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The Impact of Flood Damages on Production of Iran's Agricultural Sector

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Abstract: According to statistics provided by the UN, among natural disasters, floods and storms have the biggest losses and destructive damages in today's society. In just a decade, the amount of damages from flood and storm was over 1705 thousand dollars versus 1462 thousand dollars of damage caused by earthquake. This paper investigates the damages caused by flood on agricultural production by using Vector Auto regressive (VAR) model. The results suggest that damages caused by flood have significant and negative impact on agricultural production. The results of Impulse response functions in agricultural production show that the shock from the damages of flood has a negative influence on agriculture sector in the short time and the most influence of the shock will occur in the medium term. This trend will decrease gradually in the long term. Analysis of variance decomposition sin the agricultural sector indicates that the most volatility shocks can be explained from the damage.

JEL: E23 · Q54 · c13 · Q10
Key words: Flood · Vector Auto Regression model (VAR) · Agricultural Sector

INTRODUCTION

According to the statistics obtained by United Nations Organization, among natural disasters, floods and storms have caused the most damages in human communities. The level of damages arising from flood and storm only during a decade has been up to 1705 thousand dollars against 1462 thousand dollars for damages arising from earthquake. This affair is true in regards to our country too. During past years 70% of annual credits of plan of decreasing the effects of natural disasters and the staff of unexpected events (the staff of crisis) have been spent for compensating the damages of flood. (please rewrite this sentence). Meanwhile it is necessary to be mentioned that due to the improvement of construction methods and observing the regulations and rules, the security of structures and installations increases against dangers such as earthquake, but unfortunately the natural trend of development in some countries such as Iran has caused the damage of environment and natural resources and the damages of flood is in progress. The growth level of 250% in damages of flood in the country during past decade shows the confirmation of this claim. The damages of flood include tangible and intangible losses. Tangible losses are classified in direct and indirect losses. Direct tangible losses can include the followings: human damages and losses, flooded houses and residential and industrial places, flooded farms and losing of agriculture productions and animal damages, damages of infrastructure installations such as roads and bridges and power transmission lines and networks of water and gas. In order to estimate the damages arising from a flood it is necessary to determine a little wastage after separating damage in any sector [1]. Investigated natural disasters during the period 1991-2000 and indicated that in total 4122 million dollars losses have been created in agricultures sector (89% of total losses), 157 million dollars in residential sector and 332 million dollars in infrastructure sector [2]. Studied the influence of natural disasters on macroeconomic variables. He believes that a clear decrease occurs in agricultural production after natural crisis such as storm, flood and drought. On the basis of the studies of [3], Dominican storm has caused damages to all productions of banana in 1979 and 75% of the forests of the country and has decreased domestic gross production about 17% [4].

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Table 1: Damages caused by flood in Iran

Year	Flood damages (dollar)
1981-1991	7148660
1991-2001	63688058
2001-2009	2908650

Source: official websites.

Found that natural disasters in developing countries have deeper influences than developed countries but some kinds of natural disasters occurring with moderate severity have even had useful influences and cause economic growth such as flood that had positive influence on economic growth. In this article it I tried to investigate the influences of flood on the production of agricultural sector. So the losses of flood in agricultural sector are estimated with affirmation of agricultural production from the kind of Cobb-Douglas using the method of Vector Auto Regression (VAR) and making steady-state clear.

The following table is the value of damages caused by flood in Iran in last three decades:

Methodology: The Vector Auto Regression method (VAR) is one of the options of Box Jenkins theory which is similar to simultaneous equations [5]. This model was seriously criticized by Christopher Sims and the option of VAR offered by him. He believes that a theory cannot provide necessary limitations for determining structural models [6]. There are some endogenous variables in VAR and each one is explained by its past amounts and the lags amounts from all other endogenous variables of the model. Two time series x_t and y_t for two variables are as follows [7]:

$$X_t = a_0 + \sum_{j=1}^{k} B_j X_{t-j} + \sum_{i=1}^{n} \delta_j Y_{t-i} + u_{1t} \quad (6)$$

$$Y_t = a_0 + \sum_{j=1}^{k} A_j X_{t-j} + \sum_{i=1}^{n} \lambda_j Y_{t-i} + u_{2t} \quad (7)$$

The model VAR is estimated from OLS. The answers of this model depend on entered variables and the lag length. In relation to statically of investigated variables the existence of non-static variables intensifies the probability of creating spurious regression and the relations of cointegration. So it is necessary to test the existence of accumulated vector or vectors in VAR included non-static series. In order to evaluate the model using the method of VAR, it is necessary first to investigate the stationary of variables:

- If the variables are in the level of static then pattern becomes clear after investigating the stationary of variables. 2- If the variables are static in first order difference then first the pattern VAR becomes clear as mentioned before and then the convergence of them will be investigated. Here the cointegration test of Johansen has been used [8].

VAR of formula 8 is written with m variables as formula 9:

$$Y_t = \delta + A_1 Y_{t-i} + ... + A_k Y_{t-k} + v_t = \delta + \sum_{j=1}^{k} A_j Y_{t-j} + v_t \quad (8)$$

$$Y_t = \sum_{j=1}^{k} A_j Y_{t-j} + v_t \quad (9)$$

For making the formulation simple, intercept is eliminated. Also it is hypothesized that all variables of it have cointergration order 1 or 0. The pattern above is written as below:

$$\Delta Y_t = BY_{t-1} + \sum_{j=1}^{k-1} B_j Y_{t-j} + v_t \quad (10)$$

in which:

$$B = -(I - A_1 - A_2 - ... - A_k) \quad (11)$$

$$B_j = -(A_{j+1} - A_{j+2} - ... - A_{j+k}) \quad (12)$$

The equation of 12 is similar to the pattern of error correction and if the whole variables of it have cointergration order 1 the variables Δy_{t-j} will be static. Now with this hypothesis that there is cointegration between variables and B y_{t-j} is static it is possible to estimate the pattern consistently.

In this article in order to investigate the effects of flood on agriculture sector a function of total agricultural production has been used as follows:

$$y_t = (K_t)^a (A_t L_t)^{1-i} \qquad 0<a<1 \quad (13)$$

y: total production of agriculture sector, K: capital level in agriculture sector, A: the index of technical progress and AL: effective labor in agriculture sector, t is time, α is the elasticity of production in relation with capital and 1-α is the elasticity ofproduction in relation with effective labor. With dividing two sides of above function by effective labor, per capita production function is computed as follows:

$$y_t = k_t^a \quad (14)$$

So that y_t is per capita productionand $k_t = \frac{K_t}{A_t L_t}$ is the capital in relation with effective labor. With hypothesis that in the framework of adaptive expectations (the optimal per capita production) is as formula 15:

$$\frac{y_t}{y_{t-1}} = \left(\frac{y_t^*}{y_{t-1}}\right)^\beta \quad (15)$$

It is possible to transform it to the logarithmic form as formula 16:

$$Iny_t - lny_{t-1} = \beta(Ln\, y_t^* - Lny_{t-1}) \quad (16)$$

By substituting formula 14 by formula 16 we will have:

$$Iny_t - lny_{t-1} = \beta[aLn\, k_t^* - Lny_{t-1}] \quad (17)$$

Also parity to S=I, S=sy and I= dk/dt we can write:

$$s\,y_t = \frac{sY_t}{A_t L_t} = \frac{S_t}{A_t L_t} = \frac{I_t}{A_t L_t} = i_t \quad (18)$$

i_t is the same per capita investment in terms of effective labor. The growth rate of per capita investment in terms of effective labor (k) is as follows mathematically:

$$K = sy_t - \delta_t k_t \quad (19)$$

In steady-state the capital relation to effective labor in its steady-state is k*. In this situation real investment is equal to substituted investment. The growth rate of per capita investment of effective labor is zero. It means K=0 so:

$$sy_t = \delta_t k_t \quad (20)$$

With taking logarithm from both sides we have:

$$\ln(sy_t) = \text{In}\delta_t + \text{Ink}_t^* \quad (21)$$

Using the relations 18 and 19 we have:

$$lnk^*_t = lni_t - ln\delta_t \quad (22)$$

With inserting the relation 22 in 17 we will have:

$$\text{lny}_t - \text{lny}_{t-1} = \beta[\alpha(\text{Ln } i_t - ln\delta_t) - Lny_{t-1}] \quad (23)$$

With simplifying we have:

$$\text{lny}_t = (1 - \beta)\, \text{lny}_{t-1} + \alpha\beta \text{Lni}_t - \alpha\beta \ln\delta_t \quad (24)$$

y_t is per capita production, i_t is per capita investment and δ_t is amortization. Since natural damages (DMG) lead to decreasing the value of agriculture assets, in equation 25 the substituted variable of per capita damages (dmg) is used instead of amortization in the framework of final model below for indicating the influence of flood damage on agriculture sector:

$$\text{lny}_t = \beta_0 + \beta_1 \text{lny}_{t-1} + \beta_2 \text{Ln(inv)}_t + \beta_3 (\text{dmg})_t + \varepsilon_t \quad (25)$$

In the final model above, ***y*** is the value of per capita production in agriculture sector, ***inv*** is per capita investment value in this sector and ***dmg*** is per capita damages of flood and the effect of other variables has been summarized in intercept.

The quantity value of production and investment in agriculture sector has been taken from the national accounts of central bank and for evaluating the employment in agriculture sector the average percent employment in this sector (close to 23%) and total active population of the country (taken from the national accounts of central bank) have been used and the per capita variables have been computed. The data related to flood damages also has been collected from insurance fund of agriculture products. In this article the data of time series 1971-2009 has been used annually.

RESULTS AND DISCUSSION

In order to evaluate the model, first we investigated the stationary of pattern variables using augmented Dickey-Fuller test and the results have been indicated in Table 2. All related variables are static in first order differencing.

As mentioned earlier, in order to evaluate the pattern using VAR it is necessary first to investigate the stationary. Investigation of considered variables indicated that all variables are in static first order differencing.

Table 2: The results of stationary of the variables

Critical value at 1st difference	Observed value at 1st difference	Critical value at level	Observed value at level	state	Variable
-3.699*		3.689*-			
-2.976**		-2.971**			
-2.627**	-5.620*	-2.625**	-1.748	Static at intercept	Log y
-3.699		3.689-			
-2.976		-2.971			
-2.627	-7.868*	-2.625	-1.524	Static at intercept	Log inv
-3.699		3.689-			
-2.976		-2.971			
-2.627	-4.292*	-2.625	-2.525	Static at intercept	Log dmg

, ** and * indicate critical numbers in the level 1%, 5% and 10%, respectively.*

Table 3: Determining optimum interval for model VAR

Schwarz Bayesian criteria	Lags
-0.446	(1,1) *
0.399	(1,2)
1.063	(1,3)

Source: findings of the research

Table 4: The trace results of Johansen's cointegration test

Probability at 95%	Critical value at 95%	Observed value	the alternative hypothesis	Null hypothesis
0.0000	29.797	55.345	$r \geq 1$	r=0*
0.0027	15.494	23.309	$r \geq 2$	$r \leq 1$
0.1296	3.841	2.297	$r \geq 3$	$r \leq 2$

Source: findings of research

Table 5: The Maximum Eigenvalue results of Johansen's cointegration test

Probability at 95%	Critical value at 95%	Observed value	the alternative hypothesis	Null hypothesis
0.0010	21.131	32.036	r=1	r=0*
0.0037	14.264	21.011	r=2	$r \leq 1$
0.1296	3.841	2.297	r=3	$r \leq 2$

Source: findings of research

Then in order to make the pattern clear the model optimum order has been determined using the criterion of Schwartz-Byssian. The results have been indicated in Table 3. The interval having the least amount of statistics data is optimum.

In which the optimal lag has been determined in (1,1). The convergence of variables was investigated after determining optimal lag using Johansen's cointegration test. It is provided by two statistical data titled two matrices which represent Trace and Maximum Eigen value Matrix. The null hypothesis says that there is no co-integration of vectors; it means that there is not any long run relationship between the variables and the alternative hypothesis says that there is co-integration of vectors. The level which the null hypothesis can be rejected at indicates the numbers of vectors that are co-integrated. Test results are presented below:

Table 6: the results of evaluation of the model with VAR

Variable	Coefficient	Standard error
Log y(-1)	0.799	0.123
Log inv	0.332	0.085
Log dmg	-0.092	0.013

As can be seen in table 4 and 5, the null hypothesis has been rejected at the level and vectors have proved the existence of cointergration and long term balance relations. The results of long term relation between variables in the framework of table 6 and normalized vector in proportion with the first endogenous variable are as follows:

On the basis of results obtained, the variable of investment in agriculture sector and agriculture production with lag has positive and significant relation with agriculture production. Also the variable of damage of flood has negative but significant relation with agriculture production.

Impulse Response Functions: This index indicates the response of one variable to the shock and indicates that how that shock is eliminated during the time. For computing, the shocks are entered with the size of one standard deviation from a considered variable and then we observe the obtained response during the time which will be done in 10 periods in future.

The evaluation of impulse response functions of agriculture production variables was done for the next 10 period, which will analyze the behaviors and reactions to the incoming shocks by the relevant variables in three periods of short term, midterm and long term. The results are as follows:

- Response function of agriculture production variable to shock from production of agriculture sector: the shock from the production of agriculture sector during the first period causes increasing of production to the level 0.041. This effect causes increasing of 0.018 in the fifth period. This descending trend continues until it reaches to 0.0099 in tenth period. In other words, the shocks and the fluctuations from the production of agriculture sector make production of agriculture sector in the short time to increase about 0.041. But in the medium and long term this trend decreases and come to 0.009 in long term.
- The response function of the production to shock from the investment of agriculture sector: the production response of agriculture sector to the incoming shock in the short time was at first in the level 0.0088 but it will increase gradually and reaches to 0.0205 in midterm. But this trend decreases again and reaches to 0.0156 in the long term. In other words, the shock from investment will make the production in the medium term increase.
- The response function of the variable of agriculture sector production to the shock from the damages of flood: production response to the shock in the short time has been at first at the level -0.1540 but it will increase gradually and will reach to 0.2838 in the medium term. But this trend will decrease again and will reach to 0.1992 in the long term. In other words, the shock from the damages of flood has negative impact on agriculture sector in the short time and causes the production to decrease. But the most impact of the shock will occur in the medium term and causes the production to grow. This trend will decrease gradually in the long term.

Table 7: The impulse response functions for the variable Of agriculture per capita production

Period	Log y	Log inv	Log dmg
1	0.0418	0.0088	-0.1540
2	0.0336	0.0113	0.0873
3	0.0270	0.0173	0.2135
4	0.0220	0.0199	0.2876
5	0.0182	0.0205	0.2838
6	0.0154	0.0201	0.2698
7	0.0134	0.0192	0.2518
8	0.0119	0.0180	0.2332
9	0.0108	0.0168	0.2154
10	0.0099	0.0156	0.1992

Source: findings of research

Table 8: Variance decomposition for the variable of agriculture per capita production

Period	Log ind	Log invid	Log open
1	2.494	0.0412	97.463
2	2.229	0.531	97.239
3	4.519	1.943	93.537
4	7.686	4.289	88.023
5	10.638	7.210	82.151
6	12.970	10.286	76.742
7	14.672	13.218	72.108
8	15.871	15.850	68.278
9	16.707	18.218	65.163
10	17.296	20.060	62.643

Source: Findings of research

Analysis of Variance Decomposition: In this section the results of analysis variance decomposition forecast for a period of 10 year can be interpreted. In this method, fluctuations of different variables can be divided into variables of the pattern and the relative importance of a variable can be seen in the behavior of other variables [5]. Thus, the contribution of each variable can be measured based on the changes in other variables over the time. The results are shown in Table 8:

With the help of variance decomposition, the contribution of each variable on changes of other variables was evaluated. The results indicate that the most contributions of fluctuations in the short time is related to flood damages with the amount 97.46% and then the production of agriculture sector with 2.49% and the investment of agriculture sector with the amount 0.04%. In the medium term about 82% of fluctuations of agriculture production are explained by shock from flood damage and about 7% are explained by the investment of agriculture sector and finally about 10% are explained by the variable of agriculture sector production. Also in the long term these figures will reach respectively to 63%, 20% and 17%.

Recommendations:

- The allocation of necessary credits for compensating the created damages and preventing against the occurrence of next floods regarding to this point that the returning period of the flood is every 25 year.
- With regard to the fact that unfortunately every year the natural disasters impose many financial and bodily losses on different sectors of economic and especially agriculture, the existence of agriculture products insurance is necessary for compensating these losses.

- The continuation of production and the trend of investment for the most of weak farmers are not possible without the existence of proper insurance system. At the same time the insurance fund of agriculture products has been founded for compensating the damages of flood, drought and the other natural disasters. For providing better services and developing this kind of insurance in the country the necessary participation of the government and insurance companies is felt seriously.

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