The Impact of Changes in Commodity Prices on Household Welfare in Rural Burkina Faso

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Abstract

We use unique panel data to estimate the effect of an increase in the price of food commodities on household welfare in Burkina Faso. Our analysis includes the negative impacts on households as food consumers, as well as the positive impacts as food producers to estimate their net welfare change. The data were collected each year by the Burkina Faso Ministry of Agriculture and Food Security, which covered periods of food price crises. To evaluate the welfare effect of the price shocks, we first estimate demand and supply responses and then derive the net welfare change at the household and country level. Overall, the price shocks are associated with a gain in the rural household welfare because the producer's effect outweighed the consumer's effect.

Keywords: Welfare Economics, Microeconomics, Demand Elasticities, Supply Elasticities, Burkina Faso

1. Introduction

From 2008 to 2011, many developing countries witnessed hunger riots following a dramatic increase of food commodities price. Specifically, from mid-2007 until mid-2008, the global price of maize and rice increased by 130% and 75%, respectively, with a similar rise in the price of soybean and many other primary commodities. Overall, the real price for many products has doubled since 2000 and has been projected to increase up to 50% in the next decade (Patel and McMichael, 2009). Developing countries with large numbers of poor and vulnerable people concerns researchers and development partners particular interest because of the potential negative welfare effects of the price hikes. The recent analysis on household economics by Harttgen et al. (2016), Badolo and Traore (2015), Minot and Dewina (2015), Bellmare(2015) and Ivanic and Martin(2008) have focused on understanding and quantifying the actual and expected welfare impact on households. Resultantly, these studies generally found high welfare loss that was associated with food price shocks, especially in areas with a high level of poverty. In addition, the projections from these studies show that food price hikes would lead significant number of households into poverty.

Although research has been conducted on welfare impacts on households, the effect of food-price increases on agricultural household welfare is undetermined a priori. In fact, the effect depends empirically and theoretically on the household's net food-buying or food-selling status and the household's response to a price increase. Particularly, a net food buyer would be adversely affected, while a net seller would be better-off with the food price increase. In society, the effect may depend on the distribution of net buyer households and net sellers in the population. Notably, societal welfare could be improved under a price increase if the net sellers outweigh the net buyers, whereas, in the converse scenario, this situation would worsen. Additionally, in developing countries, the welfare effect may depend on the area of residence. To illustrate, in contrast to urban

areas, households in rural areas are more likely to be net food sellers, wherein the positive effect would outweigh the negative effect (Grimm et al., 2014; Minot and Dewina, 2015; Minot and Goletti, 2000; Nouve and Wodon, 2008; Simler, 2010; Wodon et al., 2008). In a short-term analysis, Ivanic and Martin (2008) used survey data on living standards in nine developing countries and found a positive poverty effect as a result of 10% increase in the price of seven commodities. However, an analysis for individual commodities shows a different trend in poverty level. For example, a 10% increase in the price of rice in Vietnam led to a one percent decrease in poverty in rural areas, and a 0.5% decline in poverty in urban areas. Comparatively, in Zambia and Malawi where both urban and rural households are net consumers of maize, an increase of price by 10% caused a rise in poverty in rural areas by 0.8% and 0.5%, respectively, and urban poverty by 0.2% and 0.3%, respectively (Badolo and Traore, 2015). In previous studies, households are assumed insensitive to price change which seems to be a strong hypothesis since rural household are living in the daily basis with very limited or no food stock in some period. Therefore their response time to food price increase could be very short and during which, household operates significant trade off among a group of substitute or complement food products or cereals. In light of these prior studies, we address this gap in integrating household supply and demand response and trade-offs among commodities with regards to price increase as well as the trade-off among commodities when evaluating the impact of food price increase on rural household welfare in Burkina Faso. The country is one of the low income country that endured the price hikes resulting in several demonstrations from 2008 to 2011 in major cities like Ouagadougou and Bobo Dioulasso. In a recent report, United Nation Environment Program (UNEP) listed the country as the 11th most vulnerable country to food price shocks in the world (UNEP, 2016). Yet, it is of interest to know the resulting outcome of food price shocks at rural level where the majority of the

families derive their livelihood from small scale farms and participate in the market by both selling their production and purchasing food crops. In our analysis we use four main grains (millet, maize, rice, and sorghum) and two legumes (cowpea and peanut) that are both consumed and produced. Notably, millet, maize, rice, and sorghum are the main staple foods in the country and account for 70% of the total value of food consumption and 80% of the energy intake in Burkina Faso (FAO-MAFAP, 2011). Additionally, these crops are carefully monitored by the government through a price control policy when consumers experience a price shock. Similarly, unlike cotton which is grown in few regions of the country, peanuts and soybean are more nationwide key cash crops in the country.

To evaluate the welfare effect of the price shocks, we first assessed household demand responses by estimating demand elasticities using the Quadratic Almost Ideal Demand estimate households developed by Deaton and Muellbauer (1980) and extended by Banks *et al.* (1997). Then, we determined the household supply-price elasticities using instrumental variable Tobit models to account for zero production of certain commodities by some households and the potential price endogeneity. Furthermore, we combined the household impact as producer and consumer to derive the total net effect of a price increase, in consideration of the fact that a household could be a producer and consumer. The panel data collected each year by the Burkina Faso Ministry of Agriculture and Food Security spans three years (2008-2010), covering a spike in food prices. Notably, our main contribution to the broader research is in estimating the total effect of price increase at the country level by taking into account household responses to the price shocks, in the cases of multiple commodities that may be substitutes or complements. Additionally, our study contributes to the debate surrounding price volatility and stabilization in many West African countries such as Burkina Faso, Togo, Cote d'Ivoire, and Niger where governments

adopted several policies to support production and food demand. In the case of Burkina Faso, the policies includes price capping, distribution and subsidies for inputs, stock building, registering market operators and exports restrictions. Overall the policies has been disincentives for producers in terms of price received by the producers and wholesalers (MAFAP, 2013). Thus this study is contribute in addressing the welfare effect that may occurs due to price changes.

2 Methodology and data

2.1 Methodology

We use the model of agricultural households to analyze household market participation (Singh et al., 1986). In each production cycle, households were assumed to maximize their living standard (utility) over agricultural staples, purchase market goods, and leisure. Given a farm production technology and an income constraint, household living standard is represented as follows:

$$LivingStandard_h = \psi(WageRate * TotalTime + Transfer + Profit, ConsumersPrice) \quad (1)$$

where the utility of household h (u_h) is determined by its income split into the value of its available total time ($WageRate(w) * TotalTime$), the transfer ($Transfer$) received, the Profit $Profit$ (π_h) drawn from farming or other family businesses, and the consumers price ($ConsumerPrice(p^c)$). Living standard depends on input prices (v), wage rate (w), and output or producers price (p^p) that contribute to farm profits ($Profite(v, w, p^p)$). Thus, the change in rural household welfare, or living standard, has two effects: the change of household welfare through

market-purchased goods and through market-sold goods, which following Deaton (1989) is represented by:[2]

$$\frac{\partial u_h}{\partial p} = \frac{\partial \psi}{\partial p^c} + \frac{\partial \psi}{\partial \pi_h}\frac{\partial \pi_h}{\partial p^p} = -q_i\frac{\partial \psi}{\partial I} + \frac{\partial \psi}{\partial I}y_i \quad (2)$$

where $With\ y_i$ the quantity of good, *i*, produced *qi*, the quantity of good *i* consumed[3].

The first of Equation 2 represents the welfare effect of the household as a consumer, which can be expressed as a change in household expenditure (e)), and the second part is the household welfare effect as producer, which can be expresses as change in household profit π. A producer price increase translates to a certain extent to a consumer price increase and vice versa. Thus, since $\frac{\partial \psi}{\partial I}$ is positive in Equation 2, a price shock will decrease household welfare by $-qi\frac{\partial \psi}{\partial I}$ and increase the welfare by $y_i\frac{\partial \psi}{\partial I}$. As a result, a household could end up being worse off or better off depending on purchase, sales, and consumption patterns.

The change in the consumer welfare, as shown by Equation 2, can be approximated using a consumer surplus, derived from the Marshallian demand curve. Such an approximation in developing countries where the share of agricultural commodities and income elasticities are high could lead to significant error in assessing the welfare effect of a price change (Wohlgenant, 2011). As a result, the Compensation Variation (CV) was derived from a Hicksian demand curve. As suggested by Hausman (1981), the consumers' CV was derived using the household expenditure function and then the CV was approximated by a second-order, Taylor series approximation of the

[2] Here, for simplicity, we kept the price that is changing implicit. On the consumer side, the change is in the consumer's price; on the producer's side, the change is in the output price. $q_i = -\frac{\frac{\partial \psi}{\partial p_i}}{\frac{\partial \psi}{\partial I}}, y_i = \frac{\partial \pi}{\partial p_i}$
In Equation 2,through Roy's identity and through the standard result on profit level at optimum

[3]

expenditure function (Irvine and Sims, 1998). A similar approach was used to obtain the welfare effect of production shocks. In this case, producer surplus may not be able to capture the change in household profit. Similar to the approach proposed by Irvine and Sims (1998) and Martin and Alston (1997), in our study the producer side welfare change was derived by the change in the profit function. Finally, the net rural household's welfare change is represented by the following expression:

$$\Delta welfare = \ (p_1^c, u_0) - e(p_0^c, u_0) + \pi(p_1^p, w_0, z_0) - \pi(p_0^p, w_0, z_0) \quad (3)$$

where the levels of the consumer price before and after the price change are p_0^c and p_1^c, respectively. The levels of the producer price of commodities sold on the market before and after the price change are p_0^p and p_1^p, respectively. The levels of household utility as consumer and producer are u0 and z0, respectively. Notably, it was assumed that labor is perfectly elastic in the short run; thus, input prices are constant between the two periods.

As stated earlier, a second-order Taylor series approximation of the expenditure and profit functions was used to approximate Equation 3. Setting the change in the Compensating Variation, $\Delta CV = e(p_1^c, u_0) - e(p_0^c, u_0)$, and the change in producer welfare, $\Delta PW = \pi(\ ^p_1, w_0, z_0) - \pi(p_0^p, w_0, z_0)$, Equation 3 is expressed as follows:

$$\Delta welfare \ = \ \Delta CV \ + \ \Delta PW \quad (4)$$

where:

$$\Delta CV \cong \sum_{i=1}^{n} q_i(p_0^c, u_0) p_i^c d\ln p_i^c + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \eta_{ij} q_i(p_0^c, u_0) p_i^c d\ln p_i^c d\ln p_j^c \quad (5)$$

and

$$\Delta PW \cong \sum_{i=1}^{n} y_i(p_0^p, w_0, z_0) d\ ln p_i^p + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \epsilon_{ij} y_i(p_0^p, w_0, z_0) d\ln p_i^p d\ln p_j^p \quad (6)$$

with $dlnp_i^c$ and $dlnp_i^p$ being the relative changes in consumers and producers price respectively, η_{ij} and ε_{ij} being the compensated (Hicksian) demand and supply cross-price elasticity, respectively, between the agricultural crops i and j, sold and/or purchased by the households. In Equations 5 and 6, the price at which consumers buy and sell their crops may be different mainly due to marketing differences between purchases and sales. In fact, most of the crops sales are conducted during the harvesting period, when there is an excess of supply and purchase during the lean period[4] and when food stocks from the previous harvest are almost depleted. As a result, production and consumption are considered as different activities.

Furthermore, *yi* and *qi* were estimated as the country-level total values purchased and sold, respectively, of millet, maize, sorghum, rice, cowpea, and peanut. *yi* and *qi* are referred to as approximations of market demand and supply, respectively; thus, *yi* and *qi* could be considered to better capture the household food market participation. Notably, the survey collects this variable each year, as well as the quantities in the local unit of measurement at the household level, which enables the household-level producer and consumer-level price (p_i^p and p_i^c) to be estimated. The demand elasticity, η_{ij}, Quadratic Almost Ideal Demand System (QAIDS) and supply elasticities using supply elasticities, ε_{ij}, were estimated using the Tobit model with continuous endogenous covariates, all by implementing these prices, the quantities, and the collected households characteristics.

2.2 Data

The Ministry of Agriculture and Food Security (Ministère de l'Agriculture et de la Sécurité Alimentaire (MASA) of Burkina Faso collects information on a nationally representative sample

[4] We define the lean period as the period when the household experiences depletion of its granaries.

of 4130 household farms in 826 villages in 45 provinces. The survey involved over 800 enumerators, 100 monitors, 13 regional supervisors, 45 local supervisors, 13 regional statisticians, and DGESS staff. Our study was based on the part of the survey that allowed for the creation of a food balance sheet at the household level for each food crop transaction between October 1st of the previous year and September 30^{th} of the current year. On the supply side, information on primary sources of increase in food availability (beginning stock, production, gifts, and purchases) at the household level were collected. On the utilization side, information was collected on the primary sources of the food availability reduction at the household level, such as sales, ending stock, etc. This information included the stock at the end of the crop year, the donations, and the sales. All the information was collected as quantities and in value, which allowed for the derivation of the average price for each crop at the household level. Specifically, the crop quantities were obtained in the local unit of measure and converted to a kilogram equivalence.

The survey collected information on 25 commodities, with millet, maize, sorghum, rice, cowpea, and peanut as the primary products since they are widely grown across the country by 81% of farmers. In order to comprehensively analyze the crops produced at the household level, the remaining crops were recorded as "others", while the red and white sorghum were recorded as "sorghum" since this study did not employ an intra-crops analysis. Furthermore, the price data were collected by the government on 48 reference markets (CTA and association inter-reseaux developpement rural, 2008). Also, the prices were collected at the farm, wholesale, and retail levels, and the true prices at which the household sold or purchased the products may be different than the ones collected by the government. Therefore, the unit value of each commodity was recovered as the ratio of total value (purchased or sold) and the quantities for households with data on both.

1.1 Descriptive statistics

In the survey, households were observed as mainly headed by males in the rural areas at 95%, and the average age of the head of household is 50 years. Also, the rural population is characterized by a high rate of illiteracy (75%), suggesting low human capital. The rural area household size is large with an average of eight people; most of the male family members remain in the house even after they marry. Also, a small fraction of the household is involved in a non-agricultural, secondary activity that generates additional income. Specifically, 93 households combine their crop production with owning livestock. Nevertheless, few households are involved in secondary activities such as counter-season agriculture—gardening (2.5%), handicraft (7.5%) and picking (18%).

Table 1: Rural households' socio-economic demographic characteristics in 2011 at the national level

VARIABLES	Mean	Standard error	Min	Max
Household head socio demographic Characteristics				
Gender				
Male	0.945	0.003	0	1
Female	0.055	0.003	0	1
Household size	8	0.037	2	20
Age of household head	50	0.197	17	99
Household head socio economic Characteristics				
Not alphabetized	0.757	0.006	0	1
Plot owners	0.981	0.002	0	1
Livestock owners	0.934	0.003	0	1
Involved in rainfed agriculture	0.956	0.003	0	1
Involved in counter-season agriculture	0.025	0.002	0	1
Involved in handicraft	0.075	0.003	0	1
Observations		5,849		

A significant proportion of households bought and sold their crops. For example, in 2008, 61% of households purchased rice for consumption. Millet and sorghum were significantly sold in 2008 and in 2011 by more than 90% of the households. Despite these high rates of participation, few households are net buyers across the crops and years of study. This finding is consistent with our predictions and the findings in Badolo and Traore (2015); however, the percentage of the net buyers is still important since it ranges from 10% for millet in 2011 to 37% for rice in 2008.

Among all the crops, households are more frequently net buyers of rice and sorghum than other crops. The reason for the frequency at which rice is bought is because it is not cultivated by the majority of households, and it is produced in very few regions, with the country importing around 40% of its consumption. Furthermore, sorghum is recorded at a high level of net buyers mainly due to its transformation into traditional sorghum beers. Over the years, the rate of net buyers has slightly declined. This trend supports the hypothesis that during a price hike such as in 2008, farmers in rural areas are more likely to increase their market participation by selling more crops on the market. One of the main reasons for this is that food price hikes in country induced an increase in the supply price, further inciting farmers to sell most of their harvest, which increased their revenue and their purchases in the market. Another element concerns the lower rate of net buyers of cowpea and peanut. In rural areas, cowpea and peanut are considered crops with more market value that farmers prefer to sell instead of using for consumption. Notably, these crops are subject to high demand from urban areas.

Table 2: Percentage of net buyers by year and principal crops

	Millet	Maize	Rice	Sorghum	Peanut	Cowpeas	Others
2008	0.19	0.18	0.37	0.31	0.10	0.10	0.09
2010	0.14	0.14	0.36	0.25	0.07	0.09	0.10
2011	0.10	0.12	0.36	0.20	0.06	0.06	0.06
Observations	13,574	13,574	13,574	13,574	13,574	13,574	13,574

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

2 Results

2.1 Demand and supply elasticities

Table 3 shows the estimated demand elasticities. The estimated own-price elasticities of all the crops have the expected negative sign, which means that households decrease the quantity purchased to adjust to the price increase. According to the compensated price elasticity, only millet has an elastic demand, meaning that there is a one percent increase in the price of millet because there is more than a one percent (1.13%) decrease in the quantity of millet purchased by the household. This elastic demand could be explained by the existence of substitutes for millet such as sorghum and maize. Besides millet, demand is inelastic for all the remaining commodities. For example, a one percent price increase causes a decrease of quantity in maize, rice, sorghum, peanut, and cowpea by 0.94, 0.42, 0.59, 0.97 and 0.66%, respectively. These results are close the elasticities estimated by Traore and Fields (2016) who used cross-sectional household-level data for the year 2009/2010.

The results support that millet, maize, rice and sorghum are substitutes since their Hicksian elasticities of substitution are positive, but only millet-rice and rice-sorghum have statistically significant elasticities of substitution. The data does not however show significant cross-price

elasticities for sorghum-maize, sorghum-millet, and millet-maize. The results for sorghum may be due to the fact that we aggregated white and red sorghum (white and red sorghum), which have, in general, different uses. In fact, red sorghum is widely used by local beer brewers as a raw material for local beer, while white sorghum is mainly used as a staple food; thus, white sorghum is more substitutable to millet, maize than red sorghum. As shown by Traore and Fields (2016), maize is mostly consumed in the south of the country and less in the other parts of the country where households have less access to it economically, as well as economically. In addition, maize is more difficult and time consuming to process by households than millet; thus, it is understandable that households would not significantly shift their purchases of other crops because of the change in the price of maize.

All the cereals, except rice, exhibit an elasticity of expenditure greater than one, which suggests that they are superior goods. Cowpea and peanut are normal goods, and household demand response is less proportional to a relative increase in their expenditure. The results of cowpea and peanut are not surprising in that the total consumption of peanut is 2.5% of the total household expenditure on a national level in 2005, and it is also mainly consumed in the urban areas.

Table 3: Compensated own and cross-price elasticities of demand

	Millet	Maize	Rice	Sorghum	Peanut	Cowpea	Others
Millet	-1.132***	0.352	0.690***	0.433	-0.054	0.161	0.254
	(0.206)	(0.226)	(0.265)	(0.285)	(0.151)	(0.221)	(0.195)
Maize	0.024	-0.936***	0.21	-0.03	0.102	0.080	0.083
	(0.162)	(0.170)	(0.181)	(0.190)	(0.130)	(0.169)	(0.185)
Rice	0.073*	0.038	-0.423***	0.189***	0.026	-0.019	0.056
	(0.039)	(0.038)	(0.026)	(0.055)	(0.024)	(0.027)	(0.200)
Sorghum	0.119	0.111	0.500***	-0.590***	0.206*	-0.017	0.088
	(0.120)	(0.120)	(0.154)	(0.146)	(0.114)	(0.114)	(0.349)
Peanut	0.010	0.057	0.220	0.139	-0.972***	0.176	0.028
	(0.164)	(0.155)	(0.197)	(0.235)	(0.115)	(0.161)	(0.280)
Cowpea	0.027	0.103	0.101	-0.090	0.047	-0.661***	-0.144
	(0.246)	(0.238)	(0.293)	(0.354)	(0.171)	(0.252)	(0.397)
Others	0.174	0.346	0.088	0.093	-0.060	0.124	-0.963***
	(0.781)	(0.829)	(0.768)	(1.131)	(0.482)	(0.759)	(0.143)

Standard errors in parentheses; $***p < 0.01$, $** p < 0.05$, $*p < 0.1$

Elasticities of supply were estimated with three models in mind: (1) a seemingly unrelated linear model, (2) a simple Tobit model, and (3) an instrumental variable Tobit model. Our interpretation is based on the Tobit models; a significant number of households do not sell crops on the market thus the data the left censored at zero. Also, household income was not recorded by the survey, which may lead to an omitted variable-based endogeneity and upward biased elasticities. Specifically, household income positively affects the price that households sell in the market, provided that wealthier households have more bargaining power and are more likely to propose quality products; also, the wealthier households are more likely to have higher market supply. Accordingly, we dealt with this endogeneity issue using the demand shifter; the purchasing

price of rice, sorghum, maize, and millet were used as instruments. In fact, for a given crop, the purchasing price of a substitute affects the quantity sold only through the selling price. As shown by the results, an increase in the price of sorghum reduces the quantity demanded on the market and increases the demand for rice, which in turn pushes the selling market price upward and causes an increase in the quantity sold. We performed a Wald test to verify the exogeneity of prices.

The own-price elasticities estimates are similar to the results in the instrumental variables approach (Tables 3 and 4). This finding most likely results from the fact that we do not have sufficient information to reject the hypothesis of no exogeneity for the supply own-price elasticities. Conversely, in many cases, cross-price elasticities are subject to the endogeneity issue. Our results reveal positive supply elasticities that are statistically significant and elastic for all the crops except maize[5], suggesting that household market supplies are sensitive to price increase. This phenomenon may occur because households' storage capabilities are limited in rural areas. In any case, the number substitutes for these cereals are also quite limited, which makes it difficult for consumers to shift from one crop to another.

5 The non-significance of the maize price elasticity of supply is probably due to the fact that the instrumental variables estimators are less efficient than the estimators of the same model are without instrumenting.

Table 4: Cross and own-price elasticities of supply

	Millet	Maize	Rice	Sorghum	Peanut	Cowpea	Others
Millet	1.859***	1.271	1.737	2.498***	0.643	0.611	0.975
	(0.262)	(1.441)	(1.670)	(0.864)	(0.546)	(0.702)	(1.153)
Maize	2.102	1.710	-0.697	8.023***	0.390	1.349	2.782*
	(1.436)	(1.139)	(1.761)	(2.531)	(0.786)	(1.140)	(1.433)
Rice	2.762	-0.659	1.977***	0.565	-1.015	-1.772*	4.188*
	(2.419)	(2.139)	(0.620)	(0.985)	(0.736)	(0.983)	(2.370)
Sorghum	1.742**	3.125**	0.132	1.690***	0.365	0.632	1.074
	(0.681)	(1.325)	(0.850)	(0.165)	(0.368)	(0.488)	(0.673)
Peanut	2.368**	1.825	-1.885	1.316	1.361***	1.837**	-1.887
	(1.207)	(1.686)	(1.905)	(0.840)	(0.175)	(0.759)	(1.340)
Cowpea	2.592	2.889	-10.70***	1.986*	1.089	1.792***	1.033
	(1.840)	(3.243)	(3.758)	(1.152)	(0.672)	(0.258)	(1.561)
Others	1.433	0.110	3.071	0.552	-0.257	0.0473	6.476***
	(1.158)	(0.935)	(2.277)	(0.519)	(0.330)	(0.427)	(1.304)
Observations	4,091	4,091	4,091	4,091	4,091	4,091	4,091

Standard errors in parentheses, $***p < 0.01, ** p < 0.05, *p < 0.1$

2.2 Welfare effect of price change

We evaluated the net welfare change at the country level from 2007 and 2014 using Equation 4. All the elements of Equation 4 were estimated using the real historical data recorded by the National Statistical System (NSS). As stated earlier, we estimated $p_i^c y_i$ and $p_i^p q_i$ as the country-level total values of crops purchased and sold of the different commodities, respectively (Table 5). As a result, the total values of household crops purchases and sales in 2008 are USD \$619 and \$1405.97 million, respectively, suggesting that rural households sold 2.3 times more food crop than they purchased in 2008. The total value purchased and sold represent 20% and

45%, respectively, of the agricultural GDP, which amounted to USD $3097 million in 2008. Comparatively, in 2010, the values of purchases and sales were 20% and 41%, respectively, of agricultural GDP, which amounted to USD $2922 million (WDI, 2015). This reduction in the agricultural GDP, as compared to 2008, was partly due to bad weather conditions because of a late rainy season in 2010. In 2011, the values are the lowest, which seems counter-intuitive since the price date shows a price and agricultural GDP increase, leading to higher value crop sales on the part of the households. Over the three years, the two most-purchased crops by the rural households were rice and sorghum, while the two most sold crops were peanut and cowpea in 2008, and peanut and sorghum in 2010 and 2011. Notably, the case of sorghum being among the top-sold crops is due to red sorghum being widely used by local beer brewers as a raw material for beer.

Table 5: Estimated total value (extrapolated) of crops purchased and sold by rural households in 2008 in millions of USD[6]

VARIABLES	2008		2010		2011	
	Purchase	Sale	Purchase	Sale	Purchase	Sale
Millet	94.9	152.7	81.4	100.8	35.2	55.5
Maize	92.5	147.6	76.7	152.8	32.8	49.8
Rice	108.5	85.1	103.2	119.9	61.2	40.1
Sorghum	279.1	265.7	294.8	258.4	121.6	164.5
Peanut	29.3	402.0	13.9	379.6	8.8	162.3
cowpea	15.7	352.8	14.6	183.3	6.4	117.8
Total	620.0	1406.0	584.5	1194.9	266.1	590.0
% of Ag GDP	20	45	20	41	8	18

[6] To convert the total value of 2008, 2010, and 2011 from FCFA to USD, we used the exchange rate of the World Development Indicator database (WDI, 2015). The exchange rate in 2008, 2010, and 2011 for one dollar was 447.8, 495.3, and 471.9 FCFA, respectively. The extrapolation was done using the sampling weight available in the database.

To evaluate the changes in price at the producer and consumer levels, we used the data provided by the National Statistics Institute. These data were collected on three producers' markets (Manga, Solenzo, and Leo) and five consumers' markets (Dori, Banfora, Ouagadougou, Fada Ngourma, and Bobo-Dioulasso). We assumed that the change in this market would be equivalent to the change in price at which rural households purchased and sell the crops[7]. As expected, the data revealed that during the years, 2008 and 2012, staple crops prices were subject to high-price changes. For example, compared to 2007, in the year, 2008, consumers' price of maize increased by 45%, rice by 41%, millet by 31%, and sorghum by 31%. In the producers' markets, the price increases were higher than in the consumers' markets. For instance, compared to the consumer's price, the producer's price was five percent higher for maize (50%), eight percent higher for rice (49%), 13% higher for sorghum (44%), and 10% higher for millet (44%).

As noted by Adenauer and del Granado (2011), these price increases mostly reflect two bad harvests caused by adverse weather, as well as the high international price of rice. Furthermore, in 2011, the producer price increases were by far larger than the consumer price increases. For example, the sorghum producer price increased by 16%, which is almost double the price increase in the consumer market (9%); the same range almost holds for the other cereals. This result may be partly due to the agricultural policies that the government initiated in 2011 in response to the food price crisis of 2008. As described in Adenauer and del Granado (2011), the government built food security stock by allowing the national agency of food security stock management to buy the cereal from the farmers at the market price and then sell it to consumers at a subsidized price.

In our evaluation of welfare effects, we first took into account the household response as before the granary depletion farmers react immediately as the price on the local market increases

[7] Here, we are not considering the level of prices, but their changes from a previous year to a following year. Our assumption is that the price at which consumers in rural areas purchase and sell their products will have

or decreases. For a matter of comparison, we removed the farmer responses by setting the elasticities to zero; the results are shown in Figure 1. First, with price response, the highest welfare effect is recorded in 2008 and amounted to USD $418.7 million, representing 14% of agricultural GDP in 2008. For a matter of comparison, Balagtas (2014) associated the dramatic price increase during the period of 2000–2008 with an increase of 15% in income in rural Bangladesh. Furthermore, the highest contribution is from peanut (41%), followed by cowpea (36%), millet and maize (9%), and sorghum (6%). The second-highest welfare gain is recorded in 2011 with a value of USD $81.5 million, and the highest welfare loss is recorded in 2013 with USD $96 million—mainly due to significant producer price decreases, which induced the producers' welfare loss of USD $168.0 million, outweighing the consumers' welfare gain of USD $72 million.

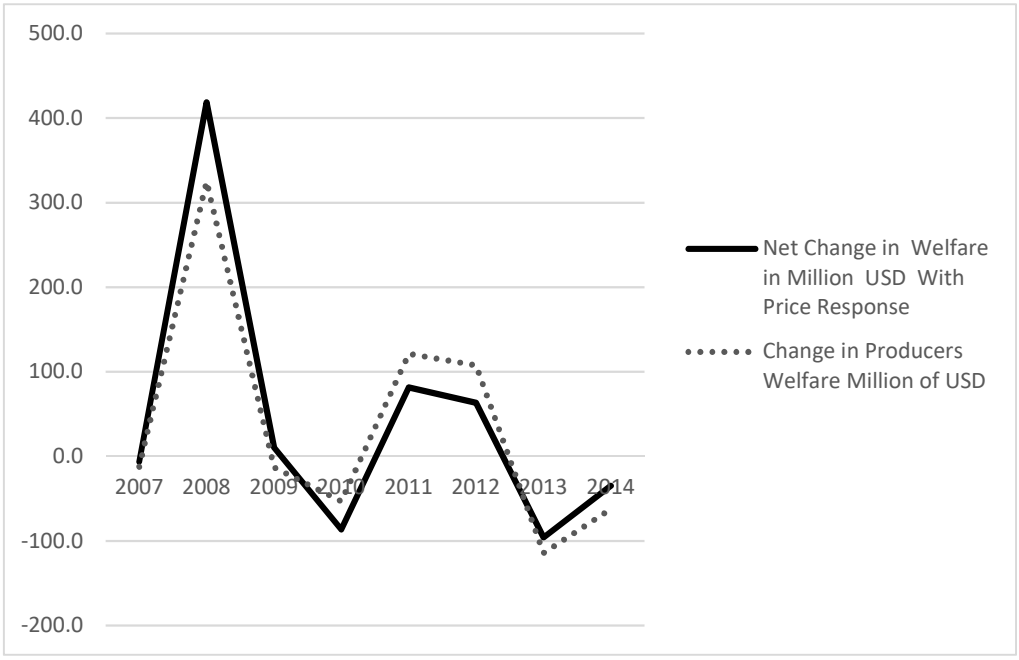

Figure 1: Net Change in welfare in Million USD with and without Price Response by crops

Secondly, household response to price change induced a welfare increase by USD $98 million in 2008, USD $24 million in 2009, USD $6 million in 2007, USD $19 million, and USD $27 million in 2014; however, it induced a welfare loss of USD $33 million in 2010, USD $40 million in 2011, and USD $44 million in 2012.

3 Conclusion

In this paper, we theoretically and empirically analyzed rural household's welfare change due to price shocks in Burkina Faso, accounting for demand and supply responses and households the trade-off between crops when they price change. In 2008, staple crop prices were subject to high price changes in both supply and demand. Additionally, the consumer price of maize increased by 45%, rice by 41%, millet by 31%, and sorghum by 31%. Compared to the consumer price, the producer price was five percent higher for maize (50%), eight percent higher for rice (49%), 13% higher for sorghum (44%), and 10% higher for millet (44%); this same pattern held true for the year 2012 as well.

As a result, the highest welfare effect was recorded in 2008, in considering household price responses, and amounted to USD $418.7 million, which represented 13% of the agricultural GDP. Additionally, the highest contribution was from peanut (41%), followed by cowpea (36%), millet and maize (9%), and sorghum (6%). Notably, for rice, this result was mainly due to the insufficient local supply. The second highest welfare gain was recorded in 2011 with a value of USD $81.5 million. Furthermore, the highest welfare loss was recorded in 2013 at USD $96 million, mainly due to significant producer price decreases, which induced a producer welfare loss of USD $168 million, which outweighed the consumer welfare gain of USD $72 million. In addition, household response to price change induced a welfare increase by USD $98 million in 2008 and USD $28

million in 2009, USD $6 million in 2007, USD $19 million, and USD $27 million in 2014 by contrast of the induced welfare loss of USD $33 million in 2010, USD $40 million in 2011 and USD $44 million in 2012. Overall, the novel message of this study is that because of the large amount of sales, rural households benefit from price shocks. However this study does not look at urban consumer impacts, and thus, the net effect to the nation is unclear.

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Annex

Tables

Table A.1: Predicted shares, budget and (un)compensated own-price elasticities

	Predicted Budget Shares	Expenditure Elasticities	Uncompensated Price Elasticities	Compensated Price Elasticities
Millet	0.065***	1.303***	-1.217***	-1.132***
Maize	0.101***	1.258***	-1.063***	-0.936***
Rice	0.458***	0.789***	-0.785***	-0.423***
Sorghum	0.209***	1.439***	-0.891***	-0.590***
Peanut	0.061***	0.794***	-1.021***	-0.972***
Cowpea	0.038***	0.735***	-0.689***	-0.661***
Others	0.068***	0.732*	-1.013***	-0.963***

Standard errors in parentheses; $***p < 0.01$, $** p < 0.05$, $*p < 0.1$

Table A.3: Market Supply Own-price elasticities

	IVTOBIT	TOBIT	OLS
Millet	1.859***	1.822***	1.051***
	(0.262)	(0.0212)	(0.00771)
Maize	1.710	2.300***	1.215***
	(1.139)	(0.0281)	(0.00942)
Rice	1.977***	1.945***	0.945***
	(0.620)	(0.0322)	(0.00791)
Sorghum	1.690***	1.873***	1.190***
	(0.165)	(0.0155)	(0.00884)
Peanut	1.361***	1.318***	0.849***
	(0.175)	(0.0124)	(0.00976)
Cowpeas	1.792***	1.466***	0.940***
	(0.258)	(0.0139)	(0.00797)
Others	6.476***	1.883***	0.976***
	(1.304)	(0.0212)	(0.0163)

Observations	4,091	10,251	2,257

Standard errors in parentheses ; $***p < 0.01$, $** p < 0.05$, $*p < 0.1$

Figure

Figure 2: Net Change in Welfare in Million USD Without Price Response by crops

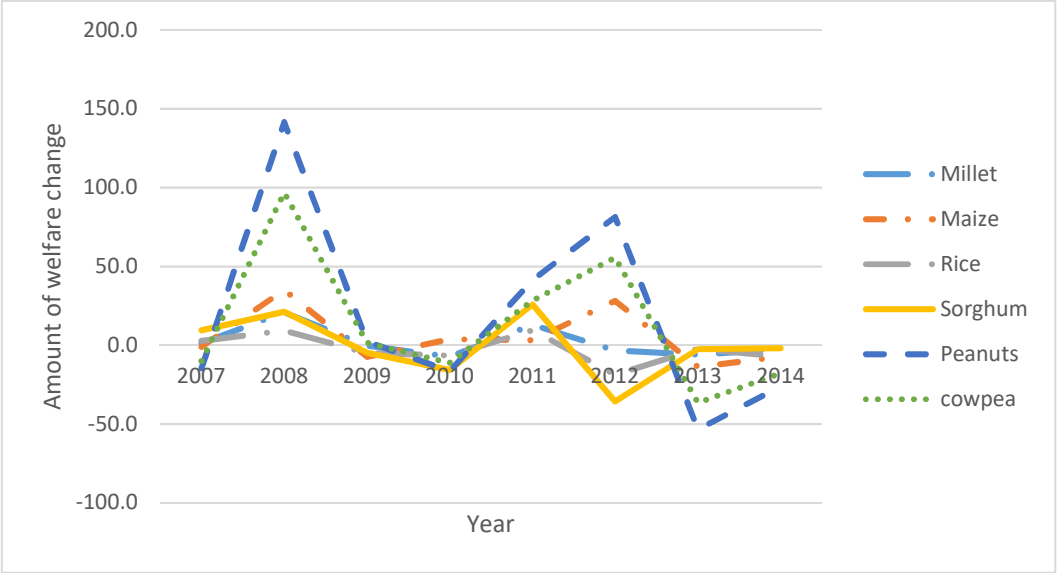

Figure 3: Net Change in welfare in Million USD With Price Response by crops