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Full Research Article

The impact of food price shocks on poverty and vulnerability of urban households in Iran

Ghasem Layani[1], Mohammad Bakhshoodeh[1], Mona Aghabeygi[2,*], Yaprak Kurstal[3], Davide Viaggi[3]

[1] University of Shiraz (Iran)
[2] University of Parma (Italy)
[3] University of Bologna (Italy)

Abstract. The aim of this paper is to assess the welfare effects of food price changes on urban households' poverty and vulnerability. This is achieved by using Hicksian price Compensating Variation (CV) and compensated price elasticities, based on Quadratic Almost Ideal Demand System (QAIDS). The study includes in total eight food groups (cereals, meats, dairy, cooking oil, sugar, fruits, vegetables, and tea and coffee) and encompasses 18852 urban households. The results showed that the welfare index for food groups was 20 USD (2.52% of the monthly average income of urban households). After increasing food prices, based on the poverty line, 41% of urban households were observed to be below the poverty line and the number of poor households increased by 10.63%. To enable food security and to execute food safety goals, the Iranian government should compensate for the welfare losses by supportive policies such as direct subsidy payments to vulnerable households.

Keywords. Compensating Variation (CV), Quadratic Almost Ideal Demand System (QAIDS), welfare effect, vulnerability, food price shocks.

JEL Codes. I32, N95, Q18.

1. Introduction

The level of the Iranian food consumption is expected to increase significantly in next years. There are two main reasons for this issue: First, the Iranian population of currently approximately 82 million is estimated to grow by around 1 million people annually in the next 5 years. The expected short-term population growth will increase demand and consumption of food products in Iran. Second, an increasing part of the Iranian population is moving from rural into urban areas. The growing urbanization decreases the amount of wholly or partly self-sufficient people in Iran. Instead, they become consumers in the urbans contributing to a growing food demand (ISC, 2016).

The GDP-growth in Iran has increased from 0.9 % in 2015 to 4.6 % in 2016. The Economist Intelligence Unit predicts that the Iranian GDP will increase further, reach-

*Corresponding author. E-mail: monaaghabeygi17@gmail.com

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ing 5.4 % in 2017 and 5.9 % in 2018. This positive development in Iranian economy is expected to contribute to a general increase in food consumption and demand, as it is likely to increase the living standard for the growing middle class in Iran, raise purchasing power and consumers' confidence. This will raise the demand for more expensive and specialized food products. The demand for basic food products is also expected to increase, as the current consumption of food products in Iran is relatively low by regional standards. This especially concerns sugar, corn, meat, and vegetable oils. During the sanctions period, real disposable incomes for most consumers were falling, due to high inflation rates not matching by salary increases. As a consequence, the consumption per capita of some of the more expensive food products like red meat, cheese and milk declined. With increasing economic growth, the repressed food demand is expected resume and continue to grow. Traditional grocery and other stores accounts for more than 80% of retail sales in Iran. However, recently hyper- and supermarkets are growing in importance thereby stimulating the demand for more advanced products. A larger product variety is expected to lead to a growing demand (IMAJ, 2016). Therefore, Iran is expected to be faced with increasing food prices, which leads to increased adverse impacts on poverty and food security. In this regard, it is of utmost importance to know how changes in food prices affect the welfare of households. Hence, understanding the effects of price increases of food especially on vulnerable households could have significant implications for the design of supporting policies (Fallahi *et al.*, 2016) and to help decrease the negative impacts of increasing prices towards achieving the goal of food security.

In the case of Iran, over the course of the last 15 years (2001-2015), the average annual imports of eight main food groups, namely meat, cereals, dairy products, oils and fats, sugar, fruits, vegetables and tea and coffee, has reached a level of 12430 million tons, which has shown an increase of 54 percent over 15 years, and around 5.21 percent increase, annually. To provide an example, Iran is the major importer of oilseeds and about 90 percent of the country's oil needs to be provided through imports. Also, in the year 2018, nearly 20 percent of meat and more than 40 percent of cereals supplied in the Iranian market have been provided through imports (FAO, 2016). This significant rise in the level of imports, hence, brought about an increase in the prices of many products. Being vulnerable to the rising food prices in the world due to high level of imports in food products and increasing global food prices also carry major implications for both the economic and social welfare of Iranian households, which has been subject of increasing concern. In this context, urban households, which constitute around 75 percent of the total number of households in Iran, and whose budget composition is directly impacted by the inflated food purchases, are hit ineluctably (Ravallion and Chen, 2007; Robles and Keefe, 2011). In this study, our aim is to estimate the effects of the 2000–2016 food price surges on urban households' expenditure and food poverty. Our methodological approach follows Azzam and Rettab (2012) and Rodriguez-Takeuchi and Imai (2013) to take into account the impacts of food price changes on households' vulnerability and poverty. The rest of the paper is structured as follows: The next section provides the background of the importance of studying the behavior of consumers. We, then introduce the methodology of the Quadratic Almost Ideal Demand System (QAIDS) model and the Vulnerability Index and Data. Own- and cross-price elasticities, welfare and poverty effects of food price changes are presented in the results section, and also, the final section offers concluding remarks and policy discussion.

1.1 Measuring economic welfare

Measuring the economic welfare and poverty effects of different policies among societies have always been one of the most important economic issues of public policies. Countries often use policy interventions to dampen the impacts of international food price spikes on domestic markets and lessen the burden of these especially on vulnerable population groups. Besides, understanding the causes of the food price shocks and addressing its significant effects on developing countries have been critical in order to analyze the efficiency and adequacy of policies in addition to be able to propose policy options. The impact of these shocks on welfare depends on a variety of factors, including but not limited to the nature of the shock, initial household, or community conditions and also policy responses by the government (UNICEF, 2009). In addition to such macro impacts, micro impacts are mainly experienced in the form of reduced household income, due to lower wages and employment or limited access to credit and reduced real income in the face of higher food prices, and decreased access to public services, as a result of reduced service delivery on the part of the government (UNICEF, 2009). Meanwhile, the extent to which households are affected by these shocks will depend on the change in relative prices, substitution of commodities and response of households to all these factors (Osei-Asare and Eghan, 2013).

Towards this end, numerous studies worked on the relative prices and substitution relation among commodities by estimating elasticities of demand functions based on Translog or "Almost Ideal Demand System" (AIDS) forms. Some of the examples include Deaton and Mulbaer (1980), studying the case of Great Britain, Blanciforti and Green (1983), and Hayes *et al.* (1990), of United States; Fulponi (1989), of France; Abdulai *et al.* (1999), of India; Tefera (2012), of Ethiopia and Suharno (2010) of Indonesia. Meanwhile, other studies have used the AIDS model, which has assumed a linear Engel curve (Tefera, 2012), while Banks *et al.* (1997) proposed a Generalized Quadratic Almost Ideal Demand System (QAIDS) that permits a non-linear Engel curve. Matsuda (2006) also applied QAIDS to estimate food demand in Japan. On the other hand, Arabatzis and Klonaris (2009) studied on cases, in which QAIDS has been applied for wood product imports in Greece. Furthermore, Layani and Esmaeili (2015) also used QAIDS and a welfare index such as Hicksian compensating variation (CV) to analyze food demand in order to assess the welfare effects of increasing food prices for households in Iran.

The significant welfare impacts of price shocks have prompted studies to evaluate recent price shocks on household poverty in developing countries (e.g., De Janvry and Sadoulet, 2010; Leyaro *et al.*, 2010; Coleman, 2012; Ivanic *et al.*, 2012; Fujii, 2013; Layani and Bakhshoodeh, 2016). In recent studies of the economic welfare effects of food price changes, Azzam and Rettab (2012) have focused on the vulnerability of households in the United Arab Emirates (UAE) as a result of increasing prices for imported food products; while, Rodriguez-Takeuchi and Imai (2013) and Fujii (2013) have first calculated the poverty line and then analyzed the effects of increasing food prices on household expenditure and the poverty line. In this study, in addition to discussing the welfare effects of food rising prices in the face of highly elastic poverty lines to relative food prices, the poverty line changes in urban households are also addressed to understand the extent of Iranian consumers' vulnerability to food price increases and food supply shocks. Measuring the welfare changes caused by increasing food prices is crucial to provide a compensatory support system. Our methodological approach follows Azzam and Rettab (2012) to determine the impacts of food price changes on Iranian urban households' expenditure and poverty line.

Within this context, the objectives of this paper are: (1) To determine the price and income elasticity for food groups by using Quadratic Almost Ideal Demand System (QAIDS); (2) To explore welfare impacts of increasing world food prices using Compensated Variation (CV); and (3) To calculate the consumer vulnerability index and poverty effects of food price shocks.

2. Methodology

2.1 Poverty Line and the Vulnerability Index

Poverty measurement is based on a comparison of resources to need (World Bank, 2000). A person or family is identified as poor if their resources fall short of the poverty threshold. Meanwhile, poverty is defined by using a poverty line; when a household falls below this line, it is considered to be poor. For instance, the World Bank considers a household to be poor if it survives on less than 1.90 USD per day. In this study, food poverty has been considered. In order to measure the poverty line based on the relative concept, poverty line can be determined by the percentage of average household expenditure. By following the work of Khodadad Kashi *et al.* (2005) and Arshadi and Karimi (2013), we take 66 percent of the average household food expenditure as a threshold for determining the relative poverty line:

$$\text{Poverty Line} = 66 \text{ percent} \times (\text{average food expenditure}) \tag{1}$$

Therefore, the relative poverty line is calculated before the change in food prices by (1). After computing the poverty line, we can divide urban households into two groups: The households that have a food expenditure higher than poverty line (above the poverty line), and the households that have a food expenditure lower than poverty line (below the poverty line). The reason for this is because poverty lines are highly elastic to relative food prices and changes in food prices result in variations of poverty prevalence. Furthermore, we then compute a new poverty line, after accounting for the rise in food prices (Rodriguez-Takeuchi and Imai, 2013):

$$\text{Secondary Poverty Line} = \text{Poverty Line} + \text{Welfare Index} \tag{2}$$

In addition, we compute the Vulnerability Index following Azzam and Rettab (2012):

$$\text{Households Vulnerability} = \text{total welfare loss relative to income} = WI/AI \tag{3}$$

In the equation, WI is the total welfare effects of rising food prices and AI is the average income of urban households.

2.2 Welfare Index with price changes

In general, in the welfare literature, there are various indexes for measuring the welfare changes due to implementation of different policies (Gohin, 2005). By changing economic conditions, such as price changes, consumers' utility rates may increase or decrease. To determine how and how much of the consumer utility changes due to changing economic conditions, some criteria are used such as Consumers Surplus (CS), Compensated Variation (CV) and Equivalent Variation (EV). In our context of rising food prices, CV is the minimum amount, the Iranian consumers are willing to accept (WTA) to tolerate higher food prices; and EV is the maximum amount they are willing to pay (WTP) to avoid higher food prices. The focus of CV is on the welfare level prior to the increase in prices, while the focus of EV is on the subsequent welfare level after the increase in prices (Azzam and Rettab, 2012). Hence, we use the CV in our study, based on the studies of Azzam and Rettab (2012), Tefera (2012) and Cranfield (2007).

The starting point of the CV model with price changes is the consumer problem of minimizing expenditures on N food commodities subject to a utility level U^0. Substitution of the resulting optimal Hicksian quantities into the expenditure equation yields the minimized expenditure function (Azzam and Rettab, 2012):

$$E = E(P_1, P_2, \dots, P_3, U^0) = p_1 q_1^H(P_1, P_2, \dots, P_3, U^0) + p_2 q_2^H(P_1, P_2, \dots, P_3, U^0) + \dots + p_N q_N^H(P_1, P_2, \dots, P_3, U^0) \tag{4}$$

Where Pi for i = 1, 2, . . ., N are the respective prices of the N commodities, 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:

$$CV = E(p_1^1, p_2^1, \dots, p_{\mathrm{N}}^1, U^0) - E(p_1^0, p_2^0, \dots, p_N^0, U^0) \tag{5}$$

Using (4), we can expand (5) as follows:

$$CV = p_1^1 q_1^H(p_1^1, p_2^1, \dots, p_N^1, U^0) - p_1^0 q_1^0 + p_2^1 q_2^H(p_1^1, p_2^1, \dots, p_N^1, U^0) - p_2^0 q_2^0 + \dots + p_N^1 q_N^H(p_1^1, p_2^1, \dots, p_N^1, U^0) - p_N^0 q_N^0 \tag{6}$$

Direct measurement of CV using (6) is not possible because the Hicksian demand functions $q_i^H(.)$ for i = 1, 2, . . ., N depend on the utility level U0, which is unobservable. However, as shown by Huang (1993), if the respective changes in prices and Hicksian quantities are defined as (Azzam and Rettab, 2012):

$$dp_{\mathrm{i}} = p_i^1 - p_i^0 \; for \; i = 1,2, \dots, N$$
$$dq_i^H = q_i^H - q_i^0 \; for \; i = 1,2, \dots, N \tag{7}$$

and substituted into (6), CV can be approximated by:

$$CV = p_1^0 q_1^0 \left(\frac{dp_1}{p_1^0} + \frac{dq_1^H}{q_1^0} + \frac{dp_1}{p_1^0}\frac{dq_1^H}{q_1^0}\right) + p_2^0 q_2^0 \left(\frac{dp_2}{p_2^0} + \frac{dq_2^H}{q_2^0} + \frac{dp_2}{p_2^0}\frac{dq_2^H}{q_2^0}\right) + \cdots + p_N^0 q_N^0 \left(\frac{dp_N}{p_N^0} + \frac{dq_N^H}{q_N^0} + \frac{dp_N}{p_N^0}\frac{dq_N^H}{q_N^0}\right) \quad (8)$$

The percentage change in Hicksian quantities is not observed. However, an approximation of the change is obtained through the total differential of the Hicksian demand functions $q_i^H(.)$. For example for i = 1, 2, . . ., N:

$$\frac{dq_1^H}{q_1^0} = \epsilon_{11}^H \frac{dp_1}{p_1} + \epsilon_{12}^H \frac{dp_2}{p_2} + \cdots + \epsilon_{1N}^H \frac{dp_N}{p_N}$$

$$\frac{dq_2^H}{q_2^0} = \epsilon_{21}^H \frac{dp_1}{p_1} + \epsilon_{22}^H \frac{dp_2}{p_2} + \cdots + \epsilon_{2N}^H \frac{dp_N}{p_N} \quad (9)$$

$$\vdots$$

$$\frac{dq_N^H}{q_N^0} = \epsilon_{N1}^H \frac{dp_1}{p_1} + \epsilon_{N2}^H \frac{dp_2}{p_2} + \cdots + \epsilon_{NN}^H \frac{dp_N}{p_N}$$

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

2.3 Quadratic Almost Ideal Demand System

To estimate the Hicksian price elasticities as shown in (9), we estimate a Quadratic Almost Ideal Demand System (QAIDS) model for N commodities by imposing the usual restrictions: Adding-up, homogeneity, and symmetry. The QAIDS model developed by Banks *et al.* (1997), which has budget shares that are quadratic in log total expenditure, is an example of the empirical demand systems that have been developed to allow this expenditure nonlinearity. The QAIDS not only retains the desirable properties of the popular AIDS of Deaton and Muellbauer (1980) nested within it, but also has the additional advantage of being versatile in modelling consumer expenditure patterns. Quadratic in the logarithm of total expenditure, the QAIDS allows such situations where the increase in the expenditure would change a luxury to necessity (Arabatzis and Klonaris, 2009).

The QAIDS model is (Gorman, 1981; Jing et al, 2001):

$$S_i = \alpha_i + \sum_{j=1}^{N} \gamma_{ij} logp_j + \beta_i log\left[\frac{M}{f(p)}\right] + \frac{\lambda_i}{g(p)}\left\{log\left[\frac{M}{f(p)}\right]\right\}^2 \quad (10)$$

Where S_i is the share of food group i in total expenditure on the N food groups, for i=1,2,..,N; and p_j is a vector of prices; M is total expenditure. Also, *f(p)* is the Stone Price Index defined by $logf(p)^* = \sum_i si\ logp_i$.

The restrictions are:

$$\sum_{i=1}^{n}\alpha_i = 1, \sum_{i=1}^{n}\gamma_{ij} = 0, \sum_{i=1}^{n}\beta_i = 0 \quad , \gamma_{ij} = \gamma_{ji} \tag{11}$$
$i,j = 1,2,\ldots,N$

The respective formulas for computing the Hicksian Price elasticities for N groups are:

$$e_{ij}^{h} = \left(\frac{u_{ij}}{s_i} - \delta_{ij}\right) + (1 + \frac{u_i}{s_i})s_j \tag{12}$$

$$u_i = \frac{\partial s_i}{\partial lnm} = \beta_i + \frac{2\lambda_i}{g(p)}\left[log\left[\frac{M}{f(p)}\right]\right]$$

$$u_{ij} = \frac{\partial s_i}{\partial lnp_j} = \gamma_{ij} - \left(\beta_i + \frac{2\lambda_i}{g(p)}\left[log\left[\frac{M}{f(p)}\right]\right]\right)(\alpha_j + \sum_{i=1}^{k}\gamma_{ji}logp_i) - \frac{\lambda_i\beta_i}{g(p)}\left[log\left(\frac{M}{f(p)}\right)\right]^2 \tag{13}$$

Where δ_{ij} is the Kronecker delta taking the value $\delta_{ij} = -1$ if i = j and $\delta_{ij} = 0$ if i ≠ 0. In terms of the u_i, the formula for Income elasticities can be written as:

$$e_i = 1 + \frac{u_i}{s_i} \tag{14}$$

Negative cross-price elasticities indicate a complementarity relationship and the positive values for cross-price elasticities indicate substitutability. Also, the positive (negative) values for expenditure elasticity indicated non-inferior (inferior). In the former case when $\varepsilon_i \geq 1$ the goods are regarded as luxury. Specifically, so-called normal necessities have an income elasticity of between 0 and 1.

But one of the problems with working with these kind of models is the phenomenon of zero consumption of a commodity or the zero budget share, which is due to the division of food groups into a large number of groups and the use of cross-sectional data at the household level. In other words, some households report a zero consumption, and some others spend a non-zero share. Therefore, the variable is censored. In order to solve this problem, based on the Bakhshoodeh (2010) study, we use the following equation instead of equation (10).

$$s_i = \varphi\left(z_i^{h}\tau_i\right)\left[\alpha_i + \sum_{j=1}^{k\sum\left[\frac{m}{f(p)}\right]\frac{\lambda_i}{g(p)}\left\{log\left[\frac{m}{f(p)}\right]\right\}^2} \gamma_{ij}\, log\, p_j\right] \tag{15}$$

Where $\phi(0)$ and $\varphi(0)$ are Cumulative Distribution Function (CDF) and Probability Distribution Function (PDF) for each household

The system of Eq. (15) is estimated using iterative seemingly unrelated regression (SURE) to calculate elasticities for eight food groups (cereals, meats, dairy, oil, sugar, fruits, vegetables, and tea and coffee).

3. Data and information

This study is based on urban household's income-expenditure survey (2012) of the Iranian Statistics Center (18852 urban households) for computing price and income elasticities. We collected data on food imports to Iran during the years of 2000 to 2016. Then the average annual growth of imported food prices is defined as a price shock scenario. By referring to Ivanic *et al.* (2012), we assume that the global food price shocks transferred completely to the domestic market in Iran. Finally, welfare effects and changes in food poverty are determined.

Mean and standard deviations of expenditure share and average monthly expenditures for eight food groups including cereals, meats, dairy, cooking oil, sugar, fruits, vegetables, and tea and coffee are presented in Table 1. Generally, the share of food and beverage expenditures in total household budget is equal to 23.5%. The share of food expenditures is in the second-placed after the share of buying/renting house budget (ISC, 2016). Among eight food groups, the maximum and the minimum average expenditure shares related to cereals were 26.21 percent (monthly 43.69 USD) and 2.9 percent for tea and coffee (about 4.69 USD) respectively.

Table 1. Average expenditure shares of different food groups.

Group	Average expenditure share	Coefficient of variation	Standard deviation	Average monthly food expenditure
Cereals	26.21	0.45	0.11	43.69
Meats	22.87	0.47	0.10	41.01
Dairy	12.16	0.51	0.06	18.68
Oil cooking	5.42	0.71	0.03	8.84
Sugar	4.60	0.81	0.03	8.13
Fruits	12.29	0.63	0.07	22.38
Vegetables	13.55	0.45	0.06	21.76
Tea and coffee	2.90	1.07	0.03	4.69

Source: Iranian Statistics Center, 2016.

4. Result and discussion

According to the price elasticities of the QAIDS[1] model, all own-price elasticities are negative. In terms of absolute values, the highest own-price elasticity is related to tea and coffee (2.19 percent) and the lowest own-price elasticity is related to fruits (0.05%). It means that, demand for tea and coffee is highly responsive to any change in the price. The estimated own price elasticities for vegetables (-0.74%) and for sugar (-0.82%) are close to one. In fact, demand for these two groups has large response to changes in their relative prices. The estimated own-price elasticity is low for others. We concluded that demand for cereals, meat, dairy and oil cooking are stable to price changes, meaning that these food groups are essential in household consumption patterns.

[1] QAIDS estimation is reported in the Annex.

Cross-price elasticities show competitive or complementary relations among products. Positive cross-price elasticities indicate competitive relations, while negative cross-price elasticities indicate complementary relations. The Cross-price elasticities presented in Table 2 also show that most of the selected goods have complementary relationship with each other. In addition, in terms of the absolute value of the elasticity, the complementary relationship can also be stronger than the substitution relation. The cross-elasticity of other commodities with cereals and meats suggest a substitution relationship between them, but the relationship between cereals and meat with other commodities is mostly complementary. This pattern of relationships can indicate the importance of consumption of cereals and meat in the consumer food pattern. By illustration, consumers prefer to add other commodities as a complement to their consumption patterns after the inclusion of cereals and meat, while these two products will be the substitution to other commodities. The patterns of household consumption, and especially the high per capita consumption of cereals such as rice and wheat, can also confirm these results.

The estimated total income elasticities presented in Table 2 have the expected positive signs in all eight commodities. The values for cooking oil (e=1.76), fruits (e=1.38), meat (e=1.22) and cereals (e=1.18) are much higher than others. This implies a fairly large response of demand for these food groups to changes in total food expenditure. Actually, the demand for cooking oil, fruits, meat and cereals are elastic with respect to total food expenditure. The estimated income elasticities of dairy, sugar, vegetables and tea and coffee are less than unity, so these goods are fairly inelastic with respect to total food expenditure.

After obtaining compensated own and cross price elasticities in this section we examine the welfare impacts of the changes in selected food items' prices. Following some recent literature, we estimate the change in consumer welfare by using the compensating variation (CV). The compensating variation is the amount needed to compensate a household for a price increase, in order for the household to remain at the same utility level after a price change. We define price shock scenarios based on average annual changes in world food prices presented by FAO (2016) for period of 2000-2014. Prices of cereals, meat, dairy, oils, sugar, fruits, vegetables and tea and coffee have increased by 9.80, 8.35, 7.72, 8.06, 8.78, 3.16, 15.70 and 4.68 percent, respectively.

We present the average compensating variation values in Table 3. Results show that the welfare losses from the price increases in cereals, meats, dairy, oils, sugar, fruits, vegetables and tea and coffee amount to 20 USD. In other words, on average, Iranian urban households need to be compensated with approximately 11.82 percent of their 2016 total household expenditure on food in order to accommodate the adverse impact of food price changes they faced between 2000 and 2014. The highest amount of CV as a result of the increase of prices is obtained for fruits. The amount of CV for fruits is estimated at 4.90 USD, which is equivalent to 2.42 percent of the average food expenditures in 2016. Also, the CV index of cereals is estimated to be 3.56 USD, which is equivalent to 2.11 percent of the average food expenditure in 2016. Thus, with an increase of 9.80 percent in the price of cereals (considering the simultaneous price change), urban household expenditures increase and their welfare decreases. The CV for meat, dairy and vegetables are 2.86 (equivalent to 1.69 percent of the average food expenditure), 3.46 (equivalent to 2.05 percent of average food expenditure) and 3.03 USD (equivalent to 1.79 percent of average food expenditure), respectively. Finally, the last column of Table 3 shows the weight of the calculated CV index for each food group

Table 2. Hicksian (Compensated) Price and income elasticities for different food groups.

	Cereals	Meats	Dairy	Oil cooking	Sugar	Fruits	Vegetables	Tea and coffee
Cereals	-0.22 (-7.51) *	-0.01 (-12.98)	0.31 (11.63)	0.17 (15.01)	0.61 (9.82)	-0.24 (-5.25)	0.02 (7.96)	1.01
Meats	0.05 (12.98)	-0.27 (-11.09)	0.15 (10.44)	0.26 (9.10)	0.25 (2.34)	-0.01 (-2.34)	0.09 (2.34)	0.23
Dairy	-0.06 (-11.63)	-0.19 (-10.44)	-0.22 (-8.04)	-0.56 (-7.26)	0.78 (6.37)	-0.01 (-4.13)	1.35 (10.51)	0.61
Oil cooking	0.13 (15.01)	0.12 (9.10)	0.14 (7.26)	-0.24 (-5.54)	0.10 (10.43)	0.12 (5.14)	-0.04 (-6.02)	0.39
Sugar	0.01 (9.82)	-0.13 (-2.34)	0.48 (6.37)	-0.60 (-10.43)	-0.82 (-7.07)	-0.25 (-8.23)	0.94 (7.05)	0.71
Fruits	-0.07 (-5.25)	-0.00 (-2.34)	0.32 (4.13)	0.25 (5.14)	0.02 (8.23)	-0.05 (-8.66)	0.25 (6.15)	-0.26
Vegetables	-0.04 (-7.96)	-0.01 (-2.34)	0.40 (10.51)	-0.21 (-6.02)	0.51 (7.05)	0.01 (6.15)	-0.74 (-7.04)	-0.07
Tea and coffee	0.28 (10.01)	0.48 (6.21)	-0.84 (-7.33)	1.36 (9.07)	-0.58 (-7.58)	0.34 (5.98)	-1.02 (-4.56)	-2.19 (-8.43)
Income Elasticities	1.18	1.22	0.23	1.76	0.39	1.38	0.58	0.14

Source: Authors' calculations
* Indicates significance at the 5% level, t-ratios are in parentheses.

from the total welfare index. According to the results, the amount of CV for fruits, cereals and dairy constitutes the highest share of the total CV index, respectively equal to 20.45 percent, 17.80 percent, and 17.30 percent of the total CV, respectively.

Table 4 shows the average monthly food expenditure of the 8 food groups, total CV, average monthly income for households, and the welfare measure of the vulnerability index (total CV relative to income). Given that the average monthly income of Iranian urban households is 792.66 USD, the total welfare loss due to rising food prices is equivalent to 2.52 percent of an average household income, which is an indicator of the vulnerability of urban households as a result of the increase in global prices. This index can be used as an effective tool as part of efforts towards enforcing supportive policies. In more detail, policymakers determine the rate of increase in employees' wage annually, based on economic indicators such as inflation. Specifying the vulnerability index would be a suitable measure to balance the wages and inflation in the society.

Finally, we examine the effect of rising food prices on poverty in urban households in Table 5. According to the average total food expenditures, the initial poverty line is computed as 111.66 USD; and after rising food prices, the secondary poverty line is computed to be 131.66 USD. In the initial setting, 30.13 percent of urban households have a monthly food expenditure below the poverty line (about 5680 households).

Table 3. Welfare effect of price changes(The average compensating variation values).

Group	Proportion of CV (%)	Compensated Variation (%)	Compensated Variation (USD)	Price Change (%)	Average monthly food expenditure (USD)
Cereals	17.80	2.11	3.56	9.80	43.69
Meats	14.29	1.69	2.86	8.35	41.01
Dairy	17.30	2.05	3.46	7.72	18.68
Oil cooking	5.59	0.66	1.12	8.06	8.84
Sugar	6.56	0.78	1.31	8.78	8.13
Fruits	20.45	2.42	4.09	3.16	22.38
Vegetables	15.15	1.79	3.03	15.70	21.76
Tea and coffee	2.84	0.34	0.57	4.68	4.69
Total	100	11.82	20	-	169.18

Source: Authors' calculations.

Table 4. Vulnerability index.

Average Monthly Urban Household Income (USD)	792.66
Total Welfare Index (USD)	20
Average Monthly Food Expenditure (USD)	169.18
Household vulnerability	2.52

Source: Authors' calculations.

Table 5. The effect of rising food prices on poverty in urban households (Poverty line for urban households).

Poverty line	Household	Percent	First poverty line (USD)
Upper	13172	69.87	111.66
Lower	5680	30.13	
Total	18852	100	

Source: Authors' calculations.

Based on what was explained, the total share of poor households in urban areas increases to 40.76 percent (Table 6). We find that 10.63 percent of households, which were above the poverty line before the food price increase, become poor after the price shock. Consequently, the overall share of poor households increases from 0.30 to 2.05 percent in urban areas. For instance, in the case of a 9.80 percent price increase for cereals, the CV is 3.56 USD and the poverty line is 115.52 USD. Our results suggest that an additional 1.79

Table 6. The impact of rising food prices on the poverty.

Group	CV (USD)	Secondary poverty line (USD)	Households (%) Poverty line		Change in household poverty	
			Upper	Lower	(Number)	%
Cereals	3.56	115.22	68.08	31.92	338	1.79
Meats	2.86	114.52	68.48	31.52	262	1.39
Dairy	3.46	115.12	68.16	31.84	323	1.71
Oil cooking	1.12	112.78	69.37	30.63	95	0.50
Sugar	1.31	115.75	69.26	30.74	116	0.62
Fruits	4.09	114.69	67.82	32.18	386	2.05
Vegetables	3.03	112.97	68.39	31.61	280	1.49
Tea and coffee	0.57	112.23	69.57	30.43	57	0.30
Total	20	131.66	59.24	40.76	2004	10.63

Source: Authors' calculations

percent of urban households (about 338 households) drop below the poverty line after a 9.80 percent price increase.

5. Policy implications

In Iran, goods and services subsidy policy has been one of the most important consumer supportive policies over the past 40 years. The main goals of this policy include controlling and stabilizing prices, supporting vulnerable groups, reducing poverty, and distributing equitable income. Although this policy instrument may help improve food security, it has been subject to increasing critiques in recent years. In fact, some local actors claim that, apart from the budget constraint, the use of goods and services subsidy policy in Iran dates to the early 1970s, however, poverty index is still high, standard welfare is not achieved for households yet, and food safety and food security for poor and vulnerable households are still major concerns. As such, this instrument is seen as inefficient given its high budget costs, as a potential source of market distortions, and benefitting some groups who do not need to be supported (e.g. target groups are not identified and households receive the same subsidy) (Azzam and Rettab, 2012; Bakhshoodeh, 2010; Tefra, 2012).

The subsidy payments by 11 USD per month for each person has been constant without considering inflation over the last two decades. These untargeted subsidy payments to the households, regardless of considering their vulnerability and their income level, in addition to being costly for the government, does not improve welfare indicators at the national level. Identification of vulnerable households and determining the amount of subsidy payment to the target groups is one of the most important challenges that policymakers in Iran are facing. Assessing the effects of simultaneous price changes on household expenditures would be one of the tools to identify target groups in receiving subsidies. In other words, determining the share of household expenditure changes (with different socio-economic characteristics) in their income show households that are more vulnerable and in need of government support. Also, the government can use the effect of total price increases on household expenditures to determine the optimal subsidy payment. Finally, implementing this supportive policy by identifying target groups could reduce poverty and increase social justice and keep households with low-income above the food poverty line.

6. Conclusion

We employed Iranian urban households' price elasticities of eight food groups (cereals, meats, dairy, oils, fruits, vegetables, sugar and tea and coffee) to evaluate the welfare effect of food price changes. For this aim, the Compensated Variation (CV) has been utilized, based on the changes in global food prices between 2000 and 2016. Meanwhile, Iranian food demand has been estimated by using the Quadratic Almost Ideal Demand System (QAIDS). This model used to explore how increasing food prices affect Iranian urban consumer welfare and the poverty line. Substitution effects among food items are estimated by including own and cross price elasticities obtained through the estimation of a demand system, QAIDS. According to the demand theory, all the estimated price and expenditure elasticities are acceptable (negative for own elasticities and positive for expenditure elasticities).

Increasing food price leads to urban Iranian household welfare losses and a decrease in the purchasing power. Also, the results of CV suggest that on average, Iranian urban households need to be compensated with approximately 11.82 percent of their 2016 total household expenditure on food in order to accommodate the adverse impact of food price changes they faced between 2000 and 2014. Although the food price changes have had differential effects for each of the food groups, price changes for the majority of households, have brought severe hardship for them to access food. The food price changes drive 2004 urban households below the food poverty line and causes a 10.63 percent increase in the number of poor urban households.

Our findings, hence, underline the negative impacts of price shocks on households' welfare, especially those that are more vulnerable than others. Being informed about the extent of these impacts, by the use of the vulnerability index, hence carries a crucial significance in the context of efforts towards achieving food security in developing countries, and towards supportive policy making targeted at especially vulnerable households. In a similar manner, in order to contribute to food security efforts and to execute food safety goals, the Iranian government should compensate the welfare loses that are incurred by vulnerable households by putting in place supportive policies including but not limited to raising wages or subsidizing vulnerable households.

The strengths of this study compared to other research include: (i) using Quadratic system of the equation which is more flexible than other demand functions, (ii) calculating welfare changes simultaneously with food price changes, (iii) calculating vulnerability index, (iv) calculating second poverty line due to simultaneous changes in food prices and (v) assessing the increase of food prices simultaneously on food poverty of rural households.

There are, however, some limitations of our study that could be addressed in order to add more precision to our results. This paper has focused on the vulnerability index of aggregate eight food groups rather than individual food items. Further research can also focus on individual food items as well as major expenditure groups such as clothing, housing services and health for urban households. Meanwhile, the compensated elasticities can also be calculated for each household in order to identify the social characteristics of households that fall in the category of vulnerable households. Moreover, in this study, all the simulations were carried out by cross-sectional data. Future research would need to use panel data and explore poverty dynamics to test how food price shock affects poverty over time by taking into account the household livelihood strategies. Last but not least, we assume that the global food price shocks transferred completely to the domestic market in Iran. Future work would benefit substantially using accurate quantities of food price transfer in welfare calculations.

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Appendix

The QAIDS for eight food groups reported below:

$$s_1 = \varphi_1(z_i^h\tau_i)\begin{bmatrix}\alpha_1 + \gamma_{11}\,log\,p_1 + \gamma_{12}\,log\,p_2 + \gamma_{13}\,log\,p_3 + \gamma_{14}\,log\,p_4 + \gamma_{15}\,log\,p_5 + \gamma_{16}\,log\,p_6 + \gamma_{17}\,log\,p_7 + \gamma_{18}\,log\,p_8 \\ +\beta_1\left[\frac{m}{f(p)}\right] + \frac{\lambda_1}{g(p)}\left\{log\left[\frac{m}{f(p)}\right]\right\}^2\end{bmatrix} + \mu_{11}z_{1_i} + \mu_{12}z_{2i} + \mu_{13}z_{3i} + \theta\phi_1(z_i^h\tau_i)$$

$$s_2 = \varphi_2(z_i^h\tau_i)\begin{bmatrix}\alpha_2 + \gamma_{21}\,log\,p_1 + \gamma_{22}\,log\,p_2 + \gamma_{23}\,log\,p_3 + \gamma_{24}\,log\,p_4 + \gamma_{25}\,log\,p_5 + \gamma_{26}\,log\,p_6 + \gamma_{27}\,log\,p_7 + \gamma_{28}\,log\,p_8 \\ +\beta_2\left[\frac{m}{f(p)}\right] + \frac{\lambda_2}{g(p)}\left\{log\left[\frac{m}{f(p)}\right]\right\}^2\end{bmatrix} + \mu_{21}z_{1_i} + \mu_{22}z_{2i} + \mu_{23}z_{3i} + \theta\phi_2(z_i^h\tau_i)$$

$$s_3 = \varphi_3(z_i^h\tau_i)\begin{bmatrix}\alpha_3 + \gamma_{31}\,log\,p_1 + \gamma_{32}\,log\,p_2 + \gamma_{33}\,log\,p_3 + \gamma_{34}\,log\,p_4 + \gamma_{35}\,log\,p_5 + \gamma_{36}\,log\,p_6 + \gamma_{37}\,log\,p_7 + \gamma_{38}\,log\,p_8 \\ +\beta_3\left[\frac{m}{f(p)}\right] + \frac{\lambda_3}{g(p)}\left\{log\left[\frac{m}{f(p)}\right]\right\}^2\end{bmatrix} + \mu_{31}z_{1_i} + \mu_{32}z_{2i} + \mu_{313}z_{3i} + \theta\phi_3(z_i^h\tau_i)$$

$$s_4 = \varphi_4(z_i^h\tau_i)\begin{bmatrix}\alpha_4 + \gamma_{41}\,log\,p_1 + \gamma_{42}\,log\,p_2 + \gamma_{43}\,log\,p_3 + \gamma_{44}\,log\,p_4 + \gamma_{45}\,log\,p_5 + \gamma_{46}\,log\,p_6 + \gamma_{47}\,log\,p_7 + \gamma_{48}\,log\,p_8 \\ +\beta_4\left[\frac{m}{f(p)}\right] + \frac{\lambda_4}{g(p)}\left\{log\left[\frac{m}{f(p)}\right]\right\}^2\end{bmatrix} + \mu_{41}z_{1_i} + \mu_{42}z_{2i} + \mu_{43}z_{3i} + \theta\phi_1(z_i^h\tau_i)$$

$$s_5 = \varphi_5(z_i^h\tau_i)\begin{bmatrix}\alpha_5 + \gamma_{51}\,log\,p_1 + \gamma_{52}\,log\,p_2 + \gamma_{53}\,log\,p_3 + \gamma_{54}\,log\,p_4 + \gamma_{55}\,log\,p_5 + \gamma_{56}\,log\,p_6 + \gamma_{57}\,log\,p_7 + \gamma_{58}\,log\,p_8 \\ +\beta_5\left[\frac{m}{f(p)}\right] + \frac{\lambda_5}{g(p)}\left\{log\left[\frac{m}{f(p)}\right]\right\}^2\end{bmatrix} + \mu_{51}z_{1_i} + \mu_{52}z_{2i} + \mu_{53}z_{3i} + \theta\phi_5(z_i^h\tau_i)$$

$$s_6 =$$

$$\varphi_6(z_i^h\tau_i)\begin{bmatrix}\alpha_6 + \gamma_{61}\, log\, p_1 + \gamma_{62}\, log\, p_2 + \gamma_{63}\, log\, p_3 + \gamma_{64}\, log\, p_4 + \gamma_{65}\, log\, p_5 + \gamma_{66}\, log\, p_6 + \gamma_{67}\, log\, p_7 + \gamma_{68}\, log\, p_8 \\ +\beta_6\left[\frac{m}{f(p)}\right] + \frac{\lambda_6}{g(p)}\left\{log\left[\frac{m}{f(p)}\right]\right\}^2\end{bmatrix} +$$

$$\mu_{61}z_{1_i} + \mu_{62}z_{2i} + \mu_{63}z_{3i} + \theta\phi_6(z_i^h\tau_i)$$

$$s_7 =$$

$$\varphi_7(z_i^h\tau_i)\begin{bmatrix}\alpha_7 + \gamma_{71}\, log\, p_1 + \gamma_{72}\, log\, p_2 + \gamma_{73}\, log\, p_3 + \gamma_{74}\, log\, p_4 + \gamma_{75}\, log\, p_5 + \gamma_{76}\, log\, p_6 + \gamma_{77}\, log\, p_7 + \gamma_{78}\, log\, p_8 \\ +\beta_7\left[\frac{m}{f(p)}\right] + \frac{\lambda}{g(p)}\left\{log\left[\frac{m}{f(p)}\right]\right\}^2\end{bmatrix} +$$

$$\mu_{71}z_{1_i} + \mu_{72}z_{2i} + \mu_{73}z_{3i} + \theta\phi_7(z_i^h\tau_i)$$

$$s_8 =$$

$$\varphi_8(z_i^h\tau_i)\begin{bmatrix}\alpha_8 + \gamma_{81}\, log\, p_1 + \gamma_{82}\, log\, p_2 + \gamma_{83}\, log\, p_3 + \gamma_{84}\, log\, p_4 + \gamma_{85}\, log\, p_5 + \gamma_{86}\, log\, p_6 + \gamma_{87}\, log\, p_7 + \gamma_{88}\, log\, p_8 \\ +\beta_8\left[\frac{m}{f(p)}\right] + \frac{\lambda_8}{g(p)}\left\{log\left[\frac{m}{f(p)}\right]\right\}^2\end{bmatrix} +$$

$$\mu_{81}z_{1_i} + \mu_{82}z_{2i} + \mu_{83}z_{3i} + \theta\phi_8(z_i^h\tau_i)$$

The results of QAIDS model represented in Table A.

Table A. Estimated parameters for the QAIDS model.

	α_i	γ_{1j}	γ_{2j}	γ_{3j}	γ_{4j}	γ_{5j}	γ_{6j}	γ_{7j}	γ_{8j}	β_i	λ_i
Cereals	0.312 (0.072*	0.142 (0.00)	-0.053 (0.00)	-0.014 (0.00)	0.001 (0.00)	0.004 (0.00)	-0.079 (0.00)	-0.021 (0.00)	0.021 (-0.02)	0.095 (0.03)	-0.009 (0.00)
Meats	-0.121 (0.06)		0.089 (0.00)	0.002 (0.00)	-0.001 (0.00)	-0.001 (0.00)	-0.038 (0.00)	-0.003 (0.00)	0.005 (-0.02)	0.131 (0.03)	-0.021 (0.00)
Dairy	0.730 (0.04)			-0.021 (0.00)	0.019 (0.00)	-0.021 (0.00)	0.028 (0.00)	0.017 (0.00)	-0.011 (-0.02)	-0.171 (0.02)	0.016 (0.00)
Oil cooking	-0.055 (0.03)				-0.033 (0.00)	6×10^{-4} (0.00)	0.001 (0.00)	-0.001 (0.00)	0.014 (-0.01)	0.099 (0.01)	-0.012 (0.00)
Fruits	0.475 (0.04)					0.021 (0.00)	-0.017 (0.00)	0.013 (0.00)	0.002 (-0.01)	-0.142 (0.02)	0.021 (0.00)
Vegetables	0.108 (0.04)						0.109 (0.00)	0.005 (0.00)	-0.010 (-0.02)	0.086 (0.02)	-0.007 (0.00)
Sugar	0.202 (0.02)							1×10^{-4} (0.00)	-0.01 (-0.01)	-0.056 (0.01)	0.008 (0.00)
Tea and coffee	-0.651 (0.13)								-0.011 (0.15)	-0.042 (-0.15)	0.003 (0.00)

*The numbers in parenthesis are standard deviation.
Source: Authors' calculations from Eviews 9.