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# Factors Affecting Agricultural Sector Growth in Pakistan: A Structural Vector Auto Regression (SVAR) Analysis

Muhammad Ajmair
Department of Economics, Mirpur University of Science and Technology

Khadim Hussain
Department of Economics, Mirpur University of Science and Technology

**Abstract**
The study followed structural vector auto regression (SVAR) approach proposed by the so-called AB-model of Amisano and Giannini (1997) to find out relevant macroeconomic determinants of agricultural sector growth in Pakistan. Before that ARDL bound testing and TVP approach with general to specific approach were employed to get relevant significant determinants of economic growth. To best of our knowledge no author made such a study in empirical literature that employed above mentioned estimation techniques but current study will bridge this gap. Annual data was taken from World Development Indicators (2014) during period 1976-2014. Akaike information criterion and Schwarz information criterion were considered for the lag length in each estimated equation. Gross fixed capital formation, gross national expenditures, permanent crop land and remittances lead to increase the agricultural sector growth while a positive shock on inflation and population lead to decrease the agricultural sector growth.Based on these empirical findings, we conclude that government should focus on variables augmenting agricultural sector growth while formulating any policy relevant to the concerned sector.
**Keywords**: Structural VAR, Time varying parametric approach, Remittances, economic growth, gross national expenditures and inflation.

## 1. Introduction:

Agricultural, industrial and services sectors are the major components of economic growth of Pakistan. In the very beginning years of Pakistan Independence, contribution of agriculture sector in economic growth was more than industrial and services sectors. With the passage of time, contribution of services sector has increased. Services sector's contribution to economic growth is 58.8 percent, industrial sector has 20.30 percent and agricultural sector has 20.90 percent share (Economic Survey of Pakistan, 2014-15). Both industrial and services sector contribution adds up to approximately 80 percent of overall GDP growth of the country. In such a situation, it is necessary to find out the relevant determinants of agricultural sector growth in Pakistan. It will make capable us to recommend policy measures to boost up agricultural sector for better economic growth of the country. No author has made such study that could collect a number of variables from existing empirical literature and capture the effect of structural changes on relevant determinants of agricultural sector growth in Pakistan while employing general to specific approach. Current study will bridge this gap.

Many empirical studies have focused on determinants of agricultural sector growth in Pakistan. Most often used determinants of agricultural sector growth in these studies are fertilizers, livestock capital, crop capital, agricultural land , labor force, real exchange rate, real GDP per capita, real government expenditure, agricultural research, real international expenditure on agricultural research, real government expenditure on agricultural extension, total rate of government assistance to agriculture, rainfall, share of food crops , infrastructure development in rural areas, irrigated area for wheat with respect to total cultivated area , financial development (credit to agricultural sector), area under crops, import penetration, trade ratio,(Odhiambo et al. (2004) , Ahmed and Heng (2012) , Warr Peter (2012) , Khalidi and Sherazi (2013) , Enu and Obeng (2013) , Chebil et al. (2015) , Camelia and Burja (2015) and Alejandro (2015)). However, none of these studies have evaluated the effect of all factors determined from empirical literature on agricultural sector growth around globe on growth process of the country. No study was found that applied ARDL bound testing approach and time varying parametric approach (TVP) approach with general to specific approach to find out relevant significant determinants of agricultural sector growth in Pakistan. This study bridges that gap. The remaining paper proceeds as: section two includes structural vector auto regression (SVAR) methodologies is described. In section three, data, its sources and construction of variables is given followed by section 4 which discusses the results in detail with the help of impulse response functions and variance decompositions analysis. Section five concludes and references are given at the end of paper.

## 2. Methodology: Structural Vector Auto Regression (SVAR) Analysis:

Before employing the structural vector autoregressive models (SVAR) we estimated the relevant significant determinants of agricultural sector growth through estimation techniques autoregressive distributive lags(ARDL) and time varying parametric approach(Kalman Filter). That estimation is not shown here due to shortage of space.

To check the possible effects of relevant determinants on agricultural sector growth in Pakistan, we employed structural vector autoregressive models (SVARs) proposed by the so-called AB-model of Amisano and Giannini (1997). The benefit of the SVAR methodology instead of the simple unrestricted vector autoregressive (VAR) models is to make researchers capable of using theoretical assumptions in their empirical models by imposing explicit restrictions for the structural relationships. Such a case can be implemented by introducing theoretical restrictions to achieve econometric identification issues. For this purpose, assume that $\sum = E[e_t e_t]$ is the residual covariance matrix. Then, the reduced form model used for the structural analysis can be defined as follows:

$$Ae_t = Bu_t \tag{1}$$

where $e_t$ is the reduced form disturbance vector, while $u_t$ represents the unobserved structural innovation vector, both with a length *k*. Thus, Eq. 1 relates the reduced form disturbances to the underlying structural shocks. The SVAR analysis requires some restrictions for A and B matrices with a dimension $kxk$ to be added. Note that the structural innovations have a covariance matrix $E[u_t u_t] = I$ where *I* represent the identity matrix so that $u_t$ imposes the following restrictions on *A* and *B*:

$$A\sum A = BB \tag{2}$$

We must specify that for the identification of the AB model at least $K^2 + k(k-1)/2 = k(3k-1)/2$ restrictions are needed. If the model is over-identified, the value of a likelihood ratio (LR) statistic will be reported.

**3. Data**

Annual data is taken from World Development Indicators (2015) for the period 1976-2014. All variables were taken as it is from WDI (2015) and converted into log form for final analysis.

After employing general to specific approach in ARDL and Time varying approach, significant determinants of economic growth were found out for structural vector auto regression (SVAR) analysis. These variables were Inflation, consumer prices (annual %) denoted as ($cpi_t$), gross fixed capital formation (% of GDP) denoted as ($k_t$), gross national expenditures (% of GDP) denoted as ($gne_t$), personal remittances received (% of GDP) denoted as ($rem_t$), Permanent cropland (% of land area) denoted as ($pcl_t$) and total population denoted as ($pop_t$).

**4. Estimation Results:**

**4.1. Determinants of Agricultural Sectoral Growth**

An unrestricted vector auto regression (UVAR) model is initially constructed upon endogenous variables. For the lag length of the said model, the Schwarz information criterion suggests the use of lag length 2(table 1). Note that such a lag selection is also supported by the Hannan- Quinn criterion, Akaike information criterion; Sequential modified LR test statistic (each test at 5% level) and Final prediction error. Thus VAR (2) model is estimated.

Table 1: VAR Lag Order Selection Criteria

Endogenous variables: $y_t^a$ , $cpi_t$ , $gne_t$ , $k_t$ , $pcl_t$ , $pop_t$ $rem_t$
Exogenous variables: C
Sample: 1976 2014
Included observations: 36

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | 423.5081 | NA | 2.11e-19 | -23.13934 | -22.83144 | -23.03187 |
| 1 | 706.9161 | 440.8567 | 4.91e-25 | -36.16200 | -33.69875 | -35.30226 |
| 2 | 814.8379 | 125.9088* | 2.57e-26* | -39.43544* | -34.81684* | -37.82343* |

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Certain assumptions are required for identification of the system since the structural shocks cannot be observed directly without identifying restrictions. For this purpose, we apply the structural restrictions to identify determinants of agricultural sector growth ( $y_t^a$ ). Here, agricultural sector growth ( $y_t^a$ ) has been assumed responsive only to own shocks leading it to be the most exogenous variable in the system. Agricultural sector growth ( $y_t^a$ ) is also responsive to inflation, consumer prices (annual %), gross fixed capital formation (% of GDP), gross national expenditures (% of GDP), Permanent cropland (% of land area), total population and remittances received leading it to be the most endogenous variable in the system. More explicitly, the AB model used in this study can be specified as follows:

$$\begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} & a_{15} & a_{16} & a_{17} \\ 0 & 1 & a_{23} & a_{24} & a_{25} & a_{26} & a_{27} \\ 0 & 0 & 1 & a_{34} & a_{35} & a_{36} & a_{37} \\ 0 & 0 & 0 & 1 & a_{45} & a_{46} & a_{47} \\ 0 & 0 & 0 & 0 & 1 & a_{56} & a_{57} \\ 0 & 0 & 0 & 0 & 0 & 1 & a_{67} \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u_t y_t^a \\ u_t cpi_t \\ u_t gne_t \\ u_t k_t \\ u_t pcl_t \\ u_t pop_t \\ u_t rem_t \end{bmatrix} = A$$

$$\begin{bmatrix} b_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{55} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{66} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & b_{77} \end{bmatrix} \begin{bmatrix} e_t y_t^a \\ e_t cpi_t \\ e_t gne_t \\ e_t k_t \\ e_t pcl_t \\ e_t pop_t \\ e_t rem_t \end{bmatrix} = B$$

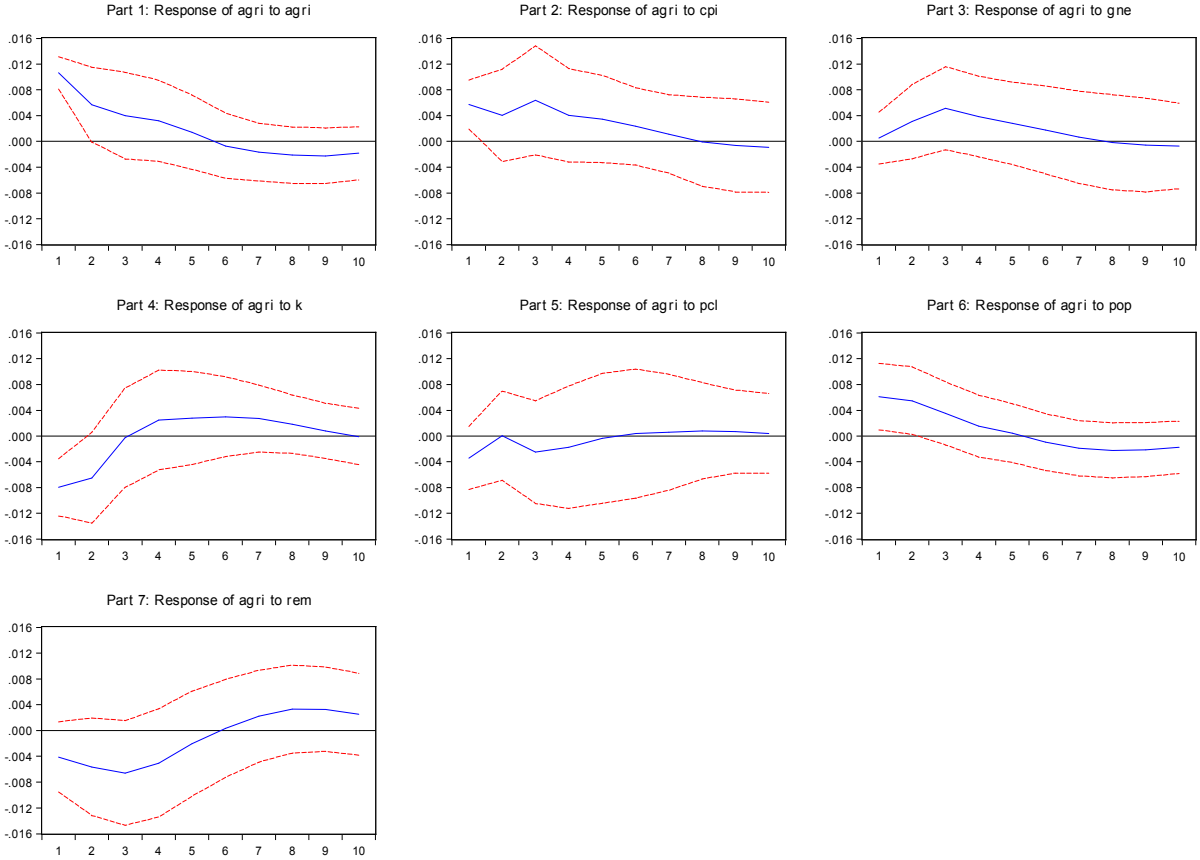
The SVAR system is just identified with 7 degrees of freedom. Note that the structural parameters are estimated by means of maximum likelihood estimator.

### 4.2. Impulse Response Function

The SVAR impulse-response functions of the economic growth in Pakistan using 95% confidence intervals with 1000 bootstrapped replications over a 10 year period suggested by the percentile method of Hall (1992) are given in Fig. 2.

Figure 2: Response to Structural One S.D. Innovations ± 2 S.E.




Part 1 of figure 2 depicts light on response of agricultural sector output growth as a result of shock in agricultural sector growth in itself which is positive in short run to medium run but negative in long run. Part 2 is showing the response of agricultural sector growth to inflation that is negative from short run to long run. The reason of this negative relationship is that an increase in the inflation rate results in a lower steady state level of output; by which people's welfare declines. Part 3 shows that response of growth of agricultural sector output is positive in short run and negative in long run as a result of shock in gross national expenditures. Justification of positive response is that the gross national expenditures increase employment, profitability and investment through multiplier effects on aggregate demand. Thus, gross national expenditures increase can contribute positively to agricultural sector output growth. If the gross national expenditures grow increasingly, the law of diminishing returns begins operating and beyond some point further increase in government expenditures contributes to economic stagnation and decline. Part 4 and part 5 indicate that response of agricultural sector growth as a result of shock in gross fixed capital formation and permanent cropland. In both cases response is negative in short run and positive in long run. Justification of positive relationship between agricultural sector growth and gross fixed capital formation can be presented through these channels: capital formation involves three inter-related conditions; (a) the existence of real savings and rise in them; (b) the existence of credit and financial institutions to mobilize savings and to direct them to desired channels; and (c) to use these savings for investment in capital goods in. If more and more land is cultivated permanently, growth of agricultural sector increases. Response of agricultural sector as a result of shock in population is positive in short run and negative in long run shown in part 6. Reason may be the presence of diminishing rate of returns in agricultural sector. Part 7 is about the negative response of agricultural sector output growth in short run and positive in long run as a result of shock in remittances. This positive response is due to capital accumulation and labor force growth in agricultural sector.

### 4.3. Variance Decomposition:

Table 2:Structural Factorization Variance Decomposition of Agricultural Sector Growth( $y_t$ ):

| Period | S.E. | $y_t^a$ | $cpi_t$ | $gne_t$ | $k_t$ | $pcl_t$ | $pop_t$ | $rem_t$ |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.016594 | 41.07728 | 11.87171 | 0.090690 | 23.00947 | 4.242830 | 13.51932 | 6.188699 |
| 2 | 0.020907 | 33.27584 | 11.15935 | 2.211418 | 24.16576 | 2.673172 | 15.33290 | 11.18156 |
| 3 | 0.024120 | 27.72332 | 15.32376 | 6.167288 | 18.16675 | 3.100519 | 13.62515 | 15.89321 |
| 4 | 0.025685 | 25.98724 | 15.97485 | 7.672094 | 16.95937 | 3.192264 | 12.35908 | 17.85510 |
| 5 | 0.026336 | 25.00771 | 16.90606 | 8.415373 | 17.25010 | 3.056678 | 11.78192 | 17.58216 |
| 6 | 0.026695 | 24.40795 | 17.21327 | 8.613842 | 18.04241 | 2.993864 | 11.60275 | 17.12591 |
| 7 | 0.027080 | 24.10863 | 16.90150 | 8.422997 | 18.52223 | 2.951625 | 11.77642 | 17.31660 |
| 8 | 0.027530 | 23.94157 | 16.35457 | 8.154234 | 18.35839 | 2.936885 | 12.05750 | 18.19684 |
| 9 | 0.027929 | 23.90408 | 15.94233 | 7.964609 | 17.91655 | 2.912340 | 12.29648 | 19.06362 |
| 10 | 0.028186 | 23.90603 | 15.76376 | 7.889432 | 17.59328 | 2.878047 | 12.46476 | 19.50470 |

The variance decomposition analysis is an alternative method to impulse response function (IRF) for examining the effects of shocks to the dependent variables. It determines how much of the forecast error variance for any variable in a system is explained by innovations to each explanatory variable, over a series of time horizons. Usually own series shocks explain most of the error variance, although the shock also affects other variables in the system. From Table 2, the VDC substantiate the significant role played by inflation ( $cpi_t$ ), gross national expenditures ( $gne_t$ ), gross fixed capital formation ( $k_t$ ), permanent crop land ( $pcl_t$ ), total population ( $pop_t$ ) and *remittances received (* $rem_t$ *)* in accounting for fluctuations in economic growth.

At 1 year horizon, the fraction of Pakistani agricultural sector growth forecast error variance attributable to variations in inflation ( $cpi_t$ ), gross national expenditures ( $gne_t$ ), gross fixed capital formation ( $k_t$ ), permanent crop land ( $pcl_t$ ), total population ( $pop_t$ ) and remittances received ( $rem_t$ ) are 11.87%, 0.09%, 23.00%, 4.24%, 13.51 and 6.18%, respectively. The explanatory power of all variables, namely remittances received, gross national expenditures and inflation (consumer prices) increases further at 3-year and longer horizon while explanatory power of gross fixed capital formation, permanent cropland and total population decreases at 3-year and longer horizon. Obviously, at longer time horizon, percentage of forecast variance in agricultural sector growth is largely explained by innovation in remittances received, gross national expenditures and inflation (consumer prices), among other explanatory variables, as these variables maintain higher percentage than the others.

Variance decomposition analysis indicates that over a period of 10 year, nearly 23.90% of the forecast error variance of the agricultural sector growth can be attributed to the own shocks. The results indicate that the variables that best explain the forecast error variance of the economic growth are inflation, gross national expenditures, and remittances received from overseas Pakistanis.

Shocks to the variables like inflation ( $cpi_t$ ), gross national expenditures ( $gne_t$ ), gross fixed capital formation ( $k_t$ ), permanent crop land ( $pcl_t$ ), total population ( $pop_t$ ) and remittances received ( $rem_t$ ) explain 15.76%, 7.88%, 17.59%, 2.87%, 12.46% and 19.50%, variation in agricultural sector growth respectively. When the overall effect of all six relevant determinants has been considered, we come to know that these factors jointly account for 76.10 % of the variation in agricultural sector growth at year ten horizon.

Our estimation results indicate (table 3) that positive shocks on gross fixed capital formation, gross national expenditures, permanent crop land and remittances lead to increase the agricultural sector growth while a positive shock on inflation and population lead to decrease the agricultural sector growth.

Table 3:
Structural VAR Estimates
Sample (adjusted): 1978 2013
Included observations: 36 after adjustments
Estimation method: method of scoring (analytic derivatives)
Convergence achieved after 1 iterations
Structural VAR is just-identified

Model: Ae = Bu where E[uu']=I
Restriction Type: short-run pattern matrix

| $y_t^a$ | $cpi_t$ | $gne_t$ | $k_t$ | $pcl_t$ | $pop_t$ | $rem_t$ |
|---|---|---|---|---|---|---|
| Estimated A matrix: | | | | | | |
| 1.000000 | -0.027340 | 0.000674 | 0.337070 | 0.148590 | -45.01259 | 0.024930 |
| 0.000000 | 1.000000 | -3.047169 | 0.372030 | 1.708971 | -166.5204 | 0.950100 |
| 0.000000 | 0.000000 | 1.000000 | -0.169629 | -0.054512 | -31.08813 | -0.011866 |
| 0.000000 | 0.000000 | 0.000000 | 1.000000 | -0.072085 | 58.48206 | 0.019285 |
| 0.000000 | 0.000000 | 0.000000 | 0.000000 | 1.000000 | -41.90048 | 0.013679 |
| 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 1.000000 | 4.51E-05 |
| 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 1.000000 |
| Estimated B matrix: | | | | | | |
| 0.010635 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.000000 | 0.209122 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.000000 | 0.000000 | 0.006047 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.000000 | 0.000000 | 0.000000 | 0.023887 | 0.000000 | 0.000000 | 0.000000 |
| 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.015910 | 0.000000 | 0.000000 |
| 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 9.74E-05 | 0.000000 |
| 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.095148 |

**5. Conclusion:**

In this paper, we examined the determinants of agricultural sector growth in Pakistan while employing structural vector autoregressive models (SVARs) proposed by the so-called AB-model of Amisano and Giannini (1997). Annual data from 1976 to 2014 was used. The widely-used Schwarz information criterion and Akaike information criterion were considered for the lag length in each estimated equation. Gross fixed capital formation, gross national expenditures, permanent crop land and remittances lead to increase the agricultural sector growth while a positive shock on inflation and population lead to decrease the agricultural sector growth.

Based on these empirical findings, we conclude that government should focus on variables augmenting agricultural sector growth while formulating any policy relevant to the concerned sector. There is need to boost up the role of agricultural sector in economic growth of Pakistan while focusing the relevant sectoral determinants.

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