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Determinants of Agricultural Sector in Developing Countries: The Case of Iran

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ABSTRACT

This article estimates the major determinants of agricultural growth and productivity in Iran and investigates 'growth accounting' approach to identify the sources of agricultural growth. The theoretical framework is based on this assumption that the identified factors jointly cause total factor productivity growth. This study uses annual time series data (1970-2007) and unit root tests and analyze them using Auto Regressive Distributed Lag (ARDL) model by Pesaran et al.[1]. This co-integration technique accommodates potential structural breaks that could undermine the existence of a long-run relationship between agricultural growth and productivity and its main determinants.

Key words: Agricultural value added, unit root test, autoregressive distributed lag (ARDL).

INTRODUCTION

Agricultural information is no doubt central in enhancing accelerated agricultural productivity, facilitating poverty alleviation and rural urban-migration among rural youth. In recognition of the significance of information in technology transfer Ajayi and Nwoko [2] opined that the emergence of information economy as a global phenomenon that organized production, conscious utilization of information and effective and efficient deployment of information is increasingly becoming the basis for creativity, productivity, and profitability. Hence, access to factors of production (land, labor, capital & management) has probably ceased to be problems but rather ability to generate and intelligently use knowledge and information resources about these factors of production.

In Iran, agricultural sector is one of the sectors which its value added share in non oil value added was changed following changes in oil incomes such that during the first oil shock (1974-1977), the share of this sector has decreased to 12.6 percent from 19.2 percent in non oil GDP.

The export of traditional and agricultural products is as one of the main pillars in non oil export so that during 1961-1965 agricultural export has climbed continuously and during 1973-1978 domestic demand has increased strongly due to increasing oil incomes and the unprecedented growth and in this period agricultural export has negative grown and from 505.1 million dollars in 1973 reached to 367.9 million dollars in 1978 year[1].

The composition of the Iranian GDP after the revolution has changed significantly. The agricultural growth rates are presented in Fig.1. During the pre-revolution period (1960-1978), the agricultural sector had an average growth rate of approximately 4.4 percent per annum. During the ten years following the revolution, the agricultural sector grew by approximately 4.3 percent annually. This shows that although the Iranian economy as a whole was affected very negatively by the war, the agricultural sector was less seriously affected than other sectors of the economy. Following the cease fire, the agricultural sector had an annual growth rate of 6.4 percent over the length of the first Five-year Economic Development Plan (FYDP). During the second FYDP (1995-1999), however, a serious and dramatic reduction in the amount of rainfall caused the average growth rate in the agricultural sector to fall to 2.2 percent, far below its target of 4.3 percent growth and During the 3th FYDP (2000-2004), the agricultural sector had an annual growth rate of 4.4 percent (Central bank of Iran). The agricultural sector enjoyed an average annual growth rate of 4.3 percent during the whole period after the revolution, reaching a peak of 11 percent in 1990. The lowest rate of –7.3 percent have been occurred in 1999 due to a drought. Official data show that while in 1989 the export of industrial products stood at 11.7 percent of total non-oil exports, this share had increased to 32.1 percent by the end of 2th FYDP in 1999 and had increased to 27.6 percent by the end of 3th FYDP in 2004. In contrast, the share of agricultural products and traditional goods (such as carpets, pistachio nuts, caviar, and saffron) over total non-oil exports decreased very significantly from 68 percent in 1979 to around 22.7 percent in 2007 (EPCI1, 2001,2008; CBI, 2001b,2008b). The top ten non-oil export items in this year were: hand-woven carpets, chemical products, pistachios and other nuts, ironware and steel, other industrial commodities, textiles, copperware, animal hides, as well as benzene and its derivatives (ICCIM, 2000).

In most oil exporting developing countries[2], industrial sector developed during 1970s but agricultural sector weakened in these countries. In this same direction, one of the economists by introducing the effect of worldly price into classic model of Dutch disease has presented a pattern for the oil exporting developing countries and has predicted that after increase in oil incomes, these countries are undergone anti-agricultural phenomenon. In the Nigerian, agriculture has been an important economic sector in the past decades, and is still a major sector despite the oil boom; basically it provides employment opportunities for the teeming population, eradicates poverty and contributes to the growth of the economy.

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[1] These are Summary of balance sheets of central banks and economic reports in the years 1961 to 2006.

[2] These Countries are an intergovernmental organization of twelve developing countries made up of Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela.

But in Iran, following oil shocks[1], some changes were created in the structure of main sectors of economy (agriculture, industry and services) which some cases such as changes in the regulation of the fifth pre-revolution civil plan[2], changes in the production factors market and value added share of sectors in Gross Domestic Product (GDP) and change in total value of imports can be indicated. In this direction, agricultural sector influenced by each of these factors was undergone fundamental changes. In Iran, agricultural sector is one of the sectors which its value added share in non oil value added was changed following changes in oil incomes such that during the first oil shock (1974-1977), the share of this sector has decreased to 12.6 percent from 19.2 percent in non oil GDP. Also in oil shock during 1982-1984, the share of this sector has decreased to 18.9 percent from 21.6 percent and after that during 1985-1994 except of some years, it has had an ascending trend. The share of agricultural sector in the third oil shock (1994-1997) has decreased to 21.7 percent from 25.9 percent while the share of this sector has always been placed on third rank after services and building sectors. In order to achieve endogenous and stability value added growth in agricultural sector and decrease in negative effects and increase in oil incomes in agricultural sector and also to prevent Dutch disease on one hand and to realize the goals of perspective document and future plans of economic development on the other hand, it is necessary to have scientific knowledge about the resources of value added growth in agricultural sector during economic development plans during pre-revolution and post-revolution periods until by exact awareness about the share of total productivity growth, factors in value added growth in agricultural sector during previous plans to increase this share in the future plans, instructions in direction of movement from surface agriculture to depth agriculture can be presented. The goal of this research is to achieve the determinants of value added growth in agricultural sector and study the effects of oil shocks on value added in agricultural sector in Iranian economy as an oil producing country during 1961-2007.

Review value-added process in agricultural sector in Iran: In this section we review processing economic sectors value added in Iran. The following table shows the average annual of value-added and growth it in economic sectors in the period of 1961-2006.

Table 1: Average annual value Added and growth value-added economic sectors

Period	Average annual growth of value added (percent)			Average annual value added (billion Rials[3])		
	Services	Agriculture	Industry and mining	Services	Agriculture	Industry and mining
1961-1972	8.79	3.17	13.08	32298	10058.55	7724.73
1973-1977	16.26	6.74	16.95	93012.67	15656	24234.17

[1] Oil shocks in Iran include: oil stagnation during 1966-1972, 1978-1981 and 1985-1993 years and oil boom during 1974-1977, 1982-1984, 1994-1997 and 2001 years.
[2] Pre-revolution economic plans in Iran include: third plan during 1963-1967, fourth plan during 1968-1972, fifth plan during 1973-1977 and economic plans during war and Islamic revolution during 1978 through 1988 and also economic, social and cultural development plans of Islamic republic of Iran including first plan during 1989-1993, second plan during 1994-1998, third plan during 1999-2004 and fourth plan during 2005-2009.
[3] IRR is monetary unit in Iran. Based on ISO-4217 standard Iran's Rial is shown with the symbol IRR In global trading.

1978-1988	-2.05	4.71	-0.44	117373	23834	30816.82
1989-1993	6.52	6.45	10.62	118625	35205.6	41899.2
1994-1999	4.16	2.25	5.39	151466	43849	55599.2
2000-2004	5.69	4.01	10.23	189306.45	49625	83280.22
2005-2006	6.52	6.93	10.48	236185.5	59761.5	116712.5

Source: central bank of Iran

Generally, from the Islamic Revolution to 1990 (except 1988) value added in only agriculture sector has had always uptrend, especially in 1985-1988 years agricultural sector has had an effective role to prevent increasing economic recession while more economic sectors have had negative growth because there was war Problems and shortages of raw materials and economic recession society. Share of services value added sector have decreased during the period 1982-1990 from 58.3% in 1982 to 50.9% in 1990 year. In 2004 services value added sector has reached the highest growth (8.1% growth) during these few years and has increased to 51.7%.

Table 2: Average annual export and export growth rates in economic sectors

Period	Average annual export growth (percent)				Average annual exports (million dollars)			
	Oil	Services	Agriculture	Industry and mining	Oil	Services	Agriculture	Industry and mining
1961-1971	16.9	36.41	18.24	20.32	1535.44	127.19	131.82	37.23
1972-1977	46.5	63.08	12.52	15.01	16857.83	2176	407.1	407.1
1978-1988	2.84	-16.58	13.98	15.32	14741.09	1435.91	527.07	527.07
1989-1993	10.6	24.69	29.57	52.08	15451	930.4	1676.38	1676.38
1994-1999	9.51	23.81	-12.29	6.47	15373.4	1466.8	1537.76	1537.76
2000-2004	18.5	39.28	5.52	19.67	26050.91	4735.7	1750.95	1750.95
2005-2006	31.7	11.30	26.43	42.97	57915.5	8138.81	2778.48	2778.48

Source: Central Bank of Iran

Table 3: The average combined share of exports in economic sectors (percent)

Period time	Oil	Agriculture	Industry and mining	Services
1961-1971	84	7	2	7
1972-1977	85	3	1	11
1978-1988	88	4	1	7
1989-1993	83	9	3	5
1994-1999	76	9	8	7
2000-2004	73	5	9	13
2005-2006	74	4	11	10

Source: Central Bank of Iran

Feder [3] studied the relationship between exports and economic growth by separating the total production into two sectors and he showed that productivity is higher in exports sectors than non-exports 13 sectors. Sheehey [4] reviewed the relation between exports and economic growth by criticizing in the previous researches. His main criticism is that the exports are a part of Gross Domestic Product (GDP) and so there is a build in relationship between these two. So if we use

Spearman test there wouldn't always be a strong relationship between these parameters. This criticism is also true about production-function-type regressions. Mellor [5] showed that growth of agriculture in countries that have natural resources is more retard than growth consequent of industry in countries without natural resources.

The present research explores from macro perspective an alternative way in which the growth in agricultural sector could be explored employing time series data. Following the neo-classical production function and "growth accounting" approach, there is a three-factor production relationship with capital, labor and land, and allowing for neutral technical change. For that purpose, we use the bounds testing (or ARDL) approach to co-integration proposed by Pesaran *et al.* [1] to test the sources of agricultural growth using data over the period 1970–2007. The ARDL approach to co-integration has some econometric advantages which are outlined briefly in the following section. Finally, we apply it taking as a benchmark Odhiambo and Nyangito [6] study in order to sort out whether the results reported there reflect a spurious correlation or a genuine relationship between agricultural growth and the variables in question. This contributes to a new methodology in the agricultural growth literature. Next section starts with discussing the model and the methodology. Then in next Section we describe the empirical results of unit root tests, the F test, ARDL co-integration analysis, Diagnostic and stability tests and Dynamic forecasts for dependent variable and its next Section summarizes the results and conclusions.

MATERIALS AND METHODS

The model: Following study of Walter *et al.* (2004), to obtain contribution of inputs, individually and jointly, to the overall output, it is necessary to estimate a production function in order to establish the relationship between the physical quantity of output of goods and specific combinations of physical quantity of inputs used in a production process. The neo-classical production function provides such a framework. It can be formulated as:

$$Y = f(X_1, X_2, X_3, \ldots, X_n) \qquad (1)$$

$$Y = AK^{\alpha}L^{\beta} \qquad (2)$$

Where Y is the output and X_i are the inputs and Y, K, L indicate output level, capital and labor inputs, respectively and A, α, β are parameters determining the production technology. In the special case that $\alpha + \beta = 1$, the production technology is said to exhibit constant returns to scale, which deviates from reality. To eliminate the biases in the Cobb-Douglas formulation of the production function, economists and econometricians have sought to reformulate it to more general and flexible functional forms. The translog function is more general and flexible than either the Cobb-Douglas or the CES as it allows for varying returns to scale and varying factor elasticity substitution. This makes it a more appropriate technique, especially where the underlying production relationship is not well understood. Taking logarithms in equation (2) above, we obtain:

$$Log\ Y = log\ A + \alpha\ log\ K + \beta\ log\ L \qquad (3)$$

Indeed this equation can show the relationship between output growth, physical capital growth and workforce growth in agricultural sector. The following modified Salehi [7] model in logarithm form is used to examine the trade-growth nexus in agricultural sector in Iran. The logarithm equation corresponding to Eq. (3) and breakdown of the factors agricultural sector gives:

$$LYag_t = \alpha_0 + \alpha_1 LAag_t + \alpha_2 LKag_t + \alpha_3 LLag_t + e_t \qquad (4)$$

Where: $LYag_t$ is Logarithm of agricultural value added in 1997 constant prices based on million dollars, $LAag_t$ is Logarithm of production technology in agricultural sector, $LLag_t$ is Logarithm of human capital in agricultural sector based on thousands (the number of employed workforce with a university degree), $LKag_t$ is Logarithm of investment in agricultural sector in 1997 constant prices based on million dollars.

This section explains the Sources of Total Factor Productivity Growth in agricultural sector in the period under review (1970-2007). The framework of analysis is the commonly used "growth accounting" approach. The technique is used to estimate the proportion of growth attributable to changes in labor, capital and land with the residual assumed to represent Total Factor Productivity Growth (TFPG). Assuming a three-factor production relationship with capital, labor and land, and allowing for neutral technical change, the agricultural production function can be expressed as:

$$Y_t = A_t F(K_t, L_t, N_t) \qquad (5)$$

Where Y_t is the value added in the agricultural sector in year t, K_t is capital, L_t is labour and N_t is land used in the sector in period t. The coefficient A_t denotes the level of technology, usually called the "total factor productivity" or "Solow residual". The challenge is then to obtain an estimate for A_t. Two distinct approaches can be used to estimate A_t: parametric and non parametric[1]. Parametric approaches utilize the traditional residual approach in which changes in output unexplained by the inputs are considered to be the total factor productivity growth. Differentiating equation (5), the production function with respect to time, t and dividing by Y, the growth rate of the Solow residual or total factor productivity growth can be estimated as:

$$\frac{dA}{dt}\frac{1}{A} = \frac{dY}{dt}\frac{1}{Y} - \alpha\frac{dK}{dt}\frac{1}{K} - \beta\frac{dL}{dt}\frac{1}{L} - \delta\frac{dN}{dt}\frac{1}{N} \qquad (6)$$

Where α, β and δ are the shares of value-added that remuneration of capital, labor and land represents, respectively. Therefore, given a neoclassical Cobb-Douglas production function**,** agricultural TFPG can be estimated (in logarithms) as the difference between output and a weighted average of the inputs as:

$$LTag_t = LYag_t - \alpha LKag_t - \beta LLag_t - \delta LNag_t \qquad (7)$$

Where: $LTag_t$ is Logarithm of Total Factor Productivity Growth in 1997 constant prices based on million dollars and $LNag_t$ is Logarithm of land used in the sector in period t based on thousands

[1] See Odhiambo, W. and H.O. Nyangito (2003). Measuring and analyzing agricultural productivity in Kenya: A review of approaches. KIPPRA Discussion Paper No. 26.

of hectares. The rest of variables are as defined earlier. The weights are estimated econometrically as coefficients in the agricultural production function. Our empirical analysis in next two sections is based on estimating directly long-run and short-run variants of Eq. (4, 7). It means that Equation (4, 7) are the basic equation used by growth economists to calculate the sources of growth. All the data in this study are obtained from *Central Bank of Iran (2004)*[1], the *Islamic Republic of Iran Customs Administration* during the period 1970-2007.

The methodology: Recent advances in econometric literature dictate that the long run relation in Eq. (4, 7) should incorporate the short-run dynamic adjustment process. It is possible to achieve this aim by expressing Eq. (4, 7) in an error correction model as suggested by Engle and Granger [8]. Then, the equation becomes as follows:

$$\Delta LYag_{t,j} = b_0 + \sum_{i=1}^{m1} b_{1i,j}\Delta LYag_{t-i,j} + \sum_{i=0}^{m2} b_{2i,j}\Delta LKag_{t-i,j} + \sum_{i=0}^{m3} b_{3i,j}\Delta LLag_{t-i,j} + \gamma e_{t-1,j} + \mu_t \quad (8)$$

$$\Delta LTag_{t,j} = b_0 + \sum_{i=1}^{m1} b_{1i,j}\Delta LTag_{t-i,j} + \sum_{i=0}^{m2} b_{2i,j}\Delta LYag_{t-i,j} - \sum_{i=0}^{m3} b_{3i,j}\Delta LKag_{t-i,j} \quad (9)$$
$$- \sum_{i=0}^{m4} b_{4i,j}\Delta LLag_{t-i,j} - \sum_{i=0}^{m5} b_{5i,j}\Delta LNag_{t-i,j} + \gamma e_{t-1,j} + \mu_t$$

Where *Δ* represents change, m_i is the number of lags, γ is the speed of adjustment parameter and ε_{t-1} is the one period lagged error correction term, which is estimated from the residuals of Eq. (4, 7). The Engle–Granger [8] method requires all variables in Eq. (4, 7) are integrated of order one, *I* (1) and the error term is integrated order of zero, *I* (0) for establishing a co-integration relationship. If some variables in Eq. (4, 7) are non-stationary we may use a new co-integration method proposed by Pesaran *et al.* [1] This approach is also known as Auto Regressive Distributed Lag (ARDL) that combines Engle and Granger [8] two steps into one by replacing ε_{t-1} in Eq. (8, 9) with its equivalent from Eq. (4, 7). ε_{t-1} is substituted by linear combination of the lagged variables as in Eq. (10, 11).

$$\Delta LYag_{t,j} = c_0 + \sum_{i=1}^{n1} c_{1i,j}\Delta LYag_{t-i,j} + \sum_{i=0}^{n2} c_{2i,j}\Delta LKag_{t-i,j} + \sum_{i=0}^{n3} c_{3i,j}\Delta LLag_{t-i,j} \quad (10)$$
$$c_4 LYag_{t-1,j} + c_5 LKag_{t-1,j} + c_6 LLag_{t-1,j} + v_t$$

$$\Delta LTag_{t,j} = c_0 + \sum_{i=1}^{n1} c_{1i,j}\Delta LTag_{t-i,j} + \sum_{i=0}^{n2} c_{2i,j}\Delta LYag_{t-i,j} - \sum_{i=0}^{n3} c_{3i,j}\Delta LKag_{t-i,j} - \sum_{i=0}^{n4} c_{4i,j}\Delta LLag_{t-1,j} \quad (11)$$
$$-\sum_{i=0}^{n5} c_{5i,j}\Delta LNag_{t-i,j} + c_6 LTag_{t-1,j} + c_7 LYag_{t-1,j} - c_8 LKag_{t-1,j} - c_9 LLag_{t-1,j} - c_{10} LNag_{t-1,j} + v_t$$

To obtain Eq. (10, 11), one has to solve Eq. (4, 7) for ε_t and lag the solution equation by one period. Then this solution is substituted for ε_{t-1} in Eq. (8) to arrive at Eq. (10, 11). Eq. (10, 11) is a representation of the ARDL approach to co-integration. Pesaran *et al.* [1] co-integration approach, also known as bounds testing, has some methodological advantages in comparison to other single co-integration procedures. Reasons for the ARDL are: i) endogenous problems and

[1] *National Accounts of Iran* in 1997 constant prices

inability to test hypotheses on the estimated coefficients in the long-run associated with the Engle and Granger [8] method are avoided; ii) the long and short-run coefficients of the model in question are estimated simultaneously; iii) the ARDL approach to testing for the existence of a long-run relationship between the variables in levels is applicable irrespective of whether the underlying regressors are purely stationary *I*(0), purely non-stationary *I*(1), or mutually co-integrated, and iv) the small sample properties of the bounds testing approach are far superior to that of multivariate co-integration, as argued in Narayan [9]. The long-run effect is measured by the estimates of lagged explanatory variables that are normalized on estimate of c_4. Once a long-run relationship has been established, Eq. (10, 11) is estimated using an appropriate lag selection criterion. At the second step of the ARDL co-integration procedure, it is also possible to obtain the ARDL representation of the Error Correction Model (ECM). To estimate the speed with which the dependent variable adjusts to independent variables within the bounds testing approach, following Pesaran et al. [1] the lagged level variables in Eq. (10, 11) are replaced by EC_{t-1} as in Eq. (12, 13):

$$\Delta LYag_{t,j} = \alpha_0 + \sum_{i=1}^{k1} \alpha_{1i,j} \Delta LYag_{t-i,j} + \sum_{i=0}^{k2} \alpha_{2i,j} \Delta LKag_{t-i,j} + \sum_{I=0}^{k3} \alpha_{3i,j} \Delta LLag_{t-i,j} + \lambda EC_{t-1,j} + \mu_t \qquad (12)$$

$$\Delta LTag_{t,j} = \alpha_0 + \sum_{i=1}^{k1} \alpha_{1i,j} \Delta LTag_{t-i,j} + \sum_{i=0}^{k2} \alpha_{2i,j} \Delta LYag_{t-i,j} - \sum_{I=0}^{k3} \alpha_{3i,j} \Delta LKag_{t-i,j} \qquad (13)$$
$$- \sum_{i=0}^{k4} \alpha_{4i,j} \Delta LLag_{t-i,j} - \sum_{i=0}^{k5} \alpha_{5i,j} \Delta LNag_{t-i,j} + \lambda EC_{t-1,j} + \mu_t$$

A negative and statistically significant estimation of λ not only represents the speed of adjustment but also provides an alternative means of supporting co-integration between the variables.

ARDL and AR forecasting models: We use the basic framework of Stock and Watson [10-11] to generate a large number of individual ARDL model forecasts of the agricultural value added growth and TFPG, where each ARDL model includes one of N potential predictors. Define $\Delta Y_t = Y_t - Y_{t-1}$, where Y_t is the log-level of the agricultural value added growth or TFPG in a particular Iran state at time t. In addition, define:

$$y_{t+h}^h = \frac{1}{h} \sum_{j=1}^{h} \Delta y_{t+j} \qquad (14)$$

So that y_{t+h}^h is the (approximate) growth rate of the agricultural value added and TFPG from time t to t Ch, where h is the forecast horizon. Let $X_{i,t}$ denote one of the N potential predictors of state-level agricultural value added growth and TFPG growth (i=1,2,…,N). Each ARDL model takes the form:

$$y_{t+h}^h = \alpha + \sum_{j=0}^{q_1-1} \beta_j \Delta y_{t-j} + \sum_{j=0}^{q_2-1} \gamma_j x_{i,t-j} + \varepsilon_{t+h}^h \qquad (15)$$

Where, ε^{h}_{t+h} is an error term. We construct recursive simulated out-of-sample forecasts for y^{h}_{t+h} at time t for a given predictor $x_{i,t}$ (denoted by $\hat{y}^{h}_{i,t+h|t}$) using Eq. (15). More specifically, $\hat{y}^{h}_{i,t+h|t}$ is computed by plugging Δy_{t-j} (j=0,1,…,q_1-1) and $x_{i,t-j}$ (j=0,1,…,q_2-1) into Eq. (15), with the parameters set equal to their OLS estimates based on data available from the start of the sample through period t, and ε^{h}_{t+h} set equal to its expected value of zero. The lag lengths in Eq. (15) are selected using the SIC, data through period t, a minimum lag length of zero for q_1 and one for q_2 (to ensure that $x_{i,t}$ appears in Eq. (15), and a maximum lag length of four for q_1 and q_2. Dividing the total sample into in-sample and out of sample portions of size R and P, respectively, we use this procedure to generate a series of P-(h-1) recursive simulated out-of-sample forecasts for the ARDL model that includes $x_{i,t}$ ($\left\{\hat{y}^{h}_{i,t+h|t}\right\}_{t=R}^{T-h}$) . Note that the lag lengths q_1 and q_2 are selected anew when forming each out-of-sample forecast, so that the lag lengths for the ARDL forecasting model are allowed to vary through time. In our applications in Section below, we consider 30–37 potential predictors for growth rate of the agricultural value added and TFPG. We will thus have 30–37 series of h-step-ahead individual ARDL model forecasts of growth rate of the agricultural value added and TFPG[1]. We also compute recursive simulated out-of sample forecasts for an AR model, which is given by Eq. (15) with the restriction □$_j$=0 (0,1,…,q_2-1) imposed. The series of out-of-sample forecasts are generated using a procedure analogous to that for the ARDL forecasting model described above[2]. The AR model is a popular benchmark model in much of the time series forecasting literature.

Structural stability tests Cumulative Sum (CUSUM) and Cumulative Sum of Square (CUSUMSQ): These tests which have been proposed by Brown *et al.* [6] was tested the stability of model coefficients. Its foundation is based on that initially, a regression equation including the variable desired is estimated using of estimated to be at least observations. Then, one observation is added to the observations of previous equation and next estimation is performed and in this same way, it is added to the observations a unit. In this way, after the estimation of each step, one coefficient is obtained for any of the variables which finally is concluded a time series of variables coefficients. These tests presents Cumulative sum (CUSUM) and cumulative sum of Square (CUSUMSQ) diagrams between two straight lines (the bounds of the 95 percent).If the diagram presented be within the boundaries, zero hypothesis is accepted which is based on lack of structural break and if the diagram go out of the boundaries (it means that if dealt to them), zero hypothesis is rejected which is based on lack of structural break and the presence of structural break is accepted (Bahmani-Oskooee, [2]). CUSUM statistics is useful to find systematic changes in long term coefficients of regression and CUSUMSQ statistics is helpful when deviation from regression coefficients stability is randomized and occasional (short term).

[1] Apart from data revisions, the recursive forecasting procedure mimics the situation of a forecaster in real time. Because some of the potential predictors we consider are subject to revision, we are computing "simulated" recursive out-of-sample forecasts.

[2] We select the lag length (q_1) for the AR model using the SIC and a minimum (maximum) value of zero (four) for q_1.

RESULTS AND DISCUSSION

Unit Root Test: Many economic and financial time series exhibit trending behavior or non stationary in the mean. During the last three decades, the methods of estimation of economic relationships and modeling fluctuations in economic activity have been subjected to fundamental changes. Nelson and Plosser [12] were of the view that almost all macroeconomic time series one typically uses have a unit root. Since the testing of the unit roots of a series is a precondition to the existence of co-integration relationship, originally, the Augmented Dickey-Fuller [13] (ADF) test was widely used to test for stationary. ADF test investigates the presence of unit root in time series data. Strong negative numbers of unit root reject the null hypothesis of unit root at some level of confidence. ADF framework to check the stationary of time series has been given in following equation:

$$\Delta X_t = \beta_1 + \beta_2 t + \theta X_{t-1} + \sum_{i=1}^{n} \alpha_i \Delta X_{t-1} + \varepsilon_t \qquad (16)$$

Where, ε_t is white noise error term. Basically, this test determines whether the estimates of θ are equal to zero or not. Fuller [14] has provided cumulative distribution of the ADF statistics by showing that if the calculated-ratio (value) of the coefficient is less than critical value from Fuller table, then x is said to be stationary. The results of ADF test is displayed in Table 4.

Table 4-Results of unit root by ADF test

Variables	Level	1st Differences	integrated of order
LYag	-1.32	-4.35	I(1)
LTag	-2.99	-6.65	I(0)
LKag	-1.02	-4.06	I(1)
LLag	-0.32	-3.91	I(1)
LNag	-3.01	-7.87	I(0)

Note: * denote statistical significance at 1%

The results reported in Table 1 show that null hypothesis of ADF unit root is accepted in case of LYag, LKag and LLag variables but rejected in first difference at 1% level of significance. This unit root test indicate that LYag, LKag and LLag variables considered in the present study are difference stationary $I(1)$ while LTag and LNag variables are level stationary $I(0)$ as per ADF test. On the basis of this test, it has been inferred that LYag, LKag and LLag variables are integrated of order one I (1), while LTag and LNag variables are integrated of order zero I(0).

ARDL co-integration analysis: When applying the ARDL approach, the focus is on a specification that includes a deterministic trend in the co-integrating vector. Table 5 reports the results where agricultural growth is the dependent variable. The empirical result based on ARDL tests repeated showed that the most significant break for variables of under investigation are consistent with time of oil boom. Therefore, at this stage we include four dummies variable of oil shocks (oil boom in 1974, 1982, 1994 and 2001); in order to take into account the structural breaks in the system. The estimated coefficients of the long-run relationship and Error Correction Mode (ECM) are displayed in Table 5.

Table 5-Long and short run coefficients using the ARDL (1,0,0) model (*Dependent Variable: LYag*)

long-run coefficients			Short-run coefficients		
Regressor	Coefficient	t-Ratio(prob)	Regressor	Coefficient	t-Ratio(prob)
LKag	0.22	4.34[001]	DKag	0.21	5.24[000]
LLag	0.37	6.97[003]	DLag	0.15	8.15[000]
C	2.12	4.55[001]	DC	0.15	5.32[000]
DU1974	-0.18	-2.37[007]	DU1974	-0.16	-6.08[002]
			ECM(-1)	-0.42	-3.08[004]

Note: The order of optimum lags is based on the specified ARDL model

Table 6 reports the results where total factor productivity is the dependent variable. In this case, the results also indicate the existence of a long-run relationship between total factor productivity and its main determinants.

Table 6-Long and short run coefficients using the ARDL (1,0,0,0,0) model (*Dependent Variable: LTag*)

long-run coefficients			Short-run coefficients		
Regressor	Coefficient	t-Ratio(prob)	Regressor	Coefficient	t-Ratio(prob)
LYag	0.12	5.21[000]	DLYag	0.09	5.56[001]
LKag	0.35	4.54[001]	DLKag	0.32	4.88[002]
LLag	0.56	3.85[002]	DLLag	0.52	4.32[004]
LNag	0.42	2.37[007]	DLNag	0.38	2.78[008]
C	2.64	0.28[018]	DC	0.54	1.87[014]
DU1994	-0.12	-4.55[009]	DDU1994	-0.11	-4.98[001]
DU1999	-0.08	-4.67[012]	DDU1999	-0.07	-5.08[000]
			ECM(-1)	-0.45	-4.08[000]

The estimated ARDL model is based on SBC and indicates 5% and 10% significance levels

Diagnostic and Stability Tests: Diagnostic tests for serial correlation, normality, heteroscedasticity and functional form are considered, and results are show that short-run model passes through all diagnostic tests in the first stage. The results indicate that there is no evidence of Autocorrelation and that the model passes the test for normality, and proving that the error term is normally distributed. Functional form of model is well specified but there is existence of white heteroscedasticity in model. The presence of heteroscedasticity does not affect the estimates and time series in the equation are of mixed order of integration, i.e., *I (0)* and *I (1)*, it is natural to detect heteroscedasticity.

Also, analyzing the stability of the long-run coefficients together with the short run dynamics, the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ) are applied. According to Pesaran and Shin [1] the stability of the estimated coefficient of the error correction model should also be empirically investigated.

The null hypothesis (i.e. that the regression equation is correctly specified) cannot be rejected if the plot of these statistics remains within the critical bounds of the 5% significance level. As it is clear from Fig. 1, the plots of both the CUSUM and the CUSUMSQ are within the boundaries and hence these statistics confirm the stability of the long run coefficients of regressors which affect the inequality in the country. The stability of selected ARDL model specification is evaluated using the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ) of the recursive residual test for the structural stability. The model appears stable and correctly specified given that neither the CUSUM nor the CUSUMSQ test statistics exceed the bounds of the 5 percent level of significance.

Dynamic forecasts LYA as dependent variable: Figure (1, 2) represents the forecasting errors and the plots of the graphs of the actual and forecast values for model. These graphs show that dynamic forecast values for the level of *LYag* and *LTag* as well as the change in the level of *LYag* and *LTag* very close to the actual data for both equations.

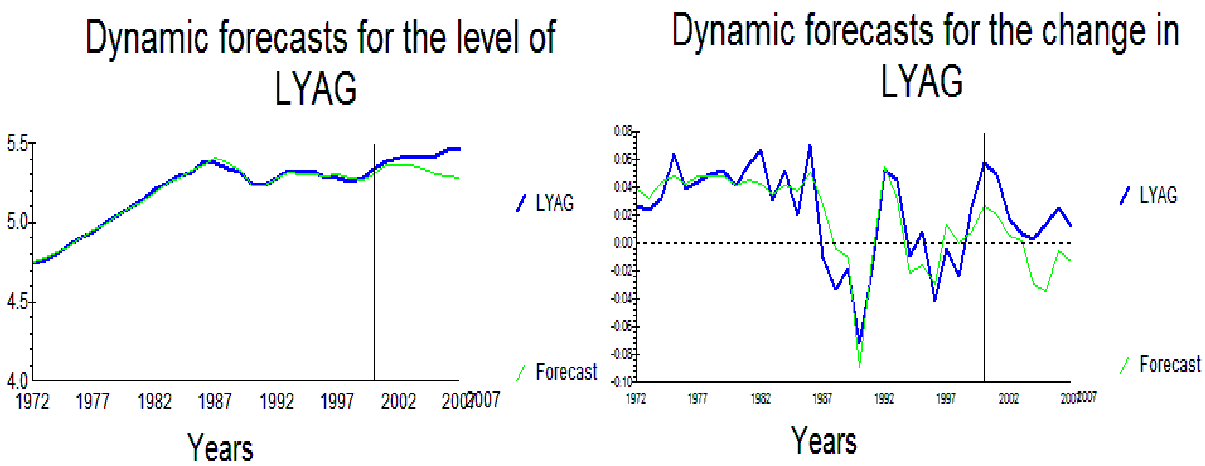

Fig. 1. Plots of the actual and forecasted values for the level of LYag and change in LYag

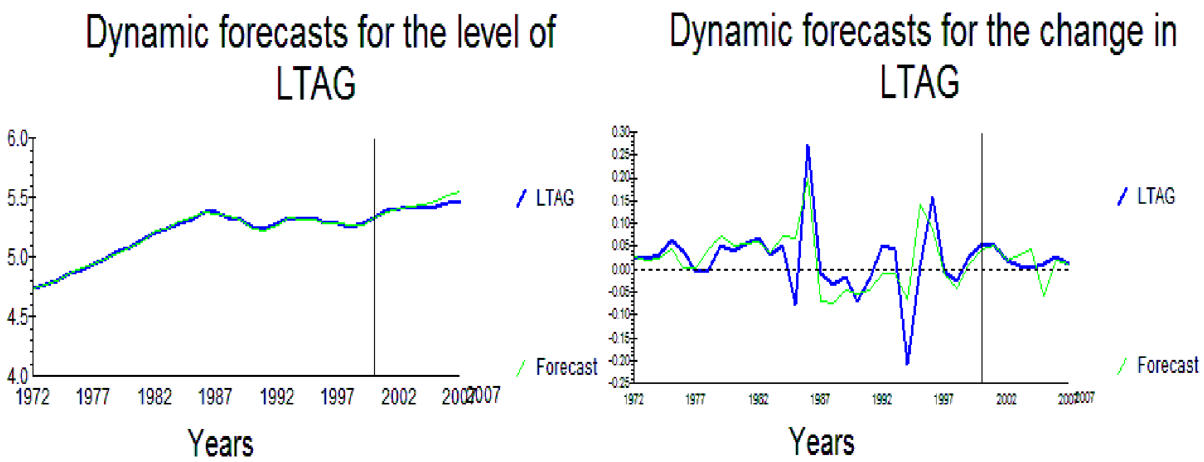

Fig. 2-Plots of the actual and forecasted values for the level of LTag and change in LTag

Regarding to these diagrams, value added in agricultural sector and total factor productivity growth have changed very much so that during the years of oil incomes boom[1], value added in agricultural sector has a descending trend and after the end of these times (stagnation of oil incomes[2]), value added in agricultural sector has had an ascending trend.

CONCLUSION

The purpose of this analysis was to understand what drives the agricultural sector in Iran. This paper investigates the possible linkages among the agricultural sector growth and its determinants and total factor productivity growth in agricultural sector. This in itself is a necessary condition in the design and implementation of policies to improve the sector. The employed approach is based on co-integration using the Autoregressive Distributed Lag approach. Growth in this sector is not only crucial for poverty alleviation but also for the performance of the overall economy. The underlying fact is that the performance of the agricultural sector has declined considerably over the years. This objective was aided by the technique of Pesaran *et al.* [1] approach to co-integration which presents non-spurious estimates. The evidence from the empirical results indicates that the Labor in particular has accounted for the bulk of the growth in the sector. Given the poor performance of the agricultural sector in the face of massive labor expansion in the sector and also considering the disguised nature of employment in the sector, one is inclined to conclude that future growth will have to come from elsewhere.

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