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Dynamic Modeling of Private Investment in Agricultural Sector of Pakistan

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1. INTRODUCTION

Agriculture is the single largest sector of the economy of Pakistan, which has a large number of for warding and back warding linkages. This sector is contributing 21 percent to GDP and employing 44 percent of the workforce. Like other developing countries, poverty in Pakistan is a rural phenomenon; therefore, its development will be a principal vehicle for alleviating poverty. Recent global food crises again providing an opportunity for developing countries like Pakistan to give more serious attention to the development of agriculture. There is no doubt that development of agriculture depends on investment in this sector.

Investment is a central issue in macroeconomic theory; it plays an important role in economic growth of a country as it raises the productive capacity of the economy and promotes technological progress through embodiment of new techniques. Investment spending is usually volatile because it depends on multiple factors, and is responsible for much of the fluctuations of GDP over the business cycle [Dornbush, *et al.* (1999)]. Therefore, it is very important to explore the determinants of investment.

The Classicals (Smith, Ricardo, Say, Marshall, and others) maintained that free markets are the best route to national prosperity and economic growth, and there is no need of government intervention to activate and regulate the economy. Keynesians (1936), on the other hand, believed that there is need for government intervention to activate and regulate the saving and investment behaviour of the society.

In the literature it is argued that public expenditures may either crowd-in or crowd-out[1] private investment, therefore, the relationship between public and private investment has received a lot of attention, both in the developed as well as in the developing countries [Hermes and Lensink (2001)]. Public expenditures are generally classified into two categories: development and non-development expenditures. Development expenditures mainly focus on the provision of infrastructure and it's up gradation and hence positively affects private investment. However, non development public

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[1]Crowding-out refers to a fall in private investment because of a rise in public expenditures, whereas Crowding-in means an increase in private investment due to a rise in public expenditures.

expenditures affect private investment positively via the demand channels but may also affect it negatively in terms of budget deficits, future taxes and no complementary effect on investment. In the age of privatisation and deregulation, the governments of developing countries continue to make substantial expenditures on development as well as on the non-development heads.

The so-called crowding-in or crowding-out affect also does not lose its significance in the developing countries even if government enterprises are privatised. A number of studies including Aschaver (1989), Greene and Villanuva (1991), Munnell (1992), Shafik (1992), Oshikaya (1994), Ramirez (1994), Ghura and Goodwin (2000), Mamatzakis (2001) and Rashid (2005) found a positive relationship. However others like Akkina and Celibi (2002), Pereira and Sagales (2001), Williams and Darius (1998) and Wai and Wang (1982) have reported a negative relationship. Thus, there is clearly a need for in-depth analysis of the effects of government expenditures on private fixed investment.

Investment is also sensitive to non-economic variables such as war, political instability and other disturbances both domestic and external. Since such uncertainties are almost impossible to quantify; researchers tend to use only crude proxies to capture the impact of uncertainty on the investment. Empirical studies on the relationship between uncertainties and the private investment are scanty and pertain largely to the United States [Pindyck (1986), Campa (1993), Goldberg (1993), Huizinga (1993), Episcops (1995)]. Studies for United Kingdom include Price (1995) and Henley (1997), and there is only one study for South Africa by Fedderke Johannes (2004). A hand full of cross-country papers including Serven and Solimano (1991), Brunetti and Weder (1997), Serven(1998), Stasavage (2001), Serven (2002) also pertain to developed economies. For the developing countries only Anita and Morisset (1993) and Pattillo (1998) have studied the issue of uncertainty and its effect on investment.

The earlier studies of private investment in Pakistan [Khan (1988) and Naqvi, *et al.* (1993)] estimated disaggregated private investment functions using conventional econometric methodologies. Looney (1997) estimated private investment for large-scale manufacturing applying Engle-Granger (1987) methodology and Naqvi (2002) estimated relationship between aggregate public and private fixed capital formation.

This study attempts to investigate the impact of development public expenditures on private fixed investment in the agriculture sector, as well as capture the effect of macroeconomic uncertainty on the private fixed investment over the period.

Section 2 highlights the investment climate in Pakistan, Section 3 describes the theoretical foundation, the specification of the econometric model and discussed the data issues; Section 4 deals with the estimation methodology; empirical results of unit roots, long run cointegration analysis and dynamic error correction mechanism (ECM) are reported and discussed in Section 5; and finally Section 6 presents the conclusion and policy implications drawn from this study.

2. INVESTMENT CLIMATE IN PAKISTAN

Pakistan was basically an agrarian underdeveloped economy with negligible industrial base and agriculture has been main stay of the economy. After the separation of East Pakistan in 1971, the new government adopted the policy of nationalisation as a result private

investment fell sharply, public investment on the other hand doubled. The military government took over in 1977 and reverses the nationalisation process gradually; as a result the private investment exhibited a positive trend. The accumulation of budget deficits and worsening of BOP in late eighties forced the government to seek IMF assistance in 1987 in the form of Structural Adjustment Programmes (SAPs). In December 1988 new government came to power, however the privatisation efforts did not gain momentum. Prime Minister's economic revival programme announced on 28th March 1997 encouraged the private investment. A new policy for Independent Power Projects (IPPs) was announced in 1998 to create a competitive power market. In 1998-99, a number of incentives were announced to improve investment in the agriculture sector. These included: reduction in prices of tractors and other machinery used for agriculture; increase in support prices of selected agricultural commodities; reduction in sales tax on bulldozers, combined harvesters, other farm machinery and pesticides; and withdrawal of customs duties on agricultural implements. To enable the farmers to avail these incentives availability of credit to the agriculture sector was ensured through increase in per acre credit ceiling for various crops by Agriculture Development Bank of Pakistan; large increase in agriculture credit line for Balochistan; and reduction in the limit of land holding for credit eligibility to purchase tractors.

Pakistan's Investment Policy has been formulated to create an investor friendly environment, with a focus on further opening up the economy and marketing the potential for direct foreign investment. Until 1997 only the manufacturing sector was open to foreign investment. Since 1997 the policy regime has become more liberal foreign investment on repatriable basis is allowed in the Services, Infrastructure, Social and Agriculture sectors. Investment in agriculture sector is allowed in the activities of Land Development/ Reclamation of Barren Land, Desert and Hilly Areas for Agriculture purposes and Crop Farming, Reclamation of water Front Areas / Creeks, Crops, Fruits, Vegetables, Flowers, Farming / Integrated Agriculture (Cultivation and Processing of Crops). Modernisation and Development of Irrigation Facilities and Water Management, Plantation/Forestry, Horticulture, Dairy, Small Ruminants (Sheep and Goats) and all other Livestock Farming and Breeding. The corporate agriculture farming (CAF) package has been introduced in October 2004. Under this package the state land can be purchased or leased for 50 years through open auction, extendable for another 49 years. All banks and financial institutions will earmark separate credit share for corporate agriculture farming. Further more special fiscal incentives including exemption from custom duty, sales tax on import of agricultural machinery has been awarded to encourage investment in agriculture sector.

3. ECONOMETRIC MODEL

Theories of investment indicate that investment is determined by income, interest rate, and macroeconomic environment. Aschaver (1989) conjectured that government expenditures/spending is another variable that plays important role in the determination of investment. The private investment is affected positively by income level; with higher income levels investors would tend to shift more of their wealth to finance investment.[2]

[2]Private investment is positively affected by income level as reported by Chhibber and Wijnbergen (1988) for Turkey, Shafik (1992) for Egypt, Ramirez (1994) for Mexico, Monadjemi (1996) for Australia, Britian and US, Mamatzakis (2001) for Greece, Pereira, and Sagales (2001) for Spain, Akkina and Celibi (2002) for Turkey, Lim and Kim (2004) for Korea and Ouattara Bazoumana (2005) for Senegal.

The interest rate has a negative effect on private investment because when the rate of interest increases the returns on investment decline. Private Investment is considered to be negatively related to uncertainty as the fixed investment decisions cannot be undone if future events turn out to be unfavorable [Dixit and Pindyck (1994)]. Capital once installed is immobile as compared to labour.[3] Public development expenditures provides basic infrastructure to the private sector that prompts private investment. Where as the public consumption expenditures have no complementary effect on private investment, it may build an upward pressure on interest rate or it may be a substitute of private investment. However, these expenditures may have positive effect on private investment via demand channel. Following Ahmad (2007) private investment in agriculture sector can be written as:

$$PIAG_t = F(R_t, Y_t, CG_t, IG_t, UN_t, e_t) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Where

$PIAG_t$ = Real Private Fixed Investment in agriculture
Y_t = Real Gross domestic product
IG_t = Real Public development expenditure
CG_t = Real Public consumption expenditure
R_t = Interest rate (weighted average rate of return on advances)
UN_t = Uncertainty measure (derived by percentage change in the annual inflation rate, where inflation rate is derived from combine consumer price index)
e_t = Random error term assumed to be independent and identically distributed (iid).

Granger representation states that the dynamic (private investment) model can be represented by the error correction mechanism on the assumption that the time series data are non-stationary and presence of cointegrating relationship between the real private investment in agriculture sector and its determinants. The dynamic error correction private investment function in Pakistan can be obtained by using autoregressive distributed lags (ADL) approach, which start as;

$$I_t = \mu + \Pi_1 I_{t-1} + \Pi_2 I_{t-2} + \ldots\ldots\ldots + \Pi_k I_{t-k} + et \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Where I_t is a vector of variables (i.e., $LPIAG_t$, R_t, LY_t, LIG_t, LCG_t) included in the private investment function, μ_t is a vector of deterministic term and e_t is iid disturbance term. The dynamic error correction model (ECM) of the real private investment in agriculture sector can be written as;

$$\Delta I_t = \mu + \sum_{i=1}^{k-1} \Gamma_i \Delta I_{t-i} + \Pi I_{t-k} + \varepsilon_t \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

where

$$\Gamma_i = -I + \Pi_1 + \ldots\ldots + \Pi_i, \qquad i = 1, 2, 3, \ldots\ldots k \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

[3]Capital equipment becomes industry-specific and can hardly be put to another use or productive process or activity without incurring a substantial cost.

and

$$\Pi = -I + \Pi_1 + \ldots\ldots + \Pi_k \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

Under the assumption of non stationary variables and existence of cointegrating relationship between the variables, the $\prod_i I_t$ term is stationary. The $\prod$ is a long run matrix that can be factorised as $\Pi = \alpha\beta'$. The vector β indicates the cointegrating relationship, it has the property that $\beta' I_t$ is stationary, though I_t itself is non-stationary. The vector a is a loading vector with negative expected sign. It gives the speed of adjustment towards the state of equilibrium.

4. ESTIMATION METHODOLOGY

The private investment model for agriculture sector is estimated by using the three steps methodology [Ahmad and Qayyum (20080 and Qayyum (2002)]. These steps include, (i) univariate statistical analysis of a time series, (ii) multivariate co-integration analysis and the estimation of the long-rum private investment function by using the Johansen (1988) maximum likelihood method, and (iii) to obtain a parsimonious short-run dynamic private investment function through the error correction mechanism.

After testing the unit root hypothesis we moved to test the presence of cointegrating relationship(s) between the private investment in agricultural sector and its determinants. For the purpose of cointegration analysis we use trace and maximal likelihood statistics proposed by Johansen (1988). These statistics are asymptotically distributed as χ^2 with r (p-r) degrees of freedom. The critical values are adjusted for small sample as suggested by Cheung and Lai (1993). Johansen (1988) maximal likelihood method is used to estimate long run relationship between private investment in agricultural sector and its determinants.

Finally we estimate dynamic error correction private investment function using general to specific methodology. As all the variables in the model are stationary, this function can be estimated by OLS. The estimation starts with the unrestricted general model, in which every variable enters with optimal lag length. The preferred private investment functions would have to pass a number of diagnostic tests. Such as test the no serial correlation by Godfrey (1981) and White (1980) test of hetroskedasticity. To test the stability of the estimated function we applied CUSUM and CUSUM of Squares tests proposed by Brown, *et al.* (1975).

Definition of Variables and Data Sources

In the study the data on variables including: Private Investment in agriculture (PIAG), Gross Domestic Product (GDP), Public development expenditure (IG), Public Consumption Expenditure (CG), Advancing rate (R), inflation rate (INF) and macroeconomic uncertainty (UN) are used.

Private investment in agriculture (PIAG) is the capital formation that consists of form machinery, implements form house, barns and sheds and land improvement. It also includes non-monetised fixed capital formation, which takes place through agriculturists, his family labour, purchase of service that is paid for in kind and his own material.

Gross Domestic Product (GDP): Gross domestic product is derived from gross output of the economy at market prices i.e., the total flow of goods and services, which are produced during the period. Inflation Rate (Inf): Inflation rate is derived from combine consumer price index (general). Uncertainty variables (UN): this variable is derived by percentage change in the annual inflation rate which is derived from combine consumer price index (general) UN.

The study covers the period 1972 to 2007 and real values series are based on the constant market prices of 1980-81. The data for advancing rate is taken from the State Bank of Pakistan's annual reports, and all other series are taken from different issues of Pakistan Economic Survey of Government of Pakistan.

5. EMPIRICAL RESULTS

We have followed three steps methodology, containing the time series properties of the data, estimation of long run private investment function and a parsimonious error correction private investment function. The results are reported here.

(a) Testing of Unit Roots

The individual series are tested for their order of integration by Augmented Dicky-Fuller (ADF). The data for public consumption expenditure (CG), public development expenditure (IG), Private investment in agriculture (PIAG), inflation rate (INF), interest rate (A) and Gross Domestic Product (GDP) are used in log form. The results show that all variables are integrated of order one i.e. I (1) except UN that is I (0). Appropriate lag length is used so that serial correlation is removed from error term. To confirm these finding of I (1) variables, the ADF test is performed on level as well as on first difference of the series.

The results indicate the presence of unit roots in the original series and taking first differences remove these roots implying that these variables are first differenced stationary where as UN variables is stationary at level. These results provide ground to move to cointegration analysis to estimate the private investment function for agricultural sector.

Table 1

Augmented Dickey-Fuller Test for Unit Roots

Variables Level	ADF-stats	Lag Length	Variables First Difference	ADF-stats	Lag Length	Result
LCG	–1.8929^{C}	1	ΔLCG	–5.7572^{C}*	0	I (1)
LIG	–2.0418^{C}	0	ΔLIG	–6.3662*	0	I (1)
LPIAG	–2.4137^{C}	0	ΔLPIAG	–6.1249*	0	I (1)
LGDP	–1.8033^{C}	0	ΔLGDP	–4.8653^{C}*	0	I (1)
LINF	0.8715	0	ΔLINF	–6.9322*	0	I (1)
LA	–2.4434^{C}	0	ΔLA	–4.0108*	0	I (1)
UN	–6.6425^{C}*	0				I (0)

Note: *Denote significance at 5percent, "c" indicates the constant term is significant; c, t, indicates that both the constant and the trend are significant; I (1), indicates unit root in levels and stationary after first differencing.

(b) The Long-run Private Investment Function for Agriculture

The study analyses the determinants of private investment in agriculture. The rate of return on advances inflation and current public expenditure that have been found insignificant and dropped from the final estimation. The proxy for uncertainty (UN) is to be used in the short-run VECMs under the assumption that investment decisions are likely to be affected by recent uncertainty. This variable captures the instability in the macroeconomic climate.

At this stage the existence of cointegrating relationship between the private fixed investment and its determinants are estimated. Before obtaining the correct model estimation, one must determine the optimal lag structure of the model, i.e. the number of lags that will capture the dynamics of the series. The appropriate lag length of the VAR is one, which is determined by following the Schawarz Bayesian information criteria (SBC) for model selection.

We have investigated the number of cointegrating vectors by applying the likelihood ratio test that is based on the maximum eigenvalue and trace statistics of the stochastic matrix of the Johansen (1988) procedure. The results from the Johansen cointegrated test (both the eigenvalue and the trace test) are presented in Table 2.

Table 2

Johansen Test for Cointegration

Maximum Eigenvalue Test			Trace Test		
Null Hypothesis	Alternative Hypothesis	Test Statistic	Null Hypothesis	Alternative Hypothesis	Test Statistic
r = 0	r = 1	23.10701*	r = 0	r = 1	33.01369*
r = 1	r =2	13.42996	r = 1	r =2	12.79504
r = 2	r = 3	1.192938	r = 2	r = 3	1.043809

Note: * Indicates significant at the 5 percent level.
Variables included in the cointegrating vector: LPIAG, LIG and LYMP.

The likelihood ratio (LR) test indicates one cointegrating equation at 5 percent level of significance in each case. The null hypothesis of zero cointegrating vector is rejected against the alternative of one cointegrating vector. Consequently we can conclude that there is one cointegrating relationships among the variables. Therefore, there exist a unique long run relationship among private investment in agriculture and its determinants. The long-run private investment function presented here is obtained by normalising the estimated cointegrated vector on the private investment (LPIAG). So the results of estimated long-run private investment function for agriculture is reported in the Table 3. The error term is well behaved, it is stationary at level, confirmed by ADF and the white noise is ensured by LM test.

The estimated coefficients of LIG and LGDP have expected signs. The analysis indicates that there is positive long run relationship between private investment in agriculture and public development expenditure. The estimated coefficient of public development expenditure is 0.66, which is positive and significant. It implies the importance of providing basic infrastructure projects to the private sector of the economy as a way to create the appropriate economic environment that prompts private incentives to invest in agriculture sector. Public development expenditures such as the gross fixed

Table 3

Normalised Coefficients of Johansen Test on LPI

Variables	Coefficients	Standard Error	T-value
LIG	0.663136	0.23172	2.86
LGDP	0.288222	0.22619	1.27
Constant	1.466120	–	–

Note: (*) represent significance at 5 percent critical values.

capital formation in construction, electricity and gas and the transport and communication (Railway, post office and T&T plus others) reduces the private sector's cost of production or increases the return to scale and hence raises the profitability of the private fixed investment in agriculture sector. This crowd in private investment activity.

The estimated co-efficient of gross domestic product (GDP) is 0.29 that is positive although insignificant. Positive sign support the idea of accelerator principle in the determination of private investment in agriculture. It may reflect the situation that as income increases; private investment in agriculture sector also increases but the economy transforms from agriculture to non-agriculture sector over time. Therefore, the income effect on private investment in agriculture is not so strong.

(c) Short-run Dynamic Model of Private Investment

After establishing the cointegration relationship an error correction model (ECM) is applied to determine the short-run dynamics of the specified regression model. Following Hendry's approach known as "general to specific" we include different lags variables and error term EC_1 (–1). The error term (EC_1) consists of the residual from the long-run private investment function of the agriculture sector. The results of final estimated parsimonious dynamic error correction model are given in Table 4.

Table 4

Error Correction Model Dependent Variable ΔLPIAG

Variables	Coefficients	Standard Error	T-value
ΔLPIAG(–1)	0.154017	0.149102	1.03
ΔLIG	0.593800	0.212262	2.79
ΔLIG(–2)	0.421257	0.171103	2.46
ΔLGDP(–1)	–1.870573	1.621690	–1.15
ΔLGDP(–2)	4.163521	1.524315	2.73
UN	–0.186779	0.069394	–2.69
EC_1(–1)	–0.290261	0.139408	–2.08
Constant	–0.139728	0.105838	–1.32
R-Square = 0.68		F (8,32) = 6.10	

The error correction term (EC) in the equation is significant with theoretically correct sign. The estimated coefficient of EC indicates that approximately 29 percent of the disequilibrium in the private investment in agriculture is corrected immediately, i.e., in the next year. It suggests a high speed of convergence to equilibrium if there appears a disequilibrating shock.

The coefficient of changes in previous period private investment in agriculture is positive and insignificant, shows that it may have a positive effect on short-term changes in private investment for agriculture.

The changes in public development expenditure such as the gross fixed capital formation in construction, electricity and gas, and the transport and communication, (Railway, post office and t&t plus others) have a significant and large positive effect on short-term changes in private investment in agriculture. The regression results indicate that the public development expenditures have a strong stimulating influence on private investment in agriculture sector in the short, as well as, the long run.

The changes in gross domestic product or income level may have negative but very small adverse effect on private investment in the agriculture sector. But mostly it will have positive and significant effect in short-term changes although in the long run there will be transformation of economy from agriculture to non-agriculture.

The estimated coefficient of uncertainty proxy is –0.19 negative and significant, indicates that macro economic instability and uncertainty adversely affects private investment for agriculture in Pakistan, mainly by creating uncertainty about current and future macroeconomic environment.

6. CONCLUSION AND POLICY IMPLICATIONS

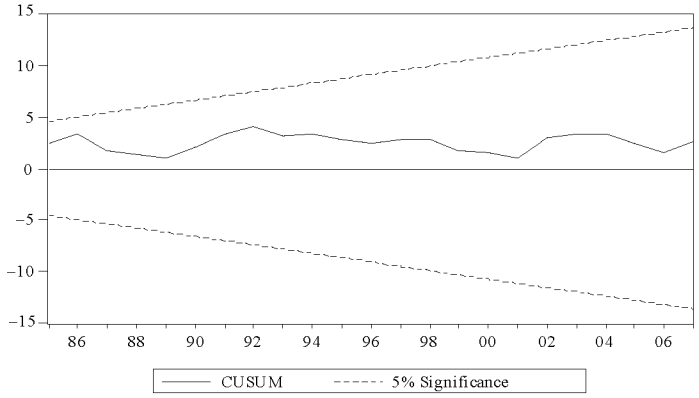
The empirical findings support the proposition that public development expenditures lead to enhance the private investment in agriculture. The implementation of well-targeted public investment in infrastructure projects complements private investment in agriculture and stimulates the private investment activities in agriculture.

Macroeconomic uncertainty is also a determinant of private investment in agriculture. The proxy used captures both political and economic instability. The empirical findings show that Pakistan has been facing the macroeconomic instability and uncertainty and it leads to depress the private investment in agriculture. We can conclude that macroeconomic stability and policy credibility are key ingredients for the achievement of strong investment response. If the policy measures are perceived as inconsistent or suspected to be only temporary, then investors will prefer to wait and see before committing resources to irreversible fixed investment. Therefore, the government should continue the current stabilisation programme to restore macroeconomic stability.

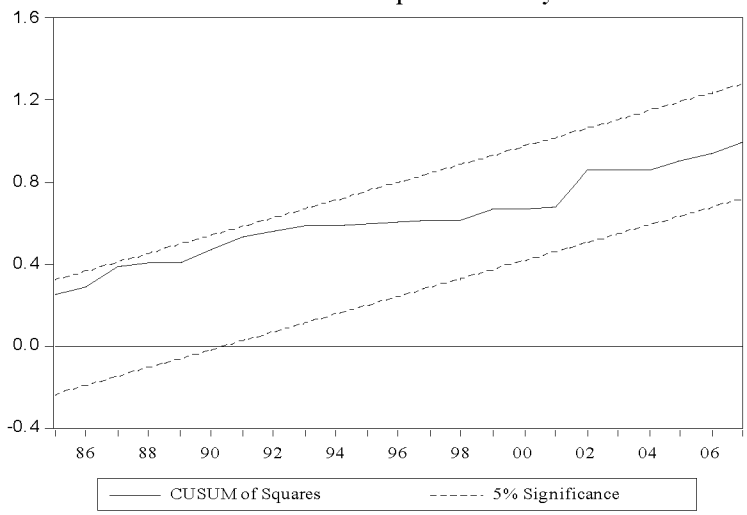
The results of the study also support the vies that private investment accelerates when there is an increase in the income level. It can also be argued that higher the size of market, higher will be the private investment in agriculture.

APPENDIX

Plot of the Cusum Stability Test



Plot of the Cusum of Squares Stability Test



There is no movement outside the critical lines in both tests that shows the coefficients are stable and there is no instability in the model.

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Comments

The paper intended to assess the effects of macroeconomic instability and public expenditures on private fixed investment in agriculture. It is an interesting and well written paper. Model used is well grounded in theory and supported by the results of empirical analysis. Results confirm that public investment expenditures enhance private investment in agriculture. Macroeconomic instability and uncertainty depress private investment by creating uncertain current and future environment.

In their analysis of data, authors have classified public expenditure into development and non-development categories. Development expenditures have, *inter alia,* included the provision of infrastructure and its up gradation. These are supposed to have positive effect on private investment. The non-development public expenditures are supposed to have positive impact via demand channels but may have negative effect through budget deficit, future taxes etc. Nevertheless, these expenditures are not clearly spelled out by authors in the paper. Crowding in increase in private investment due to rise in public expenditures while crowding out is the fall in private investment because of a rise in public expenditures. Some specific comments, in addition to the general ones given above, are arranged by the sections of the paper and are detailed below.

Investment Climate in Pakistan

Opening sentence of the section is somewhat confusing as the reference/time period of the analysis is not clearly mentioned, perhaps authors imply it to be Independence. There is a need for documentation of the measures mentioned in the section.

Econometric Model

Private investment in agriculture defined as a function of: gross domestic production, public development expenditure, public consumption expenditure, and interest rate. But the interest rate whether nominal or real is not known. And uncertainty measure reflected in change in CPI. I wish the authors had included some variable which reflected the returns to investment in agriculture (or some other proxy for it) as well in their estimated functions. The investment in agriculture has to be in response to some opportunities available in the sector itself. But his aspect has been altogether ignored in the analysis. The study period has had many abnormal years in terms of political uncertainty, floods and droughts which may have impacted on private investments and needed to be examined through dummy variables or in some other fashion. There are also many policy developments and shifts, which may have also impacted the private investments in agriculture and needed to be examined in the estimation. It would have been helpful if the authors had provided the data set used in the analysis.

Estimation Methodology

What is the difference between inflation rate and uncertainty variables? Could we capture uncertainty through some variables, other than the CPI, like exchange rate or the gap between nominal and equilibrium exchange rate?

Empirical Results

Discussion is quite pithy and interesting. But the use of resources by the authors is somewhat lopsided: 12 pages for the paper and 7 for references.

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