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An Empirical Assessment of the Welfare Impacts of the Rising Global Price of Food: The Case of Haiti

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Abstract
Global food price inflation has serious implication toward welfare and food and nutrition security in developing countries where most of the population are classified as low-income and are net-food importers. Haiti is one such nation which depend heavily on trade for food, making them extremely vulnerable to global food price increase. This study aims to investigate the welfare impact of rising global prices of imported food on Haitian consumers using annual data from 1980-2021. The LA-AIDS model was employed to estimate Hicksian price and income elasticities for the five major imported food categories, and compensating variation was used to assess the welfare impacts of rising global food prices on Haitian consumers. The study finds that all imported food categories were import price inelastic, except for meat which was price elastic. Cross-price elasticities indicated substitution and complementary relationships between various pairs of imported food categories. Income elasticities showed that demand for cereals and dairy was income inelastic, while demand for meat, vegetable oil, and sugar was income elastic. The welfare exercise revealed that price increases between 2006-2008, 2010-2013, and 2020-2021 resulted in welfare losses of around US$223.91 million, US$89.33 million, and US$458.50 million, respectively. It was also discovered that imported cereals and vegetable oil accounted for most of the lost welfare during the study periods. The results of this study provide valuable information for policymakers to develop policy intervention strategies that aims to safeguard the welfare of Haitian consumers.

Keywords: Food Imports, Compensating Variation, Welfare, Food Price Inflation, Haiti

1. Introduction

Over the last two decades, the Caribbean and Latin American region has become heavily reliant on international trade for food and capital goods (Pollard *et al.* 2008). The rising global price of food has become a growing concern for many developing nations due to the adverse impacts it has on food and nutrition security and the welfare of vulnerable populations. Rising global food prices threaten to exacerbate hunger, malnutrition, and poverty, and disrupts the economic and social stability of affected counties (Ben Hassen and El Bilali 2022, Fan *et al.* 2020, Darnton-Hill and Cogill 2010). Haiti is a small island nation situated in the Caribbean which is vulnerable to increasing global food prices (Mazzeo 2009, Himmelgreen and Romero-Daza 2009, Compton *et al.* 2010). Haiti is regarded as one of the most food-insecure nations in the world (Rasul *et al.* 2022). In 2016, it was estimated that around 30% of households were food-insecure (World Food Programme 2016), however, current estimates in 2022 indicates that around 43% of the population experience acute food-insecurity (FAO 2022b). The combination of a low level of domestic food production and a highly import-dependent food system positions Haiti as extremely vulnerable to global food price shocks and has posed a significant challenge to the country's food security and overall welfare.

Haiti's domestic food production and agricultural sector have been historically weak due to factors such as environmental degradation, deforestation, and political instability (Williams 2011, Goldstone 2018). These factors have limited the country's capacity to produce enough food to meet its growing population's needs, resulting in an overreliance on imported food products. Agriculture is the backbone of Haiti's economy, and the sector employs over two-thirds of the country's population, especially in rural areas. However, despite the sector's significant contribution to employment and the economy, agricultural productivity remains low, and the country continues to rely heavily on food imports to meet its food and nutritional needs.

The state of global food prices has a profound impact on Haiti's food and nutrition security and overall welfare. Rising food prices can exacerbate the country's already precarious food situation by increasing the cost of imported food products, making them less affordable for low-income households. The volatile nature of global food prices can also lead to price spikes, which can have severe implications for the country's food security, particularly during times of crisis, such as natural disasters or pandemics. In recent years, the global food price index has been on an upward trend, driven by factors such as climate change, trade policies, and the COVID-19 pandemic, which has disrupted global supply chains (Vidya and Prabheesh 2020, Vo and Tran 2021, Chakraborty 2023). The Food and Agriculture Organization (2022a) published data that highlights current trends in the global price of food. It was revealed that there was a significant increase in the world food price index from 72.6 points in 2006 to approximately 117.5 points in 2008, representing an uptick of around 61.9% (FAO 2022a). The global price of cereals, vegetable oils, dairy, and meat saw a significant surge during this period, with increases of 93.3%, 100.1%, 93.3%, and 17.3% respectively, as reported by the FAO (2022a). In the subsequent five-year period, from 2018 to 2022, the world food price index continued to exhibit an upward trend, rising from 95.9 points in 2018 to 145.8 points in 2022. This translates to a more than 55% surge in global food prices between 2018 and 2022.

The increase in food prices has far-reaching implications on food and nutrition security, as well as poverty levels in developing countries such as Haiti. To mitigate these effects, it is essential for governments and policymakers to institute policy interventions aimed at safeguarding consumer welfare. The impact of rising food prices on poor households is particularly significant, given that their food consumption level may already be at subsistence level, and the additional strain increases their vulnerability to food insecurity (Gregory and Coleman-Jensen 2013, Amolegbe *et al.* 2021). Furthermore, food price increases are also found to exacerbate poverty in various countries globally (Headey and Martin 2016, Warr and Yusuf 2014, Dhahri and Omri 2020)

Several studies have been conducted in various countries to evaluate the impacts of rising food prices on households, including Groom and Tak (2015) and De Janvry and Sadoulet (2009) for India, Attanasio *et al.* (2013) and Avalos (2016) for Mexico, Cudjoe *et al.* (2010) for Ghana, Khoiriyah *et al.* (2023) and Allo *et al.* (2018) for Indonesia, Ferreira *et al.* (2013) and Dimova (2015) for Brazil, Azzam and Rettab (2013) and Azzam and Rettab (2012) for the UAE, Aftab *et al.* (2015) and Idrees *et al.* (2012) for Pakistan, Aftab *et al.* (2017) for South Asian Countries, Tefera *et al.* (2012) and Shimeles and Woldemichael (2013) for Ethiopia, Layani *et al.* (2020) and

Farajzadeh and Esmaeili (2017) for Iran, Aghabeygi and Arfini (2020) for Italy, Van Wyk and Dlamini (2018) and Giwa and Choga (2020) for South Africa, and Adoho and Gansey (2019) for the Congo among many others. However, no study that explicitly focuses on the welfare impacts of rising global price of imported food on Haitian consumers has been done to date. This demonstrates the timely nature of this study.

Therefore, the purpose of this study is to investigate the welfare impacts of increasing global prices of imported food on Haitian consumers. The study utilizes annual import data for the period 1980-2021 and the linear approximate almost ideal demand system (LA-AIDS) model to derive price and income elasticities for five major imported food categories – cereals, meat, dairy, vegetable oil, and sugar. In order to evaluate consumer welfare, we employ the concept of compensating variation (CV), which measures the amount of income that would have to be transferred to a consumer in order to maintain their original level of utility in response to a price change. This study has important implications for policymakers, as it highlights the need for targeted interventions to mitigate the negative welfare effects of rising global food prices on vulnerable households in Haiti.

2. Materials and Method

2.1. Welfare Analysis

The welfare literature is proliferated with several indices for measuring the changes in welfare that result from different policies regimes (Slesnick 1998, Khoiriyah *et al.* 2023, Gohin 2005). One of the factors that can cause changes in welfare is fluctuations in economic conditions, such as changes in prices. When prices change, consumers may experience changes in their level of utility, which can be measured using various criteria such as Consumers Surplus (CS), Compensated Variation (CV), and Equivalent Variation (EV). According to Azzam and Rettab (2012), Tefera *et al.* (2012) and Aghabeygi and Arfini (2020), in the context of rising global price of food, CV is the minimum amount that consumers are willing to accept (WTA) in exchange for tolerating higher food prices. On the other hand, EV is the maximum amount that consumers are willing to pay (WTP) to avoid higher food prices. Furthermore, CV represents the amount of compensation that would need to be provided to consumers in order to maintain their initial level of utility despite the rise in food prices while EV represents the amount of money that consumers would be willing to pay to maintain their initial level of utility in the face of rising food prices.

In order to study the welfare impact of rising global prices of imported food on Haitian consumers, we will be using CV, as it has been utilized in previous studies by Azzam and Rettab (2012), Azzam and Rettab (2013), Tefera *et al.* (2012), Aghabeygi and Arfini (2020), Layani *et al.* (2020) and Roosen *et al.* (2022). The CV approach to assessing change in welfare brought about by changes in prices begins with the consumer problem of minimizing their expenditures on a set of *N* food commodities while maintaining a desired level of utility, denoted as U^0. Once the optimal Hicksian quantities are determined from this problem, they can be substituted into the expenditure equation to derive the minimized expenditure function. This approach has been outlined in detail by Azzam and Rettab (2012) as follows:

$$E = E(P_1, P_{2,\ldots}P_3, U^0) = p_1 q_1^H(P_1, P_{2,\ldots}P_3, U^0) + p_2 q_2^H(P_1, P_{2,\ldots}P_3, U^0) + \cdots + p_N q_N^H(P_1, P_{2,\ldots}P_3, U^0)$$

(1)

Where P_i for $I = 1,2,\ldots,N$ is respected to N commodity prices, and the superscript *H* stands for Hicksian. Denoting the initial and the subsequent periods by superscripts ''0'' and ''1'', respectively, consumer WTA to tolerate higher prices is given by:

$$CV = E(p_1^1, p_{2,\ldots}^1, p_N^1, U^0) - E(p_1^0, p_{2,\ldots}^0, p_N^0, U^0)$$

(2)

Using equation (1), we can expand equation (2) as follows:

$$CV = p_1^1 q_1^H(p_1^1, p_{2,\ldots}^1, p_N^1, U^0) - p_1^0 q_1^0 + p_2^1 q_2^H(p_1^1, p_{2,\ldots}^1, p_N^1, U^0) - p_2^0 q_2^0 + \cdots + p_N^1 q_N^H(p_1^1, p_{2,\ldots}^1, p_N^1, U^0)$$
$$- p_N^0 q_N^0$$

(3)

Direct measurement of CV using equation (3) is not possible since the Hicksian demand function q_i^H for $i = 1,2,\ldots,N$ is dependent on the level of utility given by U^0, which is not observable. However, the respective changes in prices and Hicksian quantities can be defined as (Azzam and Rettab 2012):

$$dp_i = p_i^1 - p_1^0 \quad for \; i = 1,2,\ldots,N$$
$$dq_i^H = q_i^H - q_i^0 \quad for \; i = 1,2,\ldots,N \tag{4}$$

Substitution of equation (4) into equation (3), CV is approximated by:

$$CV = p_1^0 q_1^0 \left(\frac{dp_1}{p_1^0} + \frac{dq_1^H}{q_1^0} + \frac{dp_1}{p_1^0}\frac{dq_1^H}{q_1^0} \right) + p_2^0 q_2^0 \left(\frac{dp_2}{p_2^0} + \frac{dq_2^H}{q_2^0} + \frac{dp_2}{p_2^0}\frac{dq_2^H}{q_2^0} \right) + \cdots$$
$$+ p_N^0 q_N^0 \left(\frac{dp_N}{p_N^0} + \frac{dq_N^H}{q_N^0} + \frac{dp_N}{p_N^0}\frac{dq_N^H}{q_N^0} \right) \tag{5}$$

However, there is still one short-coming in equation (5) since the percentage change in Hicksian quantities is not directly observed. However, an approximation of the change can be derived via the total differential of the Hicksian demand functions as follow:

$$\frac{dq_1^H}{q_1^0} = \epsilon_{11}^H \frac{dp_1}{p_1} + \epsilon_{12}^H \frac{dp_2}{p_2} + \cdots + \epsilon_{1N}^H \frac{dp_N}{p_N},$$
$$\frac{dq_2^H}{q_2^0} = \epsilon_{21}^H \frac{dp_1}{p_1} + \epsilon_{22}^H \frac{dp_2}{p_2} + \cdots + \epsilon_{2N}^H \frac{dp_N}{p_N},$$
$$\frac{dq_N^H}{q_N^0} = \epsilon_{N1}^H \frac{dp_1}{p_1} + \epsilon_{N2}^H \frac{dp_2}{p_2} + \cdots + \epsilon_{NN}^H \frac{dp_N}{p_N}. \tag{6}$$

Where ϵ_{ij}^H is the Hicksian price elasticity for i = 1, 2, . . ., N and j = 1,2, . . ., N.

2.2. The LA-AIDS Model

The almost ideal demand system (AIDS) model proposed by Deaton and Muellbauer (1980), is one of the most popular demand system used in empirical studies. Barnett and Seck (2008) attribute its popularity to several desirable properties, including perfect aggregation over consumers, exact satisfaction of the axiom of choice, a consistent functional form that fits known data, ease of estimation, and the ability to impose and test for theoretical restrictions of homogeneity and symmetry. Alston and Chalfant (1993) and Eales and Unnevehr (1991) further note that these properties have contributed to the widespread use of the AIDS model in the empirical literature.

The AIDS model for each imported food ground in budget shares is given as follows:

$$w_i = \alpha_0 + \sum_j \gamma_{ij} log p_j + \beta_i \log\left(\frac{M}{P}\right) + \varepsilon_i \tag{7}$$

where w_i is the budget share of the *ith* imported food commodity obtained by dividing expenditure on the ith group by total expenditure on all groups, p_j is the price of the *jth* imported food commodity, M is the total expenditure on all imported food commodities, and ε_i is a white noise error term. α, γ and β are all parameters to be estimated. P is a price index which according to Deaton and Muellbauer (1980) is given as follows:

$$lnP = \alpha_0 + \sum_{i=1} \alpha_i ln p_i + \frac{1}{2}\sum_{i=1}\sum_{j=1} \gamma_{ij} ln\, p_i\, ln p_j \tag{8}$$

Equation (7) estimated with the price index given by equation (8) is commonly referred to as the traditional AIDS model. To ensure that the model is consistent with demand theory the parameters are restricted using the adding-up, homogeneity and symmetry restrictions given by:

Adding-Up:

$$\sum \alpha_i = 1 \; ; \; \sum \beta_i = 0 \; ; \; \sum_{i=1}^{n} \gamma_{ij} = 0 \tag{9}$$

Homogeneity: $\tag{10}$

$$\sum_{i=1}^{n} \gamma_{ij} = 0$$

Symmetry: $\qquad\qquad\qquad\qquad\qquad \gamma_{ij} = \gamma_{ji} \tag{11}$

The adding-up restriction is automatically satisfied by simply omitting one of the share equations during estimation then recovering the parameters post-estimation. Homogeneity and symmetry restrictions are imposed during estimation of the share equations.

Despite its widespread use, the traditional AIDS model can be challenging to estimate due to the non-linearity of the model parameters resulting from the use of the price index in equation (8). This issue has been noted by several researchers, including Taljaard *et al.* (2004) and Rathnayaka *et al.* (2019). To address this problem, Deaton and Muellbauer (1980) suggested using the stone price index as an alternative to the price index in equation (8). This stone price index provides a linear specification of prices and is given by the sum of the price and quantity weighted average of the prices of all goods consumed as follows:

$$\ln P^s = \sum_{i=1} w_i \, lnp_i \tag{12}$$

Using the price index outlined in equation (12) yields the linear approximate almost ideal demand system (LA-AIDS) model which is just as popular as the traditional AIDS model in the empirical literature. The LA-AIDS model is estimated using seemingly unrelated regression techniques to account for cross-equation correlation with theoretical restrictions imposed. In addition, in order to avoid singularity of the variance-covariance matrix, one of the share equations is omitted during estimation and later recovered via the adding-up restriction.

2.3. Deriving Price and Income Elasticities

In order to derive Hicksian price elasticities as highlighted in equation (6), the estimated parameters of the LA-AIDS model are utilized. Hicksian price elasticities are derived using the formula:

$$\epsilon_{ij}^H = -\delta_{ij} + \left(\frac{\gamma_{ij}}{w_i}\right) + w_j \tag{13}$$

Where δ_{ij} is the Kronecker delta which takes the value of "1" for own-price elasticity and "0" for cross-price elasticity. For Hicksian own-price elasticity, it is expected that they should all be negative as per demand theory which postulates that there is an inversed relationship between price and quantity demanded. However, interpretation is done using the absolute value. Hicksian own-price elasticities with a value that is greater than unity means that the imported commodity has elastic demand or is very responsive to changes in price. In contrast, if the value is less than unity, it means that the commodity is not very responsive to price changes. Cross-price elasticities measure the relationship that exists between two commodities – substitution or complementary. If the cross-price elasticity between two commodities is positive, then they are substitutes. However, if the cross-price elasticity is negative, they are complements.

Income elasticities for each imported food are also calculated using the formula as follows:

$$\eta_i = 1 + \left(\frac{\beta_i}{w_i}\right) \tag{14}$$

Income elasticity measures the degree of responsiveness of demand brought about by changes in income. A positive income elasticity would mean that the commodity in question is a normal good which means increase in

income fosters increased consumption. However, if the value of the income elasticity is positive and greater than unity, then the commodity is regarded as luxurious. In contrast, if the income elasticity is negative then the commodity is regarded as inferior. For inferior goods, increase in income decreases consumption.

2.4. Data and Source

This study utilized annual import data from FAOSTAT online database for five major imported food categories, namely cereals, meat, dairy, vegetable oil, and sugar for the period 1980-2021. All quantities are given in metric tonnes and expenditures are in US dollars. The unit value of imports, which was found by dividing expenditure of a commodity group by its respective quantities was used as a proxy from import prices since this data was not readily available. Budget shares for each commodity group were found by dividing food group expenditure by total expenditure. Finally, all empirical estimations were done using Stata 17.0 version. Welfare analysis calculations were done in Microsoft excel.

For the period, average annual food import expenditure was around US$655.29 million, however, in 2020 total food imports for the five major food groups under examination research US$1.67 billion which was around 56.7% higher than in 2011 (FAO 2023b). In terms of import volumes, Haiti imported around 2.22 million metric tonnes of food in 2020 which was around 82.2% more than in 2011 (FAO 2023b). In terms of domestic food production, Haiti produced around 10.97 million metric tonnes of food in 2011, however, in 2020 production was at around 9.21 million metric tonnes or fell by around 15.3% (FAO 2023a). Table 1 highlights the summary statistics of the budget shares and unit import prices for the five food groups for the period 1980-2021. Imported vegetable oils accounted for around 43.5% of total food import expenditure for the period followed by imported cereals which was around 35.0% on average annually. In contrast, imported meat, dairy, and sugar only accounted for around 4.5%, 7.6%, and 9.0% on average annually. In terms of import price per metric tonne, imported dairy and meat was the most expensive to import by Haiti, which was around US$1,496.53 and US$1,148.59, respectively. Imported cereals were the cheapest imported food commodity by Haiti on average during the study period which was around US$376.86 per metric tonne.

Table 1: Summary Statistics for Imported Food (1980-2021)

Variable	Mean	Std. Dev.	Minimum	Maximum
		Budget Share		
w_1	0.350	0.051	0.233	0.471
w_2	0.049	0.029	0.004	0.112
w_3	0.076	0.025	0.045	0.152
w_4	0.435	0.054	0.316	0.557
w_5	0.090	0.028	0.036	0.166
		Import Unit Price (US$ per Metric Tonne)		
p_1	376.86	140.49	190.63	663.85
p_2	1,148.59	342.22	601.43	2,106.06
p_3	1,496.53	221.95	1,050.28	2,051.83
p_4	928.82	125.79	735.38	1,129.58
p_5	427.75	121.91	230.03	765.79

Note: w=budget share and p=price, 1=Cereal, 2=Meat, 3=Dairy, 4=Vegetable Oil, 5=Sugar. N=42 observations.
Source: Calculations based on data from FAO (2023b)

3.   Results and Discussion

3.1. Income and Hicksian Price Elasticities

The parameters of the LA-AIDS[1] model is used to compute price and income elasticities for the five imported food categories for Haiti which are presented in Table 2. All estimated Hicksian own-price price elasticities were found

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[1] The estimated parameters of the LA-AIDS model are presented in Appendix A, Table A1.

to carry the appropriate negative sign as expected. In absolute terms, imported meat had the highest own-price elasticity (1.87). This means that a 1% increase in the import price of imported meat is expected to result in a 1.87% decrease in import volumes on average. Imported meat was found to have elastic import demand or is very responsive to changes in import prices. In contrast, imported cereals were found to be the least responsive to changes in import prices as a 1% increase in import prices only results in a 0.23% decrease in import volumes. Furthermore, imported cereals were found to be import price inelastic. Imported dairy, vegetable oil, and sugar were all found to have own-price elasticities of 0.57, 0.53, and 0.89, respectively. This means that a 1% increase in the import prices of imported dairy, vegetable oil, and sugar is expected to result in a 0.57%, 0.53%, and 0.89% decrease in import volumes on average, respectively. There three imported food categories were found to have income inelastic demand, or they are not very responsive to changes in import prices, although, import sugar is more elastic relative to dairy and vegetable oil. Furthermore, it is suggested that all imported food categories except meat are necessary in Haitian household consumption patterns.

Table 2 also presents the cross-price elasticities of import demand which measures the relationship between various pairs of imported food categories. Most of the computed cross-price elasticities were found to be positive, which suggest that mostly substitution relationships existed between various pairs of commodity groups. Imported cereals were found to have substitution relationships with imported meat and vegetable oil, however, there were complementary relationships with dairy and sugar. This means that when the import price of cereals increases by 1%, it is expected that the import demand for meat and vegetable oil should increase by around 0.02% and 0.31%, respectively. On the other hand, a 1% increase in the import price of cereals is expected to bring about a 0.03% and 0.06% decrease in the import demand for dairy and sugar, respectively. Imported vegetable oil and sugar was found to only have substitution relationships with other imported foods.

The study also computed income elasticities for the five imported food categories. The results are presented in Table 2. All income elasticities are positive which suggest that all imported food categories are normal[2] goods. Income elasticity for imported cereals and dairy was found to be 0.82 and 0.69. This means that a 1% increase in income of Haitians is expected to bring about on average a 0.82% and 0.69% increase in import consumption, respectively. Imported dairy products were found to be the least responsive to changes in income. However, both imported cereals and dairy were found to be income inelastic. Imported meat, vegetable oil, and sugar were found to be highly responsive to changes in income with income elasticities of 1.34, 1.09, and 1.33, respectively. This means that for imported meat, vegetable oil, and sugar, a 1% increase in income is expected to bring about a 1.34%, 1.09%, and 1.33% increase in import consumption, respectively. These imported food categories can be regarded as luxurious as they are highly responsive to changes in income. Data from the World Bank (2023) reveal that per capita income of Haitians is increase over time. For instance, between 2012 and 2021, per capita income has increased by around 34.5%, hence, if current trends in income continue we can expect import demand for meat, vegetable oil, and sugar to increase in the long-run.

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[2] For normal goods, there is a direct relationship between demand and income. Increase in income is expected to bring about increase in consumption and vice versa.

Table 2: Income and Hicksian Price Elasticities

	Income Elasticity				
	Cereals	Meat	Dairy	Vegetable Oil	Sugar
	0.818	**1.337**	**0.692**	**1.091**	**1.334**
	(0.063)	**(0.204)**	**(0.118)**	**(0.041)**	**(0.123)**
Commodity	Hicksian Price Elasticities				
	P1	P2	P3	P4	P5
Cereals	**-0.234**	0.022	-0.031	0.305	-0.062
	(0.154)	(0.059)	(0.059)	(0.121)	(0.074)
Meat	0.158	**-1.866**	-0.307	1.534	0.481
	(0.418)	**(0.292)**	(0.227)	(0.318)	(0.253)
Dairy	-0.143	-0.199	**-0.569**	0.375	0.537
	(0.272)	(0.147)	**(0.237)**	(0.231)	(0.174)
Vegetable Oil	0.246	0.174	0.065	**-0.531**	0.046
	(0.097)	(0.036)	(0.040)	**(0.109)**	(0.050)
Sugar	0.369	0.069	0.095	0.454	**-0.891**
	(0.022)	(0.022)	(0.022)	(0.022)	**(0.022)**

Note: Standard errors in parentheses.

3.2. Welfare Analysis Results

After obtaining Hicksian own- and cross-price elasticities for the five imported food categories, in this section we examine the welfare impacts of the rising global price of imported food on Haitian consumers using compensating variation under three price shock scenarios. The price shock scenarios were determine by examining trends in the FAO (2022a) world food price index.

3.2.1. Price Shock Scenario A: 2006-2008

The first price shock scenario is defined as the average increase in global food prices between 2006-2008. According to data from FAO (2022a) world food price index, between 2006-2008 imported cereals, meat, dairy, vegetable oil, and sugary experienced an average increase of around 31.7%, 8.2%, 23.4%, 30.8%, and 14.9%, respectively. During that period, average annual food import expenditure was around US$764.17 million. The resulting CV presented in Table 3 reveals that welfare losses from the price increase of the five imported food categories was around US$223.91 million on average. In other words, Haitian food imports need to be compensated with around 29.3% of their 2008 total expenditure on food in order to accommodate the adverse impact of global food price changes between 2006-2008. Imported cereals accounted for the most welfare loss during the period from price increases which was around US$95.56 million or around 42.7% of total welfare loss. This was followed by imported vegetable oil which accounted for around US$74.6 million in loss welfare for the period. These two imported food categories accounted for more than 75% of total loss welfare between 2006 and 2008. Imported dairy accounted for the least welfare loss for the period which was only about 5.3% of total welfare loss or US$11.9 million.

Table 3: The welfare impacts of price changes (2006–2008).

Commodity	Average Imports (Millions US$)	Price Change* (%)	Quantity Change (%)	CV (Millions US$)	CV (%)
Cereal	294.90	31.73	0.51	95.56	42.68
Meat	34.09	8.19	36.98	16.43	7.34
Dairy	50.47	23.41	0.05	11.85	5.29
Vegetable Oil	305.93	30.83	-4.94	74.57	33.30
Sugar	78.78	14.85	15.26	25.51	11.39
Total	764.17	-	-	223.91	100

Source: Obtained from the World Food Price Index (FAO 2022a).

Table 4 presents the welfare effects of the 2006-2008 global food price increase on Haiti. It was found that the highest and lowest amount of loss welfare was from cereals (US$125.86 million) and vegetable oil (US$101.88 million). This means that based on the average import share of cereals (38.6%) and vegetable oil (40.0%) between 2006-2008, after rising global prices, welfare is expected to decrease, and the import expenditure compared to the previous period will increase. Hence, for imported cereals and vegetable oil, to compensate for the lost welfare caused by the price increase in order to ensure that consumer utility remains unchanged after the price increase, around US$125.86 and US$101.88 million must be added to the total expenditure of these food categories, respectively. Furthermore, around US$241.88 million is needed to compensate Haitian consumers for increase in food prices in order to maintain the same level of utility after the price increase.

Table 4: The welfare effects of rising global food prices for consumers in Haiti (2006-2008).

	Cereal	Meat	Dairy	Vegetable Oil	Sugar
Average Import Expenditure*	294.90	34.09	50.47	305.93	78.78
Import Expenditure Share (%)	38.59	4.46	6.60	40.03	10.31
Weight of Welfare Effect (%)	42.68	7.34	5.29	33.30	11.39
Welfare Loss*	125.86	2.50	2.67	101.88	8.98
Share of Lost Welfare (%)	52.03	1.03	1.10	42.12	3.71

Note: * Figure is in Millions of US$.

3.2.2. Price Shock Scenario B: 2010-2013

The second price shock scenario used to assess the welfare impact of rising global prices of food in Haiti is between 2010-2013. According to data from FAO (2022a) world food price index, imported dairy products experienced the most increase in prices during that period which was around 12.7% while imported sugar saw only a 1.1% increase in prices (Table 5). Table 5 also presents the average compensating variation values for the five imported food categories which showed that loss welfare between 2010-2013 due to increasing prices was around US$89.33 million. The results reveal that Haiti need to be compensated with approximately 7.8% of their 2013 food import expenditure in order to tolerate the adverse impact of rising prices of food between 2010-2013. Between 2010-2016, the highest amount of CV as a result of increasing prices was from imported vegetable oil which was around US$40.07 million or 44.9% of average total food imports for the period. Additionally, imported cereals experienced around US$32.88 million in welfare losses or around 36.8% of total average food imports. Imported meat experienced the least welfare losses during this period compared to all other imported food categories despite seeing increase in expenditure over the period. Welfare losses from meat were only around US$3.48 million or about 3.9% of average total food expenditure for the period.

Table 5: The welfare impacts of price changes between 2010-2013.

Commodity	Average Imports (Millions US$)	Price Change (%)	Quantity Change (%)	CV (Millions US$)	CV (%)
Cereal	383.35	8.36	0.20	32.88	36.81
Meat	88.04	7.16	-3.00	3.48	3.89
Dairy	72.18	12.66	-6.19	4.11	4.60
Vegetable Oil	503.77	8.07	-0.11	40.07	44.86
Sugar	101.65	1.14	7.43	8.80	9.85
Total	1,148.99	-	-	89.33	100

Source: Obtained from the World Food Price Index (FAO 2022a).

In terms of the welfare effects of the rising global price of food in Haiti for the period 2010-2013, the highest amount of welfare loss is experienced by imported vegetable oil which was around US$225.98 million followed by imported cereals which was US$141.09 million on average (Table 6). This means that according to the share of food import expenditure for imported vegetable oil (43.8%) and cereals (33.4%), after rising global price of food, welfare is expected to have decreased and import expenditure compared to the previous period would have increased. Therefore, to compensate for lost welfare and to ensure that that Haitian consumers maintain their initial

level of utility after the increasing global price of food, around US$383.83 million should be added to total food import expenditure.

Table 6: The welfare effects of rising global food prices for consumers in Haiti (2010-2013).

	Cereal	Meat	Dairy	Vegetable Oil	Sugar
Average Import Expenditure*	383.35	88.04	72.18	503.77	101.65
Import Expenditure Share (%)	33.36	7.66	6.28	43.84	8.85
Weight of Welfare Effect (%)	36.81	3.89	4.60	44.86	9.85
Welfare Loss*	141.09	3.42	3.32	225.98	10.01
Share of Lost Welfare (%)	36.76	0.89	0.86	58.88	2.61

Note: * Figure is in Millions of US$.

3.2.3. Price Shock Scenario C: 2020-2021

The third price shock scenario assessed was for the period 2020-2021 which was used to assess the welfare impact of the Covid-19 pandemic in Haiti. The Covid-19 pandemic caused rapid and intense disruption to the global trade system due to a generalized decrease in global demand, increased cross-border restrictions, port closures, and logistical disruptions (Vidya and Prabheesh 2020, Mouloudj et al. 2020, Vo and Tran 2021, Erokhin and Gao 2020, Chakraborty 2023). Furthermore, the pandemic has led to major increases in prices of major import food commodities (Agyei et al. 2021, Clapp and Moseley 2020, Ben Hassen et al. 2020). In addition, during the first few months of the covid-19 pandemic, Haiti has seen around a 16.5% increase in local food prices (Clapp and Moseley 2020). Hence, it is paramount that the welfare impact of rising food prices be assessed in Haiti during the pandemic period.

It was observed that between 2020-2021 the global price of imported cereals, meat, dairy, vegetable oil, and sugar increased by around 16.9%, 4.1%, 8.0%, 42.7%, and 19.3%. Imported vegetable oil saw the highest increase in price Table 7 presents the results of the welfare impact of rising food prices during the covid-19 pandemic period 2020-2021. The results of CV reveal that welfare losses from global food price increases during the covid-19 pandemic period was around US$458.50 million. To clarify, Haitians require compensation of around 28.2% of their 2021 total food import expenditure in order to accommodate the adverse impacts resulting from price increases between 2020-2021. The highest amount of CV was from imported cereals (US$149.18 million), vegetable oil (US$136.18 million), and meat (US$115.16 million). These three imported food categories accounted for more than 85% of welfare loss between 2020-2021 (Table 7). In contrast, imported dairy accounted for the least welfare loss which was only around US$20.68 million. Given that current data suggest that food imports for Haiti is on an upward trajectory, there is a need for major policy action as Haitians are vulnerable to outside shocks that negatively impact the global food system to which they depend heavily upon. Haiti is also regarded as food insecure (Richardson et al. 2022, Kianersi et al. 2021), hence, there is need policy action is need to improve food security.

Table 7: The welfare impacts of price changes between 2020-2021.

Commodity	Average Imports (Millions US$)	Price Change (%)	Quantity Change (%)	CV (Millions US$)	CV (%)
Cereal	574.13	16.99	7.69	149.18	32.54
Meat	155.23	4.14	67.26	115.16	25.12
Dairy	73.70	8.01	18.56	20.68	4.51
Vegetable Oil	703.90	42.68	-16.35	136.18	29.70
Sugar	121.83	19.31	9.49	37.32	8.14
Total	1,628.79	-	-	458.50	100

Source: Obtained from the World Food Price Index (FAO 2022a).

Table 8 presents the results of the welfare effects of the global increase in food prices in Haiti. It was discovered that the greatest amount of welfare loss was from imported vegetable oil which was around US$209.06 million followed by imported cereals which was estimated at US$186.80 million. This means that according to import

expenditure share of imported vegetable oil (43.2%) and imported cereals (35.3%), after rising global prices of food, welfare is expected to decrease, and the import expenditure of these commodities compared to the previous period would increase (Table 8). Therefore, in order to compensate Haitian consumers for the welfare lost as a result of increasing prices and to ensure that their initial level of welfare is maintained after the increase in prices, around US$448.08 million must be added to total expenditure of the five imported food categories.

Table 8: The welfare effects of rising global food prices for consumers in Haiti (2020-2021).

	Cereal	Meat	Dairy	Vegetable Oil	Sugar
Average Import Expenditure[*]	574.13	155.23	73.70	703.90	121.83
Import Expenditure Share (%)	35.25	9.53	4.52	43.22	7.48
Weight of Welfare Effect (%)	32.54	25.12	4.51	29.70	8.14
Welfare Loss[*]	186.80	38.99	3.32	209.06	9.92
Share of Lost Welfare (%)	41.69	8.70	0.74	46.66	2.21

Note: [*] Figure is in Millions of US$.

4. Policy Implications

The results of the study highlight the significant negative welfare impact and effect of global food price increases on Haitian consumers, especially for the periods of 2006-2008, 2010-2013, and 2020-2021. To address these challenges, policymakers in Haiti could consider implementing a range of policy recommendations that are aimed at reducing the impact of global food price volatility on the country's populace. One potential policy recommendation is to strengthen domestic agricultural production and food security in Haiti. At present, Haiti is regarded as a highly underdeveloped (Yu *et al.* 2019, Dupuy 2019, Hashimoto *et al.* 2020) and food insecure (Richardson *et al.* 2022, Kianersi *et al.* 2021, Rasul *et al.* 2022) nation within the Caribbean region. Agriculture is the primary economic sector in Haiti, employing about two-thirds of the population. However, the agricultural sector in Haiti faces several challenges, such as poor soil quality, limited irrigation, and deforestation, which have contributed to a decline in agricultural productivity. These challenges have made it difficult for Haiti to produce enough food to feed its population, leading to a heavy reliance on food imports (Wisner 2021, Jenkins 2022, Quellhorst *et al.* 2020).

Domestic food production could be increased by improving agricultural productivity, improving agricultural infrastructure, and diversifying the crops grown in the country. This could be achieved through investment in agricultural research and development, provision of credit facilities, and support for small-scale farmers via education and extension services. A robust agricultural sector could not only reduce the country's dependence on food imports but also contribute to reducing domestic food prices and ensuring stable supplies of essential food items. This can help to alleviate the looming food insecurity problem faced by Haitians.

Secondly, global food price volatility has been a major concern for many developing countries, including Haiti as seen by the negative impacts on welfare. The country's heavy reliance on food imports leaves it vulnerable to fluctuations in global food prices. Therefore, it is important for the Haitian government to implement measures to mitigate the impact of global food price volatility on Haitian consumers. Another recommendation is to implement measures to mitigate the impact of global food price volatility on Haitian consumers. These measures could include targeted subsidies or cash transfers to vulnerable households. This would help to ensure that these households can access essential food items even during times of high food prices. For example, subsidies or cash transfers could be targeted to households that are living below the poverty line, those with children or elderly dependents, and those who are experiencing temporary shocks such as unemployment or illness. This would ensure that the most vulnerable households have access to the food they need, regardless of the prevailing market conditions.

Furthermore, price stabilization mechanisms, and strengthening social safety nets can be another approach used to help shield Haitian consumers from volatile global food prices. This could include the use of strategic food reserves, which would allow the government to release food stocks onto the market during times of high food prices. Additionally, the government could implement price ceilings or floors for essential food items to prevent prices from rising too high or falling too low. These measures would help to promote stability in the food market

and ensure that prices remain affordable for Haitian consumers. However, such policy requires much financial resources from the Haitian government which might not necessary be available given the underdeveloped status of the nation currently.

Regional trade agreements can also help to reduce Haiti's dependence on global food markets and promote regional food security by facilitating greater trade in food commodities among neighboring countries. Haiti's location in the Caribbean region presents an opportunity for the country to explore potential partnerships with other countries in the region to increase food production and trade. The Caribbean Community (CARICOM) is a regional organization that Haiti is a member of, which seeks to promote economic integration and cooperation among its member states. The Haitian government could explore the potential for regional trade agreements with neighboring countries to promote greater trade in food commodities. For example, Haiti could consider entering into bilateral or multilateral trade agreements with countries such as the Dominican Republic, Jamaica, or Trinidad and Tobago. These agreements could include provisions to reduce trade barriers and promote greater cooperation in the areas of food production and trade. In addition, regional food security can also be facilitated by the establishment of a regional food security reserve. This would involve countries in the region contributing to a shared reserve of essential food items that could be distributed in times of crisis. Such a reserve could help to stabilize food prices and ensure access to essential food items in the event of natural disasters, conflict, or other disruptions to the food supply chain. The reserve could be managed by a regional organization such as CARICOM, which could also facilitate regional trade in food commodities and provide technical assistance to member states to improve agricultural productivity.

Overall, the policy recommendations outlined could help to mitigate the negative welfare impact of global food price volatility on Haitian consumers. While these recommendations may require significant investments, planning, and management, the long-term benefits of reducing the country's dependence on food imports and promoting greater food security are likely to outweigh the costs. By implementing a range of policies aimed at reducing the impact of global food price volatility, Haiti could achieve greater food security, improve the welfare of its population, and become more resilient.

5. Conclusion

The primary purpose of this study was to investigate the welfare impacts of increasing global prices of imported food on Haitian consumers. The study utilized annual data for the period 1980-2021. The LA-AIDS model was used to obtain price and income elasticities for the five major imported food categories and compensating variation was used to assess the welfare impacts and effects of rising global prices of imported food on Haitian consumers. Hicksian own-price elasticities were negative and significant for all imported food categories. All imported food categories were found to be import price inelastic except for imported meat which was price elastic. Cross-price elasticities highlighted that substitution and complementary relationships existed between various pairs of imported food categories. Income elasticities indicate that demand for imported meat, vegetable oil and sugar is income inelastic and can be regarded as luxuries, while demand for cereals and dairy is found to be income inelastic. The results of the welfare exercise reveal that price increases between 2006-2008, 2010-2013, and 2020-2021, results in CV of around US$223.91 million, US$89.33 million, and US$458.50 million, respectively. It was found that imported cereals and vegetable oil accounted for the most loss in welfare in all three price shock scenarios. These results have important implications for governments and international organizations seeking to address food insecurity and promote food access in developing countries, emphasizing the importance of implementing policies that can help reduce the negative welfare effects of rising global food prices on low-income consumers in Haiti.

Declaration of Competing Interest

The authors declare that they have no known competing financial interest or personal relationships that could have appeared to influence the results of the work reported in the paper.

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Appendix A

Table A1: Estimated Parameters of the LA-AIDS Model for Imported Food

Parameter	Import Share Equations				
	Cereals	**Meat**	**Dairy**	**Vegetable Oil**	**Sugar**
α	1.326	-0.151	0.373	-0.165	-0.383
	(0.345)	(0.156)	(0.140)	(0.276)	(0.170)
γ_1	0.146	-0.009	-0.037	-0.045	-0.053
	(0.054)	(0.021)	(0.021)	(0.042)	(0.021)
γ_2	-0.009	-0.045	-0.019	0.054	0.019
	(0.021)	(0.014)	(0.011)	(0.016)	(0.012)
γ_3	-0.037	-0.019	0.027	-0.005	0.034
	(0.021)	(0.011)	(0.018)	(0.018)	(0.013)
γ_4	-0.045	0.054	-0.005	0.015	-0.019
	(0.042)	(0.016)	(0.018)	(0.048)	(0.022)
γ_5	-0.053	0.019	0.034	-0.019	0.019
	(0.021)	(0.012)	(0.013)	(0.022)	(0.022)
β	-0.064	0.017	-0.023	0.039	0.031
	(0.010)	(0.010)	(0.009)	(0.018)	(0.011)

Note: Standard errors in parentheses.