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The Role of Banks in Financing the Slovak Agricultural Sector

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Abstract

A well-developed financial system plays an important role in financing individual sectors in the country. In this paper, we analyse credit development in the agricultural sector in the Slovak Republic from various perspectives. We examine the relationship between the agricultural sector's characteristics and the volume of funding at the regional level. The paper's methodology is based on a k-means algorithm for clustering the Slovak regions with four criteria. Then we examine the relationship between financial development and agricultural growth by employing the Cobb-Douglas production function. This study uses annual data covering the period from 2008 to 2019. The results reveal that financial development has a significant and positive effect on agricultural production and agricultural growth.

Keywords

Slovak agricultural sector, financial development, agriculture growth, cluster analysis, data analysis.

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Introduction

One of the conditions for the successful functioning of individual sectors of the national economy is a well-functioning financial system. A financial system could be defined as the sum of financial and non-financial entities that meet in the market in which they carry out financial transactions using financial instruments. The basic task of the financial system is to ensure financial intermediation, i.e. the transfer of funds from surplus to deficit entities. This transfer of funds between surplus and deficit entities can take place in two basic ways, either directly or indirectly, depending on which we are talking about direct or indirect financing. In direct financing, the transfer of funds is made directly on the financial market, with no intermediary entering into the relationship between the creditor and the debtor. For example, market deficit may offer debt security (bonds), which surplus entities may purchase In this way, the deficit entities will receive funds, while surplus entities invest their free funds with a future return prospect. The second is indirect financing, which is channelled through financial intermediaries specialising in raising funds from surplus entities and providing them effectively to deficit entities. In this case, there is no direct connection between the creditor and the debtor, but into the relationship between them, the financial intermediary is entered. In European countries, the indirect financing method prevails, where commercial banks are the leading financial intermediary. Commercial banks most often raise funds in deposits from depositors and invest them in loans offered to different economic entities, whether households, non-financial corporations or other entities. The benefits of this method are transferring the potential risk to the financial intermediary and eliminating time and volume mismatches.

Commercial banks offer solution for financing individual sectors. As one of the national economy sectors, the agricultural sector has a specific role in the process of economic development of a country. As stated by the European Environment Agency (2020), the agricultural sector is one of the primary land users in Europe and thus shapes landscapes in rural areas. Two of the main challenges confronting agriculture in Europe are climate change (European Environment Agency, 2017a) and land take, i.e. the conversion of land to settlements or infrastructure (European Environment Agency, 2017b). The importance of agriculture is higher in less industrialised countries, but this does not mean that in economically developed countries, its importance is lower. It has various direct and indirect effects on the environment, and it is dependent on natural resources, which also maintain, whereas the other sectors of the national economy only use them. In October 2018, Food and Agriculture Organization of the United Nations (2018) highlighted information that total commercial credit disbursed by commercial banks to the agricultural sector increased from 2.4% in 2016 to 2.9% in 2017. However, this appears that agricultural producers face a negative bias in access to credit due to the agriculture sector globally contributed over 4% of gross domestic product (GDP).

The role of bank credit to the agricultural sector is crucial in the southern countries, Africa and the southern region of Asia, where the population is widely involved in agriculture. One of the recent studies, by Oyelade (2019), investigates the effect of commercial bank credit on agricultural output and subsector of agriculture in Nigeria. The author explains the importance of the bank lending channel in the nation for a better performance of both the subsector of agriculture and the sector as a whole, as the monitored banking indicators are statistically significant in determining agricultural output in Nigeria. Results of the study are supported by the study by Obilor (2013). Another Nigerian study by Ammani (2012) observed that bank credit is positively and significantly related to the productivity of crops, livestock and fishing sectors. Chisasa (2014) finds a positive and significant relationship between bank credit and agricultural production in South Africa using the Cobb-Douglas function. Agbodji and Johnson (2019) show that the agriculture productivity of small farmers in Togo, who have access to credit, is higher than those who do not access it. In Pakistan, where the agriculture sector plays a major role in the economy, the analysis used by Shahbaz et al. (2013) reveals bidirectional causality between agricultural growth and financial development, with credit classification into long, medium and short terms. The importance of bank credit to agriculture in India reveals studies by Mohan (2006), Das et al. (2009), or publication by Ramakumar and Chavan (2014), which analyses an increase in the number of rural bank branches and the growth of agricultural credit in Indian in the early 2000s. Overall, we can summarise the previous results into the following points. Toby and Peterside (2014) identify a significantly positive correlation between merchant bank lending to agriculture and agricultural GDP. In the opinion of Narayanan (2015), credit can contribute to the growth of agricultural GDP through the purchase of variable inputs. He argues that a 10% increase in credit flow in nominal terms leads to an increase by 1.7% in fertilisers consumption, 5.1% increase in the tonnes of pesticides, 10.8% increase in tractor purchases. Shahbaz et al. (2013) suggest that the government should give the rural population access to financial resources at a cheaper rate to improve the contribution of the agriculture sector in the overall economic growth. A study by Khan et al. (2017) proved that agricultural credit leads to agricultural growth, bringing prosperity for the farms. Hussain et al. (2015) conclude that agriculture credit gradually increased over the past years, and they argue that institutional credit has a significant impact on agricultural productivity.

In the literature, we can also find studies that examine agricultural productivity and analyse its changes in European countries through the decomposition of Total factor productivity (TFP). As Kijek et al. (2019) mention, productivity in agriculture can be measured as partial productivity, referring to a single factor or as total productivity (multi-factor). TFP of agriculture has been investigated extensively for a selected group of states or a selected period. For example, Baráth and Fertő (2017) use country-level data for 23 European Union (EU) countries and find out slightly decrease in agricultural productivity in the EU over the analysed period from 2004 to 2013; however, there were significant differences between old and new member states. Also, Čechura et al. (2014) analyse Total factor productivity in EU countries and they observe a positive trend in agricultural productivity in most EU countries. This methodology could also be seen in the study of Nowak et al. (2016), Laborde and Piñeiro (2018), and others.

The agricultural sector is one of the sectors with a significant share in the volume of loans in several European countries. This is also proven by the data published by the European Banking Authority (Figure 1). Based on these data, we can divide European countries into countries where the agricultural sector is largely financed by bank loans and countries where this share is lower. The countries with the highest share of loans to the agriculture of the 02Q/2020 include the Netherlands (13.9%), Luxembourg (13.8%), Iceland (13.3%), and Latvia (12.1%). On the other hand, Malta (0.1%) and Germany (0.6%) are among the countries with the lowest share of loans to agriculture. On average, in the European Union countries, the share of loans to agriculture is 3.8%. Slovakia (4.1%), together with nine countries, is in the interval with the highest frequency. Besides Slovakia, we can also see Finland (5.4%), Ireland (5.1%), Croatia (4.9%), Norway (4.5%), Belgium (4%), the Czech Republic (3.9%), France (3.7%), Portugal (3.6%), and Lithuania (3.5%).

A study by Rogach et al. (2019) has pointed out that agriculture is one of the most important industrial branches of the European Union. There are developed several banking systems in the countries with an important role in agriculture, e.g. "Crédit Agricole" in France, "Rabobank" in the Netherlands, "the Union of German People's Banks" and "Raiffeisen Societies" in Germany, etc. As Koester (2016) stated, the development of the agricultural sector is strongly influenced by the European Union's Common Agricultural Policy. Currently, it features two main pillars: Pillar 1, under which direct payments to farmers and market interventions are covered, and Pillar 2, under which rural development programmes are supported. Even though the impact of agricultural finance is important, there is a lack of publications in Europe about this topic, comparing to Asia and Africa. Therefore there is a necessity of the research. One of the first studies focusing on most European countries is presented by Shan and Morris (2002), who examine causality tests for nineteen OECD countries. According to the results, they argue that in most instances, financial development occurs simultaneously with economic growth. Later, Fecke et al. (2016) examine the determinants of loan demand in agriculture in Germany and bring some practical implications for banks in the agricultural sector in developed countries. Juszcyk (2018) finds out that loans for agriculture are not determining to generate the net profit of banks in Poland. Varraso and Dimitrio (2020) analyse bank loans to agriculture in Italy and Apulia during the last global economic crisis.

The relationship between Slovak agriculture and bank lending has been analysed in a study by Rabek (2006), who focuses on the development of long-term and short-term bank credits between the 2000 and 2005 period. Kalusova and Badura (2017) examine the indebtedness rate of the selected Czech and Slovak agricultural enterprises by regression analysis, with a strong positive correlation in the long-term indebtedness. The observed enterprises use bank loans as a source of financing, but the authors argue that, in general, it is not a common way of financing agricultural enterprises in these countries. Toth et al. (2020) provide an analysis of loans in Slovak agriculture of four main banks providing loans to farmers in Slovakia. Authors arguing that banks provide working capital to farms in the amount of annual farm's direct payments, and they comment there is a lack of appropriate financial products for small and young farmers (less than 40 years, farms smaller than 100 ha).

In the economy, the agriculture sector supports the diversification of economic activities in rural areas. It is an important factor in maintaining the workforce by generating job opportunities,

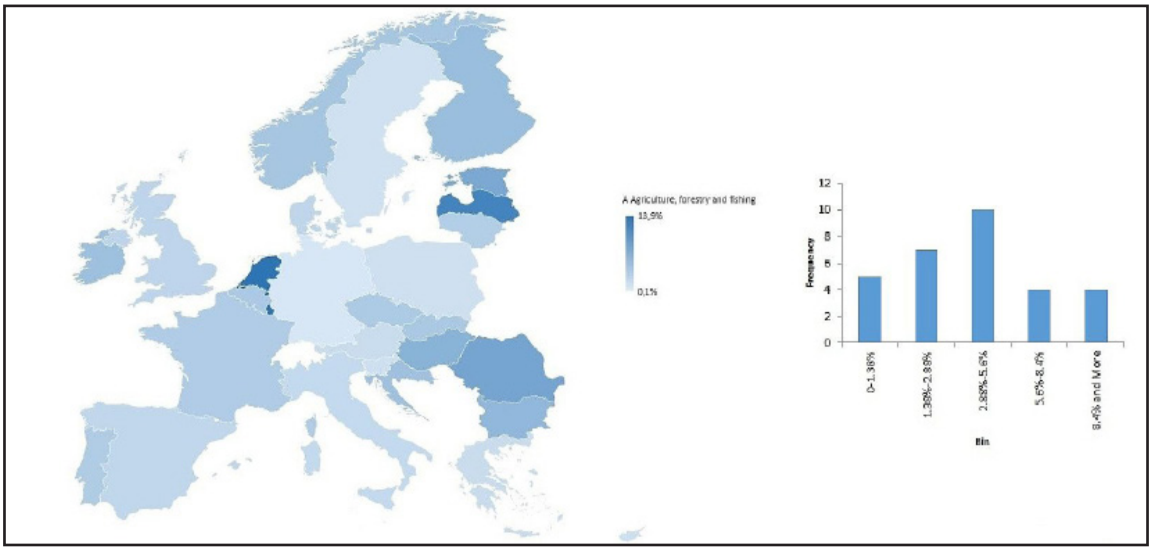

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Figure 1: Distribution of non-financial corporation loans advanced in Agriculture, forestry and fishing (percentage of total loans, Q2/2020).

thus contributing to the reduction of regional disparities. Therefore, it is important to focus on monitoring the financial situation, evaluate lending in agriculture as well as deposits in the agricultural sector. Skriniarova and Bandlerova (2012) state that the agricultural sector is one of the least capitalised sectors of the economy. This means that it needs sufficient credit resources to ensure continuous agricultural production. This paper aims to analyse the development of credit in the agricultural sector in Slovakia from various perspectives, as well as to examine the relationship between the characteristics of the agricultural sector and the volume of funding at the regional level, in order to determine whether the development of the financial market can be considered as an important factor in the development of agriculture in the Slovak regions during the period from 2008 to 2019.

Materials and methods

The methodological approach taken in this paper is a mixed methodology based on a k-means algorithm for clustering and examining the impact of financial development on agricultural growth by employing the Cobb-Douglas production function, which was previously used in several studies, e.g. Čechura (2006), Shahbaz et al. (2013), Ekwere and Edem (2014), Andersson et al. (2016) or Shabir et al. (2020).

Firstly, the k-means algorithm is used for clustering Slovak regions. We make clusters according to different criteria. Yaya et al. (2020) mentioned that the k-means cluster algorithm is a commonly used methodology due to its design simplicity, theoretical reliability, and excellent extendibility. This method uses distance as the evaluation index of similarity, divides the sample into clusters, which means the distance is negatively correlated with the similarity. Sample similarity differs significantly among clusters.

Before the application of cluster analysis, the data must be standardised to make variables comparable. In literature, we can find two types of standardisation: empirical and statistical standardisation. In our study, empirical standardisation is used, which normalise values compared to minimum and maximum within the sample. The reason is that our variables are in different units and have different variation, as could be seen in the results section (Table 1).

$$I_{it}^{n} = \frac{I_{it} - Min(I_i)}{Max(I_i) - Min(I_i)} \quad (1)$$

The classification of observations into groups requires specific methods to calculate the distance between each pair of observations. As Kaufman and Rousseeuw (1990) presented, the classical methods for distance measures are Euclidean and Manhattan distance. In our paper, we apply the Euclidean distance method, which is defined as follow:

$$d_{euc}(x, y) = \sqrt{\sum_{i}^{n} (x_i - y_i)^2} \quad (2)$$

where x and y are vectors of length n.

K-means clustering is the most commonly used algorithm for partitioning a given data set into a set of k groups (k clusters), where k represents the number of groups pre-specified by the analyst. We can use different methods to define the optimal number of clusters k. In our paper, Elbow Method, Average Silhouette Method and Gap Statistic Method are used. The Elbow method can be defined as follows:

$$min\left(\sum_{k=1}^{k} W(C_k)\right) \quad (3)$$

Where C_k is the kth cluster and $W(C_k)$ is the within-cluster variation. As presented by Kaufman and Rousseeuw (1990), the total sum of the square within a cluster measures the compactness of the grouping, and we want it to be as small as possible.

The second, the Average Silhouette Method, measures the quality of clustering. As mentioned by Young (2019), this method measures the quality of clustering by determining how well each lies within its cluster object. For a cluster to be a good quality cluster, an average silhouette width must be high. This method calculates the average silhouette of observations for different values of k. The optimal number of clusters is the maximum value of the average silhouette over an array of probable values for k.

The gap statistic has been published by Tibshirani et al. (2001). The gap statistic compares the total within intra-cluster variation for different values of k with their expected values under the null reference distribution of the data. The estimate of the optimal clusters will be the value that maximises the gap statistic. This means that the clustering structure is far away from the random uniform distribution of points.

Within the last step of our analysis, we try to investigate the impact of financial development on agricultural growth by incorporating capital in the form of loans provided by banks to the agricultural sector, while land and labour represent important impulses of agricultural productivity. We employ a Cobb-Douglas production function, where, according to Čechura (2006), the general equation can be written as follow:

$$Y_t = \alpha \times Capital_t^b \times (Land/Employees)_t^c \times klnu_t \quad (4)$$

Where Y_t is the real output of the agricultural sector measured by gross value-added in current prices in the agricultural sector in time *t*, where t = 1,2,..*n*, $Capital_t^b$ indicates capital use in the agricultural sector measured in the form of loans provided by banks to the agricultural sector in time $_t$, $(Land/(Employees))_t^c$ indicates the ratio between agricultural land in m^2 and the number of employees in the agricultural sector in time *t*, and $_u$ is residual. As presented by Shahbaz et al. (2013), coefficient *b* and *c* indicates the marginal impacts of capital, land and labour on agriculture production, which follows the assumption of constant returns to scale. The formula (4) can be expressed in the linear form (after logarithmic transformation) as presented by Čechura (2006) in the following form:

$$\ln Y_t = ln\alpha + b \ln Capital_t + c \ln(Land/Employees)_t + klnu_t \quad (5)$$

As mentioned by Shahbaz et al. (2013), the financial sector allocates funds to the farmers at a cheaper cost and enables them to utilise machinery and cultivate land to stimulate agriculture economic activity and hence agriculture growth. This implies that financial development enhances capitalisation in the agriculture sector that increases her contribution to gross domestic product and value-added, and enhances the productivity of the agricultural sector. Labour force is also an important determinant of agricultural production, as it contributes to agriculture growth by utilising the available technology in the agriculture production process. The last important determinant is the agricultural land, the active cultivation of which can also lead to economic growth in agriculture.

We use panel data for 8 Slovak regions during 2008-2019 to test the hypothesis that loans are important factors that increase the agricultural output. We use data published on the web page of the Statistical Office within the DataCube and data about the loans provided by the National bank of Slovakia.

To test the hypothesis, the standard methodology for panel data was used. According to Baltagi (2014), the estimated model (5) needs to be tested to see if it meets model assumptions (whether it is a fixed-effect model with significant time and individual effects or a random-effect model), and we also apply the Hausman test to verify which one (fixed or random-effect model) is more appropriate to use. We must test whether the model meets the statistical assumptions made on such a type of econometric model. It is testing the significance of time, individual, or both types of effects in the case of a fixed-effect model (F test), cross-sectional dependency testing (Pesaran cross-sectional dependence test), serial correlation (Breusch-Godfrey test), and heteroskedasticity (Breusch-Pagan test). To verify if it is necessary to use a panel structure of the data frame we apply a Chow test. If the p-value of the Chow test is lower than 0.05 at a 95% significance level, then it is suitable to use a panel structure of the model. Otherwise, the basic linear regression model (OLS) can be used. In the case of OLS, the standard tests are used. The presence of heteroscedasticity is examined with the Breusch-Pagan test, autocorrelation is examined with the Durbin-Watson test, multicollinearity is examined with VIF test, and normality of residuals is examined with the Jarque-Bera Normality test.

Results and discussion

As the first step of the analysis, we explore the Slovak agriculture sector and bank credit in general. In Figure 2, we can see that the volume of loans provided in Slovakia constantly increases, along with the volume of loans provided in the agricultural sector. At the end of 2019, the agricultural sector borrowed 913.286 thousand of EUR from banks. In 2019, farmers borrowed funds for long-term loans over five years (39.69% of the volume of loans provided in the sector), as well as for short-term loans where repayments last less than a year (37.61%) and medium-term loans, over one to five years (22.7%).

If we look at the distribution of loans in Agriculture, forestry, and fishing among individual regions, we can see that almost 40% of the total volume of loans

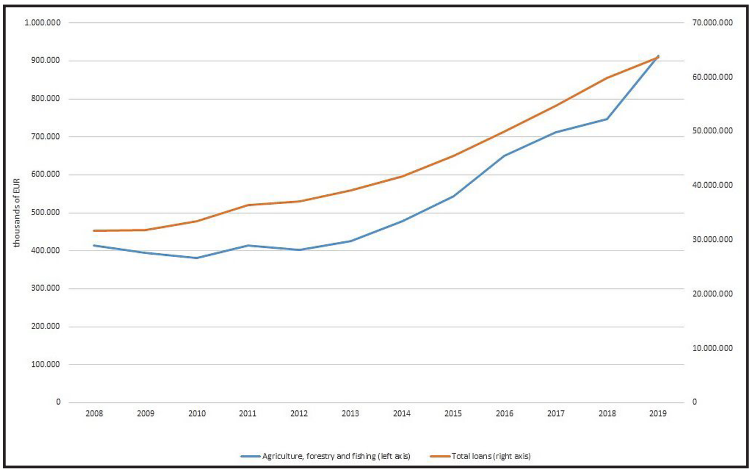

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Figure 2: Development of total loans and loans in Agriculture, forestry and fishing (thousands of EUR).

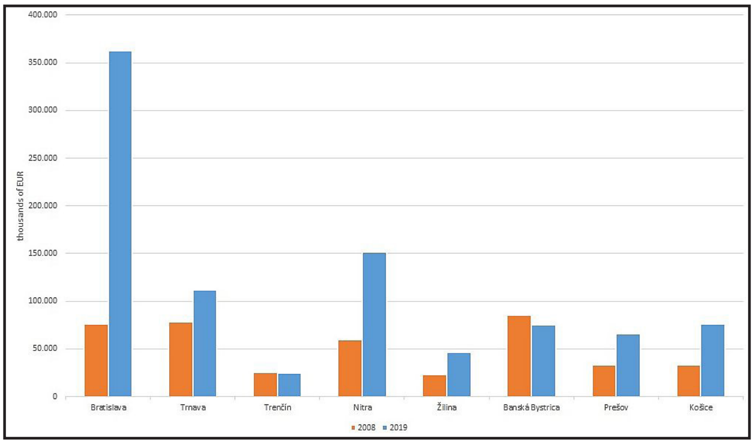

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Figure 3: The distribution of loans in Agriculture, forestry and fishing in regions of Slovakia (thousands of EUR).

in the agricultural sector in 2019 was provided in the Region of Bratislava. It was followed by the Region of Nitra (16.55%), the Region of Trnava (12.23%), the Region of Košice (8.3%), the Region of Banská Bystrica (8.24%), the Region of Prešov (7.19%), the Region of Žilina (5.09%) and the Region of Trenčín (2.71%). By comparing the volume of loans provided in individual regions in 2008 and 2019 (Figure 3), we can see that in all regions, there was an increase in the volume of loans provided by banks between the years, while the largest increase occurred in the Region of Bratislava.

Within the next step, we apply cluster analysis to analyse the similarities between Slovak regions from a different point of view, e.g. the employment in the agricultural sector, agricultural output, and agricultural land. We use data published on the web page of Statistical Office within the DataCube about the number of employees in the agricultural sector, gross value-added in current prices in the agricultural sector, and agricultural land, and data about the loans provided to agricultural subjects presented by National bank of Slovakia. The descriptive statistics and correlation analysis for all variables during the whole analysed period 2008-2019 is presented in Table 1. The results of correlation analysis show that financial development (loans), land and labour (number of employees) are positively correlated with agricultural growth measured by gross value-added in the agricultural sector. There is a negative correlation found between land and the number of employees and financial development, while the correlation between labour and land is strong and positive.

The results of the optimal number of clusters for different criteria can be seen in Table 2.

	Gross value-added in current prices in the agricultural sector	Total loans in Agriculture, forestry and fishing	Number of employees in the agricultural sector	Agricultural land
	Mil. EUR	Thousands of EUR	Number	m^2
Mean	236	67442	4827	2998336127
Median	213	61354	4648	3125527963
Maximum	543	362405	10261	4686693132
Minimum	84	16679	1712	899246400
St.dev.	1 086 682	51542.04	1 737 903	1169321580
Kurtosis	0.2159	123 259	0.6324	-0.9033
Skewness	0.9658	29 152	0.4627	-0.3445
Total loans in Agriculture, forestry and fishing	0.2501	-	-	-
Number of employees in the agricultural sector	0.5783	-0.1836	-	-
Agricultural land	0.6964	-0.2251	0.8195	-

Source: Prepared by authors

Table 1: Descriptive statistics and correlation matrix.

	Loans – Agricultural output	Loans – Labour	Loans - Land
Elbow Method	4	4	4
Average Silhouette Method	2	4	9
Gap statistic Method	2	4	4

Source: Prepared by authors

Table 2: The optimal number of clusters.

According to all criteria, mostly four clusters was set up, we decide to present the results of our analysis for four clusters.

The clusters set up according to the value of loans provided in the agricultural sector and defined criteria (agricultural output, number of employees and agricultural land) are presented in Figure 4. According to the results presented in Figure 4, we can see that one cluster has a specific position within the analysis. We could see that cluster 4 in the case of agricultural output, and cluster 1 in the case of the number of employees and agricultural land put together regions with the highest level of loans while the agricultural characteristics do not below to the "best" one. Within this cluster, we can always see only the Bratislava region. This way, we can conclude that the level of provided loans is the highest one in the case of this region despite the fact that this region does not produce the highest level of agricultural output, does not employ the highest number of employees and does not cultivate the largest area of agricultural land.

Table 3 compares the volume of provided loans in different clusters according to defined criteria. As can be seen, according to the first criterion within the fourth cluster, we can see regions with the highest volume of provided loans in the agricultural sector, while the highest value of agricultural output can be seen in the third cluster. In the case of the second criterion, the highest volume of provided loans is also not connected with the highest number of employees. On the contrary, it relates to the lowest number of employees. Also, in the third criterion, the highest volume of provided loans is not connected with the largest agricultural area but again relates to the smallest average value of the land.

We decide to apply all types of models: fixed-effect model (FE) for panel data, random-effect model (RE) for panel data and the ordinary least squares method (OLS) to estimate the parameters of the linear regression model. The Chow test results pointed out that it is not necessary to use the panel structure of the data frame. It means that the basic linear regression model could analyse the data, and additional tests for the basic linear regression model should be applied. The results

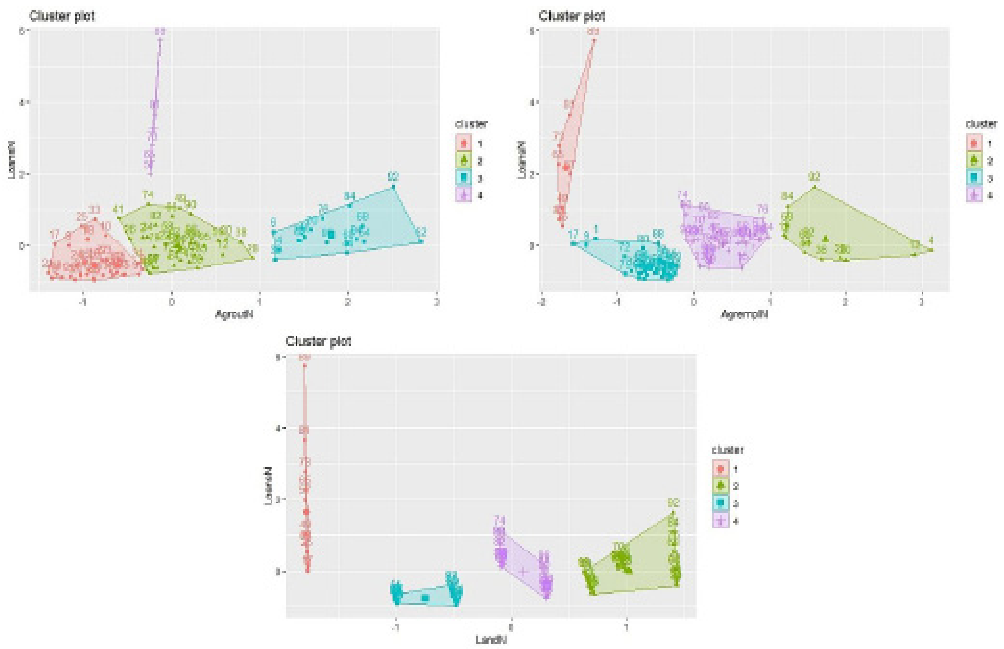

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Figure 4: Cluster analysis of Slovak regions.

	Criterion no. 1		Criterion no. 2		Criterion no. 3	
	Loans (thousands of EUR)	Agricultural output (mil. EUR)	Loans (thousands of EUR)	Labour (number of employees)	Loans (thousands of EUR)	Land (m^2)
Cluster 1 (No. of regions)	39273	141	178566	1895	151587	914151860
	(37)	(37)	(9)	(9)	(12)	(12)
Cluster 2 (No. of regions)	66089	244	75276	7836	66844	4191373572
	(37)	(37)	(13)	(13)	(36)	(36)
Cluster 3 (No. of regions)	82050	433	34593	3815	27429	2128675227
	(17)	(17)	(37)	(37)	(24)	(24)
Cluster 4 (No. of regions)	236240	214	70509	5495	66280	3120532994
	(5)	(5)	(37)	(37)	(24)	(24)

Source: Prepared by authors

Table 3: The characteristics in different clusters (2008-2019).

of Hausmann test pointed to the fact, that in the case of panel data analysis the random-effect model (RE) is more appropriate.

We interpret the results of the test in the linear regression (OLS) model in Figure 5 and Table 4. The first plot, "Residuals vs Fitted" shows if residuals have linear or non-linear patterns. As presented by Kim (2020), there could be a non-linear relationship between predictor variables and an outcome variable, and the pattern could show up in this plot if the model does not capture the non-linear relationship. If we find equally spread residuals around a horizontal line without distinct patterns, that is a good indication we do not have non-linear relationships.

In our analysis, we can see that data is simulated in a way that meets the regression assumption, which corresponds to a red line where the points are centred around the zero value. So, we can conclude that it is appropriate to apply a linear regression model. The second plot, "Normal Q-Q" shows if residuals are normally distributed. In our sample, residuals follow a straight line so we can conclude that they are normally distributed. The third plot, "Scale-Location" shows if residuals are spread equally along with the ranges of predictors. This is how we can check the assumption of equal variance (homoscedasticity). It is good if we see a horizontal line with equally (randomly) spread points. According to the results presented in our plot, we can conclude that residuals appear randomly

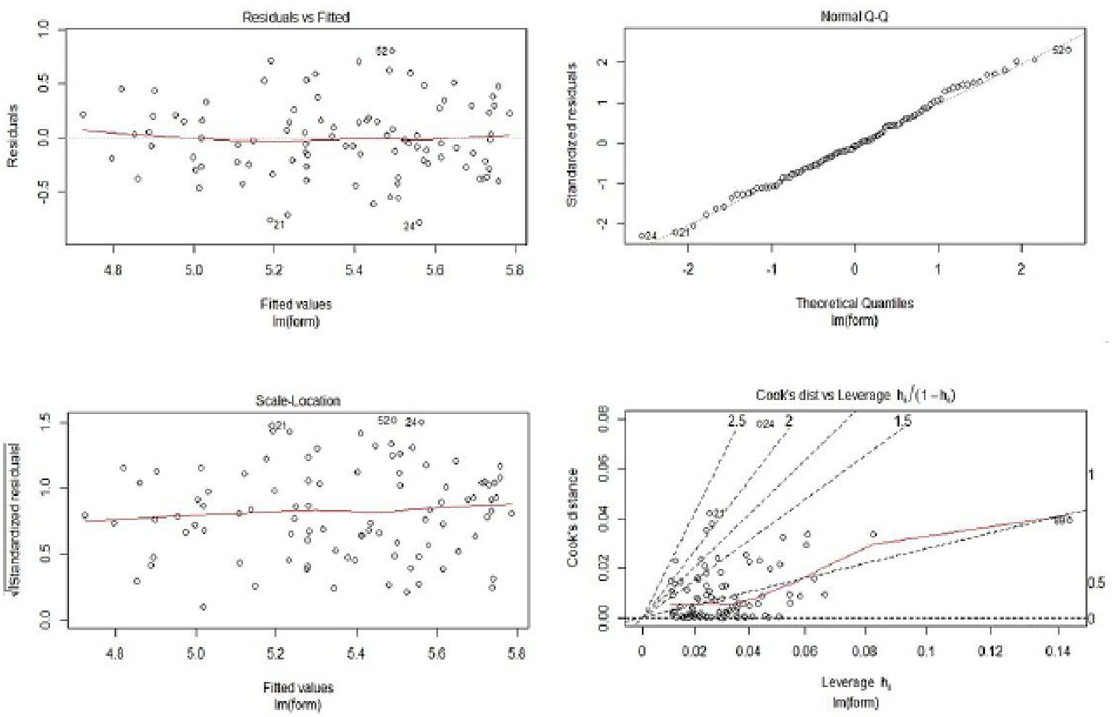

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Figure 5: Results of regression analysis.

spread. In the last plot, "Cook's distance vs leverage ", contours of standardised residuals that are equal in magnitude are lines through the origin. The contour lines are labelled with magnitudes. Cook's distance is large if either the observation has a large residual or if it exerts high leverage on the model. As we can see from the plot, there is a value at the top of the left corner, which has a high residual (2.5) but not necessarily large leverage. In the bottom of the right corner, the converse is true, where we can see value with high leverage but low residuals (0.5). Finally, we can conclude that there are not any outliers that negatively affect our regression model.

We also applied a standard methodology for panel data. We tested if it is suitable to apply the fixed-effect model (FE) with significant time, individual or both effects. As shown in Figure 6 and in Table 4, the F test results pointed out that it is necessary to use both effects. There exists heterogeneity across regions and also heterogeneity across years.

The results of model testing and the estimated regression coefficients for a fixed-effect model (FE), random-effect model (RE) and linear model (OLS) are shown in Table 4.

The model summary result states that the coefficient of determination R-squared varies between 31.35% and 39%. It implies that explanatory variables are explaining the dependent variable up to 31.35%. F-statistics reveals that the models are significantly robust. In the case of panel data analysis FE and RE model), we can see that volume of provided loans in the agricultural sector has a significant and positive impact on the growth in the agricultural sector. The results of the Pesaran cross-sectional dependence test (CD test) points to the fact that there is cross-sectional dependence in the panel. Also, the Breusch-Godfrey test (PBG test) points to serial correlation in panel models. The results of the Breusch-Pagan test (BP test) shows that there is no problem with heteroskedasticity.

In the OLS model, the result of the Breusch-Pagan test (BP test) shows that there is no heteroscedasticity. Also, the result of the VIF test pointed to the fact that there is no problem with multicollinearity, the result of the Jarque-Bera (JB) Normality test shows that residuals have a normal distribution, and the result of the Durbin-Watson test (DW test) shows there is no problem with autocorrelation. As shown in Table 4, the statistically significant variables are identified: the volume of provided loans and agricultural land in relation to the number of employees. The relationship between agricultural output and both variables is positive and statistically significant. Keeping other things constant, a 1 per cent increase in the volume of provided

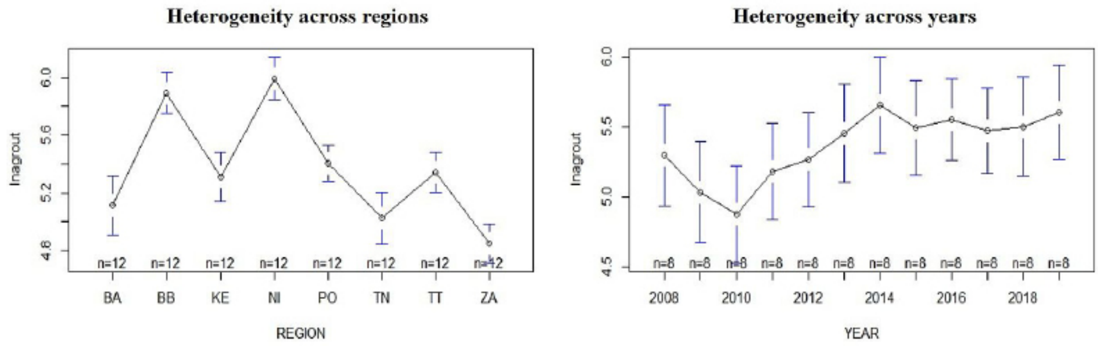

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Figure 6: Individual and time effects.

	FE model	RE model	OLS
Intercept		-1.5921	-8.6416
		(2.5252)	(2.1653) ***
ln(Loans)	0.428	0.4167	0.3733
	(0.0685) ***	(0.0655) ***	(0.0582) ***
ln(Land/Employees)	0.0905	0.1811	0.7464
	(0.1967)	(0.1857)	(0.1504) ***
Sample size	Balanced Panel: n=8. T=12. N=96		
R-Squared	0.318	0.3135	0.39
Time effects (F test)	Yes	Yes	-
Individual effects (F test)	Yes	Yes	-
CD test	Yes	Yes	-
PBG test	Yes	Yes	-
BP test	No	No	-
F-statistics	Yes	Yes	Yes
BP test	-	-	No
DW test	-	-	No
JB Normality test	-	-	Yes
VIF test	-	-	No

Note: '***' 0.01 '**' 0.05 '*' 0.1. Robust standard errors appear in parentheses below estimated coefficients
Source: Prepared by authors

Table 4: Determinants of agricultural growth.

loans in the agriculture sector will stimulate growth in value-added in the agriculture sector by 0.3733 per cent. The next statistically significant variable is agricultural land in relation to the number of employees, where the 0.7464 per cent growth in value-added in the agriculture sector is linked with a 1 per cent increase in agricultural land. It indicates that land and labour play a vital role in the production of the agriculture sector. This result is in line with Čechura (2006), or Shahbaz et al. (2013), who also pointed to the fact that financial development is crucial for agricultural development. The results indicate that financial development has a positive impact on agricultural growth. This implies that financial development plays its significant role in stemming agricultural production and hence agricultural growth. The land use in the agriculture sector in relation to the labour force in agricultural sector is also an important factor in stimulating agriculture production.

Conclusion

The role of commercial banks is essential for contribution to general prosperity for each country's economy. Banks provide many services to their clients and raise the level of economic development of the whole country. When we want to examine the issue of the role of banks more specific, one of the options is to observe individual sectors. An analysis of the agricultural credit in Europe reveals that the agricultural sector of several countries has a significant share in the volume of loans. Bank credit in agriculture has been a subject of discussion of many studies; even there is a lack of these studies in Europe. The purpose of this paper is to analyse the role of banks in the Slovak agricultural sector with the application of cluster analysis and employing the Cobb-Douglas function from 2008 to 2019.

In this study, we analysed credit development in the agricultural sector in Slovakia from various perspectives. The results pointed to the fact that commercial banks are crucial in financing agricultural sectors. Agricultural subjects in Slovakia go to banks for medium, short-term, and long-term loans, which they use on various activities to increase their agricultural production.

The cluster analysis results, which examined the relationship between the characteristics of the agricultural sector and the volume of funding at the regional level, pointed to the fact that there exist regional disparities between Slovak regions. Bratislava region tends to be the region with the highest levels of provided loans despite the fact that this region does not produce the highest level of agricultural output, does not employ the highest number of employees and does not cultivate the largest area of agricultural land. This can be influenced by the fact that some agricultural subject may have authority in the Bratislava region but operating in another region. This could be verified based on aggregated data published on the National Bank of Slovakia and the Statistical Office website. Therefore, the use of data at the farm level to examine the relationship between the location of authority and the place of activity of the agricultural operators may be subject to further analysis.

Within the last step of our analysis, we examined whether the development of the financial market expressed in the form of the value of provided loans in the agricultural sector can be considered an important factor in the development of agriculture in the Slovak regions during the period 2008-2019. We have found out that there exists a significant and positive relationship between the volume of provided loans and gross value-added in the Slovak agricultural sector. So, we can suppose that financial development plays a significant role in agricultural production and agricultural growth in Slovakia, which confirmed our hypothesis that loans are important factors that increase agricultural output.

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References

[1] Agbodji, A. E. and Johnson, A. A. (2019) "Agricultural Credit and Its Impact on the Productivity of Certain Cereals in Togo", *Emerging Markets Finance and Trade*, pp. 1-17. ISSN 1540-496X. DOI 10.1080/1540496X.2019.1602038.

[2] Ammani, A. A. (2012) "An Investigation into the Relationship between Agricultural Production and Formal Credit Supply in Nigeria", *International Journal of Agriculture and Forestry*, Vol. 2, No. 1, pp. 46-52. E-ISSN 2165-8846, ISSN 2165-882X. DOI 10.5923/j.ijaf.20120201.08.

[3] Andersson, F. N., Burzynska, K. and Opper, S. (2016) "Lending for growth? A Granger causality analysis of China's finance–growth nexus", *Empirical Economics*, Vol. 51, No. 3, pp. 897-920. ISSN 1435-8921. DOI 10.1007/s00181-015-1034-8.

[4] Baltagi, B. H. ed. (2015) "*The Oxford handbook of panel data*", Oxford Handbooks. ISBN 978-0-19-994004-2. DOI 10.1093/oxfordhb/9780199940042.001.0001.

[5] Baráth, L. and Fertő, I. (2017) "Productivity and convergence in European agriculture", *Journal of Agricultural Economics*, Vol. 68, No. 1, pp. 228-248. ISSN 1477-9552. DOI 10.1111/1477-9552.12157.

[6] Čechura, L. (2006) "The role of credit rationing in Czech agriculture–the case of large agricultural enterprises", *Agricultural Economics–Czech*, Vol. 52, No. 10, pp. 477-488. ISSN 1805-9295. DOI 10.17221/5054-AGRICECON.

[7] Čechura, L., Grau, A., Hockmann, H., Kroupová, Z. and Levkovych, I. (2014) "Total Factor Productivity in European Agricultural Production", COMPETE Working Paper, No. 9, DOI 10.13140/RG.2.1.3856.9367.

[8] Chisasa, J. (2014) "An empirical study of the impact of bank credit on agricultural output in South Africa", University of South Africa, PhD Thesis. [Online]. Available: http://uir.unisa.ac.za/handle/10500/18511. [Accessed: 12 Dec. 2020].

[9] Das, A., Senapati, M. and John, J. (2009) "Impact of Agricultural Credit on Agriculture Production: An Empirical Analysis in India", *Reserve Bank of India Occasional Papers*, Vol. 30, No. 2, pp. 75-107. ISSN 0972-7493.

[10] Ekwere, G. E. and Edem, I. D. (2014) "Evaluation of Agricultural Credit Facility in Agricultural Production and Rural Development", *Global Journal of Human Social Science*, Vol. 14, No. 3, pp. 19-26. ISSN 2249-460X.

[11] European Environment Agency (2017a) "*Climate change, impacts and vulnerability in Europe 2016*", Publications Office of the European Union. Jan. 2017. [Online]. Available: https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016. [Accessed: 10 Dec., 2020].

[12] European Environment Agency (2017b) "*Landscapes in transition - An account of 25 years of land cover change in Europe*", Publications Office of the European Union, Sep.. 2017. [Online]. Available: https://www.eea.europa.eu/publications/landscapes-in-transition [Accessed: 10 Dec., 2020].

[13] European Environment Agency (2020) "*Agriculture*", Publications by European Environment Agency, Jan. 2020. [Online]. Available: https://www.eea.europa.eu/sk/themes/agriculture [Accessed: 10 Dec. 2020].

[14] Fecke, W., Feil, J. H. and Musshoff, O. (2016) "Determinants of loan demand in agriculture empirical evidence from Germany", *Agricultural Finance Review*, Vol. 76, No. 4, pp. 462-476. ISSN 0002-1466. DOI 10.1108/AFR-05-2016-0042.

[15] Food and Agriculture Organization of the United Nations (2018) "*Credit to agriculture*", Food and Agriculture Organization of the United Nations., Oct. 2018. [Online]. Available: http://www.fao.org/economic/ess/investment/credit/en/ [Accessed: 26 Nov. 2020].

[16] Hussain, A., Ali, M., Bilal, M. and Nawaz, I. (2015) "Impact of Insitutional Credit on Agriculture Production in Pakistan: A Time Series Analysis", *World Applied Sciences Journal*, Vol. 33, No. 7, pp. 1118-1124. ISSN 1818-4952.

[17] Juszcyk, S. (2018) "The influence of loans agriculture on net profit of cooperative banks in Poland", *Problems of Agricultural Economics/Zagadnienia Ekonomiki Rolnej*, Vol. 4, No. 357, pp. 60-79. ISSN 0044-1600. DOI 10.30858/zer/100701.

[18] Kalusova, L. and Badura, P. (2017) "Factors determining the financial structure of Czech and Slovak agricultural enterprise", *Agricultural Economics*, Vol. 63, No. 1, pp. 24-33. ISSN 1805-9295. DOI 10.17221/325/2015-AGRICECON.

[19] Kaufman, L. and Rousseeuw, P. J. (1990) "*Finding Groups in Data: An Introduction to Cluster Analysis*", John Wiley & Sons, Vol. 344, ISBN 9780471878766. DOI 10.1002/9780470316801.

[20] Khan, W., Fatima, S. and Jamshed, M. (2017) "Agricultural Credit-led Agricultural Growth: A VECM Approach", *Asian Journal of Agricultural Extension, Economics & Sociology*, Vol. 19, No. 1, pp. 1-16, ISSN 2320-7027. DOI 10.9734/AJAEES/2017/32304.

[21] Kijek, A., Kijek, T., Nowak, A. and Skrzypek, A. (2019) "Productivity and its convergence in agriculture in new and old European Union member states", *Agricultural Economics*, Vol. 65, No. 1, pp. 1-9. ISSN 1805-9295. DOI 10.17221/262/2017-AGRICECON.

[22] Kim, B. (2020) "*Understanding Diagnostic Plots for Linear Regression Analysis*", University of Virginia Library. Sep. 2015. [Online]. Available: https://data.library.virginia.edu/diagnostic-plots/khk [Accessed: Nov 26, 2020].

[23] Koester, U. (2016) "*Grundzüge der landwirtschaftlichen Marktlehre*", 4th ed. in 2010, 413 p., mit vielen Übersichten und Schaubildern. Softcover Vahlen. ISBN 978-3-8006-3764-5. (in German).

[24] Laborde, D. and Piñeiro, V. (2018) "Monitoring agricultural productivity for sustainable production and R&D planning", *Economics: The Open-Access, Open-Assessment E-Journal*, Vol. 12, No. 2018-66, pp. 1-11. ISSN 1864-6042. DOI 10.5018/economics-ejournal.ja.2018-66.

[25] Mohan, R. (2006) "Agricultural Credit in India: Status, Issues and Future Agenda", *Economic and Political Weekly*, Vol. 41, No. 11, pp. 1013-1023. ISSN 2349-8846.

[26] Narayanan, S. (2015) "The productivity of agricultural credit in India", *Agricultural Economics*, Vol. 47, No. 4, pp. 399-409. ISSN 0169-5150. DOI 10.1111/agec.12239.

[27] Nowak, A., Janulewicz, P., Krukowski, A. and Bujanowicz-Haraś, B. (2016) "Diversification of the level of agricultural development in the member states of the European Union", *Cahiers Agricultures*, Vol. 25, No. 5, 7 p. ISSN 1166-7699. DOI: 10.1051/cagri/2016040.

[28] Obilor, S. I. (2013) "The Impact of Commercial Banks' Credit to Agriculture on Agricultural Development in Nigeria: An Econometric Analysis", *International Journal of Business, Humanities and Technology*, Vol. 3, No. 1, pp. 85-94. ISSN 2162-1381.

[29] Oyelade, A. O. (2019) "Impact Of Commercial Bank Credit On Agricultural Output In Nigeria", *Review of Innovation and Competitiveness: A Journal of Economic and Social Research*, Vol. 5, No. 1, pp. 5-20. ISSN 1849-9015. DOI 10.32728/ric.2019.51/1.

[30] Rabek, T. (2006) "The Analyse Of Long-Term And Short-Term Bank Credits In Slovak Agriculture", In: *Actual problems solved in agrocomplex*, Slovak University of Agriculture in Nitra. pp. 471-476. ISBN 80-8069-799-X. (in Slovak).

[31] Ramakumar, R. and Chavan, P. (2014) "Bank Credit to Agriculture in India in the 2000s: Dissecting the Revival", *Review of Agrarian Studies*, Vol. 4, No. 1, pp. 50-79. ISSN 2248-9002.

[32] Rogach, S., Vdovenko, L. and Polishchuk, O. (2019) "Agriculture of Ukraine under the joint policy of the European Union", *Baltic Journal of Economic Studies*, Vol. 5, No. 3, pp. 178-183. ISSN 2256-0742. DOI 10.30525/2256-0742/2019-5-3-178-183.

[33] Shabir, M., Amin, K., Muhammad, A. and Ahmad, J. (2020) "Impact of Agricultural Credit on Cereal Productivity: Case Study of District Sargodha, Punjab Pakistan", *Theoretical Economics Letters*, Vol. 10, No. 3, pp. 481-487. ISSN 2162-2078. DOI 10.4236/tel.2020.103030.

[34] Shahbaz, M., Shabbir S. M. and But, S. M. (2013) "Effect of financial development on agricultural growth in Pakistan: New extensions from bounds test to level relationships and Granger causality tests", *International Journal of Social Economics*, Vol. 40, No. 8, pp. 707-728. ISSN 0306-8293. DOI 10.1108/IJSE-01-2012-0002.

[35] Shan, J. and Morris, A. (2002) "Does financial development 'lead' economic growth?". *International Review of Applied Economics*, Vol. 16, No. 2, pp. 153-168. ISSN 0269-2171. DOI 10.1080/02692170110118885.

[36] Skriniarova, K. and Bandlerova, A. (2012) "Zhodnotenie finančnej situácie v poľnohospodárskom sektore", *Business in European Union, Trade Law EU II: collection of papers from international scientific conference*, Vol. 11, pp. 145-151. ISBN 978-80-552-0819-0. (in Slovak).

[37] Tibshirani, R., Walther, G. and Hastie, T. (2001) "Estimating the number of clusters in a data set via the gap statistics", *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, Vol. 63, No. 2, pp. 411-423. ISSN 1467-9868. DOI 10.1111/1467-9868.00293.

[38] Toby, A. J. and Peterside, D. (2014) "Analysis of the role of banks in financing the agriculture and manufacturing sectors in Nigeria", *International Journal of Research in Business Management*, Vol. 2, No. 2, pp. 9-22. ISSN 2321-886X.

[39] Toth, M., Rabek, T. and Strapekova, Z. (2020) "Impact of Integration and Globalisation on Business Risk and loans in Slovak Agriculture", *The 19th International Scientific Conference Globalization and its Socio-Economic Consequences 2019 – Sustainability in the Global-Knowledge Economy,* Vol. 74, 2020. ISSN 2261-2424. DOI 10.1051/shsconf/20207405027.

[40] Varraso, I. and Dimitrio, A. (2020) "Impact of the global economic crisis on bank loans in agriculture in Italy and in Apulia (2010-2013)", *Geotema*, Vol. 52, pp. 71-87. ISSN 1126-7798.

[41] Yaya, S., Xi, C., Xiaoyang, Z. and Meixia, Z. (2020) "Evaluating the efficiency of China's healthcare service: A weighted DEA-game theory in a competitive environment", *Journal of Cleaner Production*, Vol. 270. ISSN 1879-1786. DOI 10.1016/j.jclepro.2020.122431.

[42] Young, K. G. (2019) "Disease endotypes of type 1 diabetes: Exploration through machine learning and topological data analysis", Rutgers University-School of Health Professions, PhD Thesis. [Online]. Available: https://rucore.libraries.rutgers.edu/rutgers-lib/60605/ [Accessed: Nov 15, 2020].