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Study of Effective Factors on Income Inequality Decrease in Rural Areas of Iran

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Abstract

According to the Ahlowalia hypothesis (1995), the growth of total factor productivity (TFP) beside infrastructure investments of government lead to income inequality decrease in rural areas of countries. The main objective of this study is to investigate the effects of public investments such as agricultural R&E, road, education and irrigation on income inequality in rural areas of Iran. In order to get results, we used ARDL method and time series data of 1980 to 2008. However, this research attempts to survey the direction of causality between the income inequality and total factor productivity (TFP) in Iran. Empirical results show there is a negative relation between income inequality and agricultural TFP in rural areas of Iran. Hence, additional investments on rural education and agricultural R&E have significance and different impacts on income inequality. Findings showed Ahlowalia hypothesis developed for the relation among income inequality, TFP and investment in electricity is not rejected in case of Iran`s rural areas.

Keywords:
Infrastructure investment, Income inequality, Ahlowalia hypothesis, TFP

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INTTODUTTION

Productivity growth and income distribution relation is too challenging in economic development literature (Ghareh Baghian, 1996). So the attention of economists has been concentrated seriously on this matter and there are different opinions about it. Nowadays, income distribution together with economic growth is one of governments` economic disturbances. Income inequality that has increased relatively in different countries during last decades had happened because of various social and economic reasons. According to researchers view, income inequality development, on one hand, is related to productivity growth and on the other hand, is related to the degree of unbalance in income distribution pattern (Azimi, 1991). So if we want to increase society welfare and decrease inequality, we should increase productivity growth, of course, it does not mean, productivity growth improves economic situation of society. Some facts about some developing countries show that in high productivity growth conditions, the amount of inequality may become more (Amini, 2007). The important matter is choosing a productivity growth way that can reach suitable income distribution. According to Ahlowalia view (1995) if governments public costs increase in developing countries, by having productivity and economic growth, income distribution will become more suitable and exact. So according to Ahlowalia view (1995), in process of removing inequality in countries, due to great employment volume of rural population in agricultural sector, managing basic structures of this sector has special importance. Thus for having basic change in stable increase of produced products in villages such as handicrafts and livestock products, we need to infrastructure improvements as investing in electricity installations, R&E and developing literacy rate (Sadoult, 2006). In our country lack of facilities in rural areas and the big gap between urban and rural areas in enforcing five programs of government before Islamic Revolution, made sixth period (1978-1982) programmers to revise sector programming system and with a comprehensive regional program plan merging affairs of rural development and agricultural sector. But after Islamic Revolution victorious some structures and organizations helped to reconstruct and develop rural areas. Forth development program had a great view on agricultural and rural development and had special objectives and executive ways in macroeconomic situation such as acceleration of reconstruction and development in villages, special attention to villagers` living, planning for farmers more income and employment, supporting and encouraging investment and developing entrepreneur works. According to the purpose of forth program for having 8% growth in macroeconomic, productivity growth in rural and agricultural sector should be 2.5% annually to get the goal. For having this amount of productivity growth, government should take some infrastructure measures to develop total factor productivity in rural sector and by increasing productivity in rural sector, decrease the inequality gap of it. Every country for knowing it`s social and economic development programs, should identify if that program will decrease rural inequality or not and should know which program decrease the amount of social and economic inequality.

Walter Park and David Brat (1998) are first economists that studied effective factors of economic inequality in 54 countries. Their study with the topic of "The analysis of Ahlowalia hypothesis in global state" showed, beside economic growth, one of main effective variables on income inequality is R&E costs. In their pattern every unit change in R&E costs leads to 0.042 unit change in global inequality decrease. Brat and Park showed in the presence of R&E costs, Ahlowalia hypothesis all over the world is not nullified. Since R&E lead to inputs quality development in agricultural sector, by increasing production, producers income increase and income inequality in rural areas decrease. According to Anderson and Levy (2003), R&E process because of having high costs and lag in affecting, show less effects at first but after passing necessary lags lead to production development of small economic firms and this matter leads to income inequality decrease. Zhang and Fan (2005) in their studies showed in Eastern Asian countries like China and Korea, investments in agricultural R&E and infrastructural elements as watering installations, lead to low income farmers` use of the benefits of these costs and this matter increases their income and decreases in-

come inequality between villagers. They also showed by having more agricultural R&E in growth and total factor productivity, income inequality in rural areas of country will decrease more.

In Iran, Salami and *et al.,* (2007) studied income distribution of rural areas in Iran by focusing on investment in development sectors. In this study by using of 1982-2002 data and parametric method, the portion of infrastructure investment on income distribution of villagers in rural areas was estimated. Health investment, watering and draining grid development in rural areas improved income distribution. They presented for having desired efficiency in these investments, government should study the various effects of these investments to remove related obstacles and develop rural areas conditions. Torkamani and Jamali Moghadam (2008) in a research showed the importance of government investment in removing inequality. Thus, they used an equation system of effective variables on poverty, inequality and productivity growth. According to gained results, rural inequality elasticities toward investment in rural development and reconstruction are more than government`s other investments in rural affairs. Further more, they showed investment in agricultural researches has positive effects on agricultural sector`s productivity. Also building roads and electrification in rural areas beside direct effects on removing inequality lead to increase in employment in agricultural sector. The main objective of research is testing Ahlowalia hypothesis in the frame work of relation between agricultural productivity growth and income inequality with basic and developmental investments in rural areas of country.

MATERIALS AND METHODS

According to classical economists, most researches about income distribution are formed on Pareto rule (1897). Pareto believes in all times and places income distribution stays fixed. He believes structural changes, equalizing taxes or government costs don`t change this stability. But today Aleston (1999) and Ahlowalia (1995) showed income distribution not only is not fixed during time but also it can be affected by productivity, economic growth and developmental and infrastructure investments of governments. Ahlowalia believes in the presence of government`s infrastructure investment costs in rural areas, there is a linear relation between productivity growth and income inequality that increasing the amount of productivity decrease the volume of income inequality. So mathematical form of Ahlowalia function for studying income distribution with productivity and infrastructure investment costs in rural areas is:

$$In = \alpha - \gamma P - \sum \beta_i x_i + \varepsilon_i \qquad (1)$$

In above equation, x_i is infrastructure investment costs in rural area, P, productivity of agricultural sector and In, income inequality index. Different variables are used for measuring income inequality index in rural areas. One index for measuring income inequality is Gini coefficient. Gini coefficient is a quantity between 0 and 1 that 0 shows complete equal distribution in income and 1, absolute inequal distribution in income. Among researchers there are different methods for calculating this index. The most popular methods are groupage and ungroupage methods. First: The ungroupage method of calculating Gini coefficient:

$$Gini = 2\frac{cov(m_i, f_i)}{\frac{1}{n}\sum_{i=1}^{n} m_i} \qquad (2)$$

In equation 2, f is the rank of *i*th family that is considered 0 for poor families and 1 for rich families. Second: The groupage method of calculating Gini coefficient:

$$Gini = 1 - 2\int_0^1 f(x)dx$$

$$Gini = 1 - \frac{1}{n}\sum_{i=0}^{k}(y_{i+1} - y_i) \qquad (3)$$

In above equation, $\frac{1}{n}$ is groupage ratio.

Gini coefficient index with existing information and statistics has some features as observing easy calculating principle (Kafaie, 2009). Also Gini coefficient is easy to understand and has

been used directly in most empirical studies. So in this study we use Gini coefficient index as income inequality measuring variable. Now according to Ahlowalia`s linear model and empirical studies in income distribution hypothesis, the most effective variables on dependent variable (income inequality) are presented in this model.

$$\log GINI = \beta_0 + \beta_1 \log TFP + \beta_2 \log IRE + \beta_3 \log ROAD + \beta_4 \log LI + \beta_5 \log LI + \beta_6 \log R\&E + \beta_7 \log EDU + \varepsilon_t \quad (4)$$

In equation 4, beside agricultural total factor productivity that has positive effect on income inequality decrease, infrastructure investment variable is in equation too. In this model GINI is Gini coefficient of rural areas and TFP, total factor productivity. We can determine TFP index by Solo calculation method for agricultural sector:

$$TFP_{Ag} = \frac{y}{K^{\alpha}.L^{\beta}.E^{\gamma}} \quad (5)$$

So:

$$\ln TFP = \ln y - \alpha \ln K - \beta \ln L - \gamma \ln E \quad (6)$$

In above equation, y is agricultural sector`s value added (in billion rials), K, the existing amount of capital in agricultural sector (in billion rials), L, labor and E, the amount of consumed energy in agricultural sector (in Mega Joul).α, β and γ are production elasticities of capital, labor and energy in agricultural sector. Also IRE is the symbol of investing in watering installations, EDU, rural literacy rate, ROAD, investment in rural roads, LI, investment costs in electrification to villages and R&E, R&E costs in agricultural sector.

We used statistical centers resources to get Gini coefficient data in rural areas, PDS, for the variances of literacy rate in rural areas and investment costs in watering installations, electrification and building roads, ASTI, for the variable of agricultural R&E costs. In Ahlowalia linear model, agricultural R&E by making innovation and increasing the skills of farmers, has negative relation with income inequality (Fan, 2001). Also investment in watering installations, electrification and building rural roads as a symbol of infrastructure investment has a negative relation with income inequality (Torkamani, 2008). About education (rural literacy rate) as human capital and it`s effect on income distribution, there are different ideas. Human capital and education lead to increase in labor skill in agricultural sector and it improves income distribution in rural areas (Aleston, 2006). For having correct Ahlowalia hypothesis, TFP variable should be negative. Also time-series data of research is related to 1980-2008 and for estimating model we used Auto Regressive Distributed Method (ARDL).

When we use OLS method in econometric, time-series variables should be stationary (If variable is not stationary, mean, variance and covariance are not fixed during time and they change). If variables are not stationary, estimated parameters may have meaningful t-statistic and high R^2 and F-statistic but because of not having normal distribution, statistical presumption won`t be true. Phillips & Lortan (1992) showed in not stationary variables, OLS estimation will be unsuitable and may result in a false regression. Traditional method of preventing false regression is using time trend variable between independent variables of model. Of course this time trend should be definite not stochastic. Here we need to infer cointegration. Cointegration in economic sense means when two or some time-series variables according to theoretical bases relate to each other to make a long-run economic relation, even, they may have stochastic trend, during the time they follow each other well and the difference between variables is stable. For achieving long-run relation or cointegration, we can infer Engle-Granger method that because of weakness in multivariate regressions is not recommended. Another method is maximum likelihood method of Johanson-Joselius that lies on cointegration of similar or identical order that most of the time lead to I(1). Since the power of Unit-Root test for determining cointegration order and stationary is low and in most cases can not determine whether variables are stationary or not, some studies tried to remove above methods faults and find better ways to analyze short-run and long-run relation between variables. So Pesaran and Shin (1998) presented Auto Regressive Distributed Lag Method (ARDL). In this method variable cointegration has no importance and just

by determining suitable numbers of lag, unique vector for long-run relation between variables is achieved. This method estimates long-run and short-run relations among variables simultaneously. Also this method removes the problem of omitting variable and correlation and since these methods have no serial correlation, estimations are efficient and unbiased (Noferesti, 2005). In ARDL method for long-run relation estimate, we used a two-level method as follows.

In first level, existing of long-run relation among variables is tested. So dynamic ARDL model is estimated. If the sum of estimated coefficients with dependent variable lag is less than 1, dynamic model tends to long-run balance. Then for testing covergency, following hypothesis test is done.

$$\begin{cases} H_0: \ \sum_{i=1} m\beta_i - 1 \geq 0 \\ H_1: \ \sum_{i=1} m\beta_i - 1 < 0 \end{cases} \quad (7)$$

T-statistic is calculated by:

$$t = \frac{\sum_{i=1} m\beta_i - 1}{\sum_{i=1} mS_{\beta_i}} \quad (8)$$

Now by comparing t-statistic and presented critical quantity by Banerjee, Dolado& Master, we can notice that whether there is a long-run balance relation between variables or not. ARDL form is:

$$y_t = \beta_0 + \sum_{i=1}^{m} \beta_i Y_{t-1} + \sum_{i=0}^{k_1} \alpha_{i1} X_{t-i} + \sum_{i=0}^{k_2} \alpha_{i2} Z_{t-i} + \cdots + u_t \quad (9)$$

In above equation, $\Sigma\beta_i Y_{t-1}$ are lagged dependent variables, $\Sigma\alpha_{il} Y_{t-i}$ and $\Sigma\alpha_{i2} Z_{t-i}$, sets of lagged independent variables and $\beta_0, \beta_i, \alpha_{il}, \alpha_{i2}$ coefficients of regression equation. In ARDL method the maximum number of lags is determined by researcher according to observations number and model nature. So according to one of four Akaike & Schwarts-Baysian, Hannan-Quinn and R^2 criterions, one estimated regression is chosen. Then we explain cointegration among variables and estimate long-run balance relation. The superiority of ARDL method is having short-run Error Correction Model (ECM) plus long-run relations.

RESULTS

According to econometric materials about the stationary of variables and preventing false regression among variables, we use Augmented Dicky-Fuller (ADF) test to study the stationary of variables. Gained results of this test are in table 1.

According to table 1 logarithm variables of R&E, investment in rural electricity, total factor productivity in agricultural sector and rural literacy rate have become stationary with one level differentiate, on the other hand, variables are not stationary in level unit but logarithm variable of inequality (Gini coefficient), investment in roads and investment costs in watering installations are stationary in level unit.

Now we estimate dynamic ARDL model by Schowarts-Baysian criterion. Gained results of model are in table 2. Coefficients of estimated model are meaningful in 10% level of confidence. R^2 is 98% and heteroscedasticity of variance has been tested by LM test of Microfit4. According to results the hypothesis of heteroscedasticity of variance hypothesis was rejected. x^2 -statistic is 0.92 and does not reject H_0 hypothesis of homoscedasticity of variance.

Table 1: Summary of series Unit-Root test by Eviews 6 software

Variable	Number of lags		ADF statistic	Mc kinon amounts			Seri situation
				1%	5%	10%	
LR&E	2	Constant	-4.64	-3.6	-2.9	-2.6	I(1) stationary
LIRE	2	Constant and trend	-5.61	-4.30	-3.57	-3.22	I(0) stationary
LLI	2	Constant	-5.29	-4.33	-3.57	-3.22	I(1) stationary
LINEQ	2	Constant	-5.79	-3.67	-2.97	-2.62	I(0) stationary
LTFP	2	Constant	-4.54	-3.69	-2.98	-2.62	I(1) stationary
LEDU	1	Constant	-5.55	-3.76	-2.78	-2.44	I(1) stationary
LROAD	1	Constant	-4.56	-3.65	-2.87	-2.67	I(0) stationary

Table 2: Gained results of dynamic (1, 0, 0, 0, 2, 2, 0) ARDL model

t-statistic	Standard deviation	coefficient	Variable name
2.23	0.13	0.29	LINEQ(-1)
-2.26	0.59	-1.31	LTFP
-2.34	0.032	-0.07	LROAD
-3.21	0.037	-0.12	LR&E
-1.46	0.021	-0.036	LLI
-1.79	0.012	-0.022	LLI(-1)
-2.19	0.026	0.074	LLI(-2)
-2.09	0.011	-0.023	LIRE
-2.46	0.014	-0.034	LIRE(-1)
-2.54	0.015	-0.041	LIRE(-2)
-2.11	0.049	-0.13	LEDU
-1.75	1.97	-3.43	C
1.55	0.004	0.006	T
	R^2=0.98	DW=2.05	F(8,12)=11.32

DW-statistic is 2.05 that shows we don`t have any correlation problem in model. Also Ramsey test of functional form admitted H0 hypothesis of correct functional form. Normality test showed residuals have normal distribution. Also collinearity of model has been rejected because all elements of correlation matrix are less than Square-Root of R^2 (0.98).

Now by using of value-added lagged variable coefficient in short-run model, we study the hypothesis of existing long-run relation among variables:

$$t = \frac{0.29 - 1}{0.13} = -5.46 \qquad (10)$$

By calculating t-statistic and comparing with critical quantity in 95% level of confidence means -3.91, H0 hypothesis was rejected and having a long-run relation for income inequality model was admitted. Gained results of long-run relation for Ahlowalia linear model are in table 3. In this function all coefficients are meaningful in 5% level of confidence and constant is meaningful in 10% level. So Ahlowalia equation for rural areas of Iran is:

$$LGINI = -2.58 - 0.86LTFP - 0.052LLI - 0.09LR\&E - 0.08LIRE - 0.07LROAD - 0.012LEDU + 0.004T \qquad (11)$$

For having true Ahlowalia linear model, total factor productivity coefficient should be negative and meaningful. In this function total factor productivity coefficient is negative (-0.86) and meaningful. Also other coefficients of variables are negative that show their positive effect on income inequality decrease in rural areas of Iran. In model, investments in agricultural R&E and building roads (0.07, 0.09) have positive effect on income inequality decrease in rural areas of Iran. Every 1% investment in agricultural researches causes 0.09% decrease in income inequality. This matter is because of R&E effect on innovation and getting specialty in producing high quality productions. Also every 1% investment in building rural roads leads to 0.07% decrease in income inequality. Literacy rate (education) as a main variable in model has meaningful coefficient (-0.12) on income inequality decrease in rural areas. As 1% increase in literacy rate causes 0.12% decrease in income inequality. Electrification in rural areas is a meaningful variable and 1% increase in investment costs leads to 0.052% decrease in income inequality. Also 1% increasing in investment in watering installations causes 0.08% decrease in income inequality in rural areas of country. Trend variable of model is the representative of other effective variables as rural population or global price of agricultural products on income inequality decrease that because of making some econometric problems have not been entered in model. So in this model investment in rural education and agricultural R&E by having the biggest coefficients have more significance and are more effective on income inequality decrease.

Estimating Error Correction Model (ECM)

In econometric methodology ECM first was introduced by Sargan (1964) and then became

Table 3: Gained results of estimating ARDL (1, 0, 0, 0, 2, 2, 0) long-run relation

t-statistic	Standard deviation	coefficient	Variable name
-2.45	0.35	-0.86	LTFP
-2.47	0.021	-0.052	LLI
-3.82	0.027	-0.091	LR&E
-3.83	0.021	-0.081	LIRE
-5.82	0.015	-0.073	LROAD
-2.04	0.055	-0.121	LEDU
-1.40	1.87	-2.58	C
2.19	0.0023	0.005	T

Table 4: Estimation results of Error correction model of Ahlowalia Hypothesis

Standard deviation	coefficient	Variable name
0.59	1.31	dLTFP
-0.032	-0.065	dLLI
-0.033	-0.10	dLR&E
-0.015	-0.033	dLIRE
0.016	0.042	dLIRE1
-0.025	-0.034	dLROAD
0.026	0.07	dLROAD1
-0.021	-0.08	dLEDU
-2.59	-3.61	dC
0.005	0.007	dT
-0.21	-0.77	Ecm(-1)
F=8.7	DW=2.1	R^2=0.78

famous by Engel-Granger (1987). Having covergency among economic variable is the base of using Error Correction Models. In fact, Error Correction Model relates short-run fluctuations of variables to long-run amounts. In order to study short-run relations among rural inequality and other studied variables, we used ECM. Gained results of model are in table 4.

As you see, income inequality of rural sector has meaningful relation (in 5% level of confidence) with the difference of all variables except constant. Estimated coefficients signs are according to theoretical principles. The coefficient of Error Correction (ECM (-1)) is meaningful and it`s sign is negative and according to expectations. The amount of it, is -0.77. It means about 77% of variations of income inequality in rural sector are balanced with long-run balance amount after passing a period. Also it showed modification speed of model is high and policies can be effective in short-run. This suitable speed for modification makes favorable basis for enforcing income inequality decrease policies (rural Gini coefficient decrease) as the policy of increasing infrastructure costs by government.

CONCLUSION

Results show there is a negative and meaningful relation between agricultural TFP and income inequality in rural and agricultural areas of Iran. In this direction, key variables as literacy rate, investment costs in watering installations, R&E investment costs in rural electrification with agricultural total factor productivity are independent variables of Ahlowalia linear model in rural areas of Iran. According to results, additional investments on rural education and agricultural R&E have significance and different impacts on income inequality. Results show investing on literacy rate in rural areas because of having high elasticity coefficient in long-run has the most influence on income inequality decrease among development and infrastructure costs. Findings showed Ahlowalia hypothesis developed for the relation among income inequality, TFP and investment in electricity is not rejected in case of Iran`s rural areas. According to gained results, for decreasing income inequality in rural areas of country following recommendations are necessary.

1- Since income inequality in rural areas depends on agriculture and agriculture related affairs to make a living, agricultural R&E is one of efficient ways in improving agricultural productivity. Investment in agricultural R&E not only increases production growth but also decrease income inequality. So government should have more investment in agricultural researches and support private sector affairs in this direction.

2- Investment in education in human capital should expand by government and people`s structures to have income inequality decrease in rural areas, because according to the results of research, literacy rate effect on increasing labor`s skill and efficiency and finally on decreasing in-

come inequality is so meaningful.

3- According to results development and infrastructure investments in watering lead to rural inequality decrease. So government should pay more attention to this kind of investment to decrease rural inequality.

4- Building suitable roads for rural areas of country is one of basic reasons for increasing farmers income and there fore, income inequality decrease in these areas. So increase in investment volume of rural roads is recommended.

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