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Effects of Climate Change on Food Expenditures of Rural Households in Iran

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Abstract

This study examined the effects of climate change on food expenditure in rural household of Iran. Food expenditure is investigated as a function of average income of rural households, retail food price index and food expenditure for rural households, agricultural sown area and climate change. Here, the Stata11 software is used and data are from 26 provinces of the country for 10 years. Precipitation, temperature and relative humidity are considered as indicators for climate variables. The results indicated a positive and significant effect of average income of rural households, retail food prices, food expenditure of rural households with a lag and precipitation on the food expenditure of rural households. Agricultural sown area and relative humidity had no effect on the food expenditure of rural households and temperature had a significant and negative effect on the food expenditure of rural households. In the end, due to the impact that each of these variables explicitly have on food expenditure of rural households and implicitly on food security of rural households, suggestions for maintaining and improving food security of rural households is presented.

Keywords:
Food expenditure, Precipitation, Temperature, Rural household, Panel data

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INTRODUCTION

Today climate change is important issue in communities that impact on various aspects of life. One important aspect that directly affected by this change, is agriculture and food production. Since agriculture is done in rural areas and it is the main source of income there, any change in climate that affect agricultural production, will effect on rural income and food expenditure directly too. So pay attention to the issue of climate change and its impact on various aspects of agriculture, rural areas and rural income is important. To this end, in this study we have tried using data from the past 10 years, Investigate the impact of climate change on rural household food expenditure. In the past two decades, climate change has been considered as a major concern in the world. Economists believe that about 70% of economy is vulnerable against unpredictable climate patterns. Growing concerns about devastating consequences of this phenomenon caused many community organizations try to provide strategies for coping and adjustment of losses that trend. Changes in climate patterns can lead to flooding and drought that both of these phenomena can destroy food supply of the region. Scientists predict increasing temperature and unsustainable Precipitation can reduction agricultural productivity in many vulnerable areas. In developing countries, this cause many of people do not have ability to produce or purchase sufficient food. In areas where livelihood dependent on farming and animal husbandry, droughts, floods and lack of agricultural products undermine the survival and nutrition of children and mothers. Climate change will affect the suitable land for agriculture (Nellemann, 2009). Many studies have shown that one of the important aspects that can be affected by climate change is food security. In the following the impact of climate change on the four components of food security (availability, accessibility, utilization and stability) and food prices are considered.

Climate change influence on agriculture and food production in complex ways. Climate Change by changing in agricultural ecology, directly influence on food production and indirectly influence on growth and income distribution (Schmidhuber and Tubiello, 2007). Fluctuations in manufacturing yields and production risks could cause instability supply of products and reduce food security. Climate change impacts on water and food borne disease and then can affect the effective use of food. The main concern about relationship between climate change and food security is more issue of the vicious cycle of infectious diseases and hunger, which ultimately leads to vulnerable and sick people, labor with low productivity, increase in poverty and even death. Growing evidence shows that climate change such as drought, high temperatures or heavy precipitation causes incidence diseases and reduces food safety and food security (Vasilev *et al*., 2003). Intense precipitation can increases the risk of diseases prevalence due to polluted water, especially in areas with traditional water management systems (Shah *et al*., 2008). FAO long-term prospects for the 2050 shows the importance of improving conditions of demand will be even more over the next 50 years (FAO, 2006). There are studies that have been measured the effects of climate change on food prices. The results of these studies show that with increase average temperature, food prices have increased too, but overall effect of climate change on food prices is much lower than effect of economic and social changes on them (Rosenzweig *et al*., 2002).

On the other hand, the Food and Agriculture Organization (FAO) defines food security as a "situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2002). In this definition four important components of food security is shown. These components include: availability, accessibility, utilization and stability. Food availability addresses the "supply side" of food security and is determined by the level of food production, stock levels and net trade. Economic and physical ACCESS to food means an adequate supply of food at the national or international level does not in itself guarantee household level food security. Concerns about

insufficient food access have resulted in a greater policy focus on incomes, expenditure, markets and prices in achieving food security objectives. Utilization is commonly understood as the way the body makes the most of various nutrients in the food. Sufficient energy and nutrient intake by individuals is the result of good care and feeding practices, food preparation, and diversity of the diet and intra-household distribution of food. Combined with good biological utilization of food consumed, this determines the nutritional status of individuals. Stability of the other three dimensions over time that means Even if your food intake is adequate today, you are still considered to be food insecure if you have inadequate access to food on a periodic basis, risking a deterioration of your nutritional status. Adverse weather conditions, political instability, or economic factors (unemployment, rising food prices) may have an impact on your food security status (Shah *et al*., 2008).

with regard to the above, in summary it can be said climate change effect on agriculture and food production (physical accessibility of food) and food prices and incomes of farmers and rural households (economic access to food) and household food usage (utilization), that all of them are important factor of food security. Therefore there are close relationship between climate change, food expenditure and food security (in all of dimension).

Despite the importance of this issue and numerous studies that have been conducted in other countries, in relation to climate change and its impact on food security and income of rural households, these studies are very few in our country.

Hashemi *et al*., (2013) study the impact of climate change on water quality and sea products. Their study shows climate change will increase the chemical and biological pollution that is a serious threat for health and food security. Gambarali *et al.* (2012) surveyed the view of farmers about climate change. Findings show many of farmers believe that temperature has increased and precipitation has decreased and the majority of respondents have changed agricultural management operations in response to changes in climate conditions. Nikuee and Zibaee (2012) examined the impact of water resource management on food security in the basin of Zayanderood using hydrological economic planning model. The result shows the use of such program will improve the efficiency of water use in the basin and by increasing the share of downstream areas of food production in condition of reduced water supply, will improve food security. There are many foreign studies about effects of climate change on food security. Tubiello and Fischer (2007) shows effect of climate change on food prices is much smaller than the effect of economic and social changes on prices. Study of climate change on crop yields, water productivity and food security by Kang *et al.* (2009) showed that the impact of climate change on these variables is various in different areas. Wang (2010) study the impact of climate change and variables such as agricultural sown area, income of rural household and consumer food price index on rural food security in China using dynamic panel data. The result shows climate change has significant impact on food security of rural household. Arndt (2011) examined the impact of climate change on agriculture and food security in Tanzania, using dynamic economic model. Results suggest that the impact of climate change on food security is significant. Seaman *et al.* (2014) studied the vulnerable households in relation to climate change and capacity building in developing countries to manage climate change assessment, using Household Economy Approach (HEA). This approach mainly is applied by the government to assess the vulnerability of households against poverty and food security. Nhemachena (2014) by using cross-sectional data from 700 households of farmers investigated Economic impacts of climate change on agriculture in Zimbabwe. He applied the Ricardian approach to analysis impact of climate change on net income of agriculture. Result showed increase in temperature has a negative effect on net income of farmers, while increase in precipitation has positive effect. Results of the sensitivity analysis showed Zimbabwe's agricultural production is significantly affected by climate factors (such as precipitation and temperature).

Because Iran located in desert belt, climate change is greater than global average (Amiri and Eslamian, 2010). Since these changes will have important effects on different dimension of the country, these dimensions should be identified in order to planning for them. One of these dimensions that in this study will be discussed is food expenditure and implicitly food security in rural household. Methods are described in the next section and the final section includes a discussion of conclusions and suggestions in this regard.

MATERIALS AND METHODS

Data were for 26 provinces of Iran, during 2001 until 2010. Khorasan, Tehran and Alborz provinces not included because their data were not available for several years. The panel data has obvious advantages over cross-sectional data or time series dataset: (i) we have more observations which should yield more precise estimates; (ii) it allows us to control for cross-section effects; (iii) it extends easily to a dynamic model and allow us to address potential endogeneity problems of the explanatory variables. The discussion of Dynamic Panel Data (DPD) was opened by Balestra and Nerlove (1966); they proposed to estimate the model with unobserved component using the Generalized Least Squares (GLS) estimator. However, GLS or ML-Random affects (RE) estimators leads to inconsistent if the unobserved individual effects are correlated with the exogenous variables. Our proposal is to employ Difference GMM methodology (Arellano and Bond, 1991) and System GMM methodology proposed by Arellano and Bover (1995) and Blundell and Bond (1998) to deal with the problems. This paper applies the dynamic model to estimate the relationship among the food security, food prices and climate change. Consider the following dynamic panel data model (wang, 2010):

$$Ln\, y_{it} = \delta\, ln\, y_{it-1} + X'_{it}\beta + \alpha_I + \varepsilon_{it} \quad \varepsilon_{it} \rightarrow N(0, \sigma^2) \quad (1)$$

where lny is log forms of the rural per capita food consumption, X is a set of the explanatory variables including the rural per capita food consumption, food retail price index, income of rural residents, agricultural disaster area, sown area. α is a fixed effect, ε is a random disturbance, β is estimated coefficients.

According to studies conducted by Aghajani (2012), Carvalho (2006), Nellemann (2009), Ludi (2009), Schmidhuber and Tubiello (2007), and Timmer (2010), variable precipitation, average temperature and relative humidity are used as indicators of climate. Data are from Central Bank of the Islamic Republic of Iran, Meteorological Institution, Ministry of Jihad- e-Agriculture of Iran and Statistical Center of Iran. In this study to estimate the model coefficients StataSE11 software is used.

The first step is to check stationary variables. To check stationary of panel data in stata11 various tests like Levin-Lin-Chu, Harris-Tzavalis, Breitung, Breitung and Das and Fisher-type can be used (Breitung and Das, 2005). Here we used Levin-Lin-Chu Stationary test and the variables were static. In this model, because variables are static not required to estimate the Cointegration test. The next step involves choosing between pool and fixed effects by F- Limer test. If the test statistic is significant fixed effects will be confirmed. After confirming fixed effects, LM test or Lagrange multipliers test is used to select between random effects and pool. In the last stage we used the Hausman test to select between fixed and random effects. The results are summarized in table 1 in below.

Table 1: Estimation results of model

Test	Purpose of test	Statistic	Prob	Result
F- Limer test	Select between pool and fixed effect	18.04	0.000	H_0 significant Fixed effect confirmed
Lagrange coefficient test	Select between pool and random effect	316.08	0.000	H_0 significant Random effect confirmed
Hausman's Test	Select between random and fixed effect	21.55	0.000	H_0 significant Fixed effect confirmed

RESULTS

The data used in the estimation of the reference model are drawn from Statistical Center of Iran, Central Bank of the Islamic Republic of Iran, Meteorological Agency and Ministry of jihad-e-Agriculture of Iran. The data set are yearly and cover the period from 2001 to 2011, for 26 provinces. Average of data is calculated for these variables (Table 2).

According to Table 2 average temperature in the selected provinces is nearly 16 centigrade. Hormozgan province has the highest average temperature and Kohgiluyeh and Buyer-Ahmad has the lowest average temperature in the selected provinces. The average relative humidity in selected provinces is 50 percent. Guilan Province with 81% has the maximum value and Sistan with 28 percent has minimum relative humidity in selected provinces of the country. Average agricultural sown area in country is approximately 422,546 hectares. Qom and Khuzestan provinces with 991,287 and 56,092 hectares respectively have maximum and minimum agricultural sown area. Annual average precipitation is 369 mm. The highest and lowest values is 1476 and 46 mm, respectively in Guilan and Yazd provinces. Average price index of country is 241, max of it, is 251 in Mazandaran and the min is 228 in Hormozgan. Ten-year average annual income of rural households in selected provinces in Iran is 56478274 IRR Rural households in Mazandaran with 73332638 IRR has the highest value (that is above the average) and minimum annual income of rural households is in Kerman province that is 37410475 IRR (this amount is significantly less than average income of rural households in 26 provinces). Average food expenditure of rural households in selected provinces is 22710711 IRR. Kohgiluyeh and Buyer-Ahmad have the maximum expenditure for food and Qom rural households have the lowest food expenditure.

Results of the model are given in Table 3. The average income for rural households, retail food price index, food expenditure with one lag of rural household and precipitation have significant and positive impact on food expenditure of rural household. While agricultural sown area and relative humidity have positive but meaningless impact on food expenditure of rural household and temperature has negative and significant effect.

According to the tests, using dynamic panel fixed effect in this study has led to better outcomes. An overview of the results shows that:

Income of rural households have a significant positive effect on food expenditures in rural households i.e. when income increases, household's spending for food increases too. Since agriculture is the main source of income in rural any factors that effect on agricultural production, directly effect on household food expenditures and food security. One of the most important factors affecting agricultural production is climate change.

The sharp increase in rainfall and flooding, reduced rainfall and water scarcity problems And unusual increasing or decreasing in temperature are changes that reduce agricultural production and rural income severely. The other hand reducing rural income that means reduced economic access to food, which is one component of food security, will have a negative impact on food security in rural household. Agricultural products insurance is one of the most effective ways to reduce risks in agricultural production and counter the negative effects of these changes on rural income, of course if the amount of damages properly estimated and at the appropriate time given to farmers. Retail food price index has a significant positive effect on rural household food expenditure.

This effect implies that with increase in the retail price index for food, household food expenditure increases too. Increased costs does not necessarily due to increased food consumption and food security But also may be due to factors such as rising food prices, without any change in physical quantities of food and only their economic weight in the household budget increase, in other words the same amount of food with higher costs must be provided. It represents the component of economic access to food security. This may lead to disproportionate increase in food prices on the one hand and increased incomes on the other hand. Farmer in the village, not in terms of climate and not economically or

Table 2: Descriptive statistics of variables

	Per capita food expenditure in rural household (IRR)	Per capita income of rural household (IRR)	Food retail price index	Agricultural sown area (Ha)	Annual precipitation (mm)	Relative Humidity (%)	Temperature (C^0)
Fars					284	45	18
Khuzestan	24976665	66493802	241	991287*	214	40	24
Kermanshah	2067901	56269348	246	769513	345	44	15
Azerbaijan, East	1995450	49579758	241	740630	256	52	13
Lorestan	21041233	54758264	243	655637	267	42	17
Golestan	20941607	58092995	236	674482	545	75	18
Azerbaijan, West	19561541	62331966	239	671764	282	64	11
Kurdistan	20342173	60926969	237	703249	370	47	14
Hamadan	23298009	39413218	244	643130	351	54	11
Ardabil	24818655	69065732	249	593852	302	77	10
Zanjan	19749693	52689959	237	494390	319	62	11
Markazi	23060163	42047337	240	360703	302	48	14
Isfahan	23856708	59501248	248	313435	156	37	17
Mazandaran	22553609	73332638*	251*	403578	851	80	18
Kerman	22330770	37410475*	240	316099	106	33	17
Qazvin	24609132	72684763	238	287622	325	55	14
Bushehr	23524428	66774248	239	196256	290	67	25
Ilam	29268830	57337398	251	207719	566	43	16
Guilan	21878680	50744985	239	228543	1476*	81*	17
Kohgiluyeh and Boyer - Ahmad	30315589*	57056195	243	179901	842	45	14
Sistan and Baluchestan	22850746	39761686	235	157974	82	28*	11
Chahar Mahaal and Bakhtiari	28121051	54414602	241	142539	388	47	10*
Semnan	20598240	49602806	251	103973	158	43	18
Hormozgan	18353271	46470680	228*	74459	113	61	27*
Yazd	23535093	65139365	242	58190	47*	28	20
Qom	17165811*	58372004	245	56092*	158	42	19
Max	30315589	73332638	252	991287	1476	81	27
Min	17165811	37410475	228	56092	47	28	10
Average	22710711	56478274	241	422546	369	50	16

Source: coulomb 1,2,3: Iran Compendium of Statistics,4 derived from agricultural institution,5,6,7: derived from aerology

physically - is able to production all the food its requirements, thus had to prepare some of her needs from the market and out of the farm, this disproportion between food prices and income can be causing reducing economic access and food security in rural households.

As expected rainfall has significant and positive effect on food expenditure of rural households. Precipitation is one of the most important factors that influence on supply of agricultural products, particularly in crops such as wheat that Because of its high nutrient play important role in food security of society, this have confirmed in study of Shahnoushi *et al.* (2004). In recent decades, significant changes in the Earth's climate have occurred such as a gradual increase in average global temperature that there are between different regions and between land and sea in terms of average temperature. Sudden rise in global temperatures began less than one decade ago and its sign was increasing number of very hot days and decreasing in cold days (Singh *et al*., 2001). As is observed in Table 2 temperature has significant and negative effect on food security. Increase and continued of temperature and the number of hot days cause to drought, famine, epidemic and contagious diseases, loss of water resources, exacerbating conflicts and battles over water supplies, food and nutrition security is the challenge.

Table 3: Result of estimation

Variables	Constant	Climate change index			Income of	Food retail	Agricul-tural	Expendi-ture for food with
	Coefficient	Precip-itation	Relative humidity	Tempera-ture	rural residents (IRR)	price index	sown area	one lag rural house-holds
Fixed effect Model	-2.49e	1.07	0.1	-4.88	9.31	2.39	-1.76	6.85
p_ value	0.001	0.002	0.922	0	0	0.018	0.079	0

Thus reducing rainfall and increasing temperatures reducing supply of agricultural production and then availability of food, that is one of the components of food security, on the other hand, in rural areas where agriculture is the main source of income physical and economic access to food makes difficult, that is another components of food security. Due to the effects of rainfall and temperature on two important components of food security (availability and access) long-term planning at macro level to reduce air pollution (that are causing rise temperature), as well as management rainfalls and collect them to use it in the appropriate seasons and can improve food security.

Not only the temperature increases, but sudden decrease in temperature can have a negative impact on agricultural production. Sudden decrease in temperature during the flowering trees, destroy crops of farmers, if there be no insurance and support for them, it directly affects food consumption and expenditures through reducing inventory and food availability, and food security reduces. Another important variable that has impact on household food expenditures is prior period food expenditure, that has positive and significant impact on food security and reflects that the consumption pattern of rural households is almost constant.

In summary we can say that all of these variables (reduced rainfall, increased temperature, increased the food retail price index, consumption periods before and declining incomes of rural households) reduces allocated food expenditure of rural households and on the other hand by decreasing food security components (availability, access, utilization and stability) will reduce food security too. As is observed with respect to the impact of climate on almost all aspects of rural life, such as income and consumption, there is close relationship between climate change and food security at the village level. due to uncontrollable factors of climate and atmospheric conditions, these changes perhaps not be preventable but with indirect and managerial measures such as insurance of crops against these adverse weather conditions, with compensation for the loss incurred by farmers and villagers, or by creating and modifying infrastructure such as floodgate properly to prevent damage during floods or compensation for damages to farmers, consequently preventing the reduction of existing components, access and stability of food security in rural households.

In summary, all of these variables (decrease in precipitation, rising temperatures, increasing the retail price index of food consumption and income of rural households) on one hand reducing the cost allocated to rural household food and on the other hand by reducing the components of food security (availability, access, utilization and stability) will reduce food security. Perhaps because of uncontrollable climate factors conditions, this changes not be preventable but they can be managed with indirect and managerial measures like: strengthening agricultural insurance, create and modification infrastructure, due to the impact of climate on various aspects of rural life, including their income and consumption, there are close relationship between climate change and food security at the village level Since the issue of food security has always been considered and is the important

goal in country to achieve this, focus and attention to climate change and its impact, particularly in rural areas is important.

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