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Ethanol Expansion in the Food versus Fuel Debate: How Will Developing Countries Fare?

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Abstract

This paper examines the impact of ethanol expansion in the United States, brought about by higher crude oil prices, on agricultural commodity prices. Given the United States's stature as a major producer and exporter of many agricultural commodities, the resulting increase in commodity prices has spillover effects into the global market. Using the price changes estimated within a multi-commodity, multi-country agricultural modeling system, this paper attempts to show how an increase in world commodity prices would affect the costs of food baskets around the world and how higher food costs will impact food security, particularly in developing countries. In general, we find that countries where corn is the major food grain experience larger increases in food basket cost while countries where rice is the major food grain have smaller food basket cost increases. Countries where wheat and/or sorghum are the major food grains fall in between. Consequently, the highest percentage increases are seen in Sub-Saharan Africa and Latin America where food basket costs are estimated to increase by at least 10%. The lowest percentage increases are seen in Southeast Asia, with cost increases of less than 2.5%.

KEYWORDS: agricultural markets, energy, ethanol, food security

1. Introduction

The dramatic expansion in biofuels in recent years, particularly in the United States and Brazil, has been attributed to a number of economic and environmental factors. High crude oil prices have fueled interest in finding alternative energy sources and reducing dependency on imported oil supplies. Environmental concerns about greenhouse gas emissions have also contributed to the expansion. Additionally, the emergence of biofuels has represented an alternative market for a number of agricultural commodities. This push has been driven primarily by mandates and market incentives (for example, the National Alcohol Program (PROALCOOL) in Brazil, the Energy Policy Act of 2005 in the United States, and the 2003 Renewable Fuels Directive in the European Union).

Ethanol is currently the major type of biofuel in the world, and it has been expanding significantly, especially in the United States and Brazil. The two countries account for over 70% of total world production, with the United States producing 5.3 billion gallons and Brazil producing 4.5 billion gallons in 2006 (RFA, 2007). A number of countries, such as China and India, are also taking an increased interest in ethanol as an alternative fuel. Biodiesel, the other major biofuel, has been lagging behind ethanol primarily because of higher feedstock costs. However, it is significant in the European Union and gaining importance in the United States and in South American countries.

A number of studies have looked at the impact of biofuels expansion on agricultural markets both at the national and global levels (Elobeid et al., 2007; English et al., 2006; Hill et al., 2006; Secchi and Babcock, 2007; Tokgoz et al., 2007; von Lampe, 2006). These studies have found that, in general, with increased ethanol expansion, the prices of both the agricultural feedstock commodities and their competing crops increase with implications for land allocations, food prices, and the environment. While there is consensus on the impact of the growth in biofuels on the prices of agricultural commodities, there is debate as to whether the net effect on the economy and the environment is positive or negative. Doornbosch and Steenblik (2007), for example, contend that the contributions of biofuels to energy demands are very limited given their adverse effects on food prices and the environment. Nonetheless, there are benefits in terms of increased producer prices and positive income effects, particularly in rural economies (Schmidhuber, 2006).

Prior to biofuels, agricultural prices were affected by energy prices mainly through their impact on the cost of production by way of input prices such as fertilizers and pesticides. However, higher energy prices now are affecting agricultural output prices directly, as agricultural commodities have become inputs in the production of energy. Schmidhuber (2006) points out that this new relationship means that higher energy prices are creating price floors for agricultural commodities when demand from the energy sector is large and agricultural feedstocks are competitive in the energy market. Energy prices also create price ceilings for agricultural feedstocks depending on how fast the feedstock prices rise relative to energy prices and on their energy equivalents, particularly in the long run. Feedstock costs are a major component in the cost of producing biofuels, so feedstock prices need to remain competitive in the energy markets.

This paper examines the impact of ethanol expansion in the United States, brought about by higher crude oil prices, on agricultural commodity prices and how the increase in these prices will affect food prices and global food security. Ethanol is produced mainly from corn in the United States. The United States is a major producer and exporter of not only corn but also other agricultural commodities such as sorghum, soybeans, pork, and broiler meat. U.S. corn accounts for about 40% of global production and roughly 70% of world trade. Thus, an increase in the demand for U.S. corn used in ethanol production would have an impact not only in domestic markets but also in the global arena. With ethanol expanding in the United States, the increase in corn prices will bid away land from other crops such as soybeans and wheat, which will result in an increase in their respective prices. With the continuation of the ethanol expansion in the United States in 2006, U.S. corn prices increased by 60% while world corn prices increased by more than 50%. Wheat and soybean prices increased by 25% and 8%, respectively, in the United States, and increased by 21% and 7%, respectively, in the world market. Given the United States's dominance in these commodities, the increase in their prices had spillover effects into the global market.

Higher prices in agricultural commodities used in the production of food imply higher food prices. Although these higher agricultural commodity prices would benefit agricultural producers in both developing and developed countries, they would also adversely affect the ability of the poor, especially in developing countries, to purchase food. In addition, developing countries, in general, and low-income food-deficit countries, in particular, are usually net exporters of primary agricultural commodities as well as net importers of food. Thus, the rising commodity prices will have both positive and negative impacts on the economies of these countries. For this paper, the focus is on the changes in food purchasing power, especially in developing countries, given estimates of price changes due to ethanol expansion in the United States. Lower global supplies and higher world prices for commodities such as corn, wheat, and soybeans would greatly impact low-income food-deficit countries. These countries have large numbers of poor, rural, food insecure, and undernourished populations, which tend to spend a larger proportion of their income on food and are more vulnerable to rising and volatile food prices. One of the regions that is especially vulnerable is Sub-Saharan Africa, where over 30% of the population is chronically food insecure (FAO, 2007b). Using the price changes estimated within a multi-commodity, multi-country agricultural modeling system, this paper attempts to show how an increase in world commodity prices would affect the costs of food baskets around the world and how higher food costs will impact food security, particularly in developing countries.

In the following paragraphs, we define food security, identify the countries that are food insecure, and explore the impact of ethanol expansion on food security. Then, we offer a brief description of the models used for the simulations and the method used for determining the impact of higher commodity prices on the costs of individual countries' food baskets. After describing the scenarios, we present the key results and conclusions.

2. Defining food security

The Food and Agriculture Organization of the United Nations (FAO) defines food security as a condition which exists "when all people, at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 2002, p. 49). There are four dimensions of food security: food availability, stability of food supplies, access, and utilization (i.e., people's ability to absorb nutrients). Conversely, food insecurity is defined as "a situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life. It may be caused by the unavailability of food, insufficient purchasing power, inappropriate distribution, or inadequate use of food at the household level" (FAO, 2002, p. 49).

Food insecurity may be chronic, seasonal or transitory. Chronic food insecurity is a long-term phenomenon defined as the persistent inability of people to meet minimum food consumption requirements, lasting for more than six months of the year. Chronically food insecure households have reduced capability to weather shocks including higher food prices, loss of income, or loss of food crops due to weather. Transitory food insecurity is a short-term occurrence and is the temporary inability to meet minimum food requirements. Transitory food insecurity usually occurs in a more limited time frame with some indication of capacity to recover from shocks (FAO, 2002).

2.1 *Who are the food insecure?*

There are over 860 million people who can be classified as hungry or undernourished in the world. Undernourished people are those whose food intake is continuously below a minimum dietary energy requirement for maintaining a healthy life. Ninety-six percent of the hungry live in developing countries, which are characterized by reliance on agriculture, rural populations, dependence on food imports, and exports of primary commodities (FAO, 2007b). Table 1 shows the proportion of the world's undernourished by region.

Although Asia and the Pacific, and Latin America and the Caribbean have experienced a noticeable reduction in the prevalence of undernourished people, the reduction in Sub-Saharan Africa is less pronounced, with certain regions facing higher proportions of undernourishment when compared to the early 1970s.[1] Furthermore, FAO projects that by 2015 there will be a reduction in the number of undernourished people in developing countries with the exception of the Near East and North Africa, and Sub-Saharan Africa (FAO, 2006). The least-developed countries have the highest proportion of chronically undernourished populations (about 88%). These countries have become increasingly dependent on imports of basic food commodities to ensure food security. For many, this has also resulted in increased exposure to international market price fluctuations, increasing overall food insecurity. Biofuels expansion, in general, and ethanol expansion, in particular, would result in direct linkages between what happens in the energy markets and food security, thus increasing uncertainty in global agricultural markets.

Table 1. Prevalence of Undernourishment in Total Population (percent)

Country Groups	1969-71	1979-81	1990-92	1995-97	2001-03[1]	2002-04[2]
World					14	14
Developing World	37	28	20	18	17	17
Asia and the Pacific	41	32	20	17	16	16
Latin America and the Caribbean	20	13	13	11	10	10
Near East and North Africa	23	9	8	10	9	9
Sub-Saharan Africa	36	37	35	36	32	33
Developed World					3	<2.5

Source: FAO, 2007b.
1. provisional; 2. preliminary

2.2 *U.S. ethanol expansion and its impact on food security*

In this study, the impact of ethanol expansion on food security is examined through two of its four dimensions, namely, availability and access. Food availability refers to the capacity to have adequate food supplies and to meet overall food demand. With ethanol expansion, food could become less available

[1] For example, the proportion of undernourished people in Central Africa increased from 30% in 1969-1970 to 57% in 2002-2004.

as more resources are diverted away from the production of food and toward the production of biofuels. Food access refers to the ability of households to have enough purchasing power and entitlement to access food. If food prices rise faster than real income as a result of ethanol expansion, this would reduce purchasing power and, in turn, reduce the ability of households to access food (Schmidhuber, 2006). This may be especially true for the urban poor in developing countries.

3. Model calibration and data

The results from a series of models representing major agricultural commodities in U.S. and global markets are utilized in this study to evaluate the likely impact of an increase in crude oil prices, and the resulting growth in the ethanol sector, on agricultural markets.[2] The modeling system includes models of supply and demand for important temperate agricultural products in all major producing and consuming countries. The model structure was extended to incorporate and link an international ethanol model to an already established multi-market model of world agricultural and food markets. The integration of the ethanol sector into the agricultural market increases the market's susceptibility to volatility from energy markets. The modeling system allows prices, production, consumption, and trade in the ethanol, crops, livestock, and dairy sectors to be endogenized in both the U.S. and world markets. Thus, the system allows for supply and demand responses of the modeled agricultural commodities in the U.S. and worldwide to economics shocks, such as the scenarios outlined later in this paper.

The individual models are partial equilibrium, econometric, non-spatial policy models. Parameters in the model are estimated, surveyed from the literature, or obtained from consensus of expert opinion. The models include policy instruments, such as price supports, tariffs, and export subsidies that influence the incentives faced by economic agents. Supply and utilization data for the agricultural commodities were obtained from the F.O. Lichts Online Database; the FAO of the United Nations (FAOSTAT Online); and the Production, Supply and Distribution View (PS&D) database of the U.S. Department of Agriculture (USDA). Macroeconomic data were obtained from the International Monetary Fund and Global Insight. Data on the prevalence of undernutrition and the food consumption patterns of the main food items by country (i.e., the share of total dietary energy consumption) are available from FAO's Statistics Division (FAO, 2007a, b). The data and projections for the crude oil price, which is the U.S.

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[2] This analysis is derived from the results of the study "Emerging Biofuels: Outlook of Effects on U.S. Grain, Oilseed, and Livestock Markets" by Tokgoz et al. (2007) and additional projections provided by the same authors. A fuller description of the projection models is contained in the Tokgoz et al. reference or at www.fapri.iastate.edu/models/.

refiners' acquisition cost of crude oil, were taken from the U.S. Department of Energy's Energy Information Administration (EIA, 2007).

A baseline is established using the U.S. and international commodity models calibrated on 2006 historical data (2006/07 marketing year data for crops models). The projections cover the period between 2007 and 2016 (2007/08 and 2016/17 marketing years). Although the projection period covers only 10 years, a long-run equilibrium concept is used in which long-run equilibrium prices for ethanol, crops, and livestock are achieved. This occurs when there is no incentive to construct new ethanol plants (i.e., net profit margins reach zero), no incentive to expand or contract livestock and dairy production, and all crop markets clear. Therefore, the year 2016/17 is the last year of the projection period and also the year in which long-run equilibrium conditions hold for all relevant sectors. Then, two scenarios are run.

In the first scenario (Scenario 1), the crude oil price is increased by $10 per barrel over the projection period, and it is assumed that U.S. ethanol demand is constrained by the lack of flex-fuel vehicles to absorb the additional ethanol from the ethanol expansion generated by the higher crude oil price.[3] In the second scenario (Scenario 2), the crude oil price is increased by $10 per barrel over the projection period, but it is assumed that no demand constraint exists, i.e., there are enough flex-fuel vehicles to absorb the additional ethanol supply. The first scenario represents a realistic view of the current conditions in the ethanol market whereas the second scenario represents an upper bound. The two scenarios are analyzed relative to the baseline projections. Once the changes in the prices of agricultural commodities are determined in each of the scenarios, the changes in the costs of the food baskets of all available countries are calculated using the share of total energy dietary consumption.[4] The food cost calculations are based on the latest FAO food consumption data and the price changes for the basic agricultural commodities from the scenario projections. These food cost change estimates do not account for possible food substitution and it is assumed that the commodity price changes serve as a reasonable proxy for food price changes. Thus, the estimates should be viewed as upper bounds on the impacts on food basket costs. Given that the translation of commodity prices into food prices often contains additional costs, especially for developed countries, the estimates presented here will likely overstate the impacts particularly in countries with more

[3] Flex-fuel vehicles can run on gasoline, gasoline blended with 10% ethanol (E-10) or gasoline blended with 85% ethanol (E-85). The flex-fuel vehicle market is currently undeveloped, as it faces a series of issues including the relative lack of E-85 fuel stations and the price of ethanol relative to gasoline.

[4] Dietary energy consumption per person is the amount of food, in kcal per day, for each individual in the total population.

developed economies. The results for the United States are highlighted to show the possible inflation of the food basket cost impacts.

4. Results

4.1 *Higher crude oil price scenarios with and without an ethanol demand constraint*

In the first scenario, in which the constraint in ethanol demand exists, a $10 per barrel increase in the crude oil price leads to a 55% increase in the production of U.S. ethanol in 2016/17, i.e., the long run. The higher crude oil price, in combination with the projected corn price, results in positive net returns for the ethanol sector and provides incentives for the ethanol industry to expand. Ethanol produced from corn increases from 14.4 billion gallons in the baseline to roughly 22 billion gallons under Scenario 1. With the demand for U.S. corn used in ethanol increasing by 64%, the U.S. corn price increases by 20%, from $3.15 per bushel in the baseline to $3.78 per bushel in the scenario. U.S. corn area planted increases by 11% while area planted for competing crops declines, by almost 7% for wheat and by 6% for soybeans when compared to the baseline. Consequently, the prices of wheat and soybeans increase by 9% for both crops. With supply of soybean meal declining, the price of soybean meal increases by almost 5%.

As U.S. feed prices increase dramatically, so do livestock farmgate prices. The increase in the corn price and the soybean meal price result in an increase in the feed cost for livestock. U.S. exports of pork, broilers, and turkeys decline but by a smaller percentage than crop exports do (30.2% and 21% for corn and wheat, respectively, versus 6.2% and 1.5% for pork and broiler, respectively). The reason for this difference is that world demand for U.S. meat is largely unaffected by higher feed-grain prices because the rest of the world's livestock producers also face higher feed prices. Total world meat consumption declines because of higher prices, but U.S. producers still would find it profitable to supply world markets. The same situation applies to non-fat dry milk, which is the main dairy product exported by the United States. U.S. beef exports are projected to increase because the price of beef relative to other meats declines.

Scenario 2 without an ethanol demand constraint shows amplified results compared to Scenario 1. As in Scenario 1, the combination of crude oil and corn prices result in positive net returns for the ethanol sector and incentives for the ethanol industry to expand. Here, an increase in the price of crude oil results in a doubling of U.S. corn-based ethanol production in the long run to almost 29 billion gallons when compared to the baseline. The U.S. corn price increases by roughly 40%, to $4.42 per bushel. The rise in U.S. feed prices is also higher than in the Scenario 1 and the impact on the livestock sector is larger.

For this study, the key model results are the price changes for the individual commodities. Table 2 displays the long-run representative world price levels for the commodity prices under the baseline projections and the percentage changes projected under the two scenarios. These price changes serve as the primary information used in this study to determine the food basket cost changes given continuing biofuel expansion. As can be seen in the last two columns of Table 2, commodity prices under the two scenarios are above baseline levels. Given the concentration of the scenarios on biofuels, and specifically ethanol production, it is not surprising that corn prices increase sizably under the scenarios. In general, crop prices in the scenarios increase by over 10%, especially for crops of which the United States is a leading exporter. Vegetable oil prices also increase under the scenarios, as the oil crops face pressures from increased land competition from corn and possible biodiesel development. Meat and dairy prices also increase under the scenarios, as higher feed prices are projected to be passed through to consumers.

Table 2. Impact of Higher Crude Oil Prices on Agricultural Commodity Prices

Commodities	**Units**	**Prices**	**Percent Change in Prices**	
		Baseline	**Scenario 1**	**Scenario 2**
Barley and products	$/metric ton	135.0	11.9%	23.0%
Butter, ghee	$/metric ton	2,299.0	0.3%	0.5%
Cheese	$/metric ton	3,234.0	0.8%	1.7%
Corn and products	$/metric ton	159.0	18.2%	36.5%
Cottonseed oil	$/metric ton	39.7	6.2%	9.4%
Eggs and products	¢/dozen	87.3	6.3%	15.3%
Meat and products, bovine	$/metric ton	1,935.0	3.8%	8.6%
Meet and products, pig	$/metric ton	1,138.0	6.9%	16.1%
Meat and products, poultry	$/metric ton	1,612.0	5.1%	13.4%
Milk	$/metric ton	323.0	19.5%	23.2%
Oats and products	$/bushel	1.9	15.9%	30.7%
Palm kernel oil	$/metric ton	762.0	0.4%	0.5%
Palm oil	$/metric ton	740.0	2.0%	2.4%
Rape and mustard oil	$/metric ton	859.0	3.6%	4.9%
Rice and products (milled equivalent)	$/cwt	7.4	0.1%	0.4%
Sorghum and products	$/metric ton	165.0	13.3%	26.1%
Soybean oil	$/metric ton	778.0	8.4%	11.6%
Soybeans and products	$/metric ton	251.0	8.4%	18.3%
Sugar and products (raw equivalent)	$/metric ton	294.0	1.0%	2.0%
Sunflower seed oil	$/metric ton	834.0	2.6%	4.4%
Wheat and products	$/metric ton	208.7	8.3%	16.0%

4.1.1 *Impact on food baskets around the world*

For the analysis of the changes in costs of food baskets throughout the world, the price changes outlined in Table 2 are merged with food consumption data from FAO. The food consumption data provides details on the share of total dietary energy consumption by food item and country for many of the nations around the world. To estimate the percentage change in the costs of a country's food basket, we multiply the share of total dietary energy consumption by food item with the food item's corresponding commodity price change. We then add up the resulting products, and divide the total by the sum of the shares of total dietary energy consumption. The division of the sum of the dietary energy consumption is necessary as the FAO shares do not sum to 100% for each country, and price data is not available for several of the food items listed in the FAO consumption data.

As an example, Table 3 outlines the estimation process for the country of Albania. The FAO consumption data details 91% of total dietary energy consumption by food item in Albania. Wheat products and milk account for over half of the dietary energy. The sum of food item consumption shares with associated price changes is 81%, so most of the Albanian food basket is covered by this analysis. The food items for which there are no price estimates from the agricultural projection models are shown as not available. The estimated impact on the cost of the Albanian food basket is shown in the last row of the table. The 9.16% cost increase is derived by dividing the 7.42% cost increase for the food items included in the analysis by the sum of consumption shares for those food items, 81%. A table showing the food basket cost statistics for all of the countries included in this study is provided in the Appendix.

The construction of the food basket cost changes in this way assumes that the cost changes for food consumption not included in this analysis are proportional to the average cost change computed for each country. This construction also is predicated on the assumption that the world commodity prices are representative of food prices within the countries. In developed countries, this assumption likely overstates the food basket cost changes, as retail food prices contain considerable markups for packaging, processing, and marketing. For developing countries however, this assumption is less problematic, and the estimated food basket cost changes should generally reflect the food cost situation. A third key caveat is that food consumption patterns are held constant in this analysis. The combination of these assumptions implies that the estimates presented here should be viewed as upper bounds on the impacts on food cost changes.

Figure 1 shows the estimated impacts of food basket costs for countries around the world under Scenario 1. The highest percentage increases are seen in Sub-Saharan Africa and Latin America where food basket costs are estimated to increase by at least 10%. The lowest percentage increases are seen in Southeast Asia, with cost increases of less than 2.5%. Countries shown in white did not have consumption data available through the FAO database. In general, the results under Scenario 2 follow the same pattern, with the estimated impacts being roughly double those of Scenario 1.

Table 3. Example of Food Basket Cost Calculation for the Country of Albania

Food Item	**Dietary Energy Consumption Share**	**Change in Commodity Price under Scenario 1**	**Product of Consumption Share and Price Change**
		(percent)	
Wheat and products	41	8.3	3.40
Milk	16	19.5	3.12
Sugar and products (raw equivalent)	7	1.0	0.07
Sunflower seed oil	5	2.6	0.13
Vegetables, other and products	2	N/A	N/A
Rice and products (milled equivalent)	2	0.1	0
Potatoes and products	2	N/A	N/A
Meat and products, bovine	2	3.8	0.08
Meat and products, pig	2	6.9	0.14
Meat and products, poultry	2	5.1	0.10
Corn and products	2	18.2	0.36
Grapes and products (excluding wine)	2	N/A	N/A
Cheese	2	0.8	0.02
Fats, animals, raw	1	N/A	N/A
Fruits, other and products	1	N/A	N/A
Beans, dry and products	1	N/A	N/A
Meat and products, sheep and goat	1	N/A	N/A
Sum	91		7.42
Sum of food items with associated price changes	81		
Estimated food basket cost change			9.16

N/A: Not available

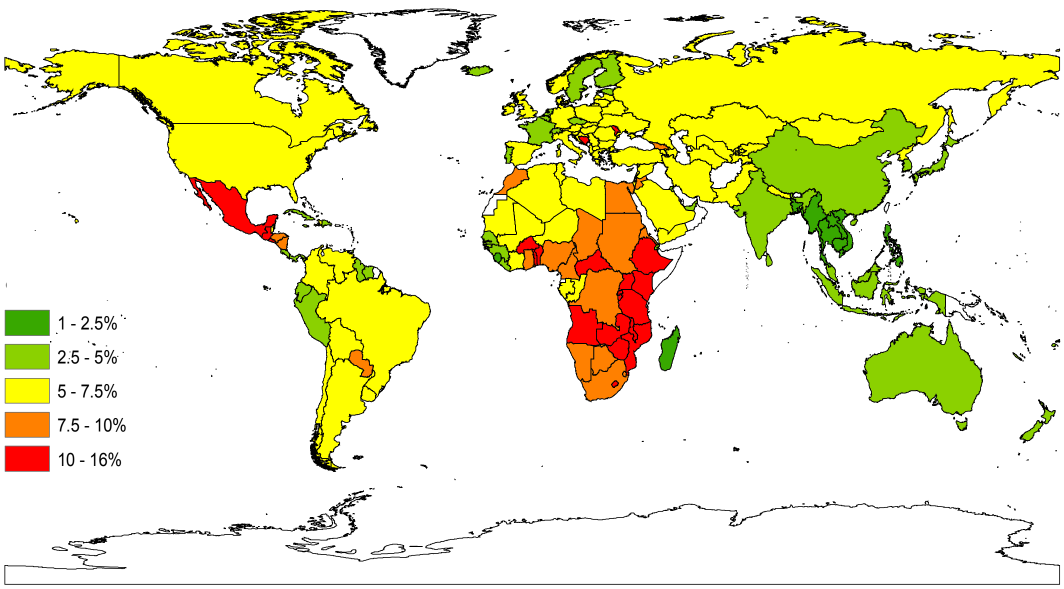

Figure 1. Impact of Increase in Crude Oil Price on the Cost of Food Baskets in Scenario 1

The results for Africa provide a summary for the world in general. Figure 2 isolates the Scenario 1 results for Africa. Countries where corn is the major food grain, such as for much of Sub-Saharan Africa, experience the larger food basket cost increases. Countries where rice is the major food grain, such as Liberia and Sierra Leone, have the smaller food basket cost increases. Countries where wheat and/or sorghum are the major food grains, such as Egypt and Sudan, fall in between.

Table 4 lists the 10 countries with the largest estimated food basket increases under Scenario 1. Nine of the 10 countries are in Sub-Saharan Africa. All of the countries listed have cost increases of at least 10%. At the bottom of the table is the estimate for the United States. In their 2007 paper, Tokgoz, et al. estimated the impact of the growth in the ethanol industry on U.S. food prices to be relatively small, about 1%.[5] Their estimate is significantly less than the estimate in this study of 5.8%. As was mentioned earlier, in developed countries, the assumption that commodity prices represent retail food prices likely overstates

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[5] Their impact of food prices is evaluated only from higher commodity prices and feed costs. It was assumed that higher feed prices travel through the supply chains in fixed dollar amounts and not in percentage terms.

the food basket cost changes because retail food prices contain significantly smaller feedstock prices relative to non-feedstock markups.

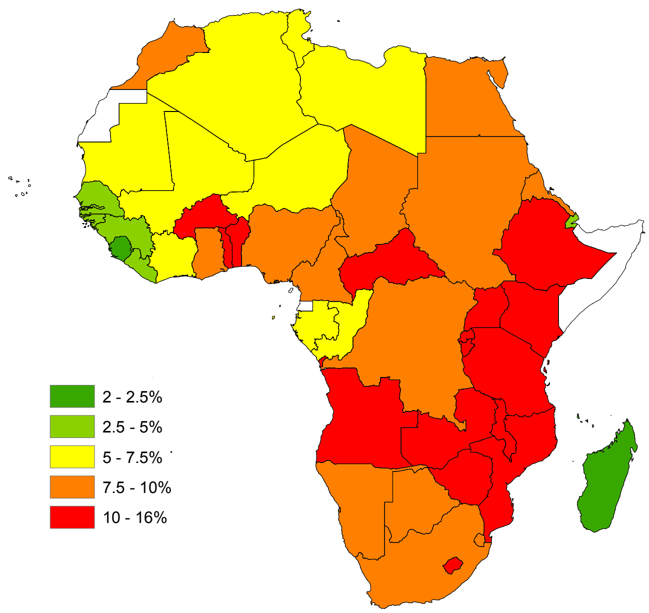

Figure 2. Impact of Increase in Crude Oil Price on the Cost of Food Baskets in Africa in Scenario 1

Table 4. Food Basket Cost Increases under Scenario 1

Country	Ranking	Cost Increase in Food Basket
		(percent)
Lesotho	1	15.3
Malawi	2	15.1
Zambia	3	14.7
Burundi	4	12.7
Ethiopia	5	12.3
Tanzania	6	12.2
Mozambique	7	11.6
Rwanda	8	11.4
Zimbabwe	9	11.1
Guatemala	10	10.8
United States	75	5.8

The impact of higher commodity prices and feed costs on U.S. food prices depends on how much of the retail prices flow back to the underlying commodity. USDA estimates show that for cereals and bakery items, less than 10% of the retail price flows back. For meat and dairy, this percentage is higher, ranging between 20% and 50%. Thus, for the United States, over half of the retail price for many food items covers packaging, processing, and marketing and not the cost of the associated commodity. The retail markup for these additional costs reduces the percentage impact commodity prices have on U.S. retail food prices. And as a comparison between Tokgoz et al. (2007) and our estimates shows, this reduction can be significant for developed countries. Arguably, for developing countries the retail markup for packaging, processing, and marketing represents a much smaller percentage of retail food prices.

The FAO database also provides estimates of the share of food consumption within total consumption for several countries around the world. Using this data, in combination with the estimated food basket cost increases, can provide an exploratory analysis on the impact for total consumption and the loss of purchasing power due to the food price increases. Table 5 highlights this data for several selected countries. These countries were selected because they were some of the most impacted countries based on our estimates. A rough measure of the loss of purchasing power is the product of the two percentages in Table 5. For countries like Guatemala and Mexico, the loss of purchasing power is between 3% and 4%, as food consumption represents roughly one-third of total consumption. For many of the African countries listed, food consumption is a much larger percentage of total consumption, so the purchasing power loss due to higher food prices is larger, on the order of 9% for a country such as Zambia.

5. Conclusion

Interest in biofuels has dramatically increased over the past several years for a variety of reasons, including high energy prices, environmental concerns, and energy security. An expansion of the ethanol industries in Brazil and the United States has accompanied this interest, so that worldwide biofuel production is much larger than in years past. There have been a number of studies examining the agricultural impacts of this biofuels expansion, but few, if any, have examined the impacts of the expansion on food costs throughout the world. In this study, we have combined large-scale agricultural model estimates of commodity price changes under two different scenarios for future U.S. biofuel development with data outlining the composition of diets in many countries around the world to compute the possible food cost ramifications of biofuel expansion by country.

Table 5. National Share of Food Consumption in Total Consumption for Select Countries

Country	Ranking of Impact on Food Basket Costs in Scenario 1	Share of Food in Total Consumption	Increase in Food Cost
		(percent)	
Ethiopia	5	52.8	12.3
Guatemala	10	37.1	10.8
Mexico[1]	17	34.0	10.3
Moldova[1]	16	68.3	10.4
Mozambique[1]	7	50.0	11.6
Rwanda	8	71.7	11.4
Tanzania	6	65.4	12.2
Uganda[2]	15	44.0	10.5
Zambia	3	64.0	14.7

Source: FAO, 2007c.
1. Food consumption refers to the monetary value of acquired food, purchased and non-purchased, including food away from home. Total consumption refers to the household's monetary value of acquired goods for consumption, food, and non-food.
2. Includes tobacco.

Our results show that the regions of the world that would face the largest food price pressures are Sub-Saharan Africa and Latin America, regions where corn is the dominant grain for food consumption. Under a scenario of higher oil prices and utilization bottlenecks of biofuels in the United States, the projected corn prices increases by 20%, leading to food basket cost changes of well over 10% for several African nations. Under a second scenario removing the utilization bottlenecks, the projected corn price and food basket cost changes approximately double. Regions where rice is the main food grain show the lowest increases in food basket costs. Many of the most affected countries in terms of food costs also devote a large portion of their total consumption to food. Thus, the increase in food costs will also impact their non-food consumption significantly since their total purchasing power is reduced.

For this study, we have concentrated on the food cost impacts and have estimated upper bounds on those impacts. The higher projected prices for agricultural commodities will also spur additional development of the agricultural sectors in many of the countries affected. Developing countries tend to be net exporters of primary agricultural commodities, but they also tend to be net food importers. Thus, the economic consequences of the biofuels expansion are mixed; agricultural producers gain via the higher prices, just as consumers' situation declines because of the same higher prices. There are a number of issues that will influence the actual impact of biofuel development on food costs that we have not accounted for. Two major issues are the development and timing of biofuels from non-food sources (cellulosic ethanol, biodiesel from algae, etc.) and the flexibility within country diets among food grains to meet food needs. Both of these issues could mitigate some of the food cost impacts as we look forward.

6. Appendix

Table A. Percentage Changes in Food Basket Costs

Country	Dietary Energy Consumption Share	Cost Increase in Food Basket, Scenario 1	Rank, Scenario 1	Cost Increase in Food Basket, Scenario 2	Rank, Scenario 2
Albania	81.0%	5.8%	74	10.7%	81
Algeria	82.0%	7.0%	44	13.3%	47
Angola	47.0%	10.1%	20	19.6%	20
Argentina	79.0%	5.2%	98	10.0%	99
Armenia	77.0%	6.2%	64	11.6%	65
Australia	71.0%	4.2%	143	7.9%	144
Austria	66.0%	5.2%	97	10.2%	93
Azerbaijan	78.0%	7.3%	38	13.7%	44
Bahamas	66.0%	4.5%	130	9.3%	118
Bangladesh	88.0%	1.3%	172	2.5%	172
Barbados	71.0%	5.3%	91	10.1%	98
Belarus	65.0%	5.2%	101	9.8%	106
Belgium	64.0%	4.5%	129	8.5%	131
Belize	66.0%	5.3%	94	10.4%	86
Benin	48.0%	10.1%	19	20.1%	18
Bolivia	70.0%	6.2%	63	12.2%	57
Bosnia and Herzegovina	70.0%	10.1%	18	19.7%	19
Botswana	72.0%	8.6%	27	16.5%	28
Brazil	72.0%	5.1%	107	9.5%	113
Brunei Darussalam	74.0%	4.3%	139	8.6%	128
Bulgaria	75.0%	6.1%	66	11.5%	68
Burkina Faso	64.0%	10.6%	12	20.8%	13
Burundi	16.0%	12.7%	4	25.4%	4
Cambodia	85.0%	1.6%	171	3.5%	171
Cameroon	53.0%	9.1%	23	17.8%	23
Canada	70.0%	5.2%	99	9.8%	105
Central African Republic	41.0%	8.0%	32	15.8%	32
Chad	56.0%	7.2%	39	14.3%	38
Chile	81.0%	6.2%	62	12.0%	60

Table A. Percentage Changes in Food Basket Costs

Country	Dietary Energy Consumption Share	Cost Increase in Food Basket, Scenario 1	Rank, Scenario 1	Cost Increase in Food Basket, Scenario 2	Rank, Scenario 2
China	75.0%	4.9%	118	9.9%	103
Colombia	74.0%	5.6%	81	10.7%	78
Comoros	43.0%	2.0%	168	4.0%	168
Congo, Dem. Republic	31.0%	8.9%	25	17.4%	26
Congo, Republic of	50.0%	5.7%	77	10.5%	84
Costa Rica	79.0%	3.4%	155	5.9%	156
Côte d'Ivoire	55.0%	5.2%	96	10.1%	95
Croatia	65.0%	6.3%	58	11.8%	62
Cuba	70.0%	4.4%	137	8.4%	135
Cyprus	69.0%	4.9%	116	9.3%	119
Czech Republic	69.0%	4.8%	120	9.0%	123
Denmark	59.0%	5.1%	108	10.2%	92
Djibouti	86.0%	4.4%	136	8.0%	143
Dominica	58.0%	5.0%	111	9.6%	111
Dominican Republic	70.0%	3.9%	148	7.0%	151
Ecuador	77.0%	3.8%	149	6.8%	152
Egypt	81.0%	7.8%	34	15.3%	33
El Salvador	76.0%	10.5%	13	20.5%	14
Eritrea	68.0%	9.6%	22	18.5%	22
Estonia	59.0%	4.4%	134	8.4%	136
Ethiopia	61.0%	12.3%	5	24.2%	6
Fiji Islands	69.0%	4.6%	125	8.5%	130
Finland	73.0%	4.8%	121	9.2%	121
France	73.0%	4.8%	119	9.5%	114
French Polynesia	67.0%	4.0%	146	8.0%	141
Gabon	55.0%	5.0%	112	9.8%	108
Gambia	69.0%	4.6%	126	8.1%	139
Georgia	83.0%	7.9%	33	15.1%	34
Germany	63.0%	5.2%	100	9.9%	102
Ghana	36.0%	8.8%	26	17.6%	25
Greece	58.0%	5.1%	102	10.1%	97
Grenada	63.0%	4.6%	124	8.8%	125
Guatemala	82.0%	10.8%	10	21.3%	10
Guinea	59.0%	2.5%	162	4.9%	162
Guinea-Bissau	73.0%	3.7%	152	7.1%	148
Guyana	69.0%	2.8%	158	5.4%	159
Haiti	69.0%	6.0%	67	11.6%	66
Honduras	81.0%	9.1%	24	17.7%	24
Hungary	65.0%	5.0%	110	10.0%	100
Iceland	66.0%	4.6%	123	8.6%	127

Table A. Percentage Changes in Food Basket Costs

Country	Dietary Energy Consumption Share	Cost Increase in Food Basket, Scenario 1	Rank, Scenario 1	Cost Increase in Food Basket, Scenario 2	Rank, Scenario 2
India	78.0%	3.5%	154	6.4%	154
Indonesia	80.0%	2.9%	157	5.9%	157
Iran	77.0%	6.0%	70	11.2%	70
Ireland	67.0%	5.3%	93	10.0%	101
Israel	76.0%	5.9%	72	11.0%	73
Italy	69.0%	5.5%	85	10.7%	79
Jamaica	71.0%	5.0%	113	9.3%	117
Japan	73.0%	4.4%	133	8.5%	132
Jordan	79.0%	7.7%	35	15.0%	35
Kazakhstan	82.0%	5.6%	82	10.3%	91
Kenya	73.0%	10.5%	14	20.3%	15
Kiribati	52.0%	3.5%	153	7.1%	149
Korea, Dem. People's Rep.	69.0%	6.4%	56	12.8%	49
Korea, Republic of	72.0%	4.2%	142	8.2%	138
Kuwait	73.0%	4.4%	135	8.6%	129
Kyrgyzstan	79.0%	6.8%	50	12.7%	52
Laos	80.0%	2.3%	165	4.8%	163
Latvia	65.0%	5.7%	78	10.5%	83
Lebanon	62.0%	5.8%	76	10.6%	82
Lesotho	83.0%	15.3%	1	30.4%	1
Liberia	59.0%	2.5%	161	4.6%	166
Libya	64.0%	6.2%	61	11.9%	61
Lithuania	66.0%	5.9%	71	11.0%	72
Luxembourg	61.0%	5.6%	84	10.9%	75
Macedonia	76.0%	6.5%	55	12.7%	51
Madagascar	68.0%	2.4%	163	4.7%	164
Malawi	67.0%	15.1%	2	30.2%	2
Malaysia	78.0%	3.1%	156	6.1%	155
Maldives	57.0%	3.7%	151	7.0%	150
Mali	66.0%	7.2%	42	13.9%	42
Malta	73.0%	5.7%	80	10.9%	76
Mauritania	83.0%	5.4%	90	9.6%	112
Mauritius	83.0%	4.5%	132	8.1%	140
Mexico	80.0%	10.3%	17	20.3%	16
Moldova	72.0%	10.4%	16	20.2%	17
Mongolia	67.0%	6.2%	60	11.5%	67
Morocco	83.0%	8.4%	30	16.1%	31
Mozambique	50.0%	11.6%	7	23.0%	7
Myanmar	80.0%	0.5%	173	1.1%	173

Table A. Percentage Changes in Food Basket Costs

Country	Dietary Energy Consumption Share	Cost Increase in Food Basket, Scenario 1	Rank, Scenario 1	Cost Increase in Food Basket, Scenario 2	Rank, Scenario 2
Namibia	59.0%	8.5%	29	16.6%	27
Nepal	78.0%	6.0%	68	11.8%	63
Netherlands	66.0%	4.5%	128	8.4%	133
Netherlands Antilles	73.0%	5.4%	89	10.7%	80
New Caledonia	67.0%	4.5%	131	8.7%	126
New Zealand	65.0%	4.3%	138	8.3%	137
Nicaragua	79.0%	7.5%	37	14.6%	36
Niger	33.0%	6.9%	49	13.5%	46
Nigeria	53.0%	7.1%	43	14.0%	40
Norway	70.0%	5.4%	87	10.2%	94
Pakistan	87.0%	5.4%	88	9.8%	109
Palestine, Occupied Tr.	70.0%	5.7%	79	10.8%	77
Panama	71.0%	4.9%	115	9.2%	120
Paraguay	65.0%	8.6%	28	16.5%	29
Peru	65.0%	4.7%	122	8.9%	124
Philippines	74.0%	2.3%	164	4.9%	161
Poland	67.0%	5.3%	95	10.3%	89
Portugal	60.0%	4.9%	114	9.4%	116
Romania	78.0%	7.2%	41	13.7%	43
Russian Federation	74.0%	5.1%	105	9.8%	107
Rwanda	15.0%	11.4%	8	22.2%	8
Saint Kitts and Nevis	65.0%	3.9%	147	7.5%	146
Saint Lucia	60.0%	5.1%	104	10.3%	90
St. Vincent/Grenadines	70.0%	5.1%	109	10.1%	96
Samoa	42.0%	4.5%	127	9.5%	115
Sao Tome and Principe	46.0%	5.6%	83	10.9%	74
Saudi Arabia	78.0%	5.8%	73	11.2%	71
Senegal	76.0%	4.1%	145	7.5%	147
Serbia and Montenegro	67.0%	6.1%	65	11.7%	64
Seychelles	69.0%	6.3%	59	12.4%	55
Sierra Leone	69.0%	2.2%	167	4.1%	167
Slovakia	70.0%	5.3%	92	10.3%	88
Slovenia	65.0%	7.0%	45	13.6%	45
Solomon Islands	40.0%	1.8%	170	3.6%	170
South Africa	81.0%	9.8%	21	19.4%	21
Spain	61.0%	5.1%	106	9.9%	104
Sri Lanka	70.0%	2.5%	160	4.9%	160
Sudan	78.0%	7.7%	36	14.5%	37
Suriname	78.0%	3.7%	150	6.8%	153
Swaziland	75.0%	8.3%	31	16.4%	30

Table A. Percentage Changes in Food Basket Costs

Country	Dietary Energy Consumption Share	Cost Increase in Food Basket, Scenario 1	Rank, Scenario 1	Cost Increase in Food Basket, Scenario 2	Rank, Scenario 2
Sweden	69.0%	4.3%	141	7.9%	145
Switzerland	71.0%	4.3%	140	8.4%	134
Syria	71.0%	6.0%	69	11.3%	69
Tajikistan	87.0%	6.5%	54	12.1%	59
Tanzania	58.0%	12.2%	6	24.2%	5
Thailand	76.0%	2.2%	166	4.6%	165
Timor-Leste	77.0%	7.0%	46	14.1%	39
Togo	58.0%	10.8%	11	21.2%	11
Trinidad and Tobago	75.0%	4.9%	117	9.0%	122
Tunisia	76.0%	7.0%	47	12.8%	50
Turkey	75.0%	6.8%	52	12.7%	53
Turkmenistan	85.0%	6.8%	51	12.5%	54
Uganda	27.0%	10.5%	15	20.8%	12
Ukraine	70.0%	5.5%	86	10.4%	87
United Arab Emirates	67.0%	4.1%	144	8.0%	142
United Kingdom	74.0%	5.1%	103	9.7%	110
United States of America	68.0%	5.8%	75	10.5%	85
Uruguay	78.0%	6.4%	57	12.1%	58
Uzbekistan	85.0%	6.7%	53	12.2%	56
Vanuatu	47.0%	2.7%	159	5.7%	158
Venezuela	74.0%	6.9%	48	13.2%	48
Viet Nam	84.0%	1.8%	169	4.0%	169
Yemen	85.0%	7.2%	40	14.0%	41
Zambia	75.0%	14.7%	3	29.3%	3
Zimbabwe	81.0%	11.1%	9	21.7%	9

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