PRINT: ISSN 0971-8923 ONLINE: ISSN 2456-6756
J Soc Sci, 42(1,2): 175-181 (2015)
DOI: 10.31901/24566756.2015/42.1,2.19

Impact of Public Investment in Irrigation Projects on Food Grain Productivity

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KEYWORDS Public Investment. Irrigation. Food Grain. Productivity. PDL Model

ABSTRACT The behaviour of agricultural investment inspired to investigate the true relationship between public investment and agricultural productivity. The present study attempted to examine the nature and extent of disparity in public investment in major and medium irrigation projects across states and to examine the long-run effect of public investment in major and medium irrigation in food grain productivity across the major states of India. The analysis showed that disparity among the states on the basis of expenditure on per hectare of gross cropped area in each state was marginally increased over the plan periods. The results obtained from Polynomial Distributed Lag (PDL) model showed that in Andhra Pradesh, Karnataka, and Orissa, a lag of six years was observed in attaining the 100 percent effect of public investment (major and medium irrigation) on food grain productivity while in Gujarat a lag of 9 years was observed. In Kerala, a lag of 11 years, Maharashtra and Rajasthan a lag of 7 years was observed. West Bengal, Punjab and Assam, a lag of 12 years was observed for realising the 100 percent effect of public investment in major and medium irrigation on food grain productivity.

INTRODUCTION

Availability of adequate, timely and assured irrigation is a critical determinant of agricultural productivity. Over the past, huge amounts have been directly invested by the public sectors in various major and medium irrigation works. The public investment in (medium and major) irrigation takes some time lag in imparting its effect on agricultural productivity. In India, more than 80% of the total public expenditure in agriculture is constituted by major and medium irrigation and about 75% of total irrigated area is under food grains, therefore, examining the long-term impact of public investment in major and medium irrigation on food grain productivity would be more rational.

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Objective

The present study attempted to examine the nature and extent of disparity in public investment (in major and medium irrigation) among major states and to examine the long-run effect of public investment (in major and medium irrigation) on food grain productivity in important food grain producing states of India.

Literature Review

Nelson (1964) and Feder et al. (1985) noted that public investment is necessary to promote technology adoption, stimulate complementarities on-farm investment and input use. Chakravarthy (1993) argued that in India, the role of the State as an investor is the compulsions arising from the existing climatic and demographic characteristics requiring different types of investment including yield-increasing investments like irrigation, fertilizers, better seeds, etc. which makes State intervention essential. He also suggested that transforming traditional agriculture means increasing public investment. Antholt (1994) justified public investment in basic infrastructure, human capital formation and research and development as necessary conditions for private investment. Roy and Pal (2002), examined the relationship between investment and productivity for the period from 1965-66 to 1998-99 using a simultaneous equation model. The authors observed that both public and private investments have positive relationship with agricultural productivity. They also explored that the effect of investment on productivity is stronger than the effect of subsidies. However, Golait and Lokare (2008) found that in India, public investment in agriculture has been loosing its share over time, more rapidly since the 1990s and compounded by inadequacy of farm credit. Inadequacy of new capital formation has slowed the pace and pattern of technological change and the infrastructural development with adverse effects on agricultural productivity. Songqing et al. (2012) the study provides strong support for continuing investment in irrigation infrastructure in India. Besides, the analyses in the present research does not identify the reasons why irrigation is more effective in some state than in others. Understanding the factors behind the heterogeneous impacts of irrigation across states is important for ensuring the optimal allocation of irrigation investment funds and is a topic for future research. Pandey et al. (2012) highlighted the need for strengthening the non-farm employment and income opportunities along with the improved farm productivity through resource diversification towards high-value crops like fruits and vegetables. Region-specific development strategies of generating non-farm activities along with improving land productivity are required for reducing rural poverty in Uttar Pradesh. The policy imperatives include public investment in irrigation and incentives to encourage agricultural diversification and intensive-use of inputs like fertilizer. Nadeem et al. (2012) examined the relationship between productivity in agriculture and investments in agricultural research, extension, irrigation, and rural roads in Punjab province, Pakistan. Results mentioned that agricultural research has a significant and positive impact on productivity with a long-run elasticity of 0.24; and the marginal internal rate of return to research is 27%. Public investments in agricultural extension, rural roads, and irrigation are also significant. Granger-causality tests show a unidirectional relationship from research to productivity. Beyene et al. (2012) used a dynamic PEP type Computable General Equilibrium (CGE) model calibrated on an updated version of the 2005 SAM. Public investment increases the supply of skilled agricultural labour and that of irrigated land by transforming unskilled labour and non-irrigated land. Two types of technologies are utilized in agriculture: a more productive technology that is intensive in skilled labour and irrigated land and a less productive technology that is intensive in unskilled labour and non-irrigated land. Financing such investment plans may require an alternative allocation of public resources and a different financing mechanism.

The dynamic effect of any intervention has been one of the most researched topics relating to various instruments. Most of the publications involve the use of distributed lag econometric models (Palda 1965; Tull 1965; Doyle 1968; Bass and Clarke 1972; Clarke 1976; Parsons 1976) highlighting the delayed response of target to interventions. Some of the more recent applications of distributed lag models on the effects of advertising to sale are the publication of Mela et al. (1997) and Pieters and Bijmolt (1997).

Rufino (2008) applied PDL model to assess the lagged effect of TV advertisement on sale and he found that among the fitted PDL models appears to be the best-fitting model among the eight alternatives tested. Fouda (2010) examined how the effects of various variables of economic policy spread on Cameroonian growth over the years. He found that investment and foreign direct investment (FDI) had a positive impact on economic growth. The effect of FDI is seemed significant only with polynomial distributed lag model. He also found out that in the presence of government expenditures, the effect of investment on growth is appeared negative after one year due probably to the existence of eviction effect. Lotz and Pouris (2013) examined this relationship specifically in South Africa for the period 1980–2008. Using the autoregressive distributed lag method; they investigated the relationship between gross domestic product (GDP) and the comparative research performance of the country in relation to the rest of the world. The results of this study indicated that in South Africa for the period 1980–2008 the comparative performance of the research output can be considered as a factor affecting the economic growth of the country. In contrast, economic growth did not influence the research output of the country for the same period (Higgs and Worthington 2014). The present paper models the price and income elasticity of retail finance in Australia using aggregate quarterly data and an autoregressive distributed lag (ARDL) approach. The researchers particularly focussed on the impact of the global financial crisis (GFC) from 2007 onwards on retail finance demand and analyse four submarkets.

The popularity of Koyck model lies not only on its intuitively appealing notion that the effect of an intervention is highest at the time it is made and gradually diminishes over time, but also on its ready transformation into a simple autoregressive model. Other model commonly employed in examining the sale response to advertisement is the Almon (polynomial distributed lag) model. The Almon lag scheme provides a more flexible method for reduced parameterization. The basis of the approximation is a function continuous in a closed interval may be approximated over the whole interval by a polynomial of suitable degree, which differs from the function by less than any given positive quantity at every point of the interval.

This behavior of agricultural investment inspires to investigate the true relationship between public investment and agricultural productivity. Most of the studies emphasized on the role of public investment as a major factor in determining agricultural production and productivity. However, an in-depth analysis of the long-run relationship between public investment in creating irrigation potential and productivity received very little attention.

DATA AND METHODS

The study is based on state-wise time series secondary data published by Central Statistical Organization and Reserve Bank of India on public investment in major and medium irrigation. The state-wise time series data of investment at current price was converted to constant price base year 2003-04 using gross domestic product (GDP) deflator. The state-wise time series data on food grain productivity was obtained from sources like Centre for Monitoring Indian Economy (*Indian Harvest*) online database, *Indiastat* online database and Directorate of Economics and Statistics, Ministry of Agriculture. The study included major food grain growing states which cover about 90 percent area under food grains. The year-wise average food grain productivity and per hectare expenditure on irrigation projects was used for different plan periods starting from Fifth to Tenth Five Year Plan viz. 1974-75 to 1979-80, 1980-81 to 1984-85, 1985-86 to 1991-92, 1992-93 to 1996-97, 1997-98 to 2001-02 and 2002-03 to 2006-07.

It is assumed that for a balanced growth of agricultural development among the states, it is necessary to mitigate the regional imbalances. Thus, the public funds must be allocated on equitable basis across various states. As a measure of inequality, Gini (G) coefficient was computed for different plan periods, which shows the mean of absolute differences between all pairs of individuals.

$$G = \frac{2}{n^2 \bar{x}} \sum_{i=1}^{n} i(x_i - \bar{x})$$

For $x_1 \le x_2 \le x_3 \ldots\ldots\ldots \le x_n$

Where, x is an observed value, n is the number of values observed and is the rank of values in ascending order. The Gini coefficient takes on values between 0 and 1 with zero interpreted as no inequality. Further, it is hypothesized that the public investment in (medium and major) irrigation takes some time lag in imparting its effect on agricultural productivity.

Long-run impact of public investment in (medium and major) irrigation on food grain productivity, non-stationarity in time series variables was tested using Augmented Dickey Fuller (ADF) test. If the variable has no unit root, then they are stationary and if it has unit roots, then differencing the variable could make it stationary. The stationary (differenced) data series were used to determine the number of lags using Polynomial Distributed Lag (PDL) [Almon, 1965] model.

Firstly, the researchers postulate the distributed lag model (Gujarati (2003) as:

$$Yt = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \beta_3 X_{t-3} + e_t \quad \text{—(1)}$$

Also, assume the âi can be approximated by a second-degree of polynomial in i, the length of the lag, explicitly, it is assumed that there exist parameters 0, 1,..., p such that

$$\beta_1 = \gamma_0 + \gamma_1 i + \gamma_2 i^2 + \ldots.. + y, i^p$$

It means
$$\beta_0 = \gamma_0$$
$$\beta_1 = \gamma_0 + \gamma_1 + \gamma_2$$
$$\beta_2 = \gamma_0 + 2\gamma_1 + 4\gamma_2$$
$$\beta_2 = \gamma_0 + 3\gamma_1 + 9\gamma_2$$

for $i = 1,2,...,m$ (with $p < m$). This assumption essentially reduces the number of parameters of (1) from $m + 1$ to $p + 1$.

Through substituting into distributed-lag model and transformation, it becomes

$Y_t = \alpha + \gamma_0 X_t + (\gamma_0+\gamma_1+\gamma_2)X_{t-1} + (\gamma_0+\gamma_1 2+\gamma_2 4)X_{t-2} + (\gamma_0+\gamma_1 3+\gamma_2 9)X_{t-3} + e_t$ —(2)

or $Y_t = \alpha + \gamma_0 (X_t + X_{t-1} + X_{t-2} + X_{t-3}) + \gamma_1 (X_{t-1} + 2X_{t-2} + 3X_{t-3}) + \gamma_2 (X_{t-1} + 4X_{t-2} + 9X_{t-3}) + e_t$

or $Y_t = \alpha + \gamma_0 Z_{0t} + \gamma_1 Z_{1t} + \gamma_2 Z_{2t} + e_t$

where Z_i variables are constructed by using the various lagged values of X_i

$Z_{0t} = X_t + X_{t-1} + X_{t-2} + X_{t-3}$

$Z_{1t} = X_{t-1} + 2X_{t-2} + 3X_{t-3}$

$Z_{2t} = X_{t-1} + 4X_{t-2} + 9X_{t-3}$

Further, imposing the restriction will lead to more efficient estimates and more powerful tests if the restriction is true. The possibility of a false restriction is notable when there is no lag present; hence we can not apply PDL model unless there is a strong *a priori* reason to believe that a lag structure in the relationship is present.

In implementing the PDL model, the challenge lies in the choice of the appropriate *m* (or the maximum duration of the intervention) and *p* (the degree of the polynomial). Another contentious issue in the use of the PDL model refers to the imposition of the so-called "end points" constraints. Unfortunately, no convincing reason has ever been advanced as to why these constraints are true, except perhaps to terminate the effect after the maximum duration. Almon (1965) merely stated, without explanation, that we will "always" want to impose these constraints. It is mentioned in the literature that user may impose or forego for any of the end point constraint. The goodness-of-fit indicators are unanimous in affirming the superiority of the model. Even the Durbin-Watson statistics indicated the absence of serial correlation. Besides, LM test was applied, if calculated LM test statistics exceeds the critical chi-square value, one can reject the hypothesis of no serial correlation up to lag order 1 at the 95% confidence level.

RESULTS AND DISCUSSION

Nature of Disparity in Public Expenditure among States

It was assumed that the public expenditure may be done in proportion of gross cropped area in each state. To examine the disparity in public expenditure on major and medium irrigation projects among states, Gini's ratios were computed for different plan periods and presented in Table 1. The analysis shows that disparity among the states on the basis of expenditure on per hectare of gross cropped area in each state has increased over plan periods. The analysis of coefficient of variation also confirms the findings of the Gini's ratios.

Long-term Effect of Public Investment on Food Grain Productivity

To examine the long-term effect of public expenditure in major and medium irrigation on food grain productivity, Polynomial Distributed Lag (PDL) Model was applied. Public expenditure per hectare of gross cropped area and average food grain productivity were used as independent and depended variable, respectively in the analysis. The stationarity series was tested with ADF test and both the series were stationary at first difference. It was observed that in four states namely, Bihar, Haryana, Madhya Pradesh, Tamil Nadu and Uttar Pradesh, has no lag structure in the relationship, thus, ADL model was not applicable in such cases. The selection of polynomial degree was taken where the value of Z_i changes the sign. The selection of "end point" was considered by observing the significance of âi and the change of sign.

The results informed that in Andhra Pradesh, there was a lag of six years in attaining the 100 percent effect of public expenditure in major and medium irrigation on food grain productivity (Table 2). The value of R^2 was 89 percent. DW

Table 1: Measurement of disparity among states over Five Year Plan periods (Expenditure on Major and Medium Irrigation (Rs/ha))

	V Plan	*VI Plan*	*VII Plan*	*VIII Plan*	*IX Plan*	*X Plan*
Mean Rs/ha	333.53	436.29	530.20	575.10	662.77	979.94
Gini Ratio	0.3636	0.3979	0.3902	0.4268	0.4342	0.4945
C.V.	79.87	89.52	84.23	93.41	96.62	103.02

Table 2: Lag effects of public investment in irrigation on food grain productivity in Andhra Pradesh, PDL (m=6, p=2) model

Lag	β_{ii}	*t*	*wi*	*Cumulative*
X_t	0.13	1.77*	5.26	5.26
X_{t-1}	0.19	7.57*	7.69	12.96
X_{t-2}	0.41	5.56*	16.6	29.55
X_{t-3}	0.53	5.24*	21.46	51.01
X_{t-4}	0.54	5.21*	21.86	72.87
X_{t-5}	0.44	4.59*	17.81	90.69
X_{t-6}	0.23	1.96*	9.31	100
Sum of â's	2.21	5.13*		
R square	0.89			
DW stat	2.14			
LM Test	1.97			

was 2.14 and LM test value was 1.97 which is less than the value of (.95, 1) indicates that there is no serial correlation up to lag order one. In Assam, a lag of twelve years was observed (Table 3). The value of R^2 was 83 percent, DW was 2.02 and LM test value was 0.04. In Gujarat state, a lag of 9 years was observed (Table 4). The value of R^2 was 59 percent. DW was 2.11 and LM test value was 0.11 which indicated that there is no serial correlations up to lag order one. Karnataka state indicates a lag of 6 years for realising the full effects of public expenditure on food grain productivity (Table 5). The value of R^2 was 61 percent. DW was 2.08 and LM test value was 2.67. In Kerala, lag of 11 years was observed in attaining the 100 percent effect of public expenditure in (major and medium) irrigation on food grain productivity (Table 6). The analysis showed that in the effect of public expenditure on food grain productivity was slow but positive. The value of R^2 was 86 percent. DW was 1.80 and LM test value was 0.15. There was a lag of 7 years in attaining the 100 percent effect of public expenditure in (major and medium) irrigation on food grain productivity in Maharashtra (Table 7). The value of R^2 was 48 percent. DW was 2.19 and LM test value was 2.19. There was a lag of 6 years in Orissa (Table 8). The value of R^2 was 48 percent. DW was 2.12 and LM test value was 0.28 which is less than the value of (.95, 1), that is, 3.84 indicated that there is no serial correlation up to lag order one. In Punjab, there was a lag of twelve years (Table 9). The

Table 3: Lag effects of public investment in irrigation on food grain productivity in Assam PDL, (m=12, p=2) model

Lag	β_i	*t*	*wi*	*Cumulative*
X_t	0.19	2.27*	9.2	9.2
X_{t-1}	0.14	2.67*	7.01	16.21
X_{t-2}	0.11	3.26*	5.35	21.56
X_{t-3}	0.09	3.22*	4.22	25.78
X_{t-4}	0.07	2.44*	3.62	29.4
X_{t-5}	0.07	2.07*	3.54	32.95
X_{t-6}	0.08	2.25*	4	36.95
X_{t-7}	0.1	3.06*	4.98	41.92
X_{t-8}	0.13	5.01*	6.49	48.41
X_{t-9}	0.18	8.45*	8.52	56.93
X_{t-10}	0.23	7.98*	11.09	68.02
X_{t-11}	0.29	5.71*	14.18	82.2
X_{t-12}	0.37	4.45*	17.8	100
Sum of â's	2.06	7.22*		
R square	0.83			
DW stat	2.02			
LM Test	0.04			

indicates significant at 1 %: indicates significant at 5%

Table 4: Lag effects of public investment in irrigation on food grain productivity in Gujarat, PDL (m=9,p=2) model

Lag	β_{ii}	*t*	*wi*	*Cumulative*
X_t	0.06	1.31*	13.14	13.14
X_{t-1}	0.04	1.34*	9.72	22.86
X_{t-2}	0.03	1.33*	7.32	30.19
X_{t-3}	0.03	1.90*	5.95	36.14
X_{t-4}	0.02	1.84*	5.59	41.72
X_{t-5}	0.03	1.98*	6.25	47.97
X_{t-6}	0.03	1.21*	7.93	55.91
X_{t-7}	0.05	1.27*	10.64	66.54
X_{t-8}	0.06	1.35*	14.36	80.9
X_{t-9}	0.08	1.03*	19.1	100
Sum of â's	0.42	3.70*		
R square	0.59			
DW stat	2.11			
LM Test	0.11			

indicates significant at 1 %: indicates significant at 5%

Table 5: Lag effects of public investment in irrigation on food grain productivity in Karnataka, PDL (m=6,p=2) model

Lag	β_{ii}	*t*	*wi*	*Cumulative*
X_t	0.02	1.17*	3.62	3.62
X_{t-1}	0.05	1.18*	9.8	13.42
X_{t-2}	0.1	1.79*	18.54	31.96
X_{t-3}	0.12	1.53*	22.61	54.57
X_{t-4}	0.11	1.46*	21.99	76.5
X_{t-5}	0.09	1.31*	16.7	93.26
X_{t-6}	0.03	1.42*	6.74	100
Sum of â's	0.51	2.70*		
R square	0.61			
DW stat	2.08			
LM Test	2.67			

indicates significant at 1 %: indicates significant at 5%

Table 6: Lag effects of public investment in irrigation on food grain productivity in Kerala, PDL (m=11,p=2) model

Lag	β_{ii}	*t*	*wi*	*Cumulative*
X_t	0.05	2.25*	8.88	8.88
X_{t-1}	0.03	2.56*	6.88	15.76
X_{t-2}	0.03	2.71*	5.46	21.22
X_{t-3}	0.02	2.39*	4.6	25.82
X_{t-4}	0.02	2.07*	4.31	30.13
X_{t-5}	0	2.08*	4.59	34.72
X_{t-6}	0.03	2.50*	5.44	40.15
X_{t-7}	0.03	3.38*	6.86	47.01
X_{t-8}	0.04	4.51*	8.84	55.85
X_{t-9}	0.06	4.93*	11.4	67.25
X_{t-10}	0.07	4.43*	14.52	81.78
X_{t-11}	0.09	3.82*	18.22	100
Sum of â's	0.51	10.08*		
R square	0.86			
DW stat	1.8			
LM Test	0.15			

indicates significant at 1 %: indicates significant at 5%

Table 7: Lag effects of public investment in irrigation on food grain productivity in Maharashtra, PDL (m=7, p=2) model

Lag	β_{ii}	*t*	*wi*	*Cumulative*
X_t	0.18	3.37*	19.59	19.59
X_{t-1}	0.13	4.50*	14.76	34.35
X_{t-2}	0.1	3.18*	11.33	45.68
X_{t-3}	0.08	2.16*	9.31	54.99
X_{t-4}	0.08	1.97*	8.68	63.67
X_{t-5}	0.09	2.22*	9.46	73.13
X_{t-6}	0.1	2.14*	11.64	84.77
X_{t-7}	0.14	1.70*	15.22	100
Sum of â's	0.9	3.66*		
R square	0.48			
DW stat	2.19			
LM Test	0.35			

indicates significant at 1 %: indicates significant at 5%

Table 8: Lag effects of public investment in irrigation on food grain productivity in Orissa, PDL (m=6, p=2) model

Lag	β_{ii}	*t*	*wi*	*Cumulative*
X_t	0.23	2*	12.37	12.37
X_{t-1}	0.24	2.42*	13.32	25.69
X_{t-2}	0.14	2.39*	7.88	33.57
X_{t-3}	0.14	2.28*	7.5	41.08
X_{t-4}	0.26	2.59*	14.47	55.54
X_{t-5}	0.26	2.86*	14.27	69.81
X_{t-6}	0.55	2.68*	30.19	100
Sum of â's	1.83	3.09*		
R square	0.48			
DW stat	2.12			
LM Test	0.28			

indicates significant at 1 %: indicates significant at 5%

Table 9: Lag effects of public investment in irrigation on food grain productivity in Punjab, PDL (m=12, p=3) model

Lag	β_{ii}	*t*	*wi*	*Cumulative*
X_t	0.34	.79*	7.5	7.5
X_{t-1}	0.31	3.00*	6.74	14.25
X_{t-2}	0.27	2.84*	5.91	20.16
X_{t-3}	0.23	2.43*	5.11	25.28
X_{t-4}	0.2	2.46*	4.48	29.76
X_{t-5}	0.19	2.61*	4.12	33.88
X_{t-6}	0.19	2.24*	4.14	38.03
X_{t-7}	0.21	1.95*	4.68	42.71
X_{t-8}	0.27	2.15*	5.83	48.54
X_{t-9}	0.35	3.08*	7.73	56.28
X_{t-10}	0.48	5.11*	10.48	66.76
X_{t-11}	0.65	4.09*	14.21	80.97
X_{t-12}	0.87	2.51*	19.02	100
Sum of â's	4.6	6.68*		
R square	0.79			
DW stat	2.23			
LM Test	0.7			

indicates significant at 1 %: indicates significant at 5%

Table 10: Lag effects of public investment in irrigation on food grain productivity in Rajasthan, PDL (m=7, p=1) model

Lag	β_{ii}	*t*	*wi*	*Cumulative*
X_t	0.5	3.07*	13.83	13.83
X_{t-1}	0.49	4.05*	13.45	27.27
X_{t-2}	0.48	5.61*	13.07	40.34
X_{t-3}	0.46	6.84*	12.69	53.03
X_{t-4}	0.45	5.45*	12.31	65.34
X_{t-5}	0.43	3.70*	11.93	77.28
X_{t-6}	0.42	2.63*	11.55	88.83
X_{t-7}	0.41	.98*	11.17	100
Sum of â's	3.64	6.39		
R square	0.67			
DW stat	2.19			
LM Test	0.24			

indicates significant at 1 %: indicates significant at 5%

analysis shows that in the effect of public expenditure on food grain productivity was slow but incremental. The probable reason for slow effect may be a good private investment in irrigation in the state. The value of R^2 was 79 percent. DW was 2.23 and LM test value was 0.70. In Rajasthan, a lag of 7 years was observed (Table 10). The value of R^2 was 67 percent. DW was 2.19 and LM test value was 0.24 indicates that there is no serial correlation up to lag order one.

CONCLUSION

The analysis showed that disparity among the states on the basis of expenditure on per hectare of gross cropped area in each state was marginally increased over plan periods. The results obtained from PDL model showed that in Andhra Pradesh, Karnataka and Orissa, a lag of six years in attaining the 100 percent effect of public expenditure (in major and medium irrigation) on food grain productivity. While in Gujarat, a lag of 9 year years was observed for realising the full effects of public expenditure on food grain productivity. In Kerala, a lag of 11 years was observed, while in Maharashtra, Punjab and Rajasthan, the lag of twelve and 7 years was observed. In West Bengal and Assam a lag of twelve year was observed for realizing the 100 percent effect of public expenditure on food grain productivity.

RECOMMENDATIONS

The findings of the study recommended that the emphasis must be laid on early completion of major and medium irrigation projects in the states where the lag is higher as major and medium irrigation project is an infrastructural development activity which has long-term effect. In states where lag period is large, private investment on minor irrigation should be encouraged which has direct and immediate positive impact. It is also recommended that cultivators should be encouraged to install micro-irrigation system which is quite effective and resource saving method of irrigation and government also providing subsidy on installation of micro-irrigation system.

REFERENCES

Almon S 1965. The distributed lag between capital appropriations and expenditures. *Econometrica,* 33: 178-196.

Antholt CH 1994. Getting Ready for the Twenty-first Century: Technical Change and Institutional Modernization in Agriculture. *World Bank Technical Paper* No. 217. February.

Bass F, Clarke D 1972. Testing distributed lag models of advertising effects. *Journal of Marketing Research,* 9: 298-308.

Beyene, Mitik L, Engeda E, Hailegiorgis Z 2012. Public Investment in Irrigation and Training for an Agriculture-led Development: A CGE Approach for Ethiopia. *Presented at the 15th Annual Conference on Global Economic Analysis,* Geneva, Switzerland.

Chakravarty S 1993. *Selected Economic Writings*. Oxford: Oxford University Press.

Dickey D, Fuller W 1979. Distribution of estimators for autoregressive time series with a unit root. *Journal of America Statistical Association,* 74: 427-431.

Doyle P 1968. Economic aspect of advertising: A survey. *The Economic Journal,* 78(311): 570-602.

Feder G, Just RE, Zilberman D 1985. Adoption of agricultural innovations in developing countries: A survey. *Economic Development and Cultural Change,* 33: 255-298.

Fouda BB 2010. *Distributed Lag Model and Economic Growth: Evidence from Cameroon.* HAL archives-ouvertes.

Golait R, Lokare SM 2008. Capital adequacy in Indian agriculture: A riposte. *Reserve Bank of India Occasional Papers,* 29(1).

Higgs H, Worthington AC 2014. Price and income elasticity of Australian retail finance: An Autoregressive Distributed Lag (ARDL) Approach, *Australasian Accounting. Business and Finance Journal,* 8(1): 114-126.

Koyck LM 1954. *Distributed Lags and Investment Analysis*. Amsterdam: North Holland Publishing Company.

Lotz RI, Pouris A 2013. The influence of scientific research output of academics on economic growth in South Africa: An autoregressive distributed lag (ARDL) application. *Scientometrics,* 95(1): 129-139.

Mela C, Gupta S, Lehmann D 1997. The long term impact of promotion and advertisement on consumer demand choice. *Journal of Marketing Research,* 34(2): 248-261.

Nadeem N, Mushtaq K, Dawson PJ 2012. Impact of public sector investment on TFP in agriculture in Punjab, Pakistan. *Pakistan Journal of Social Sciences (PJSS),* 33(1): 137-147.

Nelson R 1964. Aggregate production functions and medium-range growth projections. *American Economic Review,* 54(5): 575-606.

Palda K 1965. On the measurement of advertising effectiveness. *Journal of Advertising Research,* 4: 12-16.

Pandey L, Reddy AA 2012. Farm productivity and rural poverty in Uttar Pradesh: A regional perspective. *Agricultural Economics Research Review,* 25(1): 25-35.

Parsons L 1976. A rachet model of advertising carry over effects. *Journal of Marketing Research,* 13(1): 76-79.

Pieters R, Bijmolt T 1997. Consumer memory of TV advertising: A field study of durations, serial position and competition effects. *The Journal of Consumer Research,* 23(4): 362-372.

Roy BC, Pal S 2002. Investment, agricultural productivity and rural poverty in India: A State-level analysis. *Indian Journal of Agricultural Economics,* 57(4): 57(4).

Rufino CC 2008. Lagged effect of TV advertisement on sale of an intermittently advertised product. *De La Salle University Business and Economics Review,* 1.8(1): 1-12

Schmidt P, Waud R 1973. The Almon lag technique and the monetary versus fiscal policy debate. *Journal of American Statistical Association,* 68(341): 11-19.

Songqing J, Winston Yu, Hans GP Jansen, Rie Muraoka 2012. The Impact of Irrigation on Agricultural Productivity: Evidence from India. *International Association of Agricultural Economists, Triennial Conference,* Foz do Iguaçu, Brazil, pp. 18-24.

Tull D 1965. The carry-over effect of advertisement. *Journal of Marketing,* 29(2): 46-53.