

# Determinants of Agricultural Sector Growth in Pakistan: A Time Varying Parametric Approach

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## Abstract

This study followed time varying parametric approach with general to specific to find out the determinants of agricultural sector output growth in Pakistan. No such research study was found out in empirical literature that could collect relevant determinants of agricultural sector to employ time varying parametric approach. Annual data was taken from World Development Indicators (2014) from period 1976 to 2014. Rolling regression estimates of explanatory variables justify the use of Kalman filtering approach. The state space results indicate that gross fixed capital formation, permanent cropland and remittances receipt adversely affects agricultural sector growth. Whereas, gross national expenditure is directly related to agricultural sector growth. These findings recommend to enlarge gross national expenditures and motivate investors to make investments in agricultural sector. Farmers should be given incentives to cultivate cash crops for better profits.

**Keywords:** Kalman Filter, rolling regression, gross national expenditure, agricultural sector growth

**JEL Classification:** E22, E51, F41.

## 1 Introduction

Economic growth refers to an increase in level of national income and is measured by GDP growth. It results from increase in productive capacity which is an indicator of economy's capability to produce more goods and services and linked directly or indirectly with our living standard. A higher output growth implies increase income level and hence higher standard of living (Palmer, 2102). Higher economic growth is also linked with increased employment level in the country. Three sectors namely agricultural, industrial and services sector are mainly responsible for overall economic growth of a country. The share of agricultural sector in economic growth was larger as compare to industrial and services sectors in the early years after independence of Pakistan. Agriculture sector is the most important sector and contributing almost 23.4 percent in the economy of Pakistan. The ultimate goal of agriculture sector is to reducing poverty, provide employment opportunity which is real desire of Pakistan.

Pakistan has great potential for producing all types of agricultural commodities. The country has affluent and vast natural resource base, covering various environmental and climatic zones. Agriculture sector has always played an important role in generating the economic growth of Pakistan. The importance of agriculture to the economy of any nation can be seen in three ways: first, it provides food to consumers and inhabitants of the country; second, it is a source of foreign exchange earnings; and third, it provides a market for industrial goods. More specifically; the agricultural sector plays an important part in Pakistan's economy as it contributed 21 percent to the GDP of the country (GOP, 2013), provides food, shares about 60 percent of the country's total export earnings, employment generation [(almost 45 percent of the total work force (GOP, 2013)], main source of livelihood for the rural population and provides raw materials for industries and a market for locally produced industrial products. Effect of structural changes on GDP growth in Pakistan can be explained as: due to political instability during the early years of 1950s gross domestic product was very low. The GDP was stable during 1958-1969 except 1966, 1967 and 1971 (1965 and 1971 war with India) came out in shape of low output. During period of 1972-1988, gross domestic product remained stable. During the period of 1988-1999, continuous change of government affects the GDP and was low during the period. During the period 1999-2008 gross domestic product remained stable.

It will make capable us to recommend policy framework to boost up agricultural sector for better economic growth. There is enough empirical evidence in literature on the determinants of economic growth. However, there is dearth of empirical evidence on sectoral specific determinants of economic growth and this study bridges that gap. The rest of the paper is structured as follows: section 2 reviews the existing literature, methodology, data description and variable construction are given in section 3. Section 4 presents empirical findings, while section 5 presents conclusion of the study.

## 2. Literature Review

Hussain and Ishfaq (1997) analyzed the determinants of agricultural production in Pakistan and found crop area; fertilizers and total tractor supply play a significant role in the determination of agricultural output. The productivity growth in China's agricultural sector for the period 1984 to 1999 and found major source of growth comes from technical progress (Hsu, Yu and Chang, 2003). Odhiambo et al. (2004) examined the determinants

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of agricultural growth and productivity in Kenya. They determined that exchange rate, rainfall, government expenditures, roads, financial development have positive and significant while trade ratio and import penetration negatively affected the total factor productivity of agricultural sector in Kenya. By using a simple economic growth model for the period 1947-2006 Khalidi and Sherazi (2013) analyzed factors affecting agricultural growth in Iran and found labour and capital are main determinants of agricultural growth.

Camella and Burja (2015) investigated the relevant factors of agricultural output in Romania after its integrating into European Union. The authors concluded that utilized agricultural area is the main determinant while Labour input on each hectare and average farm capital on each hectare have less impact on agricultural productivity in Romania. For the period 1965-2009, Ahmed and Heng (2012) estimated determinants of agricultural sector productivity for Pakistan. The authors concluded that fertilizers, human capital, and credit to agricultural sector affected positively and significantly and the effect of area under crops on agricultural productivity were negative. Chebil et al. (2015) applied autoregressive distributed lags (ARDL) method of estimation for annual data from 1980 to 2012 to check the determinants of wheat output in Tunisia. Based on empirical findings they concluded that government expenditures on research and development affected wheat production positively and significantly. Effect of infrastructure development in rural areas like roads etc. and irrigated area for wheat with respect to total cultivated area could not affect wheat output in a positive way in Tunisia.

Enu and Obeng (2013) were to find out the macroeconomic determinants of agricultural output in Ghana. They concluded labour force, real exchange rate and real gross domestic product (GDP) per capita have significant effect on agricultural output. Hamid and Ahmad (2009) analyzed the major factors which were responsible for agricultural growth and productivity and found negative impact of technological change and efficiency on employment generation prospects in agriculture sector of Pakistan. Hye, Shahbaz and Din (2007) explored long-run relationship between output, technological advancement and agricultural terms of trade by using the Nerlovian Supply Response (NSR) model in case of Pakistan. Results show that technological advancement and agricultural terms of trade are important variables for determining agricultural output growth in long span of time. Kiani, Iqbal and Javed (2008) explored the relationship between total factor productivity and agriculture research expenditures for the period of 1970-2004. Results shows that agricultural research expenses, number of tractors, and tube wells have positive and significant impact on total factor productivity. Ahmad, Chaudhary, and Ilyas (2008) analyzed the trends in total factor productivity in Pakistan's agriculture sector and found that the total factor productivity is the most important source of growth.

### 3. Methodology

Over the time, the structure of any economy changes and the constancy of estimated coefficients or parameters are affected significantly by these structural changes. The fixed parametric approaches like ARDL, Engle Granger (1987), Phillips-Ouliaris (1988) and Johansen and Juselius (1988) don't take into account impact of structural changes on estimated constant parameters. It is compulsory to employ a time varying parameter approach to evaluate the impact of structural changes on constant estimated parameters (Gilal and Chandio, 2013). Kalman Filter is applied as a time varying parametric approach. Isaiah et al. (2015) preferred Kalman (1960, 1963) filter estimation strategy than other conventional method of estimation due to following advantages. First, Kalman Filter is an ideal approach as the impact of variables used changes with time (Slade, 1989). Second, Kalman filter is considered to be better than the least squares methods particularly when the parameters are not stable (Morisson and Pike, 1977). Third, this approach of estimation is prognostic and adaptive and it can be applied without checking the stationarity of variables (Inglesi-Lotz, 2011).

Prior to discussing Kalman filter approach, the rolling regression method is used to justify the use of time-varying parameter approach. We used annual data in order to reduce the variability and autocorrelation in the data. This allowed us to avoid having to include autoregressive terms and lagged components of the independent variable, hence keeping the model specification simpler and more interpretable. Annual data were also used in the studies of Moosa (1997) and Viren (2001). Rolling regression parameter estimates were obtained by employing OLS within the rolling regression framework for the period 1976–2014.  $K^l$  was set to 12. The first observation is then dropped and another one added and re-estimated. This process continues until the last observation is used in the analysis. This is in line with the duration of almost one business cycle<sup>2</sup> and is in agreement with the choice of Moosa (1997) and Gilal (2013).

#### 3.1 Data and Model Specification

For the analysis the annual data from 1976-2014 is used. The data is taken from World Bank World

<sup>1</sup> K is used for window size i.e. number of observations in rolling regression

<sup>2</sup> The cycles are of the types :1- the Kitchin inventory cycle having duration of 3 to 5 years , 2- the Juglar fixed investment cycle of duration: 7 to 11 years , 4- the Kuznets infrastructural investment cycle having duration of 5 to 25 years and 5- the Kondratieff wave or long technological cycle with duration of 45 to 60 years (Isaiah:2015).

Development Indicators. The choice of sample is based on two factors (a) disintegration of the country in December, 1971 and (b) data on most of the variables is available after 1975. Since data on most of the variables shows strong trend therefore, it is used in log form. Log transformation linearizes exponential function because log function and exponential are inversely related with each other (Asteriou and Price, 2007). Finally, log transformation allows us to interpret estimated parameters in terms of elasticities.

General model to find out the determinants of agricultural sector growth is as under:

$$y_t^a = \alpha + \alpha_1 cpi_t + \alpha_2 k_t + \alpha_3 gne_t + \alpha_4 rem_t + \alpha_5 to_t + \alpha_6 pcl_t + \alpha_7 gdp_t + \alpha_8 fdi + \varepsilon_t \dots \dots \dots 1$$

Equation (1) focuses upon the factors that affect agricultural sector output growth ( $y_t^a$ ). The regressors included in equation (1) are: inflation ( $cpi_t$ ), gross fixed capital formation ( $k_t$ ), government national expenditures ( $gne_t$ ), remittances ( $rem_t$ ), foreign trade ( $to_t$ ), permanent crops land ( $pcl_t$ ), GDP growth annual percent ( $gdp_t$ ) and foreign direct investment ( $fdi_t$ ).

Specific equation that was estimated in Kalman Filter approach is (2.1) as under:

$$y_t^a = SV_{1t}cpi_t + SV_{2t}k_t + SV_{3t}gne_t + SV_{4t}rem_t + SV_{5t}to_t + SV_{6t}pcl_t + SV_{7t}gdp_t + SV_{8t}fdi_t + [var = \exp(c(1))]. \dots \dots \dots 1.1$$

where

$$\begin{aligned} SV_{1t} &= SV_{1t-1} \dots \dots \dots 1.2 \\ SV_{2t} &= SV_{2t-1} \dots \dots \dots 1.3 \\ SV_{3t} &= SV_{3t-1} \dots \dots \dots 1.4 \\ SV_{4t} &= SV_{4t-1} \dots \dots \dots 1.5 \\ SV_{5t} &= SV_{5t-1} \dots \dots \dots 1.6 \\ SV_{6t} &= SV_{6t-1} \dots \dots \dots 1.7 \\ SV_{7t} &= SV_{7t-1} \dots \dots \dots 1.8 \\ SV_{8t} &= SV_{8t-1} \dots \dots \dots 1.9 \end{aligned}$$

$SV_{1t}$ ,  $SV_{2t}$ ,  $SV_{3t}$ ,  $SV_{4t}$ ,  $SV_{5t}$ ,  $SV_{6t}$ ,  $SV_{7t}$  and  $SV_{8t}$  are time varying coefficients of inflation, gross fixed capital formation, gross national expenditures, remittances received, trade openness permanent cropland,

GDP growth annual percent and foreign direct investment.  $[var = \exp(c(1))]$  is used to show the impact of other factors including structural changes on agricultural sector growth.

#### 4. Results: Determinants of Agricultural Sector Growth

##### 4.1 Rolling Regression:

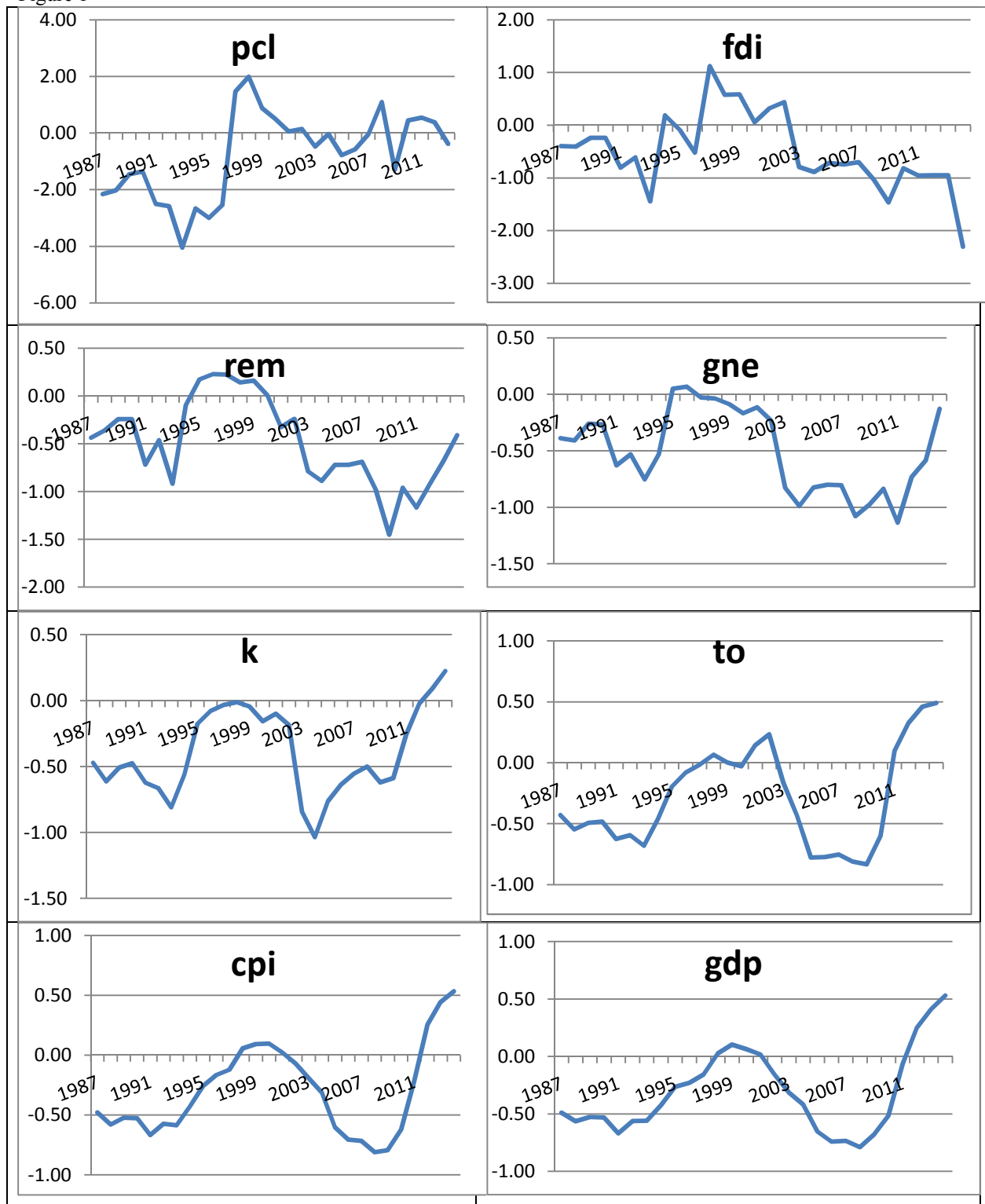
Rolling regression parameter estimates were obtained by employing OLS within the rolling regression framework for the period 1976–2014.  $K$  was<sup>1</sup> set to 12. The first observation then dropped and another one added and re-estimated. This process continues until the last observation is used in the analysis. This is in line with the duration of almost one business cycle<sup>2</sup> and is in agreement with the choice of Moosa (1997) and Gilal (2013).<sup>3</sup> Figures 1 shows rolling regression estimates of permanent cropland ( $pcl_t$ ), foreign direct investment ( $fdi_t$ ), remittances ( $rem_t$ ), gross national expenditures ( $gne_t$ ), gross fixed capital formation ( $k_t$ ), trade openness ( $to_t$ ), inflation ( $cpi_t$ ) and GDP growth ( $gdp_t$ ) with Agricultural Sector growth ( $y_t^a$ ) as dependent variable show some fluctuations thus justifying the use of Kalman filtering approach.

<sup>1</sup> K is used for window size i.e. number of observations in rolling regression.

<sup>2</sup> The cycles are of the types :1- the Kitchin inventory cycle having duration of 3 to 5 years , 2- the Juglar fixed investment cycle of duration: 7 to 11 years , 4- the Kuznets infrastructural investment cycle having duration of 5 to 25 years and 5- the Kondratieff wave or long technological cycle with duration of 45 to 60 years (Isaiah:2015).

<sup>3</sup> Moosa(1997) used 14 observations and Gilal(2013) used 13 observations.

Figure 1



#### 4.2 Kalman Filter Result Estimates: Determinants of Agricultural Sector Growth

Estimation has been made through two models to find out relevant determinants of agricultural sector growth in Pakistan. The results in table (1) indicate that gross fixed capital formation ( $k_t$ ) affects agricultural sector growth ( $y^a_t$ ) negatively and significantly at five percent level of significance. This result is same as our ARDL results and in line with Rehman and Bashir(2015) who used fixed parametric approach to check the impact of

gross fixed capital formation ( $k_t$ ) on agricultural sector growth ( $y^a_t$ ). Impact of gross national expenditures ( $gne_t$ ) on agricultural sector growth ( $y^a_t$ ) is positive and significant at five percent level of significance. This result is in line with Keynesian view that government expenditures increase employment, profitability and investment through multiplier effects on aggregate demand. In ARDL section, gross national expenditures ( $gne_t$ ) were found to have insignificant impact on agricultural sector growth ( $y^a_t$ ).

Impact of remittances received ( $rem_t$ ) on agricultural sector growth ( $y^a_t$ ) is negative and statistically significant at five percent level of significance. In ARDL results, no significant impact of remittances received on agricultural sector growth ( $y^a_t$ ) was found. There is negative and significant at five percent level of significance relationship between permanent cropland ( $pcl_t$ ) and agricultural sector growth ( $y^a_t$ ). Impact of permanent cropland ( $pcl_t$ ) on agricultural sector growth ( $y^a_t$ ) was insignificant when estimation was made by employing ARDL approach. Remaining variables could not show significant impact on agricultural sector growth ( $y^a_t$ ). Impact of other factors including structural changes(c(1)) was found to be negative and significant at five percent level of significant.

**Table 1: Determinants of Agricultural Sector Growth:**

Dependent Variable is agricultural sector growth ( $y^a_t$ )		
Variables	Model :1	Model :2
	Coefficient	Coefficient
C(1)	-8.23(-28.12) <sup>a</sup>	-8.23(-26.89) <sup>a</sup>
$cpi_t$	0.02(1.55)	
$fdi_t$	-0.00(-0.35)	
$k_t$	-0.37(-3.56) <sup>a</sup>	-0.40(-5.15) <sup>a</sup>
$gne_t$	0.99(4.05) <sup>a</sup>	0.93(19.45) <sup>a</sup>
$rem_t$	-0.04(-2.36) <sup>a</sup>	-0.05(-3.89) <sup>a</sup>
$to_t$	-0.00(-0.05)	
$gdp_t$	-0.01(-1.11)	
$pcl_t$	-0.26(-3.68) <sup>a</sup>	-0.28(-13.54) <sup>a</sup>

*a* and *b* show the significance of estimated parameters at five and ten percent significance level respectively. Calculated z statistics are in parentheses.

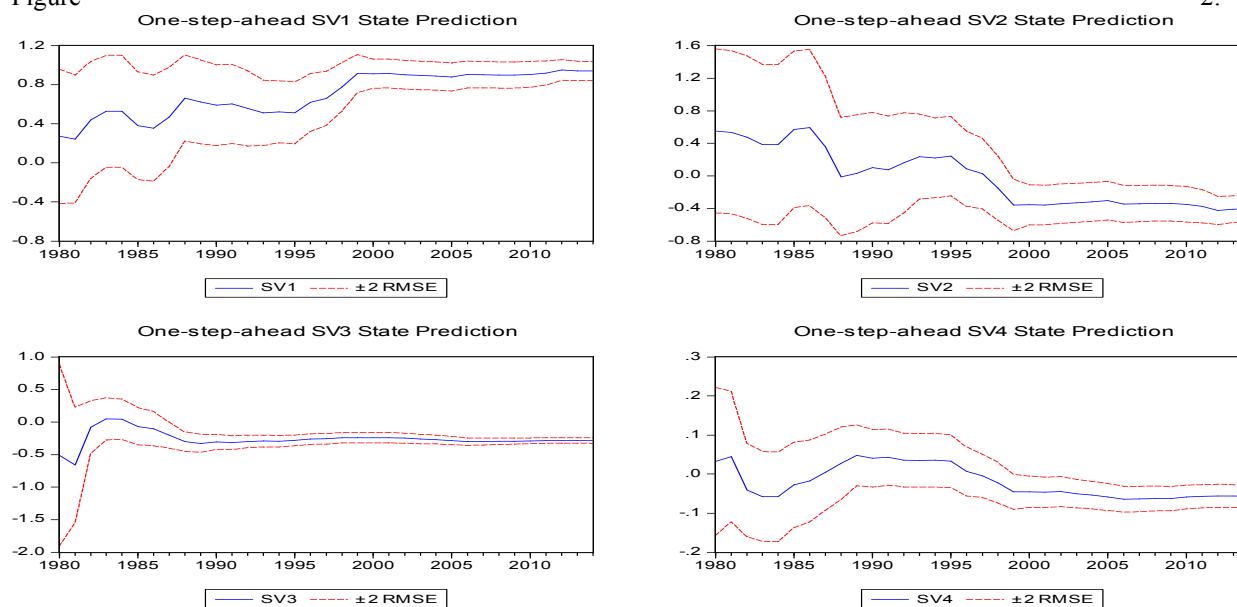
### 4.3 State Space Filtered Graph: Determinants of Agricultural Sector Growth

Figure 2 is representing the graphs of one step ahead of determinants of agricultural sector growth. SV1 represents gross national expenditures, SV2 represents gross fixed capital formation, SV3 represents permanent cropland and SV4 represents remittances received. Figure 2 shows  $\pm$  two standard error time varying parameter estimates, after recursive estimation of gross national expenditures, gross fixed capital formation, permanent cropland and remittances received with Agricultural Sector growth ( $y^a_t$ ) as dependent variable. It is clear from the figure 2 that in the beginning, all the four estimated parameters indicate fluctuation in a greater extent with increasing standard errors. This is due to the reason that additional parameters of interest were estimated with a small number of observations. As the number of observations of parameters of interest to predict t+1 increase, parameters estimated are stabilized and the standard error is reduced accordingly.

If we divide the sample period in Figure 2 into two sub-periods: period from 1976 to 1990 is called before regulation period and period after 1990 is considered the period of reforms and regulations. The results depict that all variables are found to be much instable during the non-reform period while the sample period after decade of 90s is found to be much stable. It is further clear from the figure 2 that estimated parameters are found to be within the range of  $\pm 2$ .

Figure

2:



## 5. Conclusion

The findings of the study are that rolling regression estimates of explanatory variables justify the use of Kalman filtering approach. The results indicate that gross fixed capital formation is significant at five percent level and affects negatively to agricultural sector growth. Impact of gross national expenditures on agricultural sector growth is positive and significant. Impact of remittances received on agricultural sector growth is negative and statistically significant. There is negative and significant relationship between permanent cropland and agricultural sector growth. Based on findings, it is recommended to augment gross national expenditures and motivate investors to make investments in agricultural sector. Government should advise to all commercial banks to issue long-term loans to farmers on low interest rates since many poor farmers are not able to manage to pay for mechanization for cropping. Government should establish more agricultural universities in order to enhance research and development in the sector. Government should subsidize important agricultural inputs such as fertilizer, seeds, and pesticides so that poor farmers may access these inputs easily. Farmers should be given incentives to cultivate permanent crops for better profits. Through print and electronic media, government should brought awareness to the rural farmers about the proper usage of fertilizer, pesticides and other inputs

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