Research on Influence Relationship Between Agriculture Performance, Human Capital, and Employment in Agriculture with Vector Analysis Method in Germany

Benjamin Drean
Lycée George Sand, EPL du Velay, France

Abstract : The purpose of this study is to see the relationship between agriculture performance, human capital, and employment in agriculture in Germany. The research period used is from 2000 to 2019 with the vector analysis method. We find that Germany has succeeded in successfully investing in education to improve agricultural performance. However, it is indicated that the interest of German citizens in the agricultural sector continues to decline and if no precautions are taken regarding this, it will threaten the German agricultural sector. Another effort that can be done is to automate the agricultural system so that it can improve agriculture with less manpower.

Keywords: Human Capital, Agriculture, Employment in Agriculture, Vector Analysis

JEL Classification : C01,E24,J24, J43

1 Introduction

The European Union is very concerned about the plight of its farmers, who are the biggest beneficiaries of the Common Agricultural Policy (CAP). Basically, this policy regulates direct subsidies for farmers' income. However, CAP is not free from criticism and controversy. The bombastic budget is considered less effective for equitable distribution of farmers' welfare and protecting the environment (Kiryluk-Dryjska & Baer-Nawrocka,2019). Agriculture in Germany uses technology that is already very good. Developments in Germany with a good education system are able to develop the agricultural sector well and human quality personnel is also good (Röhler et al,2021).

Migrants and agriculture in Germany are mutually beneficial. Migrants in Germany can increase human resources. Migrants provide labor assistance in various fields including agriculture. Training and education are important factors in developing human resources, including in the agricultural sector in Germany (Fiał kowska & Matuszczyk,2021).

Agriculture in Germany develops in an eco-friendly ecosystem and is driven to protect the environment. Policies in Germany encourage farmers to do agriculture by minimizing damage to the environment due to their agricultural activities. This is to preserve nature and the sustainability of environmentally friendly agriculture for a healthier life and environment (Ungaro et al,2021).

2 Literature Review

Human capital is a collection of skills, knowledge, and experience in doing work to generate income. Human capital in agriculture is a collection of knowledge, skills, and experience in working in agriculture to generate income (WIDARNI & BAWONO, 2021).

Agriculture is the activity of managing land to obtain agricultural products in order to obtain economic benefits. Agriculture itself is an effort to produce food by managing agricultural land. Agriculture is an important business for any country in terms of food self-sufficiency (Parida & Chowdhury,2020).

Food self-sufficiency is very important because food self-sufficiency reduces the risk of starvation. Food self-sufficiency can be achieved by means of agricultural exploitation in order to obtain sufficient production capacity to meet the food needs of all people living in a sovereign country (Siddig & Mubarak,2013).

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	2.62E+10	1.51E+11	7.71E+05
Median	2.65E+10	1.66E+11	6.99E+05
Maximum	3.52E+10	1.95E+11	1.06E+06
Minimum	1.86E+10	8.58E+10	5.31E+05
Std. Dev.	5.20E+09	3.68E+10	1.95E+05

Based on Table 1 above, it appears that from the period 2000 to 2019, the average agricultural performance in German is very high at around 26.2 billion USD which can be seen from the mean value in table 1. with a high level of volatility at 0.52 billion USD. With an average number of workers 771 thousand people with an average educational investment value of 151 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			56.23	0
ADF - Choi Z-stat			(6.21)	0
Series	Prob.	Lag	Max Lag	Obs
D(AGRICULTURE_PERFORMANCE,2)	0.00E+00	1.00E+00	3.00	16
D(EDUCATION,2)	2.60E-02	3.00E+00	3.00	14
D(EMPLOYMENT_IN_AGRICULTURE,2)	0.00E+00	0.00E+00	3.00	17

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	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	5.99E-01	2.60E+01	29.80	0.1279
At most 1	2.78E-01	9.56E+00	15.49	0.3162
At most 2	1.86E-01	3.70E+00	3.84	0.0544

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	-1.17E+03	NA	6.07E+49	1.23E+02	1.23E+02	1.23E+02
1	-1.13E+03	58.92885*	3.14e+48*	120.1623*	120.7588*	120.2633*

* 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 1. 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)	-5.48E-02	-1.04E+00	1.91E-06
	-3.75E-01	-7.88E-01	-4.00E-06
	[-0.14613]	[-1.31432]	[0.47361]
AGRICULTURE_PERFORMANCE(-2)	-6.42E-01	-2.40E+00	7.16E-07
	-4.33E-01	-9.10E-01	-4.70E-06
	[-1.48068]	[-2.63666]	[0.15367]
EDUCATION(-1)	9.35E-02	7.98E-01	-1.78E-06
	-1.48E-01	-3.11E-01	-1.60E-06
	[0.63197]	[2.56733]	[-1.11921]
EDUCATION(-2)	1.72E-01	5.69E-01	-3.32E-07
	-1.78E-01	-3.74E-01	-1.90E-06
	[0.96885]	[1.52283]	[-0.17350]
EMPLOYMENT_IN_AGRICULTURE(-1)	2.60E+04	-2.20E+04	5.73E-01
	-2.89E+04	-6.07E+04	-3.10E-01
	[0.89951]	[-0.36184]	[1.84662]
EMPLOYMENT_IN_AGRICULTURE(-2)	-6.81E+03	4.61E+04	4.48E-02

	-2.47E+04	-5.20E+04	-2.66E-01
	[-0.27505]	[0.88754]	[0.16865]
C	-9.00E+09	2.35E+10	5.14E+05
	-2.90E+10	-6.10E+10	-3.10E+05
	[-0.31212]	[0.38709]	[1.65838]
R-squared	5.00E-01	9.41E-01	9.54E-01
Adj. R-squared	2.27E-01	9.10E-01	9.29E-01
Sum sq. resids	2.16E+20	9.52E+20	2.49E+10
S.E. equation	4.43E+09	9.30E+09	4.76E+04
F-statistic	1.83E+00	2.95E+01	3.79E+01
Log likelihood	-4.21E+02	-4.34E+02	-2.15E+02
Akaike AIC	4.75E+01	4.90E+01	2.47E+01
Schwarz SC	4.79E+01	4.94E+01	2.50E+01
Mean dependent	2.69E+10	1.58E+11	7.39E+05
S.D. dependent	5.04E+09	3.09E+10	1.78E+05

In the first period, Agriculture Performance has a significant negative relationship with a t-table value of -0.14613 and a coefficient value of 0.0548. It has a significant negative relationship with education with a t-table value of -1.31432 and a coefficient value of 1.04. Has a significant positive relationship with employment in agriculture with a t-table value of 0.47361 and a coefficient value of 0.0000019.

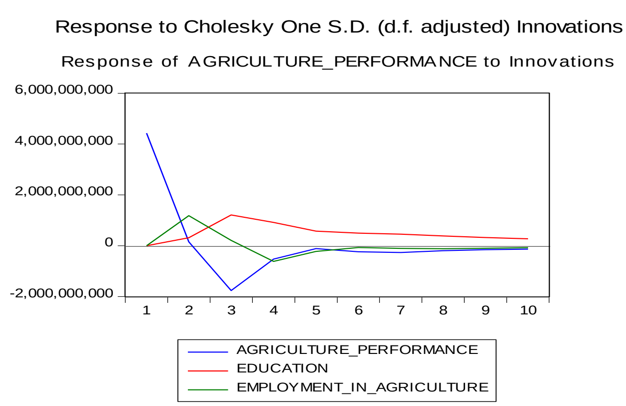
In the second period, agriculture performance has a significant negative relationship with agriculture performance itself with a t-table value of -1.48068 and a coefficient value of 0.642. There is a significant negative correlation with education with a t-table value of -2.63666 and a coefficient value of -2.4. There is a significant positive correlation with employment in agriculture with a t-table value of 0.15367 and a coefficient value of 0.000000716.

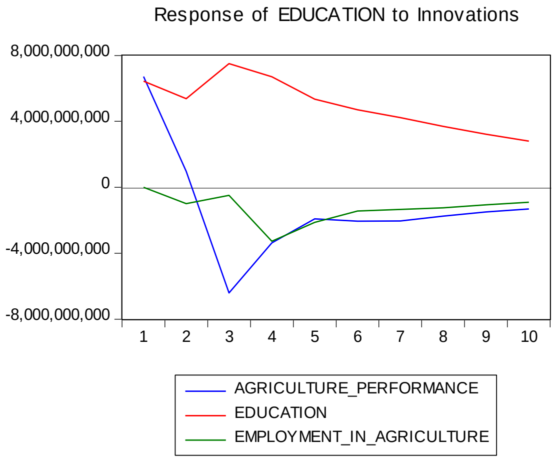
In the first period, education has a significant positive correlation with agriculture performance with a t-table value of 0.63197 and a coefficient value of 0.0935. Has a significant positive relationship with education itself with a t-table value of 2.56733 and a coefficient value of 0.798. It has a significant negative correlation with employment in agriculture with a t-table value of -1.11921 and a coefficient value of 0.00000178.

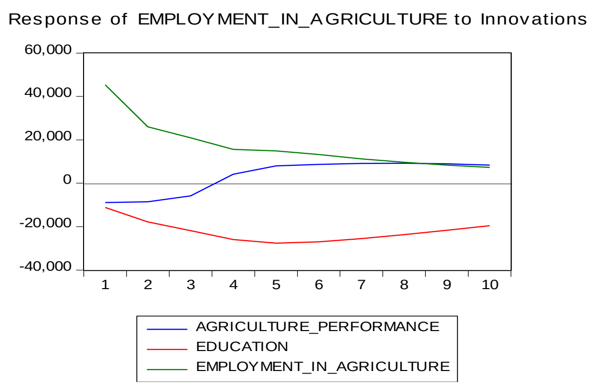
Education in the second period has a significant positive correlation with agriculture performance with a t-table value of 0.96885 and a coefficient value of 0.172. There is a significant positive correlation with education itself with a t-table value of 1.52283 and a coefficient value of 0.569. There is a significant negative correlation with employment in agriculture with a t-table value of -0.17350 and a coefficient value of -0.000000332.

In the first period, Employment in Agriculture has a significant positive correlation with agriculture performance with a t-table value of 0.89951 and a coefficient value of 26000. It has a negative and insignificant correlation with education with a t-table value of -036184 and a coefficient value of -22000. There is a significant positive correlation with employment in agriculture itself with a t-table value of 1.84662 and a coefficient value of 0.573.

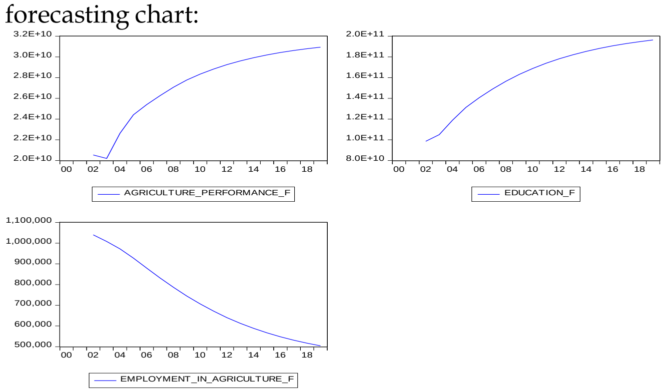
In the second period, employment in agriculture is negatively and insignificantly related to agriculture performance with a t-table value of -0.27505 and a coefficient value of -6810. No significant positive correlation with education with a t-table value of 0.88754 and a coefficient value of 46100. There is a significant positive correlation with employment in agriculture itself with a t-table value of 0.16865 and a coefficient value of 0.0448. The value of the coefficient of determination (Adj. R-Square) shows the degree of truth of the estimate of 0.227. This means 23% 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 1. This shows that in German the three variables influence each other. To see the direction of influence can be seen in the following forecasting chart:



Based on the forecasting graph, it can be seen that the growth of agriculture performance is in line with or in line with education investment in Germany. This indicates that Germany has succeeded in successfully investing in education to improve agricultural performance. However, it is indicated that the interest of German citizens in the agricultural sector continues to decline and if no precautions are taken regarding this, it will threaten the German agricultural sector. Another effort that can be done is to automate the agricultural system so that it can improve agriculture with less manpower.

5 CONCLUSION

Germany has succeeded in successfully investing in education to improve agricultural performance. However, it is indicated that the interest of German citizens in the agricultural sector continues to decline and if no precautions are taken regarding this, it will threaten the German agricultural sector. Another effort that can be done is to automate the agricultural system so that it can improve agriculture with less manpower.

REFERENCES

Fiał kowska,K, Matuszczyk,K. (2021). Safe and fruitful? Structural vulnerabilities in the experience of seasonal migrant workers in agriculture in Germany and Poland. Safety Science,Volume 139, July 2021, 105275. doi :10.1016/j.ssci.2021.105275

Kiryluk-Dryjska,E., Baer-Nawrocka,A. (2019). Reforms of the Common Agricultural Policy of the EU: Expected results and their social acceptance. Journal of Policy Modeling,Volume 41, Issue 4, July–August 2019, Pages 607-622. doi :10.1016/j.jpolmod.2019.01.003

Parida,Y., Chowdhury,J.R. (2020). An empirical analysis of the effect of floods on rural agricultural wages across Indian states. World Development Perspectives [Online],doi :10.1016/j.wdp.2020.100272

Röhler,K., Haluska,A.A., Susset,B., Liu,B., Grathwoh,P. (2021). Long-term behavior of PFAS in contaminated agricultural soils in Germany. Journal of Contaminant Hydrology,
Volume 241, August 2021, 103812. doi :10.1016/j.jconhyd.2021.103812

Siddig,K.H.A., Mubarak,A.M.(2013). Food self-sufficiency versus foreign currency earnings in the Sudanese irrigated agriculture. Journal of the Saudi Society of Agricultural Sciences.Volume 12, Issue 1, January 2013, Pages 19-25.doi :10.1016/j.jssas.2012.05.001

Ungaro,F., Schwartz,C., Piorr,A. (2021). Ecosystem services indicators dataset for the utilized agricultural area of the Märkisch-Oderland District-Brandenburg, Germany. Data in Brief,Volume 34, February 2021, 106645. doi :10.1016/j.dib.2020.106645

WIDARNI, E. L., & BAWONO, S. (2021). Human Capital, Technology, and Economic Growth: A Case Study of Indonesia. The Journal of Asian Finance, Economics and Business, 8(5), 29–35. doi :10.13106/JAFEB.2