# Vector Analysis and Fore Casting Agriculture Employment, Human Capital and Employment in Agriculture in South Africa

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**Abstract :** The purpose of this study is to see the influence between agriculture performance, education investment, and employment so that forecasting can be done which can be an illustration of the condition of the influence of the relationship that indicates various things in the three variables in South Africa. The study was conducted using an annual period starting from 2000 - 2019. Using vector analysis and forecasting the influence of the relationship from the results of vector analysis. We find that Agriculture performance in South Africa has decreased continuously in the 8th period in the forecasting chart. If this continues, it can lead to hunger or food dependence on imports. Likewise, the education graph also decreased in period 10. This is very bad because education is an important component in educating the nation's children which has an impact on the development of the human capital of the population in the future. However, employment in agriculture has increased in period 8. This is very strange. The possibility of wrong policies where the number of people working in the agricultural sector should improve agricultural performance. However, what happened was the opposite. More and more people in South Africa are working in the agricultural sector, but the performance of agriculture has actually decreased, coupled with a decrease in investment in education.

**Keywords:** Human Capital, Agriculture, Employment in Agriculture, Vector Analysis.
**JEL Classification :** C01,E24,J24, J43

## 1 INTRODUCTION

President Cyril Ramaphosa in 2018, stuck to a plan to expropriate land from white farmers without compensation and distribute it to the landless black majority. He insisted there would be no land grabs, adding that the policy change would not damage agricultural production or the economy. Lack of clarity on land reform policy proposals, particularly uncompensated expropriation, is a key risk that has the potential to undermine investment and long-term growth prospects in the sector (Reuters2018).

Human capital is a collection of skills and knowledge and experience in completing work to generate income. This is important in the economy. Human capital development is very important in South Africa. This needs to be done to face challenges, especially the challenge of food independence. South Africa with fertile agricultural land needs to be managed properly and must be developed properly. The land of south africa has the potential to produce various agricultural products. It is necessary to strive for food self-sufficiency for the people of South Africa (Ajide & Alimi,2021).

South Africa has a variety of natural potentials that can be used to increase the prosperity of the people of South Africa. South Africa with all its natural wealth should be the capital for South Africa to become a country that continues to grow and prosper. This can be done by increasing food self-sufficiency first, then human capital development in South Africa (Aye & Odhiambo,2021).

## 2 LITERATURE REVIEW

Technology is support in improving human performance. To optimize technology so that it can support and improve human performance, human capital is needed. In South Africa, the transfer of technology from abroad to South Africa is already underway. Agricultural policies were also developed to prosper the local population. However, human capital to develop skills and mastery of technology in South Africa needs to be continuously encouraged (Das & Drine, 2020).

Investment in protecting nature and developing natural sustainability is very important in South Africa. Because the natural beauty and diversity of animals and plants in South Africa is a wealth that must be preserved (Crookes & Blignaut, 2019). This natural preservation can be developed in environmentally friendly agriculture in South Africa and can increase the selling value of environmentally friendly organic agricultural products.

Human capital from immigrants can be assimilated with indigenous people of South Africa and collaborate in the exchange of knowledge so as to form human capital as a

community. Education is developing and it is necessary to encourage education in the form of educational investment in encouraging the development of human capital in South Africa. Investments can be made in the form of human capital investments to improve the quality of human resources. It can also be done to support the business sector in the form of direct investment (Olarewaju & Msomi, 2021).

## 3 RESEARCH OBJECTIVE AND METHODOLOGY

This research begins by conducting a study of the factors that affect agricultural performance. We carry out factor understanding through research conducted previously through qualitative methods in each country. In general, there are two dominant factors that are generally accepted in every country that we have studied, namely the human factor in the form of a collection of skills, experience, and knowledge of humans who become workers in the field of agriculture, labor absorption in the field of agriculture or called work participation and non-human factors in the form of capital and equipment resources and technology availability. In this study, we focus on analyzing human capital which is significantly affected by education and government investment in education. So that it can be generalized that the encouragement of human capital development is in the form of state investment in education. This is a key factor of human capital development. The second key factor is work participation. Employment participation itself reflects the interest of citizens of productive age to work in the agricultural sector. And the last is the performance of the agricultural industry itself.

In this study, we use secondary data from the world bank that we process and use to understand the effectiveness of human capital investment in each country and the interest of educated citizens in the agricultural sector in relation to the performance of the agricultural industry. The research period that we took was adjusted to our research period, which is from 2000 to 2019. We focused on the analysis before the covid-19 pandemic occurred to avoid biasing the analysis results. In accordance with the purpose of this study, namely to analyze the relationship model between the key variables, namely human capital represented by education investments made by the government, work participation in agriculture, and agricultural industry performance. We derive an econometric model with a Vector Autoregressive approach that focuses on phenomena with the assumption that the autoregressive vector model does not differentiate between exogenous and endogenous variables. Therefore, one variable can be an independent variable in an equation and can also be a dependent variable in another equation. The basis for taking the key variables is the theory of human capital which becomes education as a mechanism in developing human capital (Widarni & Bawono, 2021). Where human capital has an impact on human work performance itself. This study using vectors which are generally used in atheory research so that human capital theory is used as a determinant of key factors, not as the basis for econometric equations. The results of the vectoring carried out in this study can be described through the estimation of the IRF (impulse response function) estimation. The next step is to forecast the influence of each variable in the form of a forecasting graph so that it can be seen clearly the combination of the direction of the relationship or the influence of each variable.

Estimation using the VAR model requires all variables to be stationary at the level, if the variables are not stationary at the level, the estimation is carried out using the VECM model with the condition that all variables formed are cointegrated. The test is carried out in three stages, namely testing at the level, 1st difference, and 2nd difference. Each variable is tested starting at the level, if it is not stationary at this level it is continued at the 1st difference level, and if it is still not stationary it is continued to the 2nd difference level. Where in this study to test the stationarity of the data, the Augmented Dickey-Fuller test was used. One of the data stationarity is seen by comparing the alpha value with the probability value. When the probability value is below the alpha value, it can be said that the variable is stationary and vice versa. Because in this study using an alpha value of 5%, the variables that are declared stationary are only variables that have a probability value below the 5% alpha. Cointegration test to see the long-term integration between variables. If there is cointegration between variables, the estimation is made using the Panel Vector Error Correction Model (VECM) method, but if there is no cointegration then the estimation is made using the vector autoregression (VAR) method.

## 4 RESULTS AND DISCUSSION

The table below presents a summary of descriptive statistics of several variables used in this study during the period 2000 to 2019.

**Table 1.** Descriptive statistics of agricultural performance in USD value in January 2021, education (investment in education in USD value in January 2021), and employment in agriculture (total working population).

| | AGRICULTURE_PERFORMANCE | EDUCATION | EMPLOYMENT_IN_AGRICULTURE |
|---|---|---|---|
| Mean | 6.94E+09 | 1.62E+10 | 1.20E+06 |

| | | | |
|---|---|---|---|
| Median | 7.13E+09 | 1.66E+10 | 1.20E+06 |
| Maximum | 9.52E+09 | 2.40E+10 | 1.63E+06 |
| Minimum | 3.91E+09 | 5.85E+09 | 8.85E+05 |
| Std. Dev. | 1.65E+09 | 6.02E+09 | 2.17E+05 |

Based on table 1 above, it appears that from the period 2000 to 2019, the average agricultural performance in South Africa is very high at around 6.9 billion USD which can be seen from the mean value in table 1. with a high level of volatility at 4.73 billion USD. With an average number of workers 1.2 million people with an average educational investment value of 16.2 billion USD. To see a more detailed and careful relationship of influence, vector analysis is carried out, namely Vector Autoregressive. Before estimating using Vector Autoregressive, there are several conditions that must be met from several observed variables, namely Stationarity Test, and Optimum Lag Test. This book will also include a cointegration test to see if there is a long-term relationship between variables and a causality test to see a reciprocal relationship between variables. Estimation using the VAR model requires all variables to be stationary at the level, if the variable is not stationary at the level, the estimation is carried out using the VECM model on the condition that all variables formed are cointegrated with each other where the results are shown in table 2 below:

Table 2. stationarity test

| Method | | | Statistic | Prob.** |
|---|---|---|---|---|
| ADF - Fisher Chi-square | | | 5.91E+01 | 0.00E+00 |
| ADF - Choi Z-stat | | | -6.61E+00 | 0.00E+00 |
| Series | Prob. | Lag | Max Lag | Obs |
| D(AGRICULTURE_PERFORMANCE,2) | 0.00E+00 | 1.00E+00 | 3.00E+00 | 1.60E+01 |
| D(EDUCATION,2) | 2.30E-03 | 1.00E+00 | 3.00E+00 | 1.60E+01 |
| D(EMPLOYMENT_IN_AGRICULTURE,2) | 0.00E+00 | 0.00E+00 | 3.00E+00 | 1.70E+01 |

From the results of stationarity testing with Augmented Dickey-Fuller, it can be seen that at the 2nd level the difference is stationary and vector estimation uses Vector Autoregressive. It can be seen that the probability is less than 0.05 in each tested variable. After doing the stationarity test, a cointegration test was conducted to see the long-term integration between variables. If there is cointegration between variables, the estimation is made using the Panel Vector Error Correction Model (VECM) method, but if there is no cointegration, the estimation is made using the Vector Autoregressive method. Cointegration test results are shown in table 3.

Table 3. Cointegration test results

| Hypothesized | | Trace | 5.00E-02 | |
|---|---|---|---|---|
| No. of CE(s) | Eigenvalue | Statistic | Critical Value | Prob.** |
| None * | 8.40E-01 | 4.35E+01 | 2.98E+01 | 8.00E-04 |
| At most 1 | 4.40E-01 | 1.05E+01 | 1.55E+01 | 2.42E-01 |
| At most 2 | 5.75E-03 | 1.04E-01 | 3.84E+00 | 7.47E-01 |

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

From the cointegration result, the critical value is higher than the Trace Statistics value and the Max-Eigen Statistics value which shows that there is no cointegration relationship in the variable equation so that the next method that can be used to determine the long-term and short-term relationship is the Vector Autoregressive method.

Optimum lag test is used to determine the time period of the influence of a variable on other variables which will give optimal results. This is because changes in the movement of a variable are not directly responded to by changes in other variables, but there is still a certain grace period. Therefore it is important to know the lag length. The optimum lag test can be seen in table 4.

Table 4. Optimum lag test

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -1.05E+03 | NA | 1.54E+47 | 1.17E+02 | 1.17E+02 | 1.17E+02 |
| 1 | -1.01E+03 | 5.81E+01 | 6.77E+45 | 1.14E+02 | 1.15E+02 | 1.14E+02 |
| 2 | -1.00E+03 | 17.06240* | 4.35e+45* | 113.4694* | 114.5082* | 113.6127* |

* 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

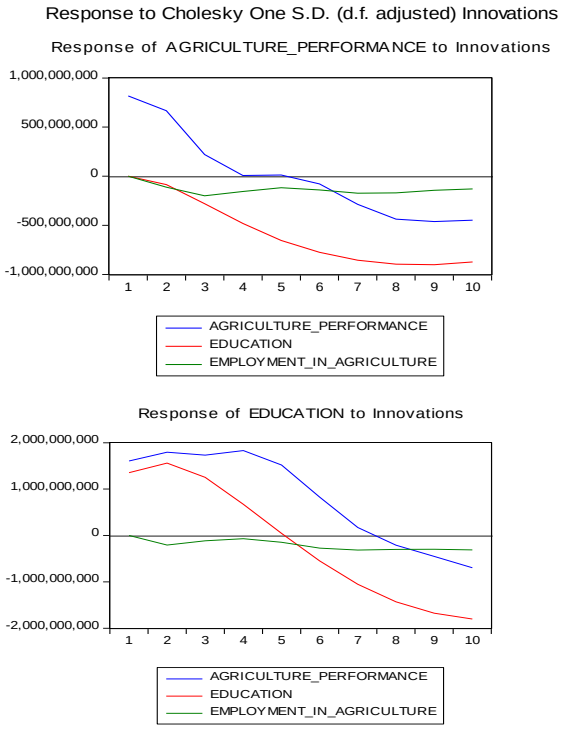
From the results of the Optimum lag test, it can be seen that the optimum lag is found in lag 2. The results of the Vector Autoregressive estimation are shown in table 5.

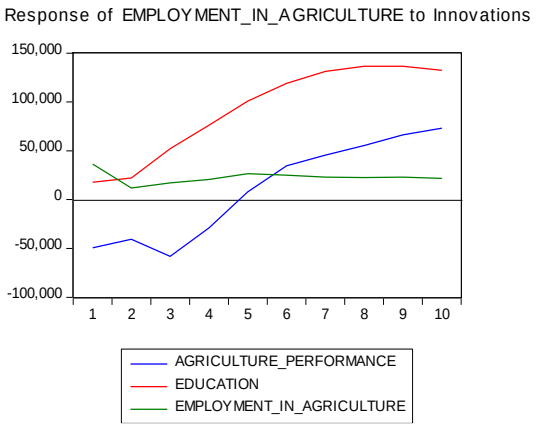
Table 5. The results of the Vector Autoregressive estimation.

| | AGRICULTURE_PERFORMANCE | EDUCATION | EMPLOYMENT_IN_AGRICULTURE |
|---|---|---|---|
| | | | |
| AGRICULTURE_PERFORMANCE(-1) | 6.73E-01 | -5.58E-01 | -5.38E-05 |

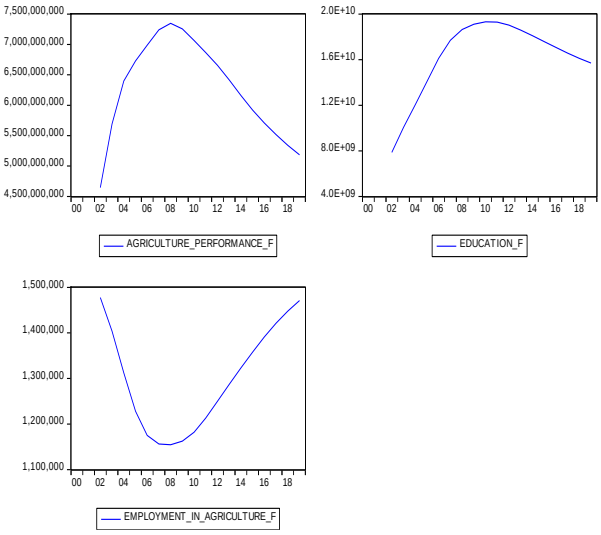
| | | | |
|---|---|---|---|
| | -4.83E-01 | -1.24E+00 | -3.80E-05 |
| | [ 1.39355] | [-0.44935] | [-1.42699] |
| | | | |
| AGRICULTURE_PERFORMANCE(-2) | -4.31E-01 | 7.77E-01 | -4.57E-05 |
| | -4.73E-01 | -1.22E+00 | -3.70E-05 |
| | [-0.91050] | [ 0.63951] | [-1.23742] |
| | | | |
| EDUCATION(-1) | -2.23E-02 | 1.23E+00 | 1.21E-05 |
| | -1.61E-01 | -4.13E-01 | -1.30E-05 |
| | [-0.13913] | [ 2.97004] | [ 0.96575] |
| | | | |
| EDUCATION(-2) | -5.44E-02 | -4.78E-01 | 1.23E-05 |
| | -1.52E-01 | -3.89E-01 | -1.20E-05 |
| | [-0.35907] | [-1.22857] | [ 1.03800] |
| | | | |
| EMPLOYMENT_IN_AGRICULTURE(-1) | -3.09E+03 | -5.70E+03 | 3.25E-01 |
| | -4.24E+03 | -1.09E+04 | -3.31E-01 |
| | [-0.72922] | [-0.52340] | [ 0.98223] |
| | | | |
| EMPLOYMENT_IN_AGRICULTURE(-2) | -2.54E+03 | 3.95E+03 | 2.68E-01 |
| | -3.73E+03 | -9.60E+03 | -2.91E-01 |
| | [-0.67990] | [ 0.41110] | [ 0.91864] |
| | | | |
| C | 1.33E+10 | 5.22E+09 | 7.61E+05 |
| | -6.90E+09 | -1.80E+10 | -5.38E+05 |
| | [ 1.93189] | [ 0.29460] | [ 1.41573] |
| | | | |
| R-squared | 7.75E-01 | 9.01E-01 | 9.16E-01 |
| Adj. R-squared | 6.52E-01 | 8.47E-01 | 8.70E-01 |
| Sum sq. resids | 7.35E+18 | 4.86E+19 | 4.48E+10 |
| S.E. equation | 8.18E+08 | 2.10E+09 | 6.38E+04 |
| F-statistic | 6.31E+00 | 1.67E+01 | 1.99E+01 |
| Log likelihood | -3.91E+02 | -4.07E+02 | -2.20E+02 |
| Akaike AIC | 4.42E+01 | 4.61E+01 | 2.53E+01 |
| Schwarz SC | 4.45E+01 | 4.64E+01 | 2.56E+01 |
| Mean dependent | 7.26E+09 | 1.73E+10 | 1.15E+06 |
| S.D. dependent | 1.39E+09 | 5.38E+09 | 1.77E+05 |

Based on the results of the estimated output, it can be indicated the direction of the relationship, and the significance of each variable and each period. Negatively related variables are marked (-). Significant relationships are marked with a sign (*). The value of the coefficient of determination (Adj. R-Square) shows the degree of truth of the estimate of 0.652. This means 65% accuracy of the calculation rate of the vector error correction model. Impulse Response Function (IRF) describes the response of an endogenous variable to shock that occurs in other variables in a dynamic VAR system. IRF can be used to see the effect of fluctuations or shocks from one variable on the value of another variable either now or in the future. The results of the Impulse Response Function (IRF) of the Infrastructure variable against other variables are shown by the following Impulse Response graph:






Based on the response and impulse graphs, it can be seen that each variable responds to each other since the first time period with a lag of 2. This shows that in South Africa the three variables influence each other. To see the direction of influence can be seen in the following forecasting chart:




Based on the results of forecasting graphs, agriculture performance decreased in period 8. Until the end of the research period, it continued to decline. This is of course bad because the performance of agriculture in South Africa continues to decline. If this continues, it can lead to hunger or food dependence on imports. Likewise, the education graph also decreased in period 10. This is very bad because education is an important component in educating the nation's children which has an impact on the development of human capital of the population in the future. However, employment in agriculture has increased in period 8. This is very strange. The possibility of wrong policies where the number of people working in the agricultural sector should improve agricultural performance. However, what happened was the opposite. More and more people in South Africa are working in the agricultural sector, but the performance of agriculture has actually decreased, coupled with a decrease in investment in education.

## 5 CONCLUSION

Agriculture performance in South Africa has decreased continuously in the 8th period in the forecasting chart. If this continues, it can lead to hunger or food dependence on imports. Likewise, the education graph also decreased in period 10. This is very bad because education is an important component in educating the nation's children which has an impact on the development of the human capital of the population in the future. However, employment in agriculture has increased in period 8. This is very strange. The possibility of wrong policies where the number of people working in the agricultural sector should improve agricultural performance. However, what happened was the opposite. More and more people in South Africa are working in the agricultural sector, but the performance of agriculture has actually decreased, coupled with a decrease in investment in education.

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