent studies projected agricultural production in many African countries to be severely affected by climate change. New studies confirm this by demonstrating that due to their low adaptive capacity, poorest countries in Africa are most vulnerable to climate variability and change (LimLi, Edwards, & Scialabba, 2011). For the increase in maize production, it is worth recalling that maize production in Africa is increasing faster (2.8% per annum) than global production (2.5% per annum) according to Jones & Tambi (December, 09). Most of these producer countries are located in southern, Central and West Africa, and then are LDCs. So by 2020, LDCs countries could increase it Maize production.

Table 6 shows the tariff revenues resulted from the application of import tariffs by the Government. They are calculated by multiplying tariffs with valued import flows, and summing over all product lines. Not surprisingly, Government would suffer from tariff revenues decrease for wheat and rice, consequence of the reduction of import quantity of these two staples. However, tariff revenues from maize are projected to raise greatly, around 149.50% due to the increase of wheat import.

Impact on consumers, producers and governments of other African trade blocks in CAPRI and result comparison.

Results from Table 7 point out that like Africa LDCs countries, the countries aggregated in Africa-Rest and Ethiopia as a single country would face a decrease in consumer surplus by respectively -8.87% and -21.07%. Only Ethiopia's agricultural income slightly increases over the scenario, around 1.08%, but this increase cannot compensate the losses from consumer surplus, thus we observe a relatively strong drop in the overall welfare of Ethiopia. The level of decrease in the overall welfare of Africa LDCs is greater than that of Africa-rest which is -4.14%. Africa-Rest suffers less than LDCs from price increase because many of the aggregated countries have suitable weather conditions for agricultural production. For instance, Ghana, Ivory Coast, Equatorial Guinea, Cape Verde are aided by favorable weather and agricultural land, so that these countries have more diversified products that can be used as substitutes when grain price increase.

Given that land is use as input in CAPRI modeling system, regions in Africa with greater land yield elasticities may be less affected by price shocks. This is also consistent with our hypothesis and with earlier work. For example, Ng (2008) demonstrated that low-income countries in Africa, even if they are net food importing countries, their imports are negligible (only 0.2 percent of their imports) and they have a large trade surplus in other agricultural commodities which can be easily substituted for foods if relative prices change significantly. The model equations take into account the cross price effect, so following an increase in one product price, demand for other products will grow with soaring price for a substitute. The most remarkable reduction in consumer surplus is observed in LDCs, -17.18% against -8.87% for Africa-Rest. One reason could be the fact that transportation cost is determining factor of consumer price in the CAPRI market module. Among the 15 landlocked countries in Africa, 9 countries (Burkina Faso, Mali, Niger, Chad, Burundi, Botswana, Central African Republic, and Rwanda) belong to the LDCs trade block in the market module. This can also explain that LDCs consumers are typically affected disproportionally as these countries experience higher cost of transport to markets.

Table 4: Sectorial effect on Consumer surplus, Human consumption and Import Flows into LDCs

	Baseline*			**Scenario***			**Percentage change**		
	wheat	maize	rice	wheat	maize	rice	wheat	maize	rice
Consumer surplus	10451.66	25493.21	31277.44	3661.51	9494.55	11463.29	-63.97%	-62.76%	-33.36%
Human consumption	9207.34	21157.70	23876.82	1060.67	21338.80	20558.07	-88.48%	0.86%	-13.90%
• **Calorie intake**	143.18	318.56	517.95	15.60	303.94	421.88	-89.10%	-4.59%	-18.55%
• **Protein intake**	4.59	7.24	9.77	0.50	6.91	7.96	-89.10%	-4.59%	-18.55%
Import flow(1000t)	5961.06	819.25	6557.20	515.89	1412.06	6102.48	-91.35%	72.36%	-6.93%

* Unit of measurement: Million Euro.

Table 5: Sectorial effect on Production and Profits in LDCs

Unit of measurement: Mio Euro	Baseline			Scenario			Percentage change		
	wheat	maize	rice	wheat	maize	rice	wheat	maize	rice
Production									
• **Net production**	3308.37	22555.51	17842.30	665.96	22578.22	14925.62	-79.87%	0.10%	-16.35%
• **Processing**	47.04	78.63	122.28	28.23	79.08	123.02	-39.99%	0.57%	0.6%
• **Feed use**		2117.46	306.17		2222.47	223.46		4.96%	-26.78%
Profits									
• **Agricultural profits**	141.31	2851.46	2392.94	94.17	1682.51	2286.49	-33.36%	-40.99%	-4.45%
• **Profits of Feed industry**		-106.80	-15.39		-69.69	-12.22		34.74%	20.59%
• **Processing profits**	0.80	3.98	6.56	6.64	11.77	37.69	728.47%	195.96%	474.60%

Table 6: Effect on Tariff revenues in LDCs

Unit of measurement: Mio Euro	Baseline			Scenario			Percentage change		
	wheat	maize	rice	wheat	maize	rice	wheat	maize	rice
Tariff revenues	90.19	12.45	139.17	14.73	31.05	126.43	-83.67%	149.50%	-9.15%

In the other side, Nigeria and South Africa would benefit under grain price increase scenario. The overall welfare is projected to increase in both countries, resulting mainly from increase in consumer surplus and increase in profits of processing activities that outweigh the losses in agricultural income and tariff revenues. It is worth noting that even if consumer surplus increase in South Africa and Nigeria, the sectorial consumer surplus decreases in both countries. More specifically, in Nigeria, the consumer welfare gains decrease by -60.69% in wheat market, by -58.73% in maize market and by -64.27% in rice market, and in South Africa, it drops by -56.89% in wheat market, -41.71% in maize market and -9.97% in rice market. Nigeria is among the world biggest importing country of wheat, in 2012 it is estimated to 3700 (1000MT) while producing only 100 (1000MT). Nigeria is also the world second largest importer of rice after Indonesia. These results prove that the increase in the consumer surplus is driven by the substitution effect. The model equations take into account the cross price effect, so following an increase in one product price, demand for other products will grow with soaring price for a substitute. The increase in the overall welfare in Nigeria and South Africa may also be explained through the fact that these two countries are identified as less vulnerable to food price shocks because either they are oil exporter (Nigeria) or middle income country (South Africa) (Conceição, Levine, & Brixiova, 2011). These two countries have efficient logistic, infrastructures for agricultural production than African LDCs countries.

Some Policy recommendations

We explored in this study the economic impacts of global grain price increase on the Least Developed Countries in Africa and made some comparisons with the other African trade blocks in CAPRI. Important policy implications follow our findings. Regarding the adverse effects that international price may have on the welfare of African LDCs, Governments could invest to develop wheat, rice and maize industry in order to reduce the countries vulnerability to international shocks.

Bilateral cooperation between African countries and the others should be more oriented toward transfer of technology, knowledge and managerial skills. Financial aid can be a short term remedy, but not for long term agricultural growth purpose. When global food price increase, aid donor countries lower their fund to African LDCs agricultural sector which heavily depend on foreign aid. A perfect illustration is the case of 2008 global food price crisis. Even though international community was committed to increase financial support to LDCs for agricultural development, in the short run the priorities and objectives of national governments were more focused on their own food security and agriculture (Abbott, 2012). The Senior Economist in the World Bank's Agriculture Unit Robert Townsend also highlights the fact that the availability of food aid tends to be lower when global food prices are high, as food previously provided as aid goes to other uses. The decline of aid to agricultural in short term leads to less accessibility in fertilizers, and in long run to less investments, lack of suitable infrastructures. This paper was one part motivated by the acknowledgement of the neglect of investments in agriculture and the lack of regular food and trade policy in the most of African countries, especially in LDCs.

High transportation costs and poor logistics are likely to amplify the negative impacts of global price on Africa. This highlights the importance of investing in transportation and logistics infrastructures. This is particularly important, since not only, poor transportation magnifies the import prices but also, it impedes the distribution of products between production zone and consumption area within the country. In line with the reduction of transportation cost, the enhancement of intraregional trade remains a credible remedy for Governments in LDCs countries for mitigating the transaction costs, especially for landlocked countries and increase exports. An obvious relevant policy recommendation emerging from this paper refers to the current project of the African Union to implement the Continental Free Trade Area. The effect of grain prices on the agricultural income is negative in the long run.

An income diversification policy such as earning from livestock, earning from fishing can serve as means to withstand the unfavorable effects of price spikes in LDCs. It is worth recalling that in light of the literature, food prices are likely to remain volatile. Highly volatile prices reduce the ability of farmers to cope with risk, especially in the LDCs countries where future markets are not available. A relevant policy recommendation is the implementation of grain reserve in most African countries, or the introduction of export taxes as suggested by Gouel & Jean (2012). This is particularly an important issue, since the fact that LDCs countries may not take advantage of higher international grain prices attests the lack of sufficient storage in these countries.

Table 7: Effect on Overall Welfare in other African countries Trade Blocks in CAPRI

Unit of Measurement: Mio Euro		Consumer surplus	Agricultural Income	Tariff revenues	Profits of processing activities: Profit of non-agricultural land use	Profit of dairies	Profit of other processing	Profit of feed industry	Welfare
Africa-Rest	Baseline	213929.89	29013.12	1293.47	00	-955.56	1189.44		244470.38
	Scenario	194959.92	20801.71	931.55	1392.39				234352.59
	Percentage	-8.87%	-28.30%	-27.98%	9490	1672.34	5716.72	750.16	-4.14%
	change					275.01%	380.62%	-46.12%	
South Africa	Baseline	203748.98	10525.33	409.90		-202.72	106.06	2161.92	214587.55
	Scenario	319182.28	7554.75	549.11	2682.03	495.35	4361.88	2079.34	336915.69
	Percentage change	56.65%	-28.22%	33.96%		344.36%	4012.71%	-3.82%	57.01%
Nigeria	Baseline	155845.66	20966.93	455.88		-77.33	558.82	1338.88	177749.97
	Scenario	191834.70	19948.23	377.92		22.00	3953.05	2487.30	227672.09
	Percentage	23.09%	-4.86%	9048.31		128.44%	607.39%	85.77%	28.09%
	change			-17.10%					
Ethiopia	Baseline	44513.97	3016.18			-122.97	7.63	17.24	47414.82
	Scenario	35133.34	3048.77		1599.76	321.50	112.96	11.80	40228.67
	Percentage change	-21.07%	1.08%			361.45%	1380.44%	-31.55%	-15.16%

5. Conclusions

Assessment of the economic impact of global grain price increase has been the subject of numerous research and approaches. Various papers also investigated the driving forces behind the global food price surge in order to put the commodity price boom into perspectives. Many factors contribute to grain price increase including demand side factors and supply side factors. Using the CAPRI modeling system, this paper estimates the economic impact of higher global grain price on the African LDCs, where food security was so far under-researched.

The simulation shows that higher commodity prices are projected to have negative effects on the overall welfare of LDCs countries in the medium term. More precisely, the three crops wheat, maize and rice price spike leads to a reduction of consumer surplus, agricultural income, tariff revenues in these countries. Profits from processing and feed use activities are projected to increase, but not enough to outweigh the losses in consumers, producers and Governments. The analysis on sectorial effects, illustrates that wheat sector is most adversely affected in term of net production and welfare. It appears also, that in general, consumers tend to substitute wheat and rice for maize during higher food price surge periods, leading to an increase in domestic wheat production. Domestic and import demands fall as well as calorie and protein intakes bringing the food security issue into perspectives in the LDCs countries in Africa.

Our results reveal that, not surprisingly, the negative effect on welfare is greater in the LDCs than in the Africa-Rest. This highlights the LDCs vulnerability to food price fluctuations in the international markets. Countries such as Nigeria and South Africa, respectively oil exporter country and middle income country benefit from the higher prices in term of overall welfare, although they also experience sectorial losses in consumer welfare from grain consumption. Ethiopia as a single country would benefit in terms of producer surplus.

This paper highlights the importance of investing in investments in agricultural industry, the commitment to increase transportation and logistics infrastructures to mitigate the transaction costs, and the implementation of grain reserves to cope with food price crisis in the LDCs countries in Africa. Our study has faced some practical difficulty and limitations. The aggregation of different countries into one trade block masks differences across countries, including country's location, consumption behavior and structural characteristics. It does not allow observing the effect on every country or differentiating the impact on rural and urban area. While we hope that this work helps to fill the gap of existing studies on LDCs countries in Africa, one may adopt to disaggregate the LDCs trade block in the future.

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