Czech University of Life Sciences Prague
Faculty of Economics and Management

agris on-line

Papers in Economics and Informatics

http://online.agris.cz

ISSN 1804-1930
XII, 2020, 1

International scientific journal
Prague

Agris on-line Papers in Economics and Informatics

The international reviewed scientific journal issued by the Faculty of Economics and Management of the Czech University of Life Sciences Prague.

The journal publishes original scientific contributions from the area of economics and informatics with focus on agriculture and rural development.

Editorial office

AGRIS on-line Papers in Economics and Informatics
Department of Economics of FEM CULS Prague
Kamýcká 129, 165 00 Praha-Suchdol
Czech Republic
Phone: +420 224 382 056
E-mail: agrisonline(at)pef.czu.cz

Publisher

Faculty of Economics and Management
Czech University of Life Sciences Prague
Kamýcká 129, 165 00 Praha-Suchdol
Czech Republic
Reg. number: 60460709

ISSN 1804-1930

XII, 2020, 1
30th of March 2020
Prague

Agris on-line
Papers in Economics and Informatics

ISSN 1804-1930

XII, 2020, 1

Agris on-line Papers in Economics and Informatics

Volume XII Number 1, 2020

Content:

Agris on-line Papers in Economics and Informatics

Volume XII Number 1, 2020

Diversifying Effect of Digital Competence

Adrián Csordás

Department of Business Informatics, Faculty of Economics and Business, University of Debrecen, Hungary

Abstract

Information and communication technology determines not only the development of companies but also the development of nations. Among other things, with the usage of eGovernment, the administrations can put „digitally pressure“ on their citizens which can lead to the appreciation of the role of digital competence. Based on data from the European Statistical Office, the digital competences of the EU Member States were examined between 2015 and 2017. A significant relationship was found between the level of digital knowledge and the level of unemployment. There is a strong positive correlation between the levels of digital competence and corporates training. In the clustering of countries, three distinct groups were created. The underdeveloped, developing and developed countries differed not only in the number of digitally educated people but also in the distribution of the digitally qualified groups.

JEL Classification: D83, E24, M53

Keywords

ICT, EU, unemployment, training.

Csordás, A. (2020) “Diversifying Effect of Digital Competence", *AGRIS on-line Papers in Economics and Informatics*, Vol. 12, No. 1, pp. 3-13. ISSN 1804-1930. DOI 10.7160/aol.2020.120101.

Introduction

In our decade the main challenges for companies are neither technological trends, disruptive innovations, nor new customer behaviors. Their aim is to adapt their throughway, culture, and competencies to the new, digital way of working (Accenture, 2016; Maedche, 2016). What kind of change does this revolution cause for the workforce (Murawski and Bick, 2017)? The publication of Frey and Osborne generated the biggest attention (Frey and Osborne, 2013). They estimated that 47 % of current US employment is at risk due to computerization. Among other things, as a result of this alarming article, several new reports on this topic have been published recently (Autor, 2015; Miroudot et al., 2016). The numerical results and conclusions of these reports are not similar, but they agree that the concept of work is going to change significantly in the coming decades (Murawski and Bick, 2017). The macroeconomic scientists are still focusing on the numerical results and conclusions of their reports, while the consequences for the individual workers are often neglected (Wang and Haggerty, 2011). One of the most important questions is “Which digital competencies are required for employability in the digital age (Dubey and Gunasekaran, 2015)”?

But what does digital competence exactly mean?

The concept of digital competence has not yet been applied consistently (Vieru, 2015). There are several ways to define it (Ferrari, 2012) because the existing definitions are quite general (Hoel and Holtkamp, 2012). Digital competence is one of the eight key competencies that are essential for lifelong learning within the European Union. Anusca Ferrari determines it as the confident, critical and creative use of Information and Communications Technology to achieve goals related to work, employability, learning, leisure, inclusion and/or participation in society. It is also a transversal key competence (Ferrari, 2013). It means with the help of digital competence possible to acquire other key competencies (e.g. language, mathematics, learning to learn, cultural awareness).

We can see the rapid change in computer software and hardware, which can make learned skills redundant (Lengyel et al., 2017). However, there are fundamental and enduring concepts of digital competencies that will be important for future

job seekers to master them (Hajkowicz et al., 2016). Educational institutions, governments and the players of the industry need to work together to develop the right e-skills, which increase competitiveness and productivity (Herdon et al., 2015). Because of ICT, people have a large digital footprint so the e-business and internet marketing are now easily mass-customized. Fake news is also often found on social sites, so it is important to learn the basics of digital literacy at a young age, including which source or database we consider reliable. The introduction of the blockchain could help to replace a trusted third-party in the verification and authentication of information. Although researchers have great hopes for blockchain-based technologies, while they are sufficiently transformative and fundamental, it is really difficult to evaluate its payback. Since 2010, Israeli schools have been gradually implementing the National ICT Program to align the education system to the digital era (Albion et al., 2015). Of course, the skills, beliefs, and attitudes of the teachers affect the effectiveness of ICT integration (Blau and Peled, 2012). They need to perceive the integration of technology in education as an integral part of the development of professional knowledge in order to maximize the potential impact of technology on teaching and learning (Wang et al., 2014). This could among other things, reduce the digital gap that causes more and more difficulties for university teachers and companies (Várallyai et al., 2015). The increased usage of digital technologies at work raises the demand for new skills. The employees need to acquire generic ICT skills to be able to use new technologies in their daily work (Australian Industry Group, 2018). However, technology has blurred borders between work and non-work activities (Reyt and Wiesenfeld, 2015). The use of the Internet, e-mailing and the use of social media is also an integral part of the work, but they can also be easily used to communicate with family and friends (Colbert et al., 2016). In spite of this according to Beitz ICT skills and capabilities are important for the whole workforce and not just those engaged in specialist ICT roles (Beitz, 2015).

Mohammadyari and Singh have shown that the digital competence of the workforce can contribute to successful technology adoption outcomes (Mohammadyari and Singh, 2015).

It is also important, that the companies need to invest not only in the technologies but also in people and skills. That is how they can enable the workforce uses the technologies optimally. With these acts the companies can reach, what Soule et al. called „digital dexterity” (Soule et al., 2016).

Materials and methods

To analyze the context of digital competence and human resources, a comprehensive dataset was needed which consisting of variables measuring ICT competences and some macroeconomics indicators of several countries globally. National statistical offices often estimate domestic values in their own national currencies. That is why they are not directly international comparable. The data was compiled after reviewing the databases of several international organizations. The main sources of the database were the European Statistical Office (Eurostat) and the OECD. Due to the limited accessibility of ICTs data for developing countries, only 28 members of the European Union were analyzed, during the period of 2015 - 2017. Cyprus and Malta did not have enough data in the database of Eurostat to be part of the research. The quantity of these data and the period under review are not as big as, they would be ideal, but it can be enough to illustrate proportions and directions. The variables which were used in this research are shown in Table 1.

The vast majority of terms in the table are clear, but there are some definitions that need to be clarified.

When the Eurostat classified the individuals, according to their digital skills, it had to compose digital skills indicators which are based on selected activities related to internet or software use performed by individuals aged 16-74 in four specific areas (information, communication, problem-solving, software skills). The participants completed a self-assessment survey. In most Member States the final sample size was between 3000 and 6000 elements.

When we summarize these results from the four fields, we can divide the next four groups:

- no skills: Digitally illiterate. He could not solve any tasks, despite he used the internet at least once during the last 3 months.
- low: He could not pass minimum one, maximum three tasks from the four areas.
- basic: He could solve all of the tasks, and he passed at least one at the “basic” level.
- above basic: He passed all of the tasks at the “above basic” level (Eurostat, 2019).

The database was analyzed with SPSS software. In the first step, the relationships were examined between the variables. The direction and strength of the relationship between them are determined by Pearson's correlation coefficient. During the correlation analysis, the value range is between 1 and -1. If the absolute value of the coefficient

Description	Variable	Value	Measurement	Data Source
Individuals who have no overall digital skills	ind	% of the total number of individuals aged 16 to 74	The standard deviation should not exceed 2 % of the overall proportions	Eurostat
Individuals who have low overall digital skills	ild			
Individuals who have basic overall digital skills	ibd			
Individuals who have above basic overall digital skills	iabd			
The development of web solutions is mainly performed by own employees	dwe	% of enterprises	Based on a sample of the population. The results are therefore subject to the usual types of errors associated with random sampling.	Eurostat
The support for web solutions is mainly performed by own employees	swe			
ICT functions are mainly performed by own employees	fpe			
Enterprise (SME) provided training to their personnel to develop/upgrade their ICT skills (reduced comparability with 2007)	train			
GDP/hour worked	gdp/hour	USD (constant prices 2010 and PPPs)	The OECD is responsible for collecting data and calculating the rates. (National Statistical Offices measure it.)	OECD
GDP	gdp	USD, Per head, current prices, current PPPs		
Harmonized unemployment rate	uemp	In numbers of unemployed people as a percentage of the labour force and it is seasonally adjusted		
Inflation	infl	Total, Annual growth rate (%)		

Source: own elaboration

Table 1: Descriptive of variables used in models.

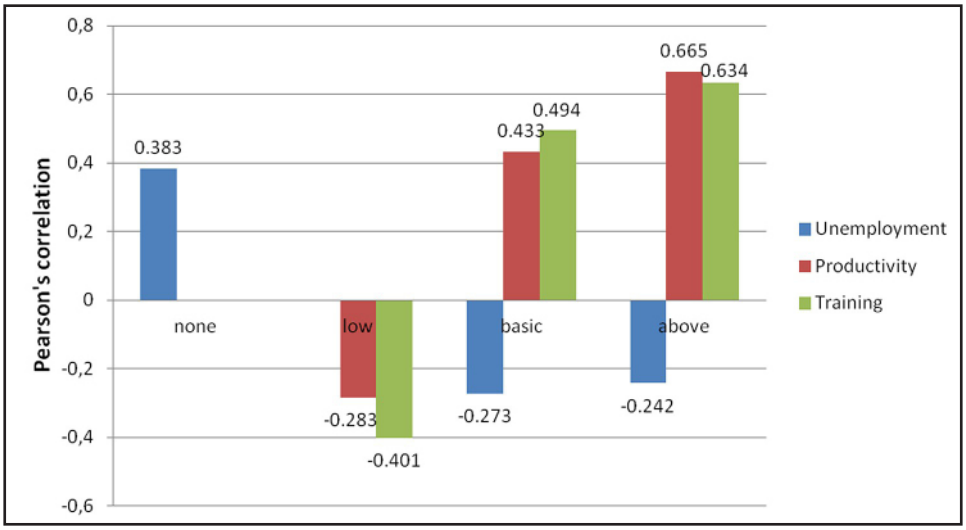
is close to one, it means that there is a strong relationship between the two studied variables (co-movement). If the value is positive, they move in the same direction (together), while in the case of a negative value, they move in the opposite direction (Field, 2013).

The classification of the countries of the European Union according to their level of development was made by K-Mean Method. The classification of similar things is called clustering, where the alike items are placed into groups. The basic purpose of this is to classify the observed units into relatively homogeneous groups, which are based on certain aspects. Among the hierarchical clustering methods, the use of Ward and the average chain method are quite popular, but they increasingly become "complementary" to non-hierarchical methods. The best solution is to run a hierarchical method first, to find out how much the ideal number of clusters would be, and then to run the non-hierarchical method, where we set that value to the number of groups. In our case, the singular use of the K-Mean Method was sufficient, because our goal was to define a predetermined number of groups (underdeveloped, developing and developed) (Sajtos and Mitev, 2007). The K-Means clustering algorithm uses k as a parameter, divide n objects into k clusters. The objects from the same cluster are similar to each other however differing from the other objects which belong to the other clusters. The algorithm tries to find the centers of the clusters, (C_1 ,C_2, C_3,…… C_k), such that the sum of the squared distances of each data point, x_i, $1 \leq i \leq n$, to its nearest cluster center C_j, $1 \leq j \leq k$, is minimized (Arpit et al., 2017).

Results and discussion

The connection between the analyzed variables

In these countries where the percentage of individuals with basic digital skills is higher, there the harmonized unemployment rate is lower (-0.273), than in those states where the individuals have above-average digital skills (-0.242). It can see in Figure 1. Although the correlation coefficients are quite weak in both cases and the significant level is only 95 %, it is obvious that in those places where the citizens do not have a general digital



Source: own elaboration

Figure 1: The relationship of different levels of digital competences to unemployment, productivity, and training.

knowledge, the unemployment rate (0.383, at 95 % significance level) is higher.

The result is not surprising. Today, even the simplest tasks require some degree of digital knowledge. Because of this, the employment of digital illiterates is difficult.

Kashan and Fouzia had the same result. To own digital skills like usage of computers, the internet and the ability to use other technology are very crucial for getting a job. There are also many other factors like higher education and health, which also affect employability, but these are rather expected in the case of well-payed jobs (Kashan and Fouzia, 2013). According to Bello et al. (2013), ICT skills are one of the most important requirements for employment. In addition, the dynamic nature of the labour market and the demand for new skills are the other considerable factors identified by 21-century studies.

In the Figure 1, the correlation was checked between the rate of productivity and the different level of digital competences too. Apart from digital illiterates, there are significant results for all three groups. In the case of individuals with low digital competence at 95%, in the case of basic and above basic individuals at 99% significance level, we can say that the higher digital competence means higher productivity.

This may be explained by the fact that higher-skilled people produce higher value-added products. Thus, they generate many more benefits at the same time, or in less time they produce the same benefits. Miikka et al. also think ICT is a potential source of productivity improvement. With the usage of ICT, we can eliminate non-value-adding tasks or make them more efficient. It gives (more) time for the more important tasks. In their study, the usage of ICT saved 19.5 minutes for one person in a week (Miikka et al., 2013). According to Cardona et al. ICT plays an important role in everyday lives, and in productivity as well. The authors say, the effect of the productivity is not only significant and positive but also increasing over time (Cardona et al., 2013), so the usage of ICT will be even more important.

This raises the question, whether companies want to train their less skilled people to produce higher value-added products, or do they promote the already higher qualified people, to further develop their high value-added productivity.

Based on the Figure 1., we can say that companies provide further training to people with at least basic digital competence. In the case of digitally unqualified people, we did not get any significant value, while the other correlation coefficients depicted were measured at 99% significance level.

It is assumed that the training of unskilled people requires a lot of time and money. It seems economy to further develop the more skilled people. It is logical, that from the "basic" level to „above" level can be achieved by using fewer resources. The "low" rated people (and the digitally unskilled) would require much more effort to reach the "basic" level.

We can interpret the publication of Khawaja and Nadeem in the same way. According to the authors, there are organizations that develop

employees who apply their abilities and skills for their organizations and with the training improve their loyalty (Khawaja and Nadeem, 2013). We can assume from the word “develop” that the above mentioned employees have at least a basic qualification. In the case of unskilled labor, they would use the word “train”, to teach them the essential of the job.

The work of Costen and Salazar takes the opposite view. According to the results of their survey, which made in the lodging industry, managers need to ensure that all employees receive formal training to help them learn the essential components of their jobs and the company standards associated with successfully performing their jobs (Costen and Salazar 2011). It is important to emphasize that the survey was conducted in the lodging industry, where digital competence and digitization are not so critical, and it is also important to note that unskilled employment is also a feature of this field, which makes it "obligatory " to train the employee.

Classification of countries

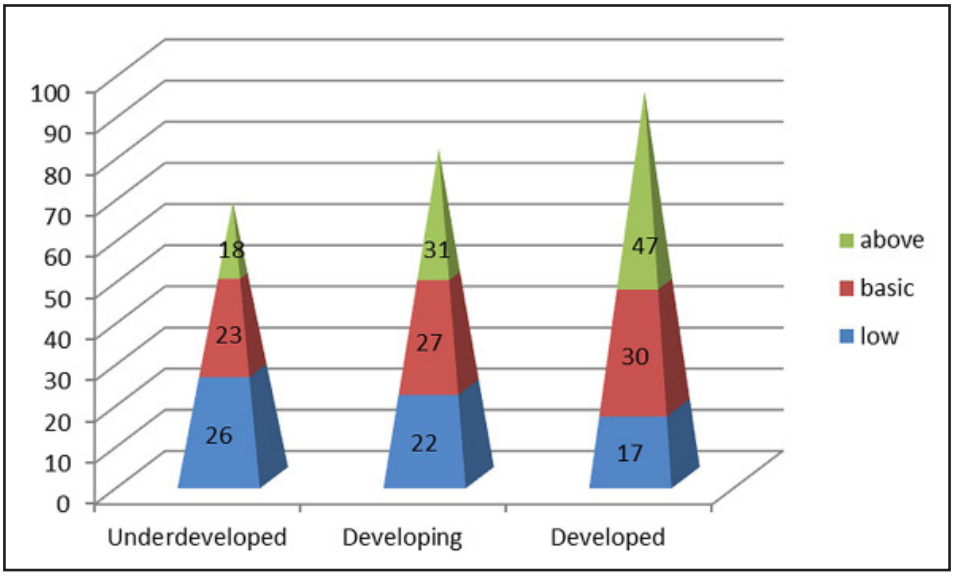
In this research, digital competence is in focus, so for group creation, variables were defined for SPSS such as individuals who have low/basic/above basic digital skills. (It would be more interesting the classification if I would test the different levels of digital skills together with productivity or GDP of the countries. Unfortunately, there was data e.g. Luxembourg's productivity / GDP, which would distort the sample and the further investigation of this would be meaningless.) Using the K-Mean Cluster method, three clusters were generated in the year 2015. The final cluster centers are shown in Figure 2.

The chart above shows that there are fewer citizens with digital competences in the underdeveloped group than in the developing or in the developed countries. Only 80% of people have any kind of digital competences in the developing group, however, in the developed group this percentage is higher (94 %).

It is interesting how the dimensions of the groups in the developed countries look like. While in the underdeveloped group we cannot speak of graduality, the developing group already shows that the goal is to expand higher-level groups. This "developing" process is already appearing in a relatively proportional way in developed countries. People with low competencies make up the smallest group (17%). Almost two times bigger is the group of basic users (30%), than the lower cluster. The group of "above" users is the widest. Nearly one and a half times bigger (47%) than the basic cluster. The most significant difference is in the size of the "Individuals who have the above basic overall digital skills" group.

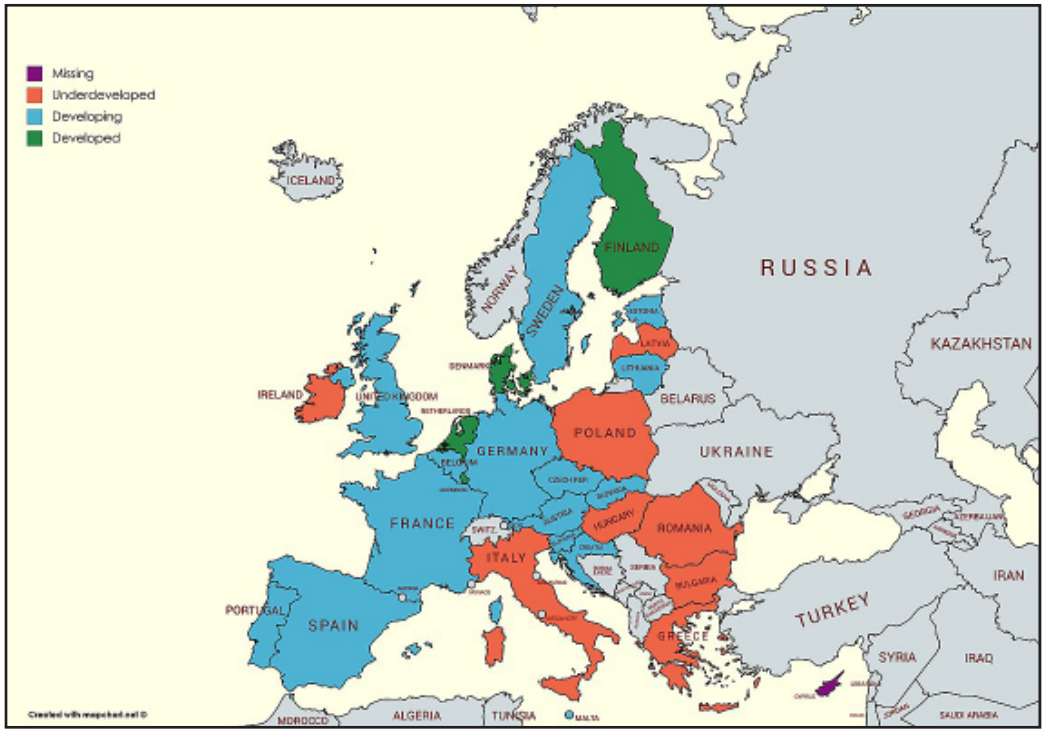
The Figure 3 shows the classification of countries according to the examined indicators.

Surprisingly only Luxembourg and the Netherlands belong to the group of developed countries from the (EU) founding states. Finland‘s top ranking is probably due to the excellent education system, which is known for its openness and continuous innovation worldwide (Williams et al., 2013).



Source: own elaboration

Figure 2: Underdeveloped, developing and developed clusters in 2015.



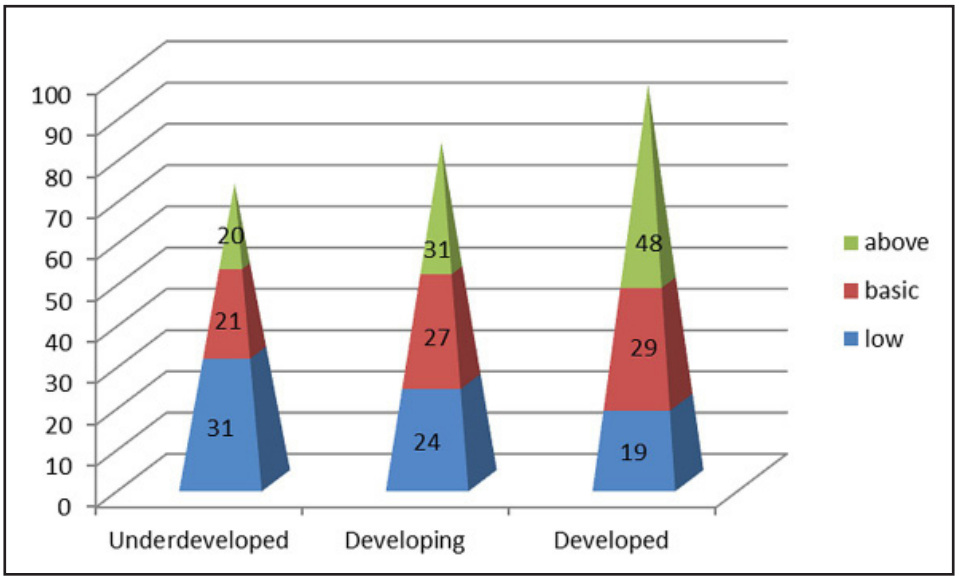
Note: Missing: Cyprus, because it has not enough data to the classification
Source: own elaboration

Figure 3: The classification of EU members in the year of 2015.

Denmark's developed classification is also could be connected with its education system and the high standard of living, that even the wealthy Germans are threatened by "brain drain" in Denmark. Excluding Italy, - it is the only founding member who belongs to the group of underdeveloped countries - the other founding member countries are members of the developing group. The otherwise internationally dominant Italy (it is a member of the G7), perhaps offers the locals a faster and easier way to earn money with tourism, thus Italy has individuals with fewer and lower levels of ICT than other founding Member States. Interestingly, Estonia which belongs to the developed Baltic States's, and its administration is almost completely digitalized, in spite of this, this country is not enough developed to be part of the smartest's cluster. Several countries of the underdeveloped group (Hungary, Poland, Romania) are affected by the emigration. In these countries, the unskilled people -who did not move abroad- work in factories that hardly create added value (Figure 4).

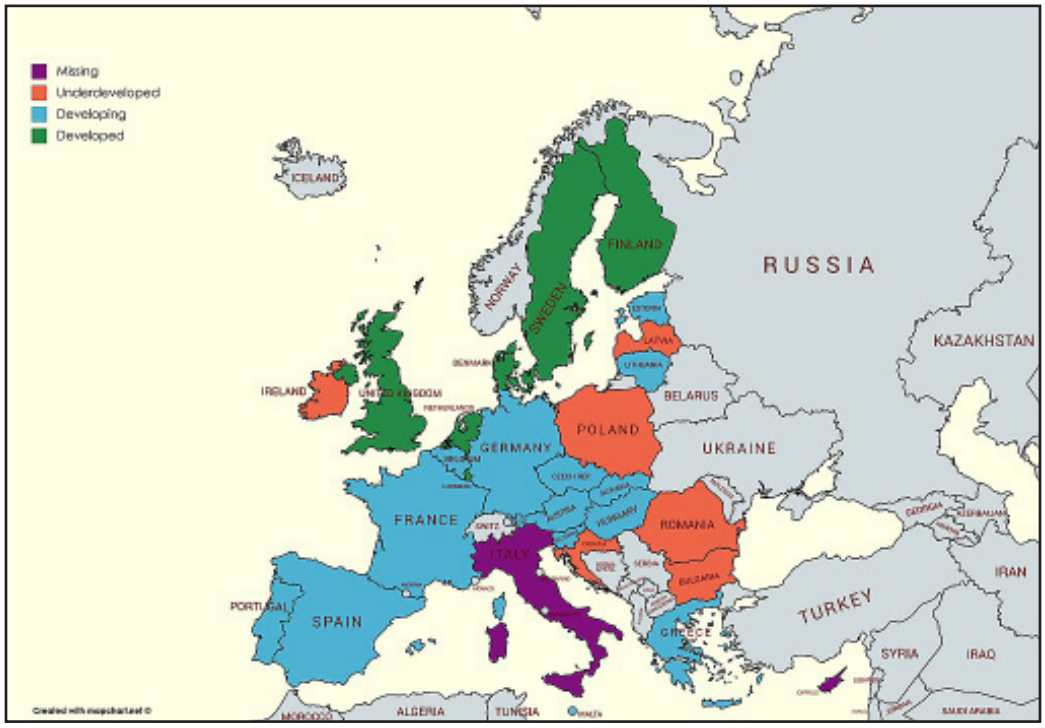
In accordance with previous correlation studies, we can see from these pyramids that basic users were trained to the above basic level in the underdeveloped and developed countries (the proportion of basic users decreased as much as, the proportion of users with the above basic level increased), while individuals with low digital competencies were not promoted to reach the "basic" level. (The proportion of users with low digital competence increased, while the proportion of users with basic digital competence decreased) (Figure 5).

When we compare the data of 2015 and 2017, it is clear that the group of developing countries was the largest in both years. During the period under review, Greece and Hungary moved forward from the cluster of underdeveloped countries to the group of developing countries, while Croatia fell to the underdeveloped countries from the developing cluster. The setback of Croatia explicable with its new EU membership. In the first phase after accession (2013.07.01-2015.06.30), 13 EU member states restricted the employment of Croatian citizens, in the second stage (2015.07.01-2018.06.30) only 5 countries applied restrictions against them. From 1 July 2018, only Austria regulates the employment of Croatian citizens (European Commission). Against this background, we can assume that the more skilled workforce emigrated from the country, which led to a decrease in the proportion of digitally competent residents. Sweden and the United Kingdom stepped forward. They moved from developing countries into clusters of developed countries.



Source: own elaboration

Figure 4: Underdeveloped, developing and developed clusters in the year of 2017.



Note: Missing: Cyprus, because it has not enough data to the classification
Source: own elaboration

Figure 5: The classification of EU members in the year of 2017.

Conclusion

A correlation was found between the level of digital competence of the country's residents and the harmonized unemployment rate. In these countries where the citizens own basic digital competence, there the harmonized unemployment rate is lower, than in those countries where individuals have above-basic digital competence. In the lower-skilled countries (where citizens do not have any digital competence), the unemployment rate is higher. Other authors (Kashan and Fouzia, 2013; Bello et al., 2013) also discuss a similar relationship between employability and digital knowledge.

According to the result of this paper higher digital competence means higher productivity. Higher-skilled people generate many more benefits at the same time, or in less time they produce the same benefits. Miikka et al. also think ICT is a potential source of productivity improvement (Miikka et al., 2013). According to Cardona the effect of productivity increasing over time (Cardona et al., 2013). That is while important to keep in mind that e-business and internet marketing are key factors in the 21st century, which could further boost the economy by engaging less digitally skilled people. In agriculture, the technology (especially GPS, RFDI, IoT) is becoming an increasingly important factor. With blockchain-based systems, this field can bring a new kind of added value (food tracking) that can further expand the economy as a whole, but in the case of large-scale production and cultivation, it also can make the digital competence useless because of automatization.

The openness of companies for training is also influenced by the digital competence of the inhabitants of that country. In these countries where more skilled people live, companies offer more opportunities for further training, than in countries with less educated people. A moderately strong negative correlation was found between low digital competence and workplace training. That means the companies do not offer training in these countries, where low digital educated people live. According to the above statement, an EU country has to create its digitally “educated” competent inhabitants, in order for a company - to reduce the burden of the country and increase its revenues - to further educate the local population. Taking advantage of the "training wave", in the long run, a wide "above" layer can be created with fewer "average" and or "low" digital competences. This can cause (beyond the "reverse competency pyramid" and developed status) the so-called "digital dexterity" by Soule et al (Soule et al., 2016). However not only certain companies can reach it, but also whole sectors.

When the Member States of the European Union were grouped, two interesting findings were made. The biggest difference between the three groups (underdeveloped, developing and developed) was not only the proportion of people with above basic digital competence but also in the proportion of individuals with any digital competence. In addition, in the group of developed countries, we also can observe an interesting phenomenon, the so-called "reverse competence pyramid". This means that as the level of competence increases, the number of individuals who own it increases as well. This reverse pyramid is not observed in underdeveloped countries, while in the developing countries there are signs of „gradualness”. The existence of a "reverse competency pyramid" would also be worth examining in economic areas, where the salaries of high value-added jobs (ICT specialists) do not differ significantly between the countries of the region. Because of the sense of free labor flow within the European Union, a "top" digitally competent programmer can move abroad (by "brain drain") for higher salaries, so instead of they would increase the income and the number of well-educated people in their country of origin, they do these in another country, what we cannot track.

Corresponding authors
Adrián Csordás
Department of Business Informatics, Faculty of Economics and Business University of Debrecen
Debrecen, Böszörményi út 138 4032, Hungary
E-mail: csordas.adrian19@gmail.com

References

[1] Accenture (2016) "*People First: The Primacy of People in a Digital Age*", Accenture Technology Vision 2016. [Online]. Available: https://www.accenture.com/t20160314t114937__w__/us-en/_acnmedia/accenture/omobono/technologyvision/pdf/technology-trends-technology-vision-2016.pdf [Accessed: 15 May 2019].

[2] Albion, P. R., Tondeur, J., Forkosh-Baruch A. and Peeraer J. (2015) "Teachers’ professional development for ICT integration: towards a reciprocal relationship between research and practice", *Education and Information Technologies*, Vol. 20, No. 4, pp. 655-673. E-ISSN 1573-7608, ISSN 1360-2357.

[3] Arpit, B., Mayur, S. and Shalini, G. (2017) "Improved K-mean Clustering Algorithm for Prediction Analysis using Classification Technique in Data Mining", *International Journal of Computer Applications* , Vol. 157, No. 6. ISSN 0975 - 8887. DOI 10.5120/ijca2017912719.

[4] Australian Industry Group (2018) "Developing the Workforce for a Digital Future". [Online]. Available: https://cdn.aigroup.com.au/Reports/2018/Developing_the_workforce_for_a_digital_future.pdf. [Accessed: 29 Aug. 2019].

[5] Autor, D. H. (2015) "Why are there still so many jobs? The history and future of workplace automation", *Journal of Economic Perspectives*, Vol. 29 No. 3, pp. 3-30. ISSN 08953309. DOI 10.1257/jep.29.3.3.

[6] Beitz, S. (2015) "Developing the capacity to adapt to industry transformation", in "*Australia's future workforce?"*, Committee for Economic Development of Australia, pp. 156-166. ISBN 0 85801 300 2.

[7] Bello, H., Shu'aibu, B., Sukri bin Saud, M. and Buntat, Y. (2013) "ICT Skills for Technical and Vocational Education Graduates' Employability", *World Applied Sciences Journal,* Vol. 23, No. 2, pp. 204-207. ISSN 1818-4952.

[8] Blau, I. and Peled, Y. (2012) "Teachers' openness to change and attitudes towards ICT: Comparison of Laptop per Teacher and Laptop per Student programs", *Interdisciplinary Journal of E-Learning and Learning Objects*, Vol. 8, pp. 73-82. E-ISSN 2375-2092, ISSN 2375-2084. DOI 10.28945/1728.

[9] Cardona, M., Kretschmer, T. and Strobel, T. (2013) "ICT and productivity: conclusions from the empirical literature", *Information Economics and Policy*, Vol. 25, No. 3, pp. 109-125. ISSN 0167-6245. DOI 10.1016/j.infoecopol.2012.12.002.

[10] Colbert, A., Yee, N. and George, G. (2016) "The digital workforce and the workplace of the future". *Academy of Management Journal*, Vol. 59, No. 3, pp. 731-739. E-ISSN 1948-0989, ISSN 0001-4273. DOI 10.5465/amj.2016.4003.

[11] Costen, W. M. and Salazar, J. (2011) "The Impact of Training and Development on Employee Job Satisfaction, Loyalty, and Intent to Stay in the Lodging Industry", *Journal of Human Resources in Hospitality & Tourism*, Vol. 10, No. 3, pp. 273-284. E-ISSN 1533-2853, ISSN 1533-2845. DOI 10.1080/15332845.2011.555734.

[12] Dubey, R. and Gunasekaran, A. (2015) "Education and training for successful career in big data and business analytics", *Industrial and Commercial Training*, Vol. 47 No. 4, pp. 174-181. ISSN 0019-7858. DOI 10.1108/ICT-08-2014-0059.

[13] EUROPEAN COMMISSION (2018) "Horvátország - Foglalkoztatás, szociális ügyek és társadalmi befogadás - Európai Bizottság". [Online]. Available: https://ec.europa.eu/social/main.jsp?catId=1067&langId=hu. [Accessed: 30 Jun. 2019].

[14] Eurostat, (2019) „Individuals who have basic or above basic overall digital skills by sex". [Online]. Available: https://ec.europa.eu/eurostat/cache/metadata/en/tepsr_sp410_esmsip2.htm. [Accessed: 17 Sept.2019].

[15] Ferrari, A. (2012) "*Digital Competence in Practice: An Analysis of Frameworks*", European Commission, Joint Research Center, Institute for Prospective Technological Studies. [Online]. Available: https://ec.europa.eu/digital-single-market/en/news/digital-competence-practice-analysis-frameworks. [Accessed: 10 June 2019].

[16] Ferrari, A. (2013) "DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe". [Online]. Available: https://publications.europa.eu/en/publication-detail/-/publication/a410aad4-10bf-4d25-8c5a-8646fe4101f1/language-en [Accessed: 10 June 2019].

[17] Field, A. (2013) "Discovering statistics using IBM SPSS Statistics" paperback (4th ed.). Thousand Oaks, CA, USA: SAGE Publications. ISBN-13: 978-9351500827, ISBN-10: 1446249182.

[18] Frey, C. B. and Osborne, M. A. (2013) "The Future of Employment: How Susceptible are Jobs to Computerization?", Oxford University Programme on the Impacts of Future Technology, 72. p.

[19] Hajkowicz, S., Reeson A., Rudd, L., Bratanova, A., Hodgers, L., Mason, C. and Boughen, N. (2016) "Tomorrow's Digitally Enabled Workforce", Commonwealth Scientific and Industrial Research Organisation, [Online]. Available: https://data61.csiro.au/en/Our-Work/Future-Cities/Planning-sustainable-infrastructure/Tomorrows-Digitally-Enabled-Workforce [Accessed: 17 Sept.2019].

[20] Herdon, M., Botos, S. and Várallyai, L. (2015) "Decreasing the Digital Divide by Increasing E-Innovation and E-Readiness Abilities in Agriculture and Rural Areas", *International Journal of Agricultural and Environmental Information Systems*, Vol. 6, No. 1, pp. 1-18. E-ISSN 1947-3206, ISSN 1947-3192. DOI 10.4018/ijaeis.2015010101.

[21] Hoel, T. and Holtkamp, P. (2012) "Requirements modelling in international information systems design – what competencies are needed and how to manage them?", *ECKM '12: Proceedings of the 13th European Conference on Knowledge Management*, Cartagena, Spain, pp. 466-475.

[22] Kashan, P. and Fouzia, N. K. (2013) "Measuring Relationship between Digital Skills and Employability", *European Journal of Business and Management*, Vol. 5, No. 24. E-ISSN 2222-2839, ISSN 2222-1905.

[23] Khawaja, J. and Nadeem, A. B. (2013) "Training and Development Program and its Benefits to Employee and Organization: A Conceptual Study", *European Journal of Business and Management*, Vol. 5, No. 2, 2013, E-ISSN 2222-2839, ISSN 2222-1905.

[24] Lengyel, P., Herdon, M., Pancsira, J., Ráthonyi, G. and Füzesi, I. (2017) "The E-learning system success assessment of the service quality using binominal logistic regression", *Journal on Efficiency and Responsibility in Education and Science,* Vol. 10, No. 2, pp. 51-57. E-ISSN 1803-1617, ISSN 2336-2375. DOI 10.7160/eriesj.2017.100203.

[25] Maedche, A. (2016) "Interview with Michael Nilles on "What makes leaders successful in the age of the digital transformation?", *Business & Information Systems Engineering*, Vol. 58, No. 4, pp. 287-289. E-ISSN 1867-0202, ISSN 2367-7005.

[26] Miikka P., Antti, L. and Maiju, V. (2013) "Analysing the impacts of ICT on knowledge work productivity", *Journal of Knowledge Management*, Vol. 17, No. 4, pp. 545-557. ISSN 1367-3270. DOI 10.1108/JKM-03-2013-0113.

[27] Miroudot, S., Marcolin, L. and Squicciarini, M. (2016) "Routine Jobs, Employment and Technological Innovation in Global Value Chains", OECD Science, Technology and Industry Working Papers. DOI 10.1787/5jm5dcz2d26j-en.

[28] Mohammadyari, S. and Singh, H. (2015) "Understanding the Effect of e-Learning on Individual Performance: The Role of Digital Literacy", *Computers & Education,* Vol. 82, pp. 11-25. ISSN 0360-1315. DOI 10.1016/j.compedu.2014.10.025.

[29] Murawski, M. and Bick, M. (2017) "Digital competences of the workforce – a research topic?" *Business Process Management Journal*, Vol. 23, No. 3, pp. 721-734. ISSN 1463-7154. DOI 10.1108/BPMJ-06-2016-0126.

[30] Reyt, J. and Wiesenfeld, B. M. (2015) "Seeing the forest for the trees: Exploratorylearning, mobile technology, and knowledge workers' role integration behaviors", *Academy of Management Journal*, Vol. 58, pp. 739-762. E-ISSN 1948-0989, ISSN 0001-4273. DOI 10.5465/amj.2013.0991.

[31] Sajtos, L. and Mitev, A. (2007) "*SPSS Kutatási és adatelemzési kézikönyv*", Alinea Kiadó, ISBN 978-963-9659-08-7. (in Hungarian).

[32] Soule, D. L., Puram, A. D., Westerman, G. F. and Bonnet, D. (2016) "Becoming a Digital Organization: The Journey to Digital Dexterity", *SSRN Electronic Journal*, 25 p. E-ISSN 1556-5068. DOI 10.2139/ssrn.2697688.

[33] Várallyai, L., Herdon, M. and Botos, S. (2015) "Statistical Analyses of Digital Divide Factors", *Procedia Economics and Finance*, Vol. 19, pp. 364-372. ISSN 2212-5671. DOI 10.1016/S2212-5671(15)00037-4.

[34] Vieru, D. (2015) “Towards a multi-dimensional model of digital competence in small- and mediumsized enterprises”, in Khosrow-Pour, M. (Ed.) "*Encyclopedia of Information Science and Technology*", 3rd ed., IGI Global, Hershey PA, pp. 6715-6725. ISBN-13: 978-1466658882. ISBN-10: 1466658886.

[35] Wang, S. K., Hsu, H. Y., Reeves, T. C. and Coster, D. C. (2014) "Professional development to enhance teachers' practices in using information and communication technologies (ICTs) as cognitive tools: lessons learned from a design-based research study", *Computers & Education*, Vol. 79, pp.101-115. ISSN 0360-1315. DOI 10.1016/j.compedu.2014.07.006.

[36] Wang, Y. and Haggerty, N. (2011) “Individual virtual competence and its influence on work outcomes”, *Journal of Management Information Systems*, Vol. 27, No. 4, pp. 299-334. E-ISSN 1557-928X, ISSN 0742-1222. DOI 10.2753/MIS0742-1222270410.

[37] Williams, R., de Rassenfosse, G., Jensen, P. and Marginson, S. (2013) "The determinants of quality national higher education systems", *Journal of Higher Education Policy and Management*, Vol. 35, No. 6, pp. 599-611. E- ISSN 1469-9508, ISSN 1360-080X. DOI 10.1080/1360080x.2013.854288.

Agris on-line Papers in Economics and Informatics

Volume XII Number 1, 2020

E-AGRO: Intelligent Chat-Bot. IoT and Artificial Intelligence to Enhance Farming Industry

Jayalath Ekanayake, Luckshitha Saputhanthri

Sabaragamuwa University of Sri Lanka

Abstract

This study develops a chat room and a Chat–Bot to discuss the prevailing issues related to farming with peers and expertise and support farmers to make timely decision on farming. A standard set of questions was identified through discussions and surveys with farmers, expertise and other stakeholders. Intents, which the users might want to know, and examples, which the users use to explain a specific intent and entities that are different objects referring to an intent were identified from the questions. Artificial Intelligence Markup Language (AIML) was used to train a model, which predicts an intent based on the given example. The Chat-Bot was implemented in a cloud platform and therefore, the client end does not require more computational resources.

Keywords

Chat-Bot, Agriculture, Chat-room, Artificial Intelligence, Farming Industry, intents, examples.

Ekanayake, J. and Saputhanthri, L. (2020) “E-AGRO: Intelligent Chat-Bot. IoT and Artificial Intelligence to Enhance Farming Industry", *AGRIS on-line Papers in Economics and Informatics*, Vol. 12, No. 1, pp. 15-21. ISSN 1804-1930. DOI 10.7160/aol.2020.120102.

Introduction

The agricultural sector has been the mainstay of the Sri Lankan economy over the past centuries and currently, the sector contributes 7.5% for the national Gross Domestic Product (GDP) of Sri Lanka and provides employments for 80% of the rural community of Sri Lanka. Agriculture by products are raw materials for the other industries, which earns foreign exchange. In Sri Lanka the agriculture industry is dominated by small-scale farmers, whose farming range is from 0.3 to 0.5 hectares. However, farming becomes less profitable industry in Sri Lanka and there is a trend that the small-scale farming community is leaving from farming.

There are many reasons for less attraction on farming. Among them lack of the knowledge on modern technologies of farming is a major problem faced by the rural community. Information is key for knowledge gain on farming and hence, information is a valuable resources for rural development (Carter, 1999; Meyer, 2003; Morrow et al., 2002) and can assist small-scale farmers in making timely decisions and taking appropriate actions. Marchionini (1995) emphasizes that people need to change the state of their knowledge to access information, which implies that information is a critical resource for socio-economic development because it empowers people to make informed choices for attaining better livelihoods. Kalusopa (2005) revealed that the development in the agriculture sector is required a well organized functional integrated information delivery system, supported by efficient national collaboration programs. However, Burton (2002) noted that most people in underdeveloped communities do not know what information they lack, nor do they know that information is available to help them solve their problems. Also, Oladele (2011) observed that lack of agricultural information is a key factor that has greatly limited agricultural advancement in developing countries. Thus, agricultural information interacts with, and influences, agricultural activities in a variety of ways. This tends to imply that agricultural information can help inform decision-making regarding land, labour, livestock, capital and management. Interestingly, agricultural information is not static but, instead, needs updates through research and development. Opara (2008) mentioned that agricultural activities can arguably be improved by relevant, reliable and useful information and knowledge. Aina (1991), and Mooko

and Aina (2007) revealed in their research findings that agricultural information is an essential recipe for successful farming. Radhakrishna (2007) pointed out the other externalities such as money, favorable socio-political stability, and good governance that have to be in place so that information can make an impact. Invwieri (2007) opined that, rural community who are mainly illiterate require access to appropriate information to be able to make decisions and participate fully in the national development processes, including agriculture. However, the literacy rate of the rural community in Sri Lanka is higher compared to the other countries in the region and hence, providing necessary infrastructure will enable them to access the right information at right time. Zhao (2008) pointed out that the Internet adoption is required to empower the rural society since the majority of the people in developing countries belong to rural communities. Galagedarage (2015) identified the relationship between Internet adoption and infrastructural facilities, the adopter characteristics of rural communities, the characteristics of technology and affordability. Further, she explored that the issues such as lack of infrastructural facilities, problems of affordability and low computer and English language skills, negative attitudes, relevancy, and a lack of knowledge about benefits and usage of the Internet are negatively impact on Internet adoption among rural communities in Sri Lanka.

All the above research findings revealed that the development in the agriculture field needs crucial information to be made easily accessible, particularly to the small-scale farmers. Also, it reveals that productivity of farming can be improved by providing right type of information and at the right time, using the right channels and with all other necessary infrastructure in place, like telecommunication facilities, access roads, education, agricultural policies.

The state institutions of Sri Lanka and the private sector have taken several measurements to improve the IT infrastructure as well as the IT literacy in rural areas. Further, they have taken some initiatives to disseminate information through Information Technology. To that end the Department of Agriculture of Sri Lanka has developed several systems to provide information and disseminate knowledge among the rural farming community. The official website of the Department of Agriculture - www.doa.gov.lk - has been started since 2005 in English medium but later it was revamped and developed in all local languages Sinhala and Tamil. The web portal Wikigoviya - wwww.goviya.lk - was built to facilitate progressive dialogues on agricultural issues (Agriforum) and establish public knowledge repository called Agripedia. It also facilitates distance learning in agriculture and ICTs (e-learning). The e-SMS Service, which the farmers can send messages to an expert team called krushifm to discuss their maters in radio programs or send messages to Call Centre team requesting advice on their issues. All the above methods do not provide real-time interaction between farmers and experts.

Meeting with an agent of the Agricultural Department to solve certain issues related to farming is a traditional way of knowledge sharing and it is still practicing in Sri Lanka. However, this is very inconvenient to the farmers as the agent can be met only on scheduled dates. All of the above methods are not interactive and not real-time and hence, they are not popular among the farming community.

Jayarathna and Hettige (2013) developed a multi-agent system, which represents farmers, sellers, buyers and agricultural instructors and provided facilities to communicate with each other. This system used the multi-agent technology and is somewhat similar to our system, but we used the Chat-Bot technology, which received wider attention recently and used for several applications. The first Chat-Bot was the Eliza program (Weizenbaum, 1966). Later, Richard Wallace wrote A.L.I.C.E., the Artificial Linguistic Internet Computer Entity, a new Chat-Bot program (Wallace, 2003). It won the Loebner Award, which is the first formal instantiation of a Turing Test. A.L.I.C.E. was later updated by Dr. Wallace, Jon Baer, and others and programmed in Java. They later set up the Alice AI Foundation to promote the programming of Alicebots and help direct the new Artificial Intelligence Mark-up Language (AIML). The open source platforms like Dialogflow, IBM Watson can be used to build the Chat-Bot. However, the Chat-Bot technology has not been used in Agriculture domain very often.

Hence, this project aims on developing a web based interactive and intelligent Chat-Bot for farmers to discuss their issues. Further, this project implements a chat forum to interact with peers and share their knowledge and experiences. As the Internet infrastructure and mobile technology are rapidly developing in the rural areas, the rural community can access these systems at anywhere, anytime and from any device.

Materials and methods

WebSocket

Websocket exchanges text and binary data with client and server. It opens up interactive communication sessions between user and server that user can send messages to server and get an event driven response without poll the server to reply. Unlike http it is full-duplex and real time data flow.

On the request of client the server gives access to chat application through opening a websocket between client and server. All the connected clients have separate websocket connections toward the server. When a client sends message to the server through the chat application, server sends that message to the other connected clients through the websocket. So the others can display the message in their chat. The communication channel can be secured by applying Transport Level Security (TLS).

Socket.io

Socket.io is an event based emulation of websocket. It is a javascript library that can use for real-time web application. It is build on the top of Engine.IO. It primarily uses protocol of websocket and AJAX long polling for transport. It has two parts client-side and server-side libraries. It has cross browser and is working for all browsers now.

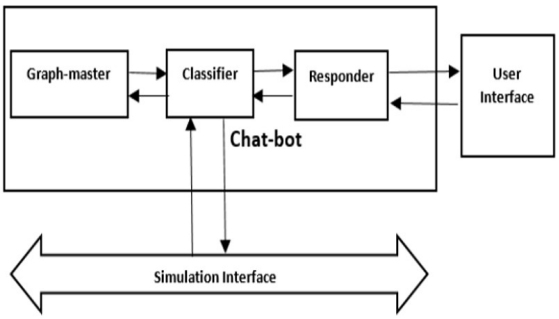
The chat room is integrated into E-Agro platform server, which is working on node server. It uses Socket io and express js. We installed the required libraries; express, socket.io and http and set the paths for the front-end and the server. The front-end of the application is implemented by using angular js as shown in the Figure 1 and the bootstrap framework is used to develop the chat application.

The chat-room is mainly comprised of messagebox, send button and the view of the other group members. The interface is made considering the standard features such as clarity, consistency, feedback, assistance and guidance, and user centric.

Google Translation API is used to translate messages between English and Sinhala. This is a simple tool to interact with other people and share their knowledge and experiences in their own language.

AI Chat-Bot

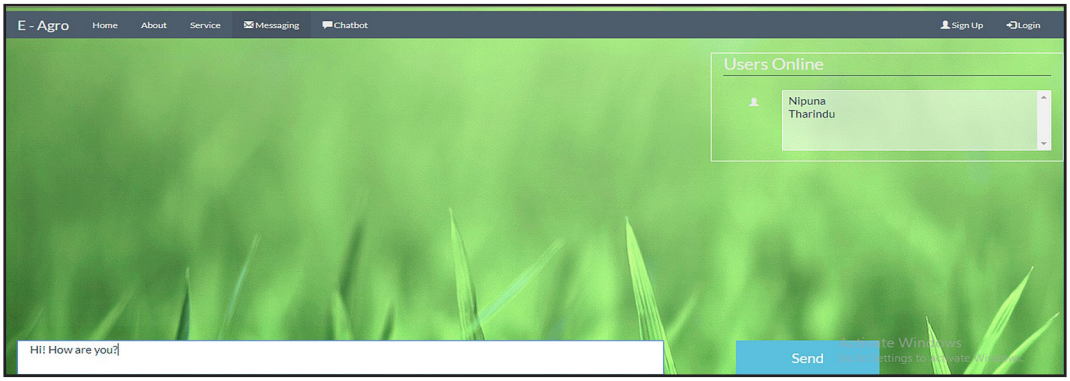
Chat-Bot is a latest technology to duplicate human conversation. Artificial Intelligence (AI) technologies and natural language processing techniques are integrated into the Chat-Bot. The Chat-bot can be trained to convers with human in any domain.



Source: Stoner, 2004

Figure 2: Chat-Bot Components.

As in the Figure 2 the Chat-Bot has three major components: Responder, Classifier, and Graph-master. Through the user interface user send response to the responder. The responder transfers data from user to classifier and the other side. Classifier filters and normalizes inputs and passes them to the Graph-master. Graph-master is the brain



Source: own processing

Figure 1: Chat room interface.

of the Chat-Bot. It matches the patterns with the stored information and sends them to the classifier. Then classifier also process the output respond.

Artificial Intelligence Markup Language (AIML) is used to encored the graph master representing examples and their corresponding intents. Following is a sample code of AIML.

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<aiml>
<category>
<pattern>HELLO *</pattern>
<template>Hi.</template>
</category>
</aiml>
```

The above example code generates the intent response “Hi” for the input example “Hello”.

When generating intents the sub categories of intents are also generated. For an example if a user example describe a location with an image then the intent response is an image of the location.

Adding more examples, which describe the same intent, can increase the accuracy of the Chat-Bot.

In this project the intents and the examples were collected through questionnaires, interviews with farmers, expertise and other stakeholders in the agricultural domain. The intents and the examples are the data used to train the Chat-Bot. The Chat-Bot is trained to predict an intent for the given example.

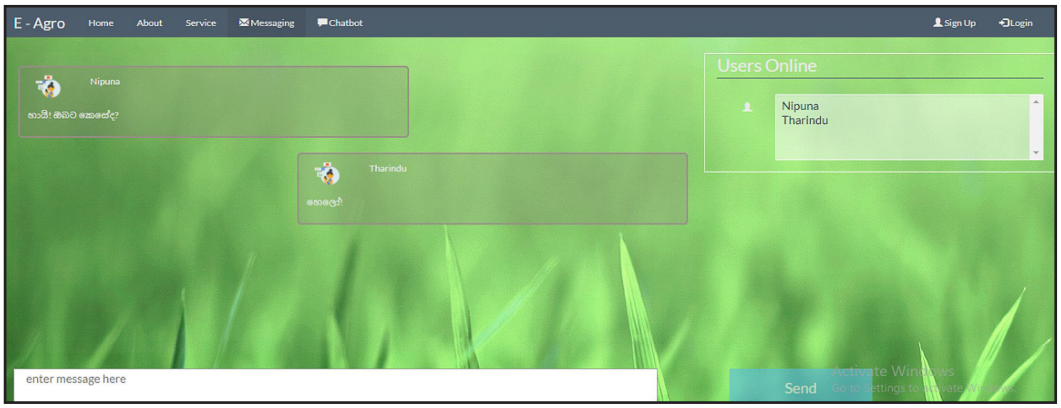
The user input text that is an example, is split into words and labeled according to their positions. Next according to different disciplines of grammar the words are chunk while omitting the unwanted words. Then important words are checked against key words and corrected them if necessary. The word pattern is passed into graph-master to retrieve the corresponding pattern from the knowledge base.

The open source platforms like Dialogflow, IBM Watson can be used to build the Chat-Bot as it allows both text and voice and also, a user can create their own intents, entities and context, and train the Chat-Bot easily.

Results and discussion

Translation Chat-Room

The Figure-3 shows the user interface of the chat room. The conversation is in the local language Sinhala. The user interface was developed considering the properties such as guidance, user-in-control, consistency, prevent errors, feedback, and simplicity. Also, the interface should provide facilities for the illiterate farmers. The task analysis was conducted with farmers, expertise in the field of agriculture and the expertize group of academics in User Interface designing at our university to identify and trace the tasks and subtasks, which the user requires to accomplish in order to successfully interact with the interface as mentioned by (Johnson, 1992). The initial version of the interface was designed with the help of the UI design group of our university accommodating all the requirements of the users. The initial version of the interface was presented to 40 farmers selecting from different areas in Sri Lanka. Mostly, they agreed on the objects presented in the interface however, they found difficulties in identifying the objects. Also, the majority did not agree on the organization of the objects. Hence, we changed the appearance of the objects as well



Source: own processing

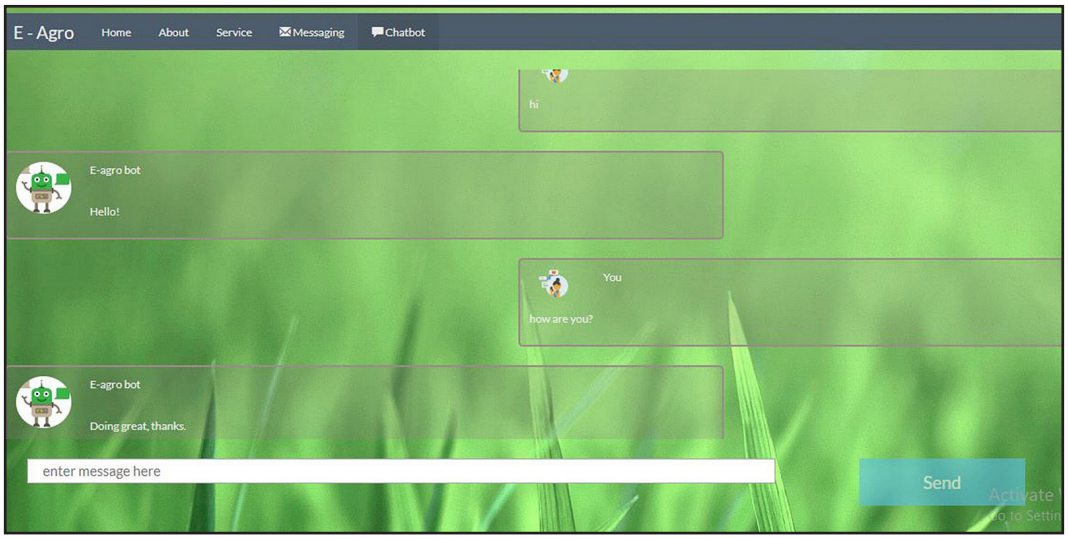
Figure 3: User interface of the chat room.

as the organization of the objects and finalized the interface as shown in Figure 3. The usability test of the interface was conducted in the laboratory with the help of the UI group at our university. The test was successful and subsequently, the usability test was conducted with real users in the field. This time we selected different set of farmers, who did not involve in the feedback session conducted at UI design stage. The majority of farmers successfully used the chat room without a difficulty and they impressed about the system. However, they found somewhat difficulty in the keyboard layout and hence, a user-friendly keyboard layout is required to design specially targeting the farmers.

Chat-Bot

Figure 4 shows the interface of the Chat-Bot. The interface was designed using the same procedure as above. The test was conducted in the laboratory and subsequently in the field. Test samples were selected from the frequently asked questions. Most of the test samples were drawn from the examples used to train the Chat-Bot. However, the test examples were slightly revised so that the Chat-Bot was tested with new queries, which are not seen by the Chat-Bot during the training. Some of the examples are included for greeting based on the time and some examples introduce the Chat-Bot itself to the users. Table 1 shows 13 test samples of user inputs and the Chat-Bot responses out of more than 50 test cases. The first three test cases are for the greeting and the introduction. The Chat-Bot is trained with examples, which are atomic sentences. The atomic sentences are not combined with logical connectors; AND and OR. The Chat-Bot failed to answer the questions 6 and 7 as they are not atomic questions. Also, the Chat-Bot did not answer for the question 8 as the required information is not stored in the knowledge base. The intents for the examples from 9 to 13 were identified in our previous research (Tharindu and Ekanayake, 2018) and the provided intents by the Chat-Bot for the given examples are correct. The system developed by Jayarathna and Hettige (2013) is somewhat similar to our system. They used multi-agent technology while we used Chat-Bot technology, which is widely used in applications like question-answering systems in many areas. Also, our system is interactive and the farmers' feedbacks indicated that it is user-friendly and a useful tool, which can assist for decision-making and information delivery in real-time. The web portal wwww.goviya.lk managed by the Department of Agriculture in Sri Lanka is not a truly question-answering system and hence, the farmers want to spend more time to search information. Also, the e-SMS service is not real-time system and hence, it is not popular among the farming community.

In general, the Chat-Bot provides reasonably correct answers for the given quires. Further, the farmers, who involved for the evaluation process accepted the Chat-Bot as a user-friendly and helpful tool for their farming industry. Hence, they are willing to use it in future farming activities. However, the Chat-Bot is required to train with the composite examples, which two or more



Source: own processing

Figure 4: Interface of the Chat-Bot.

examples are connected using logical operators. Further, the Chat-Bot does not provide answers if the required information is not encoded into its knowledge base. Therefore, the knowledge base of the Chat-Bot is required to populate with more examples and intents.

	User's Inputs	Chat-Bot Response
1	Hi	Hello
2	How are you?	Doing great, thanks
3	Who are you?	I'm a bot that can help you to get knowledge about farming, and economic status of plants
4	Crops suitable for grown in Monaragala district	tomato, maize.
5	Crops suitable for Badulla district	potatoes
6	Crops suitable for rainy season in Monaragala and Badulla?	?
7	Different soils existing in Monaragala and Badulla area?	?
8	Cost for growing tomato	?
9	Best time period to grow green gram	April, May, June, July
10	Best time period to grow maize	November, December
11	Best time period to grow potato	June, July, August, November, December
12	Best time period to grow red onion	January
13	Best time period to grow tomato	June, July, November, December

Source: own processing

Table 1: Sample test cases.

Conclusion

Agriculture is the main industry in the rural areas of Sri Lanka and the agriculture contributes a significant amount to the economy of Sri Lanka. However, the agriculture is becoming less profitable industry and hence, there is an inclined trend that the rural community keeps away from agriculture. There are many reasons for this development. Among them accessing information at right time about agriculture is a major issue.

Hence, the aims of this project are to network farmers and provide solutions to farmers' issues at right time. To that end, we developed a chat room to share the farmers' experiences and knowledge. Further, we developed an intelligent Chat-Bot, which provides solutions for certain issues of farmers through an online system.

The intents and examples were extracted through questionnaires and interviews with farmers and expertise. The knowledge base of the Chat-Bot is programed using the Artificial Intelligent Markup Language (AIML). The Chat-Bot is trained using the atomic examples to predict the intents. The user interacts with the Chat-Bot through a User Interface.

The chat room and the Chat-Bot were evaluated in the laboratory and with farmers. The farmers accepted the tools and they are willing to use them for their farming activities.

As the Chat-Bot is trained using atomic examples, it does not provide answers for composite examples. Further, the Chat-Bot is trained in a small domain and hence, it's capabilities are limited. As a pilot project the data is collected only on two districts in Sri Lanka, but in future, it will be covered the whole country. The Chat-Bot is designed and implemented in cloud platform and hence, the client end is not required more computing power.

Corresponding authors
Jayalath Ekanayake
Sabaragamuwa University of Sri Lanka, Belihuloya 70140, Sri Lanka
Phone: +94711954433, E-mail: jayalathek@appsc.sab.ac.lk

References

[1] Aina, L. O. (1991) "Information for successful agriculture", *Journal of Library and Information Science*, Vol. 2, No. 1, pp. 1-6. E-ISSN 2374-2364, ISSN 2374-2372.

[2] Burton, S. (2002) "Development at any Cost: ICTs and People's Participation in South Africa Communication", *Communicatio*, Vol. 28, No. 2, pp. 43-53. ISSN 0250-0167. DOI 10.1080/02500160208537941.

[3] Carter, I. (1999) "Locally Generated Printed Materials in Agriculture: Experience from Uganda and Ghana", Education Research Papers 12845, Department for International Development (DFID) (UK).

[4] Galagedarage, G. T. M. (2015) "Issues in Internet Adoption and Rural Empowerment in Sri Lanka", *Journal of Humanities & Social Sciences*, Vol. 09. ISSN 1934-7227.

[5] Invwieri, J. W. (2007) "Information needs of illiterate female farmers in Ethiope East local Government Area of Delta State, Nigeria", *Library Hi Tech News*, Vol. 24, No. 9/10, pp. 38-42. ISSN 0741-9058. DOI 10.1108/07419050710874278.

[6] Jayarathna, H. and Hettige, B. (2013) "AgriCom: A communication platform for agriculture sector", *Conference paper: Agricultural Communications Documentation Center (ACDC),* USA: IEEE, New York City, New York, pp. 439-444. DOI 10.1109/ICIInfS.2013.6732024.

[7] Johnson, P. (1992) "*Human Computer Interaction: Psychology, Task Analysis, and Software Engineering*", Berkshire: McGraw-Hill Europe. ISBN 10: 0077072359, ISBN 13: 978-0077072353.

[8] Kalusopa, T. (2005) "The Challenges of Utilizing Information Communication Technologies (ICTs) for the Small-Scale Farmers in Zambia", *Library High Technology,* Vol. 23, No. 3, pp. 414-424. ISSN 0737-8831. DOI 10.1108/07378830510621810.

[9] Marchionini, G. (1995) "*Information Seeking in Electronic Environments*", Cambridge: Cambridge University Press. E-ISBN 9780511626388. DOI 10.1017/CBO9780511626388.

[10] Meyer, H. W. J. (2003) "Information Use in Rural Development", *The New Review of Information Behaviour Research*, Vol. 4, No. 1, pp. 109-125. E-ISSN 1740-7877, ISSN 1471-6313. DOI 10.1080/14716310310001631471.

[11] Mooko, N. and Aina, L. O. (2007) "Information Environment of Artisans in Botswana", *Libri Journal*, Vol. 57, pp. 1-7. ISSN 0024-2667. DOI 10.1515/LIBR.2007.27.

[12] Morrow, K., Nielsen, F. and Wettasinha, C. (2002) "Changing Information Flows", *LEISA Revista de agroecología*, Vol. 18, No. 2, pp. 4-5. ISSN 1729-7419.

[13] Oladele, O. I. (2011) "Effect of Information Communication Technology on agricultural information access among researchers, extension agents and farmers in South Western Nigeria", *Journal of Agriculture and Food Information*, Vol. 12, pp. 167-176. E-ISSN 1540-4722, ISSN 1049-6505. DOI 10.1080/10496505.2011.563229.

[14] Opara, U. N. (2008) "Agricultural information sources used by farmers in Imo State, Nigeria", *Information Development*, Vol. 24, No. 4, pp. 289-292. E-ISSN 1741-6469, ISSN 0266-6669. DOI 10.1177/0266666908098073.

[15] Radhakrishna, R. B. (2007) "Approaches for linking markets and farmers to foster indian'srural development", *Proceedings of the 24th Annual Meeting*, E.A.R.T.H. Costa Rica, 1-17.

[16] Stoner, D. J., Ford, L., and Ricci, M. (2004) "Simulating Military Radio Communications Using Speech Recognition and Chat-Bot Technology", The Titan Corporation, Orlando.

[17] Tharindu, S. and Ekanayake, J. (2018) "Data Mining Approach to predict Suitable Seasons to Cultivate Crops", *EdHat IRCICT: International Research Conference on ICT*, Colombo Sri Lanka.

[18] Wallace, R. (2003) "The elements of AIML style," Alice AI Foundation. 139

[19] Weizenbaum, J. (1966) "ELIZA - a computer program for the study of natural language communication between man and machine", *Communications of the ACM*, Vol. 9, No. 1, pp. 36-45. E-ISSN 1557-7317, ISSN 0001-0782. DOI 10.1145/365153.365168.

[20] Zhao, J (2008) "ICT4D: Internet Adoption and Usage among Rural Users in China", *Knowledge, Technology & Policy*", Vol. 21, No. 1, pp. 9-18, E-ISSN 1874-6314, ISSN 0897-1986. DOI 10.1007/s12130-008-9041-0.

Agris on-line Papers in Economics and Informatics

Volume XII Number 1, 2020

Application of the Quadratic Almost Ideal Demand System (QUAIDS) Model in the Demand of the Household Animal Sourced Food in West Java

Bayu Kharisma[1], Armida S. Alisjahbana[1], Sutyastie Soemitro Remi[1], Putri Praditya[2]

[1] Department of Economics, Universitas Padjadjaran, Indonesia

[2] Central Bureau of Statistics, Sumedang Regency, West Java, Indonesia

Abstract

This paper aims to determine the effect of demographic and socio-economic factors and household responses to household changes in prices and income against the demand for household animal-sourced food in West Java Province. The study used cross-section data sourced from the National Socio-Economic Survey (SUSENAS) of West Java Province in 2017 analyzed through the Quadratic Almost Ideal Demand System (QUAIDS). The results showed that the demand for household animal-sourced food in West Java was influenced by price, income, and social demographic factors. All groups of animal-sourced food were categorized as normal goods, as characterized by an income elasticity value of more than zero. The income elasticity established meat commodities as the highest with eggs being the lowest. The nature of the commodity determined that all animal-sourced food groups except eggs are luxury goods. Luxury goods are categorized as such due to their above one value of the demand response against changes in income- which in this paper refers to the commodities of fish, meat, poultry, and milk. The own-price elasticity also showed meat as the most responsive commodity to price increases compared to fish, poultry milk, and eggs. The five groups of commodities achieved a negative elasticity value, as reflected by the reduced share when the decreasing demand responds to the commodity price increase. The cross-price elasticity of most animal-sourced food commodity groups achieved negative elasticity values, which indicated that the related animal-sourced food commodity groups were complementary, whereas positive elasticity values indicate the related food commodities group as a substitute.

Keywords

West Java province, QUAIDS, animal sourced food, elasticity.

Kharisma, B., Alisjahbana, A. S., Remi, S. S. and Praditya, P. (2020) “Application of the Quadratic Almost Ideal Demand System (QUAIDS) Model in the Demand of the Household Animal Sourced Food in West Java", *AGRIS on-line Papers in Economics and Informatics*, Vol. 12, No. 1, pp. 23-35. ISSN 1804-1930. DOI 10.7160/aol.2020.120103.

Introduction

Protein, as an essential nutrient in the food and to the body, can be obtained from plant-sourced foods (vegetable protein) and animal-sourced foods (animal protein). However, animal protein has a complete amino acid composition and better digestibility when compared to vegetable protein. According to Soehadji (1993) in Ariningsih (2004), animal protein is an agent for the development of a nation and has indispensable properties. Meanwhile, Pakpahan (2018) stated that the low consumption of animal-sourced food is a significant factor in the high Global Hunger Index (GHI) in Indonesia. IFPRI (2016) stated that Indonesia is categorized as a country with a severe hunger rate with a GHI value of 22.0, only better than Cambodia, Laos, and Myanmar. Besides the Global Hunger Index (GHI), the overall food consumption can be seen from the Nutrient Adequacy Score (NAS). The Central Statistics Agency (BPS) data in 2017 showed that for the first time, the average consumption of calories and protein of Indonesian people have met nutritional adequacy standards, as seen in Table 1 below.

Table 1 shows that the Indonesian nutrient consumption has achieved sufficient standards for calories and protein, albeit still dominated by plant-sourced foods. The calory consumption derived from animals is 128.17 kcal or 6 % of total caloric intake, while protein derived from animals

Food Group	Calories (kcal)		Protein (gram)	
	2016	2017	2016	2017
Non-Animal sourced food	1877.36	1975.28	42.81	46.41
Animal sourced food	1 60.03	177.34	13.86	15.78
- fish	42.88	49.17	7.17	8.23
- Meat	56.02	67.70	3.35	4.2 0
- Eggs and Milk	61.13	60.47	3.34	3.35
total	2037.39	2152.62	56.67	62.19

Source: Susenas, 2017

Table 1: Average daily consumption of calories and protein per capita according to the food group 2016-2017.

was 7.55 g/capita/day, which is 12.1% of the total protein intake. Meanwhile, when compared with the Food and Agriculture Organization (FAO) data in Balance livestock in 2009, the average animal-sourced calory and protein intake of countries in the world is 388.2 kcal and 23.9 gr/capita/day with each share of total intake being 12.9% and 27.9% respectively. The low consumption of animal-sourced food may discourage the quality improvement of Indonesian labor. Therefore, increasing consumption of animal protein is necessary for increasing the health and productivity of Indonesians, which consequently can improve the competitiveness of Indonesian labor in the international arena (Ministry of Health, 2015).

West Java Province is the largest consumer base in Indonesia; however, food remains a prevalent issue. BPS (2017) disclosed that the average calory consumption per capita in West Java was 2230.92 kcal/day, and per capita, protein consumption reached 65.59 grams/day; the numbers categorized the consumption as reaching standards. However, plant-sourced protein still dominated that consumption, making the quality of food consumption low as indicated by the low score of Desirable Dietary Pattern (DDP), which is below the national DDP of 85.2%. The Election Organization Ethics Council (DKPP, 2018) has argued that one cause of the low score of DDP in West Java is due to the community's high dependence on staple foods and the low consumption of animal-sourced foods. Until now, the Energy Adequacy Level (EAL) is still dominated by rice food groups, with grains amounting to 58.9% which is above the 50% ideal level when based on the ideal standard of DDP 100. The rice-dominated consumption patterns of society may cause a high contribution of rice EAL.

The government's burden in improving the quality of human resources is parallel to the population increase. Thus, comprehensive efforts are needed to prevent these obstacles from interfering with future development in West Java Province. The government continuously conducts programs to improve the quality of human resources, among others, by improving and increasing the nutritional status of the community. Therefore, an exhaustive analysis of the food demand, especially animal-sourced food, is required, in terms of factors the demand, as well as consumer responses towards changing prices and income.

Some previous studies of food demand state that there is a relationship between income, own prices and other food prices on household consumption of food. Burger et al (2017) in their research find substantial variation in the price and income elasticities of demand for items across the income distribution, with the bottom quartile being extremely sensitive to increases in the price of food and clothing items, and the top quartile being as sensitive as households in developed countries. Hoang and Glewwe (2011) investigated the impact of an increase in food prices on welfare and poverty rates in Vietnam. The results showed that a 20% price increase in all products, assuming that consumer and producer prices rise proportionally, resulted in an increase in household expenditure by up to 3.4%. If the producer's price is higher than the consumer's price, the agricultural household's welfare will improve. Pangaribowo and Tsegai (2011) found a high income or expenditure elasticity for milk, meat and fish food goups, especially in poor households. Ravallion and Van der Walle (1991) indicated that a 10% increase in food prices had an impact on severe poverty in Indonesia. Bopape and Myers (2007) on household-level food demand in South Africa, presented differences in households consumption patterns in the rural and urban areas as well as households at each income level.

The research identified meat and fish as luxury items in all household income level groups. Thus, the purpose of this study, in particular, is to identify the socioeconomic, demographic factors influencing the demand for animal-sourced food in West Java Province and determining the income elasticity, own price elasticity and cross-price elasticity of demand for animal-sourced food in West Java.

This research provides important empirical contributions, where previous studies on food demand are more concerned as food as a whole in a national scope. Meanwhile, this study will be more specific and analyze animal sourced food and protein and divide it into five food groups, namely fish, meat, poultry, eggs and milk at the provincial level, namely West Java with the Quadratic Almost Ideal Demand System (QUAIDS) model.

Materials and methods

This study will use secondary data collected by the Central Statistics Agency (BPS), namely KOR and Expenditure Consumption (KP) in the socio-economic survey (SUSENAS) and applying the Quadratic Almost Ideal Demand System (QUAIDS) model. For data processing, Stata 14.2 is used to estimate the models. This model can maintain consistency with the Engel curve and the effect of relative prices in utility maximization. Additionally, this model allows more parameters to be predicted compared to previous models such as LA/AIDS (Aepli, 2014). This model requires all sample households to consume all the studied commodities. Anticipating zero consumption can be done by incorporating groups of commodities or food into a larger group should there still be zero consumption, the Inverse Mills Ratio (IMR) variable is added as an independent variable. The IMR variable is obtained by performing a two-step estimation from the Heckman test (Widarjono and Rubcha, 2016; Mayasari, Satria and Noor, 2018)).

The disadvantage of using household survey data is its lack of price for the commodities consumed. Price (unit value) is obtained by dividing the value issued by the quantity purchased. This method can be used for research in small areas with more homogeneous demographic factors. According to Zheng and Hennebery (2010), should the research be conducted in large areas with varying demographic factors, the unit value approach will contain several errors, one of which will result in biased measurements. To overcome this problem, the price variable in this study utilized the unit values corrected by the price differential method as done by Majumder, Ray and Kompal (2012). The unit value is corrected by adding the district/city middle value and estimated residual regression difference in the middle value of each district/city with social demographic factors. This method assumes households in the same district/city to face the same commodity prices. Mathematically, it can be written as follows:

$$v_i - v_{median} = \alpha_0 + \alpha_1 dloc_i + \alpha_2 hsize_i + \alpha_3 dgender_i + \alpha_4 educ_i + \alpha_5 inc_i + \varepsilon_i \quad (1)$$

correction prices are formed from the sum of the average value per unit of commodity group at the commodity and residual level:

$$(p_i)_{median} = (v_i)_{median} + (\hat{e}_i)_{median} \quad (2)$$

The generated price assumes that every household in one district/city experience the same market price for each item. The price is not affected by the endogeneity problem caused by different quality factors among households in a group (Majumder, Ray and Kompal, 2012). The equation for estimation in this study is the model developed by Ray (1983) and Poi (2012), where the QUAIDS equation becomes:

$$w_i = \alpha_i + \sum_{j=1}^{n} y_{ij} \ln p_j + \beta_i \ln\left\{\frac{x}{a(p)}\right\} + \frac{\lambda_i}{b(p)}\left[\ln\left\{\frac{x}{a(p)}\right\}\right]^2 + \alpha_{i1} dloc_i + \alpha_{i2} hsize_i + \alpha_{i3} dgender_i + \alpha_{i4} educ_i + \alpha_{i5} inc_i + a_{i6} IMR + \varepsilon_i \quad (3)$$

where:

w_i = expenditure share from animal sourced food groups to *i*

lnp_j = the aggregate price of the j-animal sourced food commodity group

x = household expenditure for animal sourced food consumption

ln (a/p) = price index

b(p) = price aggregator

dloc = location (urban = 1)

hsize = household size

dsex = head of household sex (male = 1)

educ = years of schooling

Inc = income group (low income group = 1 as reference category, middle income group = 2, high income group = 3)

IMR = inverse mills ratio

There are three types of demand elasticity that can be derived from the QUAIDS model. The three elasticities are as follows:

1. Income elasticity

$$\mu_i = 1 + \frac{1}{w_i}\left[\beta_i + \frac{2\lambda_i}{b(p)}\left\{ln\left(\frac{x}{a(p)}\right)\right\}\right] \quad (4)$$

2. Marshallian price elasticity (*Uncompensated price elasticity*)

$$\varepsilon_{ij}^{NC} = \frac{1}{w_i}\left[\gamma_{ij} - \mu_i\left(\alpha_j + \sum_{k=1}^{n}\lambda_{jk}\, ln\, p_k\right) - \frac{\lambda_i\beta_j}{b(p)}\left\{\ln\left(\frac{x}{a(p)}\right)^2\right\}\right] - \delta_{ij} \quad (5)$$

3. Compensated price elasticity

$$\varepsilon_{ij}^{C} = \varepsilon_{ij} + \mu_i w_j \quad (6)$$

where:

ε_{ij} = price elasticity

γ_{ij} = parameter of animal-sourced food prices

β_i, λ_i = linear and quadratic parameters of income

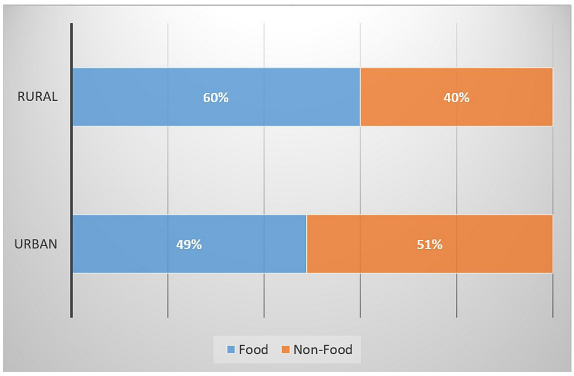
W_i = average share of animal-sourced food expenditure

δ_{ij} = the delta kronecker is zero for the own price ($i = j$) and worth 1 for the cross price ($i \neq j$)

Results and discussion

Allocation of household expenditures in West Java province

The demand level for food and non-food consumption is highly dependent on the socio-economic characteristics of each region. The urban and rural classification identified a difference of share in the average monthly expenditure for food and non-food households. The average food expenditure share (food share) in rural and urban areas households was 60% and 49% of the total household expenditure, respectively. The result showed that the expenditure majority in rural areas were food, while urban areas had a majority of non-food groups, as seen in Figure 1.



Source: Own calculation based on data from Susenas, 2017

Figure 1: The share of household expenditures in West Java province (%).

The difference in the share of expenditure between urban and rural areas was based on income, i.e., the income in urban areas tend to be relatively higher than rural areas. Previous studies also supported the research of Bopape (2007) and Mittal (2010) which stated of a substantial difference in rural and urban household's consumption patterns; urban households had higher expenditure budgets than rural households.

In addition to regional differences, the education level of the head of the household influenced the household expenditure priority. Head of household (HoH) with less than or equal to 9 years of age (basic education) allocated 58.35% of their expenditure for food, and 41.65% for non-food items. In contrast, the head of households with more than nine years of education allocated greater expenditure for non-food items; 57.41%, while food was only allocated with 42.59%, as shown in Table 2. This is in line with the research conducted by Mayasari, Satria & Noor (2018), which stated that the education of the head of the household plays an essential role in determining the share of household food expenditure. This study also mentioned that the higher the education of the head of the household, the more the head of the household is concerned about food quality consumed by the household.

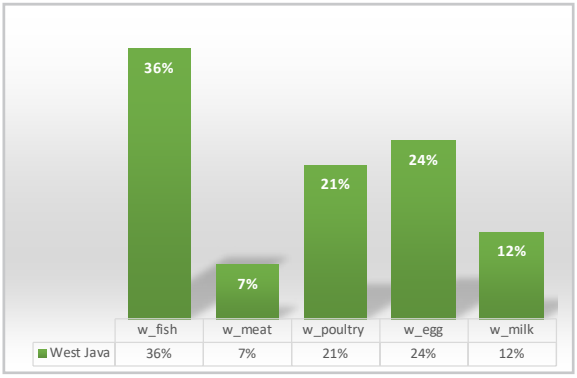
Years of Schooling of Head of Household	Expenditure Group			
	Food		Non-food	
	Value (rupiah)	%	Value (rupiah)	%
<= 9	1,651,303	58.35	1,178,829	41.65
> 9	2,578,218	42.59	3,475,034	57.41

Source: Own calculation based on data from Susenas, 2017

Table 2: Household expenditures by education level in West Java province 2017.

Meanwhile, the level of income significantly impacted the allocation of household expenditure. The higher the level of household income, the lower the share of food expenditure; inversely the expenditure share on non-food items will increase along with the increase in income. Households in the low and middle-income groups spent over 50% of expenditures for food, on the other hand, households in the high-income groups spent more than 50% of expenditure for non-food items, as seen in Table 3. Similar results were found in Abdulai's research (2002), which argued that future increase in income would shift the consumption pattern towards non-food items. This research is in line with Zheng and Henneberry (2010), which stated of different expenditure patterns of food demand in each income and distribution level of a community in a region.

Furthermore, food consumption was categorized into the consumption of animal-sourced food and non-animal-sourced food. Figure 2 shows that the expenditure share of the animal-sourced food is highest in the fish commodity group, amounting to 36% while the lowest is the meat commodity group with 7%.



Source: Own calculation based on data from Susenas, 2017

Figure 2: Share of household animal sourced food expenditures in West Java (%)

Animal-sourced food expenditures in urban and rural households in West Java were different. Urban households spent 17.69% of the total food expenditure for animal-sourced food, while rural households only spent 14.24%, as seen in Table 4. This showed that households in urban areas have more means to consume animal-sourced food than rural households. This result is in line with the Molina and Gil (2005) which stated that the influence of residential locations provides a positive response to the expenditure share, they also stated that urban areas households tend to have higher incomes than people in rural areas.

Additionally, animal-sourced food expenditures in households in West Java showed that the higher the level of education, the higher the expenditure on animal-sourced food. Households with HoH of over nine years of schooling will spend almost 20% of their food expenditure on animal-sourced food, as seen in Table 5. This result is in line with Molina and Gil (2005) which stated that demand by consumers is not only influenced by price and income but also by other variables, one of which is perception/information of the product quality.

Household income also affected the expenditure of animal-sourced food. The Susenas data in 2017 showed that the low and middle-income households only spent 13-14% of total food expenditure for animal-sourced food, while high-income households used 20%, as shown in Table 6. This comparison means that the higher the level of income, the higher the expenditure on animal-sourced food. This is also in line with the research conducted by Pangaribowo and Tsegai (2011) regarding consumption patterns in Indonesia. The research stated that households with the lowest income had the highest expenditure for staple foods and a small possibility for consuming dairy products, whole relatively high-income households allocated most of their food expenditure for food other than staple foods, namely plant-sourced food, meat and fish and dairy products.

Income Level	Expenditure Group			
	Food		Non-food	
	Value (rupiah)	%	Value (rupiah)	%
Low	1,206,015	65.68	630,060	34.32
Medium	2,098,544	57.00	1,583,400	43.00
High	3,138,808	37.81	5,161,773	62.19

Source: Own calculation based on data from Susenas, 2017

Table 3: Household expenditures by income level and household animal sourced food consumption in West Java province 2017 (%)

Regional Classification	Food Expenditures				
	Animal sourced food		Non-Animal sourced food		Total Food
	Value (rupiah)	%	Value (rupiah)	%	Value (rupiah)
Urban	374,489	17.69	1,741,950	82.31	2,116,439
Rural area	233,623	14.24	1,407,288	85.76	1,640,911

Source: Own calculation based on data from Susenas, 2017

Table 4: Food expenditures as classified by regions in West Java province 2017.

Years of Schooling	Food Expenditures			
	Animal sourced food		Non-Animal sourced food	
	Value (rupiah)	%	Value (rupiah)	%
<= 9	239,370	14.50	1,411,933	85.50
> 9	505,660	19.61	2,072,558	80.39

Source: Own calculation based on data from Susenas, 2017

Table 5: Food expenditures according to education of the head of household in West Java province.

Income level	Food Expenditures				
	Animal sourced food		Non-Animal sourced food		Total Food
	Value (rupiah)	%	Value (rupiah)	%	Value (rupiah)
Low	128,142	13.19	843,014	86.81	971,155
Middle class	302,698	14.97	1,719,066	85.03	2,021,764
High	763,747	20.30	2,998,798	79.70	3,762,545

Source: Own calculation based on data from Susenas, 2017

Table 6: Food Expenditures According to Household Income Levels in West Java.

Households with higher income tend to consume animal-sourced foods, consequently more expensive, than those with lower income. Low-income groups consumed more fish, followed by eggs and poultry, and consumed very little meat and milk. In contrast to households with high income, albeit being dominated by fish, the expenditure of poultry, eggs, and milk is evenly distributed. This is in line with Abdulai's (2002) research which stated that the demand for meat and fish would increase along with the increase in consumer income, the research also expresses similar results by Hayat, Hussain and Yousaf (2016) which stated that higher household income would lead to an increase in household demand for dairy and meat products. The findings above are also in line with Bennet's Law stated that increasing income results in decreasing consumption of staple food. The consumption pattern is influenced by income, the wealthier a society is, the more varied its food consumption; initially dominated by simple starchy plants and later diversifying to plant-sourced food, fruit, dairy products, and especially meat.

Estimating parameters of the animal sourced food demand system model

Overcoming endogeneity required an instrumental variable, i.e., the total household income against the total household expenditure by adding food and non- food expenditures. According to Bopape (2006) and Fashogbon et al. (2012), the total income is a useful instrumental variable as it is correlated with the instructed variables and did not correlate with errors in the main equation. The disregard of blank data or zero consumption will lead to selectivity bias that will affect the estimation results. This study overcame it by adding the Inverse Mills Ratio (IMR) variable to the equation.

The effect of the own-price variable on each group of animal-sourced food commodities suggested a positive and significant for the group's expenditure share. The coefficient prices showed that should price increase by 1%; the expenditure share would also be felt by the food groups; fish groups with 0.236% followed by eggs with 0.192%, poultry with 0.172%, milk with 0.091%, and the lowest was the meat with 0.053%, assuming

ceteris paribus. This is in line with Abdulai's (2002) research, which stated that the own-price variable significantly influenced the increase of the expenditure share of the food commodity group, and prices affected all food commodities demand. Thus price policy as an agricultural policy instrument is fundamental.

Income variables demonstrate a positive relation with expenditure share. Thus, an increase in income will be followed by an increase in expenditure share. The coefficients for meat, egg, and milk commodity groups have a positive influence; an increase in income increase will be followed by an increase in group share. This finding is in line with Hayat, Hussain and Yousaf (2016), which stated that an increased household income would lead to increased demand for dairy and meat commodities. However, fish and poultry commodity groups have a negative coefficient; an increase in income will be followed by a decrease in the expenditure share of the dairy and meat commodities. This relation is likely to occur as an increase in household income will shift the demand towards more expensive animal-sourced food like meat and milk. These phenomena demonstrated the application of Bennet's Law in West Java Province, namely the high income would shift the consumption pattern towards better quality food.

Regional dummy variables indicated that fish groups had a positive relation; household expenditure share for animal-sourced food commodities is higher in households living in urban areas compared to rural areas. Conversely, the expenditure share of milk commodity is lower for households living in urban areas compared to those living in rural areas. The comparison reflects the significant role that milk plays to fulfill the nutritional adequacy of children in rural areas, and the non-substitutable characteristic of milk, especially baby formula.

The years of schooling variables show that the years of schooling provides significance at the level of 1-10% of the poultry and milk groups. The years of schooling have a positive relation with the share of poultry expenditure but have a negative effect against the share of milk expenditure. Research conducted by Capps and Smith (1991) in Nugroho (2015) on the effect of health and nutritional factors in the analysis of food demand, described that demand by consumers is not only influenced by prices and income but also by other variables such as perceptions and product information.

The size of the household (the number of household members) had a significant influence on the level of 1-10% in the egg commodity group, which means that the size of the household influences the demand for eggs. This study indicated a negative effect between household size and share of egg expenditure. This negative effect indicated that the bigger the household, the smaller the expenditure for eggs. According to Mittal (2010), food is a private item that is difficult to substitute, especially for poor households. With per capita resources as constant, food consumption per capita should rise as household size increases. In fact, the more the family members, the less the food consumption. This phenomenon is called the Deaton-Paxson paradox proposed by Deaton and Paxson (1998). The study conducted by Deaton and Paxson (1998) in several countries: The United States, the United Kingdom, France, Taiwan, Thailand, Pakistan, and South Africa, indicated the negative correlation between the number of family members and the demand for food. This is because food consumed by people cannot be substituted with cheaper public goods, particularly in low-income countries. This result is different for rice; a household with more infants and adults consumes more rice. This implies that a household with more household members spends a higher proportion on various at-home foods such as rice. Abdulai (2010) also stated that parameters related to household size affect consumption patterns; large families are often forced to adjust their consumption patterns to buy the relatively cheaper commodity, as indicated by the low egg consumption in West Java province of 10kg/capita/year. Meanwhile, the consumption of chicken meat and eggs in Asian countries has now reached 15 kg/capita, and some have even reached 20 kg/capita (West Java Provincial Government, 2015).

The sex of the head of household is significant at the 1-5% real level for poultry and egg groups. Eggs have a positive effect if the sex of the head of the household is male, and poultry has a negative effect. A positive effect means that households with a male head of household consume 0.011% more eggs compared to households with a female household; whereas female head of household will rely on poultry to meet animal-sourced food needs. Pangaribowo and Tsegai (2011) examined the same thing for the sex dummy of the head of household (male), which gave a positive and negative relation. Usually, a positive relation is shown on higher quality and more expensive foods such as meat. The implication is that the difference in sex

of the head of household leads to differences in consumers' behavior. This condition indicates that food policies should take the difference in sex of the head of household characteristics into consideration.

The Inverse Mills Ratio (IMR) is significant at the 60% coefficient, reflecting the problem of selectivity bias sample. This problem was overcome by adding the IMR variable to unbias the estimation parameters in the equation. Thus, the insignificant IMR variables with a 40% coefficient show that the selectivity bias problem does not occur for these commodity groups (Table 7).

Variables	Fish Share	Meat Share	Poultry Share	Eggs Share	Milk Share
	1	2	3	4	5
Fish Prices	0.236 ***	-0.036 ***	-0.054 ***	-0.057 ***	-0.087 ***
	(0.017)	(0.009)	(0.012)	(0.011)	(0.011)
Meal Price	-0.036 ***	0.053 ***	-0.049 ***	-0.026 ***	0.059 ***
	(0.009)	(0.011)	(0.011)	(0.009)	(0.008)
Poultry Price	-0.054 ***	-0.049 ***	0.172 ***	-0.056 ***	-0.012
	(0.012)	(0.011)	(0.019)	(0.014)	(0.010)
Egg Price	-0.057 ***	-0.026 ***	-0.056 ***	0.192 ***	-0.051 ***
	(0.011)	(0.009)	(0.014)	(0.014)	(0.009)
Milk Price	-0.087 ***	0.059 ***	-0.012	-0.051 ***	0.091 ***
	(0.011)	(0.008)	(0.010)	(0.009)	(0.011)
Income	-0.644 ***	0.201 ***	-0.325 ***	0.446 ***	0.322 ***
	(0.044)	(0.021)	(0.042)	(0.048)	(0.029)
Quadratic Income	-0.023 ***	0.019 ***	-0.037 ***	0.029 ***	0.011 ***
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Years of Schooling (years)	-0.000	0.000	0.001 *	-0.000	-0.001 **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Location (urban = 1)	0.009 ***	-0.001	0.004	-0.003	-0.009 ***
	(0.002)	(0.001)	(0.003)	(0.003)	(0.002)
Sex (male = 1)	-0.001	0.001	-0.011 ***	0.011 ***	0.000
	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)
Household Size	0.002	0.001	0.002	-0.005 ***	-0.000
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Middle Income Group	0.015 **	0.007 **	-0.013 *	0.005	-0.015 ***
	(0.006)	(0.003)	(0.007)	(0.007)	(0.004)
High Income Group	0.035 **	0.012 **	-0.026 **	0.008	-0.030 ***
	(0.011)	(0.005)	(0.012)	(0.013)	(0.007)
Instrumental Variable	0.030 ***	-0.005 ***	0.014 ***	-0.030 ***	-0.009 ***
	(0.002)	(0.000)	(0.002)	(0.002)	(0.001)
Mills_Fish	0. 075 ***	-0.017 **	-0.021	-0.170 ***	-0.093 ***
	(0.010)	(0.008)	(0.017)	(0.020)	(0.011)
Mills_Meat	0.088 ***	0.003	-0.053 ***	0.040 **	-0.078 ***
	(0.016)	(0.009)	(0.018)	(0.017)	(0.013)
Mills_Poultry	0.026	-0.005	-0.027 ***	0.049 **	-0.015
	(0.018)	(0.008)	(0.0 09)	(0.024)	(0.012)
Mills_Eggs	0.006	-0.022	0.222 ***	-0.145***	-0.028
	(0.041)	(0.020)	(0.047)	(0.010)	(0.028)
Mills_Milk	-0.132 ***	0.019	0.061 **	-0.027	0. 151 ***
	(0.023)	(0.012)	(0.027)	(0.029)	(0.011)
Constant	0.242 ***	0.205 ***	-0.063	0.581 ***	0.032
	(0.036)	(0.035)	(0.046)	(0.044)	(0.030)

Note: *** p <0.01, ** p <0.05, * p <0.1. Standard errors in parentheses
Source: Own calculation based on data from Susenas, 2017

Table 7: The result from QUAIDS model of West Java province.

Income Elasticity

The result showed that the demand income elasticity for household animal-sourced food in West Java had a positive relation; all groups of animal-sourced foods were categorized as normal goods, and there were no inferior goods. The value of income elasticity is shown in Table 8 below. In general, income elasticity for animal-sourced food in urban areas is lower tha in rural areas. This comparison indicated that from an economic standpoint, foods commodity are more affordable for urban households than rural households as the income of urban households on average is higher than rural households.

Income elasticity for meat is very responsive, even in rural areas the value is more than 2. Thus, a 1% income increase will cause a consumption increase of this food group, assuming ceteris paribus. The high value of meat elasticity can be caused by meat's high prices, making meat a food group as the first choice should an income increase happen. On the other hand, urban areas have a smaller value as urban areas as it tends to have a higher increase in income.

For meat demand, the income elasticity will become smaller as income increases. This finding in line with the research conducted by Bopape (2007) and Faharudin et al. (2015) which stated that meat and fish are luxury goods in all household groups. Expenditure on meat and fish is more elastic among rural and low-income households than among urban households and high-income households. The same findings are found in the research conducted by Akinwumi et al. (2011) in Alimi (2013) which stated that beef and chicken are the most preferred meat and the level of household income strongly influenced the demand.

Meanwhile, the high-income households' groups have a 0.889 high-income elasticity for poultry, which means that changes in demand will be lower than changes in income. The HoH with less than or equal to 9 years of schooling is more responsive than HoH with more than nine years of schooling. The lower elasticity value of poultry compared to meat indicated that poultry is one of the mainstays of the community in meeting animal protein needs in West Java. DKPP West Java Province (2018) stated that 65% of West Java households still rely on poultry such as chickens and ducks as the main protein intake. Presently, the consumption of protein sources other than poultry food, both fish and meat, is still low, changing it will be difficult and will require a long process.

Eggs were one of the most consumed commodities by all levels of households because they contain high-quality, practical proteins, are easy to prepare, and are the cheapest among other animal-sourced food commodities. The value of income elasticity for egg commodities is positive, indicating eggs as normal goods. Thus, any increase in household income will cause the share of egg expenditure to increase. The income elasticity for eggs is the lowest compared to other animal-sourced food groups and is worth less than one.

Milk has complete nutritional content and is very beneficial for the health and human body. The value of milk's income elasticity is positive; this indicated that an increase in household income would cause the share of milk expenditure to increase. Milk is categorized as luxury goods which contrasted with other animal-sourced food groups. Thus, the higher the income, the more responsive to the demand it is, which means that high-income household will prioritize demand for milk if there is an increase in income. This finding is in line with Fabiosa (2005) which stated that the increasing consumption levels of animal-sourced protein are dairy products and poultry, this increased demand for animal-sourced food products is in line with increasing economic growth and urbanization.

Animal Sourced food	Region		Education		Income		
	City	Village	<= 9 years	> 9 years	Low	Middle class	High
Fish	1.073	1.036	1.050	1.086	1.084	1.054	1.032
Meat	1.748	2.210	1.998	1.681	1.944	1.968	1.631
Poultry	1.116	1.310	1.275	1.005	1.464	1.117	0.889
Egg	0.341	0.425	0.410	0.260	0.436	0.352	0.126
Milk	1.236	1.306	1.310	1.186	1.240	1.247	1.250

Source: Own calculation based on data from Susenas, 2017

Table 8: Income elasticity.

Own-price elasticity

The value of the own-price elasticity for animal-sourced food commodities is shown in Table 9. The elasticity value showed that all groups are negative, which means that the increase in commodity prices would cause a decrease in the consumption demand of the commodity, assuming ceteris paribus.

When viewed from absolute value, own-price elasticity has a value of less than one or is inelastic. This means that the percentage change in price is higher than the percentage change in demand; if there is a 1% increase in commodity prices, there will be a decline in commodity quantity of 0.399% for fish, 0.781% for meat, 0.320% for poultry, 0.178% for eggs and 0.333% for milk, assuming ceteris paribus.

Among the five groups of animal-sourced foods, the most inelastic is the egg group as it has the lowest own-price elasticity value, which is equal to 0.178. This condition occurred as eggs are a cheap source of animal-sourced food with high nutrient content, becoming a mainstay of households in West Java in meeting the needs of animal protein. Thus, price increase was not responded by the household. The highest price elasticity was in the meat group, which is relatively more expensive. Meat commodity group has a price elasticity of 0.781; thus, the increase in food prices in households is almost proportional to the decrease in consumption of each food commodities, assuming ceteris paribus.

Meat and milk are more responsive in urban areas compared to rural areas. Thus, the higher the level of education and income, the more responsive the demand will be. However, it is not so for groups of fish, poultry, and eggs. The own-price elasticity showed that the higher the income group, the lower the value of elasticity, or the smaller the response value against the increase in education and income. This comparison indicated that households continuously try to maintain the quantity of consumption of fish, poultry, and eggs despite price increases. In West Java, when viewed based on the share of each group, fish, poultry, and eggs has the highest consumption compared to meat and milk groups, as prices are more affordable.

Cross-price elasticity

Cross-price elasticity showed the effect of price changes in other commodity groups against the demand for commodity groups. A positive value of the cross-price elasticity indicated that a price increase of a commodity group would increase the demand for other commodity groups or be substituted. Whereas a negative value indicated that a price increase of a commodity group would reduce the demand for other commodity groups or be complementary. The value of cross-price elasticity in this study resulted from 20 compositions is shown in Table 10 below.

Animal Sourced Food	Total	Region		Education		Income		
		City	Village	<= 9 years	> 9 years	Low	Middle Class	High
Fish	-0.399	-0.347	-0.485	-0.454	-0.268	-0.497	-0.372	-0.276
Meat	-0.781	-0.821	-0.632	-0.705	-0.863	-0.600	-0.772	-0.905
Poultry	-0.320	-0.290	-0.388	-0.369	-0.244	-0.419	-0.357	-0.163
Egg	-0.178	-0.135	-0.255	-0.252	0.020	-0.361	-0.118	0.298
Milk	-0.333	-0.421	-0.079	-0.157	-0.535	-0.001	-0.378	-0.560

Source: Own calculation based on data from Susenas, 2017

Table 9: Own price elasticity.

Animal sourced food	Commodity Group				
	Fish	Meat	Poultry	Egg	Milk
Fish		-0.063	-0.205	-0.167	-0.222
Meat	-0.611		-0.575	-0.342	0.470
Poultry	-0.403	-0.141		-0.294	-0.022
Egg	-0.004	-0.011	-0.069		-0.110
Milk	-0.765	0.335	-0.063	-0.428	

Source: Own calculation based on data from Susenas, 2017

Table 10: Cross price elasticity.

Table 10 shows only two commodities with a substitution effect with other animal-sourced food groups, namely meat, and milk; the substitution relation to meat is milk. This substitution demonstrates that a 1% increase in meat will increase the demand for milk by 0.335%, assuming ceteris paribus. While other commodities such as fish, poultry, and eggs are complementary to meat commodities, which means an increase in meat prices will decrease the demand for these three commodity groups. Thus, the substituting commodity of meat as a source of animal-sourced food is milk. Meanwhile, milk has a substitution effect with meat, meaning that a 1% increase in milk prices will increase demand for meat, which is equal to 0.470%, assuming ceteris paribus. While other commodities such as fish, poultry, and eggs are complementary to dairy commodities, which means an increase in milk prices will decrease the demand for the three groups.

Conclusion

The result showed that the independent variables, i.e., price, income (expenditure approach) and demographic, socio-economic characteristics in the Quadratic Almost ideal demand System (QUAIDS) model could be used in estimating the share of animal-sourced food expenditure at the household level. The price variable, both the own-price and the cross-price of other animal-sourced foods are mostly positive and negative in determining the share of each group. The income and squared income of a household are significant for the share of animal-sourced food group.

The income elasticity showed that all animal-sourced food groups are categorized as normal goods, characterized by an income elasticity value of more than zero. The value of income elasticity for meat commodities is the highest and eggs are the lowest. The demand for meat will provide the highest response if there is an increase in income. However, eggs have the lowest response.

The own-price elasticity showed that the most responsive commodity is meat, followed by fish, poultry milk, and eggs. The five groups of commodities have a value of negative elasticity, which means that increasing commodity prices decrease the demand in the form of a reduced share of expenditure. While the cross-price elasticity of animal-sourced food commodity groups identified most groups as having a negative value, further proving that the related animal-sourced food commodity groups are complementary. Meanwhile, the meat and milk group have a substitution effect; the commodities that can replace meat as a source of animal protein is milk and vice versa.

Policy implications and recommendations

The income elasticity is higher than the value of price elasticity, meaning that the most effective way to direct the pattern of food consumption in West Java is through increasing people's income. Although price policy is crucial, in the long run, changes in the pattern of food consumption are primarily determined by the increase in people's welfare in the form of increased income.

Government policy priorities related to food and nutrition are prioritized for groups of people who live in rural and low-income areas. The order of consumption of high animal-sourced foods is fish and eggs, followed by poultry meat, especially from chicken. The demand or consumption of beef is relatively low. Thus, the government should encourage self-sufficiency in animal protein to ensure that various layers of society can feel the benefits. Diversification of food is a difficult task for the provincial government.

Diversification efforts include campaigns or outreach on the consumption of diverse, nutritious, and safe food for the community. As it also involves aspects of community behavior, then developing food consumption policies must be made into a mass movement that involves not only the government but covers all elements of society.

Corresponding authors
Dr. Bayu Kharisma
Department of Economics, Faculty of Economics and Business
Universitas Padjadjaran, Bandung, Indonesia
E-mail: bayu.kharisma@unpad.ac.id

References

[1] Abdulai, A. (2002) "Household Demand for Food in Switzerland. A Quadratic Almost Ideal Demand System", *Swiss Journal of Economics and Statistics (SJES)*, Vol. 138, No. 1, pp. 1-18. ISSN 2235-6282.

[2] Aepli, M. (2014) "Analysis of Final Demand for Food and Beverages in Switzerland", Unpublished Ph.D. Thesis, ETH Zurich Switzerland. DOI 10.3929/ethz-a-010251132.

[3] Alimi, S. R. (2013) "Households Expenditure Pattern on Beef and Chicken of Selected Households in Akoko South-West LGA of Ondo State, MPRA Paper No. 52153.

[4] Ariningsih, E. (2004) "Study of Animal Protein Consumption in The Time of Economic Crisis in Java", ICASERD Working Paper No. 28. [Online]. Available: https://pse.litbang.pertanian.go.id/ind/pdffiles/WP_28_2004.pdf [Accessed: 1 Jan. 2019].

[5] Bopape, L. and Myers, R. (2007) "Analysis of Household Demand for Food in South Africa: Model Selection, Expenditure Endogeneity, and the Influence of Socio-Demographic Effects", *African Econometrics Society Annual Conference*, Cape Town, South Africa.

[6] BPS (2017) "*Pengeluaran Untuk Konsumsi Penduduk Indonesia Per Provinsi*" (In Indonesia), Maret 2017, Publikasi BPS. Jakarta.

[7] Burger, R. P., Coetzee, L. Ch., Kreuser, C. F. and Rankin, N. A. (2017) "Income and Price Elasticities of Demand in South Africa: An Application of The Linear Expenditure System", *South African Journal of Economics,* Vol. 85, N. 4, pp. 491-514. ISSN 1813-6982. DOI 10.1111/saje.12167.

[8] Deaton, A. and Paxson, C. (1998) "Economies of Scale, Household Size, and The Demand for Food", *Journal of Political Economy*, Vol. 106, No. 5, pp. 897-930. ISSN 00223808. DOI 10.1086/250035.

[9] DKPP West Java Province (2018) "*Pola Pangan Harapan Provinsi Jawa Barat Tahun 2018*" (In Indonesia), Bandung. [Online]. Available: http://dkpp.jabarprov.go.id/wp-content/uploads/2018/04/POLA-PANGAN-HARAPAN-PROVINSI-JAWA-BARAT-TAHUN-2018.pdf. [Accessed: 20 March,, 2019].

[10] Fabiosa, J. F. (2005) "Growing Demand for Animal-Protein-Source Products in Indonesia: Trade Implications". CARD Report and Working Papers. 419. Iowa State University.

[11] Faharuddin, Mulyana, A., Yamin, M. and dan Yunita (2015) "Analisis Pola Konsumsi Pangan di Sumatera Selatan 2013: Pendekatan Quadratic Almost Ideal Demand System" (In Indonesia), *Jurnal Agro Ekonomi,* Vol. 33, No. 2, pp. 123-140. E-ISSN 2541-1527, ISSN 0216-9053. DOI 10.21082/jae.v33n2.2015.121-140.

[12] Hayat, N., Hussain, A. and Yousaf, H. (2016) "Food Demand in Pakistan: Analysis and Projections", *South Asia Economic Journal,* Vol. 17, No. 1, pp. 94-113. ISSN 1391-5614. DOI 10.1177/1391561415621826.

[13] Hoang, L. V. and Glewwe, P. (2011) "Impacts of Rising Food Prices on Poverty and Welfare in Vietnam", *Journal of Agricultural and Resource Economics,* Vol. 36, No. 1, pp. 14-27. ISSN 10685502.

[14] IFPRI (2016) "*Global Hunger Index: Getting to Zero Hunger*", Washington, DC (US): International Food Policy Research Institute. ISBN 9780896292260. DOI 10.2499/9780896292260.

[15] Majumder, A, Ray, R. and Kompal, S. (2012) "Calculating Rural-Urban Food Price Differentials from Unit Values in Household Expenditure Surveys: A Comparison with Existing Methods and A New Procedure", *American Journal of Agricultural Economics*, Vol. 94, No. 5, pp. 1218-1235. ISSN 0002-9092. DOI 10.1093/ajae/aas064.

[16] Mayasari, D., Satria, D. and Noor, I. (2018) "Analisis Pola Konsumsi Pangan Berdasarkan Status IPM di Jawa Timur" (In Indonesia), *Jurnal Ekonomi dan Pembangunan Indonesia*, Vol. 18, No. 2, pp. 191-213. ISSN 10685502. DOI 10.21002/jepi.v18i2.801.

[17] Ministry of Health (2015) "*Nutritional Status Affects Nation Quality*", [Online]. Available: http://www.depkes.go.id/article/print/15021300004/status-gizi-pengaruhi-kualitas-bangsa.html. [Accessed: 10 Feb., 2019].

[18] Mittal, S. (2010) "Application of The Quaids Model to The Food Sector in India", *Journal of Quantitative Economics*, Vol. 8, No. 1. pp. 42-54. ISSN 0971-1554.

[19] Molina, J. E. and Gil, A. I. (2005) "The Demand Behavior of Consumers in Peru: A Demographic Analysis Using the QUAIDS", *Journal of Developing Areas*, Vol. 39, No. 1, pp. 191-206. ISSN 0022037X. DOI 10.1353/jda.2005.0038.

[20] Nugroho, S. and Suparyono, S. W. (2015) "Pola Permintaan Daging Tingkat Rumah Tangga di Indonesia: Analisa Data Mikro 2013" (In Indonesia), *Jurnal Ekonomi dan Pembangunan Indonesia,* Vol. 16 No. 1, Juli 2015: 47-58. ISSN 10685502. DOI 10.21002/jepi.v16i1.668.

[21] Pakpahan, A. (2018) "Pergeseran Dalam Indeks Kelaparan Global (Global Hunger Index) 2000-2017: Implikasi Terhadap Kebijakan Pertanian, Pangan, dan Kualitas Sumber Daya Manusia Indonesia" (In Indonesia), *Jurnal Forum Penelitian Agro Ekonomi,* Vol. 35, No. 2. ISSN 0216-4361. DOI 10.21082/fae.v35n2.2017.75-90.

[22] Pangaribowo, E. H. and Tsegai, D. W. (2011) "Food Demand Analysis of Indonesian Households with Particular Attention to the Poorest", Discussion Papers 116748, University of Bonn, Center for Development Research (ZEF). ISSN 1436-9931.

[23] Poi, B. P (2012) "Easy Demand-System Estimation with Quaids", *The Stata Journal,* Vol. 12, No. 3, pp. 433-446. E-ISSN: 1536-8734, ISSN 1536-867X. DOI 10.1177/1536867X1201200306.

[24] Ravallion, M. and Van de Walle, D. (1991) "The Impact on Poverty of Food Pricing Reforms: A Welfare Analysis for Indonesia", *Journal of Policy Modeling*, Vol. 13, No. 2, pp. 281-299. ISSN 0161-8938. DOI 10.1016/0161-8938(91)90015-Q.

[25] Ray, R. (1983) "Measuring the Costs of Children: An Alternative Approach", *Journal of Public Economics*, Vol. 22, No. 1, pp. 89-102. ISSN 0047-2727. DOI 10.1016/0047-2727(83)90058-0.

[26] West Java Provincial Government (2015) "*Consumption Position of Chicken Meat and Eggs in West Java 10 Kg/capita*". [Online]. Available: http://www.jabarprov.go.id/index.php/news/11686/2015/03/30/Posisi-Konsumsi-Daging-Ayam-dan-Telur-Di-Jabar-10-Kgkapita. [Accessed: 15 Feb. 2019].

[27] Widarjono, A. and Rucbha, S. M. (2016) "Household Food Demand in Indonesia: A Two-Stage Budgeting Approach", *Journal of Indonesian Economy and Business*, Vol. 31, No. 2, pp. 163-177. ISSN 2338-5847. DOI 10.22146/jieb.15287.

[28] Zheng, Z. and Henneberry, S. R. (2010) "The Impact of Changes in Income Distribution on Current and Future Food Demand in Urban China", *Journal of Agricultural and Resource Economics*, Vol. 35, No. 1, pp. 1-21. ISSN 10685502.

Agris on-line Papers in Economics and Informatics

Volume XII Number 1, 2020

Consumer Preferences in the Content of Loyalty to the Yoghurt Brand

Ingrida Košičiarová, Zdenka Kádeková, Mária Holotová, Ľubica Kubicová, Kristína Predanocyová

Faculty of Economics and Management, Slovak University of Agriculture in Nitra, Slovakia

Abstract

The aim of submitted paper was to analyze customer preferences in the context of loyalty to the brand of selected food products in the segment of yoghurts. In order to achieve the mentioned aim, we used methods of survey, structured questionnaire (sample of 693 randomly chosen respondents) and blind test (sample of 100 respondents testing the four yoghurts – 2 yoghurts of traditional brands and 2 yoghurts of private labels). For a deeper analysis of the obtained results, totally four hypotheses were set out and tested by using the statistical methods of Contingency table chi-square test, Pearson´s chi-square test, Cramer's coefficient, Friedman test and Kolmogorov-Smirnov Test. The results of the survey proved that more than 30 % of respondents consume yoghurts on a daily basis, 30 % of respondents prefer to buy the yogurts of private labels, more than 64 % of respondents consider themselves as loyal consumers and based on the package, the tested sample of private label yoghurt (sample A) would be purchased by 56 % of respondents while the same sample of yoghurt (sample A) would be purchased for its taste just by 47 % of respondents.

Keywords

Yoghurt, private label, traditional brand, consumer preference, loyalty.

Košičiarová, I., Kádeková, Z., Holotová, M., Kubicová, Ľ. and Predanocyová, K. (2020) "*Consumer Preferences in the Content of Loyalty to the Yoghurt Brand*", *AGRIS on-line Papers in Economics and Informatics*, Vol. 12, No. 1, pp. 37-48. ISSN 1804-1930. DOI 10.7160/aol.2020.120104.

Introduction

In today's modern and globalized world, the consumers live in an increasingly competitive and dynamic market environment (Smutka et al., 2016, Polakevičová, 2015; Džupina et al., 2016; Mach et al., 2018; Balcarová et al., 2014; Kádek, 2014), where the brand by itself either loses its power or strengthens it. One of the primary objectives of the brand's existence is to establish a relationship with the consumer. The choice of the right brand is made through two crucial moments, namely by selecting the product in the store, where the customer decides which of the brands to buy; and by an additional decision at consumer´s home, when the product of the given brand is used and then consumer realizes whether is satisfied with product or not (Animashaun et al., 2013; Alić et al., 2017).

Brands that win again in both of these critical cases gain a special place in the hearts and minds of consumers. The result can be the creation of so-called love brands, i.e. permanent even lifelong brand relationships with consumers (Das, 2019).

At a time when consumers are talking about brands, they often pay attention to only one of its aspects, either the name or the logo. However, in brand management, we are talking about an entire system that applies to the concept of the natural value of products and services defined by the name and set of characteristics (Kapferer, 2012; Hereźnia et al., 2018).

Brand management focuses on managing aspects of the company's offerings such as brand, logo, motto, character, product design or packaging to achieve the company's ultimate marketing goals. When we reconcile goals and marketing actions, we can talk about building a strong brand (Chernev, 2018; Urbancová and Hudáková, 2017).

Today, customers are surrounded by a large number of different brands. If consumers believe that most brands offer the same characteristics, that there are only minor quality differences between brands. This means that the consumer does not buy goods of just one particular brand, but rather purchases a group of acceptable brands. Purchasing decisions depend on criteria such as availability, price, or a particular

product-specific offer, and hence the main criterion is not quality. As a result of this process, customer loyalty to a particular brand decreases significantly (Clow and Baack, 2008).

The brand contains basic visual elements such as logo, slogan or the name itself, on the basis of which consumers are able to identify the brand or company as well as to associate it with deeper values e.g. certain emotion, experience, story or relationship to lifestyle or status. The aim of the brand is to reach a potential target group of consumers in such a way that the brand becomes an integral and natural part of their being. To achieve this desired effect, it is necessary to use marketing tools designed to understand the needs of the market. (Banyár, 2017; Bartosik-Purgat, 2019).

A brand image is a multifunctional set of tangible and intangible elements that allows consumers to identify a product or service (Beverland, 2018). It has a complex and multidimensional nature and is the result of the consumer's mental process, respectively potential consumer receiving brand information. In this process, the individual gathers, evaluates, and combines brand-related information. The result is an image of a product, service or brand that plays an important role in its purchasing decisions (Singh and Duhan, 2016).

While the brand image is a tactical element that brings short-term results thanks to advertising and promotion experts; on the other hand, brand value is a strategic asset of the company that can underpin competitive advantage and long-term profitability and must therefore be closely monitored by the top management of the organization (Joachimsthaler and Aaker, 2009). In essence, brand value is an added value that affects each customers´ purchasing decision and motivates them to purchase. It is demonstrated by knowing the brand name and responding to the product. It depends on customer loyalty, as it reflects the brand's identification with product quality (Jakubíková, 2009; Janoskova and Kliestikova, 2018).

The consumer is considered to be the end user of the product, unlike the one who buys goods or services but does not consume them himself (Bulanda et al., 2018a; Bulanda et al., 2018b; Pilar et al., 2018). Attracting customers is the primary goal of any business, as the customer creates demand for goods and services and is very likely to become a loyal consumer who becomes loyal to brand. Companies compete in particular by promoting and reducing prices to attract the largest customer base (Kenton, 2018; Světlík and Bulanda, 2019; Janková and Strbová, 2017; Kaliji et al., 2014).

The strategy of foreign, but also of domestic companies is to reach all groups of customers − to satisfy those customers, who are critical for low costs, but also those who prefer the purchase of high quality products. All designated requirements have to be satisfied by private label products, whose share in Europe, particularly in Slovakia, is constantly increasing (Košičiarová, et al., 2014). Private labels, very simply explained, represent a strategy for branding traditional brand products, but with a retailer's brand (whether by his own name or with a name which he owns) (Košičiarová and Nagyová, 2014). Private label brands have established their market in the United Stated and Europe in the past few decades. In their beginnings, consumers tended to perceive them just as a substitute or option to the traditional brands because of their white − black packs, location somewhere on the bottom shelves and low price. However, over the time, there have been several significant changes, which have made private labels acceptable alternatives for the purchase (Nagyová and Košičiarová, 2014). Development of private labels is now a global phenomenon, which brings both − advantages as well as disadvantages. The most apparent expansion of private labels, for the year 2013, was noticed in Switzerland with 37.7 %, unchanged in USA and the lowest one in China (0.4 %) (blog.euromonitor.com, 2014; IRi Growth delivered, 2013).

Submitted paper focuses on consumer preferences in the context of loyalty to the brand of selected food products in the dairy yoghurt segment. There have been investigated the consumers' preferences between the traditional brand or a private one in the segment of yoghurts, namely two traditional-brand of yoghurts and two private-brand of yoghurts, which were tested in the form of a blank test.

Milk and dairy products, including yoghurt, rank among the commodities produced by food businesses and are thus integrated into the agro sector. Manufacture of dairy products is one of the key sectors within the food industry in the Czech Republic (Naglova et al., 2017) which is declared also by the fact, that dairy products are the export pillars of Czech agrarian foreign trade (Špička et al., 2015). Also in the Slovak Republic, the history of production and consumption of milk and dairy products has a very long tradition (Špička, 2015). In 1989, there was consumed 260 kg milk

per person per year in Czechoslovakia and in that time there were 166 centrally managed dairies. After the Slovak Republic joined the EU, milk quota was allocated for milk production, which was set at the level of 1,061.6 mil.kg in 2009/2010 (Kubicová, 2012) and further increased to the level of 1,115.6 mil.kg in 2014/2015 (Kubicová, 2014); and after five years of a preparatory increase in their level, milk quotas disappeared on April 1th 2015 (Eurostat, 2015). Nowadays trend shows, that the of milk and dairy products consumption declines (Košičiarová et al., 2017).As presented in the part Results and discussion, the current consumption of milk and dairy products in the Slovak Republic is about 174 kg per person per year, which represents lower consumption by 20% compared to the recommended intake (Kubicová et al, 2019).

Materials and methods

The aim of the present paper was to analyze customer preferences in the context of loyalty to the brand of selected food products in the segment of dairy yoghurt. In order to achieve the above mentioned aim, there had been used the methods of survey, structured questionnaire and blind test. The questionnaire survey was conducted from April to May 2019 on a sample of 693 respondents chosen randomly, their basic characteristics are given in the Table 1. The sample can be considered as a representative on the 95% confidence level and 4% error margin, since $n \geq 600.25$. The blind test was then realized in May 2019 on a sample of 100 respondents, who were testing totally four yoghurts – 2 yoghurts of traditional brands (Pribináčik as the sample B and Bánoveský jogurt as the sample C) and 2 yoghurts of private labels (K classic as the sample A and Clever as the sample D).

The justification and selection of the above mentioned yoghurts can be justified by the fact that according to the results of several surveys (GfK Slovakia, 2010; TNS Slovakia, 2015), as well as according to the opinion of the most important retail chains operating in Slovakia, interest of Slovak consumers in private labels is constantly growing. Among the most frequently purchased private label categories can be clearly ranked milk and dairy products, juices, lemonades and mineral waters, respectively salty snacks (Košičiarová and Nagyová, 2014).

The questionnaire covered the entire territory of Slovakia, representing all regions. The questionnaire was conducted over the internet and consisted of 13 questions divided into two parts – the first part consisted of questions on the subject and the second part consisted of the classification questions. In order to ensure the representativeness of the results, we applied the random selection and geographic diversification of our respondents. The questionnaire was evaluated using the contingency tables prepared by Microsoft Office Excel, under which they were subsequently created the graphs.

Characteristics of the respondents		Number
Category of respondents	Male	321
	Female	372
Age structure of respondents	Up to 26 years	197
	27 - 35 years	245
	36 - 45 years	158
	46 - 55 years	67
	56 years and more years	26
Educational structure of respondents	Primary education	5
	Secondary education without A level	49
	Secondary education	84
	Higher education I degree	227
	Higher education II degree	302
	Other	26
Economic activity of respondents	Student	282
	On maternity leave	15
	Unemployed	21
	Employed	305
	Retired	4
	Other	56
Region	Banská Bystrica	99
	Bratislava	93
	Košice	58
	Nitra	118
	Prešov	64
	Trenčín	98
	Trnava	96
	Žilina	67

Source: Results of the research

Table 1: Characteristics of respondents.

The collected data were processed out with the use of Microsoft Excel and then evaluated in the statistical program XL Stat. The formulated hypotheses were tested by applying the statistical methods of Contingency table chi-square test, Pearson´s chi-square test, Cramer's coefficient, Friedman test and Kolmogorov-Smirnov Test.

In hypothesis testing, if the p-value is lower than

significant level, in case of XL Stat software, it is 0.05, the null hypothesis is rejected, and the alternative hypothesis is confirmed (Witek, 2016).

For a deeper analysis of the research objectives, the following hypotheses were formulated:

Hypothesis 1: We assume that there is a relationship between the kind of preferred brand of purchased yogurts and the age category of respondents.

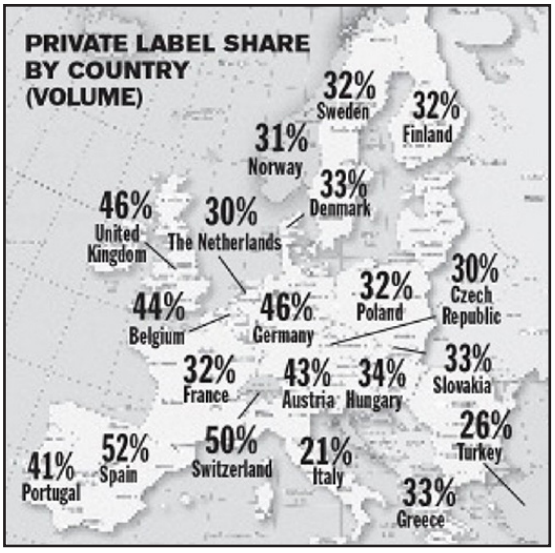
Hypothesis 2: We assume that there is a relationship between the kind of preferred brand of purchased yogurts and the gender of respondents.

Hypothesis 3: We assume that there is a statistically significant difference in the purchasing preferences of the product based on the packaging.

Hypothesis 4: We assume that there is a statistically significant difference in the evaluation of yogurt flavors.

Results and discussion

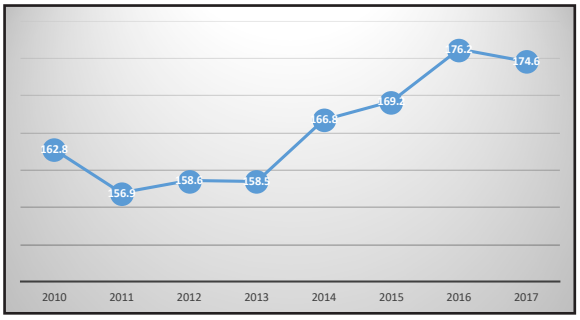
One of the most successful strategies of retailers is the sale of goods under the private label (Adamson, 2007). The purpose of this kind of sale is to attract new customers, which will later become loyal customers, and to build the image of the corresponding retail chain. In many cases, private labels are described and perceived as a global phenomenon (Herstein and Gamliel, 2004; Smith and Bashaw, 2009; Kakkos et al., 2015), which are constantly competing for the market position. Despite the fact that traditional brands are still dominant in today's competitive market, private labels are gradually progressing and tend to take over (Chimhundu, 2011; Ruiz-Real et al., 2016). Private label research shows that while 7 out of 10 buyers have already purchased a private label product in the US and considers it to be comparable to traditional brands or even higher quality (Park City Group, 2000). In the case of Europe, this share is even greater as the private label purchases in its individual countries increases year by year – actually, it has increased in 12 out of 19 European countries, and in 17 of them reached levels equal or greater than 30 % (PLMA, 2018).



Source: PLMA. Industry news. Private label today (2018).

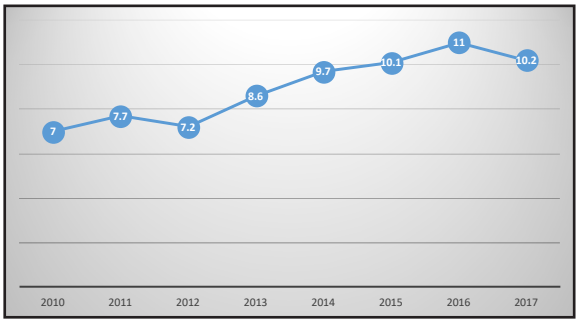
Figure 1: The share of private label chain purchases in household expenditures in 2018 (in %).

Milk and dairy products represent one of the most elemental foods for all age categories of the population because of its biological component (Michaelidou, 2008; Maitah and Smutka, 2012; Pereira, 2014), but also a valuable food that have a beneficial effect on consumer health (Habánová, 2010; Dudriková et al., 2017; Kubicová et al., 2019). We classify them as functional foods that provide the consumer with a range of beneficial substances for immunity and vitality in addition to satiety. The benefits of this key nutritional food should motivate consumers to their daily consumption. In the Slovak Republic, the recommended dose of milk and dairy products is declared at 220 kg per person per year (Košičiarová et al., 2018). Figure 2 presents real consumption figures, which, unfortunately, have been lower than recommended over recent years - the last value meeting the recommended dose of consumption was recorded in 1990.



Source: SO SR

Figure 2: Development of milk and dairy products consumption in the Slovak Republic (per person in kg).



Source: NPPC

Figure 3: Average annual consumption of yoghurts in the Slovak Republic (per person in kg).

Despite the consumption of milk and dairy products, which has generally declining trend in recent decades, the average consumption of yoghurt in kilograms per person has been on an upward trend almost annually. Figure 3 shows the development of this consumption, which has increased by 4 kg per person per year (by 57%) over six years, which, despite the non-compliance with the recommended dose of dairy products, shows the increasing interest of yoghurts.

For this reason, milk yoghurts were the object of the study of submitted paper, where we focused on two samples of yoghurts sold under the traditional brand (samples B and C) and two samples of yoghurts sold under the private label (samples A and D).

As explained in the part Materials and methods, the choice of samples can be clearly explained by the increasing interest of Slovak consumers in the purchase of private label products, as well as by the fact that milk and dairy products are among the most frequently purchased private label categories in the food segment (Košičiarová, Nagyová, 2014). In terms of interest in the purchase of private label products of individual retail chains, respectively advantageous purchases and better customer orientation in stores, based on a survey conducted by TNS Slovakia in June 2012, the most popular private brands include brands by TESCO (49% of respondents), COOP Jednota (44% of respondents), Kaufland (32% respondents) and Billa (23%). According to the research, the products sold under private labels of COOP Jednota and TESCO are bought by women rather than men, and only 14% of respondents stated they do not buy any private label products (Fedorková, 2012).

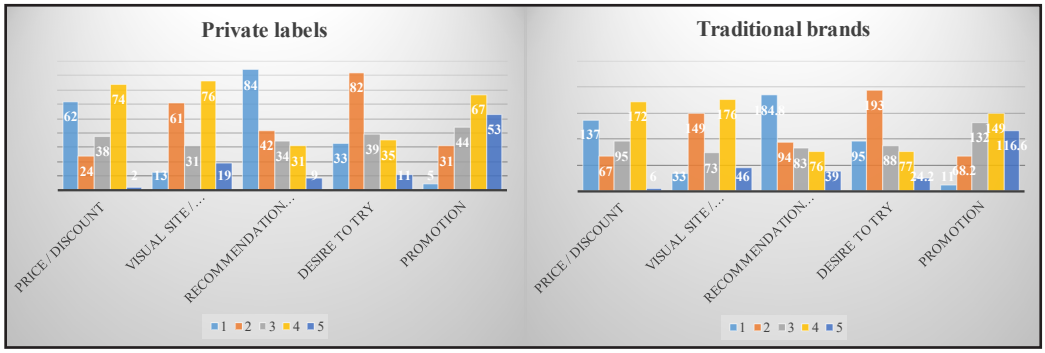
As outlined above, research, questionnaire and blind test methods were chosen to investigate consumer preferences in the context of loyalty to the brand of selected food products in the segment of yoghurts. As can be seen from Table 1, a total of 693 respondents participated in the research, of which the majority were women (53.68%), 27-35 years old respondents (35.35%), employed (44.01%)), with higher secondary education (43.58%) and respondents from the Nitra region (17.03% of respondents).

The questionnaire survey focused mainly on their purchase and frequency of purchase, brand loyalty, brand preference (i.e. traditional brand or private label), as well as motives for purchase of individual types of brands. The survey was then supplemented by a blind test to examine the sensory properties of yogurts as well as the subsequent buying preference without knowing the real brand.

Research results point to many interesting findings - in terms of yogurt consumption, up to 33% of respondents (out of 677 respondents who eat yoghurts) consume yoghurts on a daily basis (18% once a day and 15% several times a day), up to 30% of respondents prefer to buy private label yoghurts and up to 64.21% of respondents consider themselves as loyal customers.

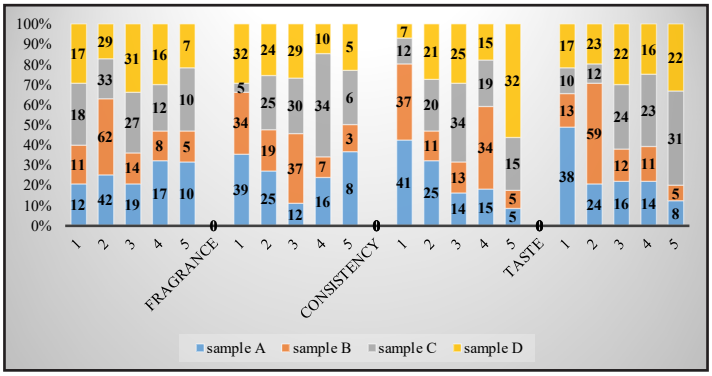
Consumer behavior does not only mean the behavior when purchasing a product or service, it is a sequence of several steps that the customer's mind goes through before buying something (Kumar, 2016). Consumers make this type of decision in average of 200 times a day, it is unlikely that they invest a lot of cognitive power in purchasing decisions (Wansink, 2010). Moreover, even if they are willing to think carefully about all their food choices, they have limited capacity to process all available information (Mawad et al., 2015). For this reason, they usually invest only a few seconds in purchasing decisions, paying attention only to some information (Mormann, Cerf, 2008).

In order to find out what leads the respondents to purchase a particular type of yoghurt brand, the questionnaire survey formulated questions about the motives for buying private labels and then the motives for buying traditional brands. Respondents were asked to assess individual motives on a scale of 1 to 5 (where 1 was the most and 5 was the least). As can be seen in Figure 4, the motives for buying either private yogurt label or traditional yogurt brands are essentially perceived the same. The most important motive for the purchase are recommendations from friends and acquaintances, the desire to try the product and then the promotion, price and visual site of the packaging.



Source: results of own research

Figure 4: Motives for purchasing the yoghurts of private labels and traditional brands.



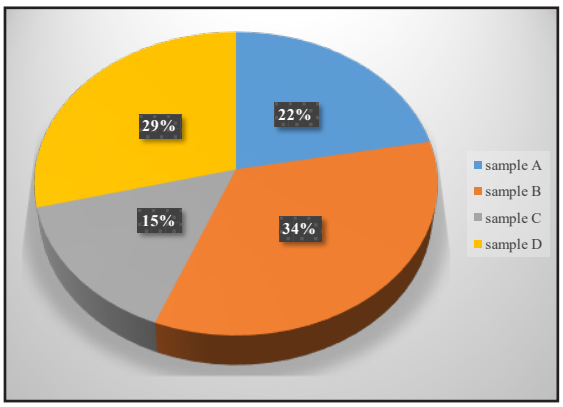
Source: results of own research

Figure 5: Evaluation of the sensory properties of the examined yogurt samples.

As we wanted to find out which of the examined yoghurt respondents prefer in their purchase (samples A to D, or none of them), which sample they would buy only on the basis of packaging and then on the basis of taste, in the questionnaire survey were also formulated these questions. Research results show that respondents prefer Sample A (private label sample) 34 % of respondents, and sample B (traditional brand sample) 23% of respondents. Based on the packaging they mainly buy sample A (private label sample) 56% of respondents, and sample B (traditional label sample) 32% of respondents. On the basis of taste, they would prefer to buy sample A (private label sample) 47% of respondents, and sample B (traditional brand sample) 24% of respondents.

In the case of evaluating the sensory properties of the examined yogurt samples as color, fragrance, consistency and taste can be said that respondents rated most positively samples A and B - one sample of a private yogurt label and one sample of a traditional yogurt brand. If we focused on the individual sensory properties, we would find that the best scent had Sample C- sample of the traditional yoghurt brand; while the sample A- the private yogurt label was then best rated for its consistency and taste (Figure 5).

An interesting finding of the research is that when the respondents had been asked to determine whether it was a traditional or private brand of yogurt based on the flavor, the most respondents did not identify it correctly - see Figure 6. The most respondents correctly identified only sample D, which was truly a private yogurt label. The remaining samples were identified incorrectly.



Source: results of own research

Figure 6: Identification of traditional brand and private label flavor of yoghurts.

As mentioned above, the survey also focused on evaluating a total of four statistical hypotheses,

which were verified and statistically evaluated using the chosen statistical tests. Research shows that three of them have been confirmed, hypothesis 1, 2 and 4.

Hypothesis 1: We assume that there is a relationship between the kind of preferred brand of purchased yogurts and the age category of respondents.

	Type of preferred brand		Total
Age category	Private label	Traditional brand	
Up to 26 years	31	166	197
27-35 years	76	169	245
36-45 years	67	91	158
46-55 years	18	49	67
56 years and more	8	18	26
Total	200	493	693

Source: Results of own research

Table 2: Chi square test for two independent sets for preferred yogurt brand type and respondent age.

Test characteristics (TCH) – 31.373

Table value (TH) – 9.488

TCH > TV

H_0 rejected, H_1 accepted

Based on these calculations we accept the hypothesis H_1, with 95% probability can be said that the type of preferred brand when buying yoghurt depends on the age category of the respondents. Since the dependence was found, we also examined the strength of the dependence. Based on the results of the Cramer coefficient, it can be said that this is a weak but statistically significant dependence (the Cramer coefficient was 0.0347).

Hypothesis 2: We assume that there is a relationship between the kind of preferred brand of purchased yogurts and the gender of respondents.

	Category of respondents		Total
Type of preferred brand	Woman	Man	
Private label	145	55	200
Traditional brand	270	223	493
Total	372	321	693

Source: Results of own research

Table 3: Chi square test for two independent sets for the preferred yogurt brand type and category of respondents .

Test characteristics (TCH) – 40.047

Table value (TV) – 3.841

TCH > TV

H_0 rejected, H_1 accepted

Based on these calculations, we accept the hypothesis H1, with 95% probability can be said that the type of preferred brand when buying yoghurt depends on the category of respondents. Since the dependence was found, we also examined the strength of the dependence. Based on the results of the Cramer coefficient, it can be said that it is a weak but statistically significant dependence (Cramer coefficient value was equal to 0.0118).

Hypothesis 3: We assume that there is a statistically significant difference in the purchasing preferences of the product based on the packaging.

	Number of respondents
sample A	378
sample B	221
sample C	65
sample D	14
Total	677

Source: Results of own research

Table 4: Purchase of selected brand of yogurts on the basis of packaging.

The result of the Kolmogorov-Smirnov test shows, that the value of the K-S test statistic (D) is 0.28759.; the p-value is 0.71235. Based on the written we can say, that the data does not differ significantly from that which is normally distributed - we do not reject the null hypothesis

Hypothesis 4: We assume that there is a statistically significant difference in the evaluation of yogurt flavors.

Average value	
A	0.05
F (TCH)	11.36
TV	0.022

Source: Results of own research

Table 5: Friedman test for yogurt flavor evaluation.

Test characteristics (TCH) – 11.36

Table value (TV) – 0.022

TCH > TV

H_0 rejected, H_1 accepted

Based on the results of Friedman's test, with 95% probability can be said that there is at least one pair of yogurts with a statistically significant difference in appraisal of flavors.

Conclusion

Despite the fact, that the overall consumption of milk and dairy products has been rather negative and declining in recent decades, the average consumption of yoghurt (in kg per capita) has increased almost annually (increased by 4 kg per year over the past six years). Mentioned is the reason why yoghurts, both traditional and private-brand yoghurts, have gradually become the object of our research. As we have pointed out in the introduction of the submitted paper, the results of our research can be used as a material for further research in this field as well as a guide to increase the attractiveness of yoghurt and thus increase its consumption by Slovak consumers. The results of our research point to many interesting findings – from the point of view of yogurt consumption, up to 33% of respondents consume yoghurts on a daily basis, up to 30% of them prefer in their purchase the private label yoghurts, up to 64% of respondents consider themselves as loyal customers, up to 34% of respondents prefer in their purchase exactly that sample of private label yoghurt, which was tested by us, also 23% of respondents prefer in their purchase that sample of traditional brand yoghurt, which was tested by us, and only on the basis of the package, as well as on the basis of taste, exactly 56 % of respondents and 47% of respondents would buy the tested sample of private label product (sample A). Regarding the motives leading to the purchase of both yogurts (traditional brands and private labels), it can be concluded these motives are essentially the same – at first the recommendations from friends and acquaintances, the desire to try it and just then their promotion, respectively price and visual aspect of the packaging. Indeed, the results are surprising, as we would expect respondents to clearly prefer traditional brand yoghurts over private label yoghurts, but this has not been confirmed. On the basis of the above mentioned it can be said that the boundaries between traditional and private labels are gradually blurring and customers begin to realize that the private label products are a suitable alternative to their purchase. Possibilities of increasing the attractiveness of private label yoghurts (as we consider them as adequate alternatives to buying traditional brands of yoghurts) could be based in raising awareness about private labels and their real producers among Slovak consumers. In many cases, we find that Slovak consumers still hesitate to buy the private label products, because they do not have any experience with these products, respectively do not know their real producer. For this reason, the submitted paper can also serve as a tool to raise awareness of both the professional and general public, especially about the existence of private labels, their meaning, advantages and potential pitfalls.

Acknowledgements

The paper is a part of the research project GA SUA no. 8/2019 "Private labels as the alternative to purchase", solved at the Department of Marketing and Trade, Faculty of Economics and Management, Slovak University of Agriculture in Nitra.

Corresponding authors
Ing. Zdeňka Kádeková, Ph.D.
Department of Marketing and Trade, Faculty of Economics and Management
Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia
E-mail: zdenka.kadekova@uniag.sk

References

[1] Adamson, A. P. (2007) "*Brand Simple: How the Best Brands Keep it Simple and Succeed*", 1st ed., Palgrave Macmillan, 256 p. ISBN-13: 978-1403984906.

[2] Alić, A., Agić, E. and Činjarević, M. (2017) "The Importance of Store Image and Retail Service Quality in Private Brand Image-Building", *Entrepreneurial Business and Economics Review*, Vol. 5, No. 1, pp. 27-42. E-ISSN 2353-8821, ISSN 2353-883X. DOI 10.15678/EBER.2017.050102.

[3] Animashaun, J. O., Williams, F. E. and Toye, A. A. (2013) "Towards Validating Moringa´s Nutraceutical Benefits: An Examination of Consumers´ Perspectives vis-a-vis Health Benefits Efficacy and Willingness to Pay", *Agris on-line Papers in Economics and Informatics*, Vol. 5, No. 2, pp. 11-21. ISSN 1804-1930.

[4] Balcarová, T., Pokorná, J. and Pilař, L. (2014) "The Influence of Children on the Parents Buying Behaviour: Food Purchase in the Czech Republic", *Agris on-line Papers in Economics and Informatics*, Vol. 6, No. 2, pp. 11-19. ISSN 1804-1930.

[5] Banyár, M. (2017) "*Značka a logo: vizuálne prvky značky a ich význam v procese brandingu*", Zlín: Univerzita Tomáše Bati, 300 p. ISBN 978-80-745-4681-5. (In Czech).

[6] Bartosik-Purgat, M. (2019) "Digital Marketing Communication from the Perspective of Individual Consumers: A Cross-Country Comparison", *Entrepreneurial Business and Economics Review*, Vol. 7, No. 3, pp. 205-220. E-ISSN 2353-8821, ISSN 2353-883X. DOI 10.15678/EBER.2019.070311.

[7] Beverland, M. (2018) "*Brand Management: Co-creating Meaningful Brands*", California, SAGE Publications Ltd., 414 p. ISBN 978-14-739-5198-3.

[8] Bulanda, I., Džupina, M. and Franková, V. (2018a) "*Consumer Assessment of Selected Food Commodities by Slovak Woman from Generation Y*", QUAERE 2018, Hradec Králové, pp. 174-184. ISBN 978-80-87952-26-9.

[9] Bulanda, I., Viteková, I., Koprda, T., Blahová, B. (2018b) "Slovak consumers from generation Y and their shopping behavior on discount portals", Proceedings of *International Scientific Days 2018: "Towards Productive, Sustainable and Resilient Global Agriculture and Food Systems"*, Prague, Wolters Kluwer, pp. 275-287. ISBN 978-80-7598-180-6. DOI 10.15414/isd2018.s2-1.01

[10] Clow, K. and Baack, D. (2008) "*Reklama, propagace a marketingová komunikace*", Brno, Computer Press, 484 p. ISBN 978-80-251-1769-9. (In Czech).

[11] Das, G. (2019) "Does brand experience translate into brand commitment?: A mediated-moderation model of brand passion and perceived brand ethicality", *Journal of Business Research*, Vol. 95, pp. 479-490. ISSN 0148-2963. DOI 10.1016/j.jbusres.2018.05.026.

[12] Dudriková, E., Nagyová, M., Dičáková, Z. (2017) "Survival of Lactobacillus Bulgaricus and Bifidobacterium Animalis in Yoghurts Made From Commercial Starter Cultures During Refrigerated Storage", *Potravinarstvo Slovak Journal of Food Sciences*, Vol. 11, No. 1, pp. 597-601. ISSN 1337-0960. DOI 10.5219/758

[13] Džupina, M., Hodinková, D. and Kiková, H. (2016) "*Spoločensky zodpovedné podnikanie ako zdroj hodnôt značky*", Nitra, UKF, 84 p. ISBN 978-80-558-0991-5. (In Slovak).

[14] Džupina, M. and Janková, G. (2017) "Development of sustainable consumption through consumer education", *20th International Scientific Conference „Economic and Social Development"*, Prague, 27-28 April, pp. 243-251. ISSN 1849-7535.

[15] Euromonitor (2014) "*The New Face of Private Label: Global Market Trends to 2018*". [Online]. Available: http://blog.euromonitor.com/2014/01/the-new-face-of-private-label-globalmarket-trends-to-2018.html [Accessed: 13 Sep. 2019].

[16] Eurostat (2015) "*Milk and milk products – 30 years of quotas*". [Online]. Available: http://ec.europa.eu/eurostat/statistics-explained/index.php/Milk_and_milk_products_-_30_years_of_quotas [Accessed: 20 Nov. 2019].

[17] Fedorková, J. (2012) "Najvýhodnejšie nákupy robíme v Kaufland". [Online]. Available: http:// www.tns-global.sk/informacie-pre-vas/tlacove-spravy/najvyhodnejsie-nakupy-robime-v-kauflande [Accessed: 15 Nov. 2019]. (In Slovak).

[18] Habánová, M., Lorková, M. and Kopčeková, J. (2010) "The consumption of acidophylus drinks and yogurts in selected population of pupils in years 2004 and 2008", *Potravinarstvo Slovak Journal of Food Sciences*, Vol. 4, No. 3, pp. 19-23. E-ISSN 1337-0960. DOI 10.5219/26.

[19] Herstein, R. and Gamliel, E. (2004) "An Investigation of Private Branding as a Global Phenomenon", *Journal of Euromarketing*, Vol. 13, No. 4, pp. 59-77. ISSN 0309-0566. DOI 10.1300/J037v13n04_04.

[20] Hereźniak, M., Florek, M. and Augustyn, A. (2018) "On Measuring Place Brand Effectiveness – between Theoretical Developments and Empirical Findings", *Economics and Sociology*, Vol. 11, No. 2, pp. 36-51. ISSN 2071-789X. DOI 10.14254/2071-789X.2018/11-2/3.

[21] Chernev, A. (2018) "*Strategic Brand Management*", Chicago, Cerebellum Press, 206 p. ISBN 978-19-365-7238-0.

[22] Chimhundu, R. (2011) "Private Label Marketing Performance: An Analysis of Historical Trends Using Theories of Cumulative Change and Punctuated Equilibrium", *International Journal of Business and Management*, Vol. 6, No. 8, pp. 58-65. ISSN 1833-3850. DOI 10.5539/ijbm.v6n8p58.

[23] IRi Growth delivered. (2013) "*Private Label: Balancing Quality and Value*". [Online]. Available: http://www.iriworldwide.eu/Portals/0/articlepdfs/PrivateLabel_2013_Full%20Report.pdf [Accessed: 10 Sep. 2019].

[24] Jakubíková, D. (2009) "Marketing v cestovnom ruchu", Prague, Grada Publishing, 288 p. ISBN 978-80-247-3247-3. (In Czech).

[25] Janková, G. and Strbová, E. (2017) "Educational aspect of advertising from perception of future marketing experts", *20th International Scientific Conference „Economic and Social Development"*, Prague, 27-28 April, pp. 598-609. ISSN 1849-7535.

[26] Janoskova, K. and Kliestikova, J. (2018) "Analysis of the impact of selected determinants on brand value", *Journal of International Studies*, Vol. 11, No. 1, pp. 152-162. E-ISSN 2306-3483, ISSN 2071-8330. DOI 10.14254/2071-8330.2018/11-1/11.

[27] Joachimsthaler, E. and Aaker, A. D. (2009) "*Brand Leadership: Building Assets In an Information Economy*", New York, Free Press, 368 p. ISBN 978-14-391-7291-9.

[28] Kádek, P. (2014) "*Súčasné dimenzie právnej zodpovednosti v medicíne a zdravotníctve*", Bratislava, Wolters Kluwer, 182 p. ISBN 978-80-8168-124-0. (In Slovak).

[29] Kakkos, N., Trivellas, P. and Sdrolias, L. (2015) "Identifying Drivers of Purchase Intention for Private Label Brands. Preliminary Evidence from Greek Cnsumers", *Procedia - Social and Behavioral Sciences*, Vol. 175, pp. 522-528. ISSN 1877-0428. DOI 10.1016/j.sbspro.2015.01.1232.

[30] Kaliji, S. A., Mojaverian S. M., Amirnejad, H. and Canavari, M. (2019) "Factors Affecting Consumers´ Dairy Products Preferences", *Agris on-line Papers in Economics and Informatics*, Vol. 11, Vo. 2, pp. 3-11. ISSN 1804-1930. DOI 10.7160/aol.2019.110201.

[31] Kapferer, J. N. (2012) "*The New Strategic Brand Management: Advanced Insights and Strategic Thinking*", New York, Kogan Page Publishers, 512 p. ISBN 978-07-494-6515-5.

[32] Kenton, W. (2018) "*Customer*". [Online]. Available: https://www.investopedia.com/terms/c/customer.asp [Accessed: 13 Sep. 2019].

[33] Košičiarová, I., Holienčinová, M. and Nagyová, Ľ. (2014) "Knowledge and preference of private label products by Slovak consumer", *Improving performance of agriculture and the economy: challenges for management and policy, MVD*, 71 p. [Online]. Available: http://spu.fem.uniag.sk/fem/mvd2014/proceedings/articles/Sedliakova.pdf [Accessed: 12 Sep. 2019].

[34] Košičiarová, I. and Nagyová, Ľ. (2014) "Private label: the chance how to increase the consumer's interest in a proper retail chain", *ICABR 2014*, pp. 452-467. [Online]. Available: http://www.icabr.com/fullpapers/icabr2014.pdf [Accessed: 13 Sep. 2019].

[35] Košičiarová, I., Nagyová, Ľ. and Holienčinová, M. (2017) "Consumer behaviour on Slovak yoghurt and fermented milk products market", *Universitatis Agriculturaevet Silviculturae Mendelianae Brunensis*, Vol. 65, No. 6, pp. 1967-1978. E -ISSN 2464-8310, ISSN 2464-8310. DOI 10.11118/actaun201765061967.

[36] Košičiarová, I., Nagyová, Ľ., Holienčinová, M., Kádeková, Z. and Rybanská, J. (2018) "Preference and perception of private label products and yoghurts - a case study of Slovak consumers with the age up to 30 years", *International Scientific Days 2018: "Towards Productive, Sustainable and Resilient Global Agriculture and Food Systems*", Prague, Wolters Kluwer, pp. 372-390. ISBN 978-80-7598-180-6. DOI 10.15414/isd2018.s2-1.08.

[37] Kubicová, Ľ. and Habánova, M. (2012) "Development of milk consumption and marketing analysis of its demand", *Potravinarstvo Slovak Journal of Food Sciences*, Vol. 6, No. 4, pp. 66-72. E-ISSN 1337-0960. DOI 10.5219/236.

[38] Kubicová, Ľ., Kádekova, Z. and Dobák, D. (2014) "Trends in consumption of milk and dairy products in Slovakia after EU accession", *Polityki Europejskie, Finanse i Marketing*, Vol. 12, No. 61, pp. 90-97. ISSN 2081-3430.

[39] Kubicová, Ľ., Predanocyová, K. and Kádeková, Z. (2019) "The importance of milk and dairy products consumption as a part of rational nutrition", *Potravinarstvo Slovak Journal of Food Sciences*, Vol. 13, No. 1, pp. 234-243. E-ISSN 1337-0960. DOI 10.5219/1050.

[40] Kumar, R. (2016) "*Consumer behavior. The role of Consumer Behavior in marketing strategy in the 3 marketing stimuli*", San Francisco, GRIN Publishing, 20 p. ISBN 978-36-569-8858-8.

[41] Mach, J., Dvořák, M. and Hošková, P. (2018) "EU Milk and Dairy Market Changes and Impact of Globalisation Trends", *Globalization and its socio-economic consequences (Part III.- Economic Progress in Post-Soviet Countries) 10.10.2018*, Rajecke Teplice, Slovak Republic, Zilina, Slovakia, ZU-University of Zilina, pp. 1204-1212. ISSN 2454-0943.

[42] Maitah, M., Smutka, L. (2012) "Economic analysis of milk production and consumption in the Middle East adn North Africa", *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, Vol. 60, pp. 245-254. E-ISSN 2464-8310, ISSN 2464-8310. DOI 10.11118/actaun201260040245.

[43] Mawad, F., Trías, M., Giménez, A., Maiche, A. and Ares, G. (2015) "Influence of cognitive style on information processing and selection of yogurt labels: Insights from an eye-tracking study", *Food Research International*, Vol. 74, pp. 1-9. ISSN 0963-9969. DOI 10.1016/j.foodres.2015.04.023.

[44] Michaelidou, A. M. (2008) "Factors influencing nutritional and health profile of milk and milk products", *Small Ruminant Research*, Vol. 79, No. 1, pp. 42-50. ISSN 0921-4488. DOI 10.1016/j.smallrumres.2008.07.007.

[45] Mormann, M. and Cerf, M. (2008) "First attention then intention. Insights from computational neuroscience of vision", *International Journal of Advertising*, Vol. 27, pp. 381-398. E-ISSN 1759-3948, ISSN 0265-0487. DOI 10.2501/S0265048708080037.

[46] Naglova Z., Boberova B., Horakova T. and Smutka L. (2017) "Statistical analysis of factors inflencing the results of enter-prises in dairy industry", *Agricultural Economics (AGRICECON)*, Vol. 63, No. 6, pp. 259–270. ISSN 0139-570X. DOI 10.17221/353/2015-AGRICECON.

[47] Nagyová, Ľ. and Košičiarová, I. (2014) "*Privátne značky: fenomén označovania výrobkov 21. storočia na európskom trhu*", Nitra, SUA, 168 p. ISBN 978-80-552-1172-5. (In Slovak).

[48] Park City Group. (2000) "*Private Label. A Store Brand Primer*", 4 p. [Online]. Available: https://www.parkcitygroup.com/wp-content/uploads/WP_Private_Label_Primer.pdf [Accessed: 9 Sep. 2019].

[49] Pereira, P. C. (2014) "Milk nutritional composition and its role in human health", *Nutrition*, Vol. 30, No. 6, pp. 619-627. ISSN 0899-9007. DOI 10.1016/j.nut.2013.10.011.

[50] Pilař, L., Kvasničková Stanislavská, K., Gresham, G., Poláková, J., Rojík, S. and Petkov, R. (2018) "Questionnaire vs. Social Media Analysis - Case Study of Organic Food", *Agris on-line Papers in Economics and Informatics*, Vol. 10, No. 3, pp. 93-101. ISSN 1804-1930. DOI 10.7160/aol.2018.100308.

[51] PLMA (2018) "*Industry news. Private label today*", [Online]. Available: https://www.plmainternational.com/industry-news/private-label-today [Accessed: 12 Sep. 2019].

[52] PLMA (2018) "*Private label gains across Europe, climbing to all-time highs in seven countries*", [Online]. Available: https://www.plmainternational.com/news-update [Accessed: 13 Sep. 2019].

[53] Polakevičová, I. (2015) "Application of transactional analysis in marketing research - models of the hierarchy of effects of marketing communication and structural analysis", *Prohuman: vedecko-odborný internetový časopis - sociálna práca, psychológia, pedagogika, sociálna politika, zdravotníctvo, ošetrovateľstvo*, Vol. 7, No. 2, pp. 1-10. ISSN 1338-1415.

[54] Ruiz-Real, J. L., Gázquez-Abad, J. C., Esteban-Millat, I. and Martinez-Lopez, F. J. (2016) "Betting exclusively for private labels: Could it have negative consequences for retailers?", *Spanish Journal of Marketing – ESIC*, Vol. 11, 12 p. ISSN 2444-9709. DOI 10.1016/j.sjme.2016.12.004.

[55] Singh, A. and Duhan, P. (2016) "*Managing Public Relations and Brand Image through Social Media*", Pensylvania, IGI Global, 353 p. ISBN 978-15-225-0332-3.

[56] Smith, R. K. and Bashaw, E. R. (2009) "Using Information Processing To Build A Private Label Brand In Big Emerging Markets", *International Business & Economics Research Journal* , Vol. 8, No. 4, pp. 27-42. E-ISSN 2157-9393, ISSN 1535-0754. DOI 10.19030/iber.v8i4.3123.

[57] Smutka, L., Svatoš, M., Tomšík, K. and Sergienko, O. I. (2016) "Foreign trade in agricultural products in the Czech Republic", *Agricultural Economics (AGRICECON)*, Vol. 62, No. 1, pp. 9-25. ISSN 0139-570X. DOI 10.17221/18/2015-AGRICECON.

[58] Statistics (2019) "*Spotreba vybraných druhov potravín na 1 obyvateľa*", [Online]. Available: http://datacube.statistics.sk/#!/view/sk/VBD_SLOVSTAT/ps2041rs/Spotreba%20vybran%C3%BDch%20druhov%20potrav%C3%ADn%20na%201%20obyvate%C4%BEa%20%5Bps2041rs%5D [Accessed: 13 Sep. 2019]. (In Slovak).

[59] Světlík, J. and Bulanda, I. (2019) "Adolescents Perception of the Commercial Advertising in Slovakia", *Economic and Social Development*, Buenos Aires, pp. 201-209. ISSN 1949-7535.

[60] Špička, J. (2015) "The Efficiency Improvement of Central European Corporate Milk Processors in 2008-2013", *Agris on-line Papers in Economics and Informatics*, Vol. 7, No. 4, pp. 175-188. ISSN 1804-1930.

[61] Špička, J., Smutka, L. and Selby, R. (2015) "Recent areas of innovation activities in the Czech dairy industry", *Agricultural Ecnomics (AGRICECON)*, Vol. 6, No. 22, pp. 249-264. ISSN 0139-570X. DOI 10.17221/128/2014-AGRICECON.

[62] TASR (2010) "*Prieskum: Predaj značkových tovarov si udržal postavenie aj v čase krízy*". [Online]. Available: http://www.edb.sk/sk/spravy/prieskum-predaj-znackovych-tovarov-si-udrzal-postavenie-aj-v-case-krizy-a2398.html [Accessed: 15 Nov. 2019]. (In Slovak).

[63] TNS (2015) "*Obľúbenosť privátnych značiek na Slovensku rastie*". [Online]. Available: https://www.tns-global.sk/informacie-pre-vas/tlacove-spravy/oblubenost-privatnych-znaciek-na-slovensku-rastie [Accessed: 15 Nov. 2019]. (In Slovak).

[64] Urbancová, H. and Hudáková, H. (2017) "Benefits of Employer Brand and the Supporting Trends", *Economics and Sociology*, Vol. 10, No. 4, pp. 41-50. ISSN 2071-789X. DOI 10.14254/2071-789X.2017/10-4/4.

[65] VEUPP (2018) "*Mlieko*", [Online]. Available: http://www.vuepp.sk/dokumenty/komodity/2018/Mlieko_nov_18.pdf [Accessed: 12 Sep. 2019].

[66] Wansink, B. (2010) "From mindless eating to mindlessly eating better", *Physiology & Behavior*, Vol. 100, No. 5, pp. 454-463. ISSN 0031-9384. DOI 10.1016/j.physbeh.2010.05.003.

[67] Witek, L. (2016) "Influence of Socio-demographic Characteristics of Consumers on Attitudes Towards Cause Related Marketing", *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, Vol. 64, No. 6, pp. 2173-2182. E-ISSN 2464-8310, ISSN 1211-8516. DOI 10.11118/actaun201664062173.

Agris on-line Papers in Economics and Informatics

Volume XII Number 1, 2020

The Impact of Energy Consumption and Agricultural Production on Carbon Dioxide Emissions in Portugal

Nuno Carlos Leitão[1], Jeremiás Máté Balogh[2]

[1] Polytechnic Institute of Santarém, CEFAGE, Évora University, Portugal
[2] Corvinus University of Budapest, Hungary

Abstract

The consequences of climate change heavily influence the Mediterranean region. However, the Portuguese CO_2 emission shows a decreasing tendency, the evolution of livestock and animal production have significantly increased its level in agriculture. The article investigates the role of the agricultural output and energy consumption in the environmental pollution in Portugal. It explores the short and long-run cointegration between carbon dioxide emissions and agricultural activities such as crop production, livestock production, and agricultural land use applying Autoregressive Distributed Lag (ARDL), Granger causality, Newey-West Standard Errors regression, as well as ARIMA model for the period of 1960-2015. The causality relation between CO_2 emissions and agriculture is also analyzed. The Augmented Dickey-Fuller (ADF) unit root tests suggest that all variables are stationary. ARDL model demonstrates a long-run relationship between CO_2 emissions, agriculture, and energy consumption. Results indicate that agricultural activities and energy use have a positive effect on environmental pollution; therefore, the Portuguese agriculture needs to achieve a higher level of sustainable development, with reducing the impact of animal husbandry and intensive crop production.

Keywords

Climate change, carbon dioxide emissions, agricultural production, time series, Portugal.

Leitão, N. C. and Balogh, J. M. (2020) "The Impact of Energy Consumption and Agricultural Production on Carbon Dioxide Emissions in Portugal ", *AGRIS on-line Papers in Economics and Informatics*, Vol. 12, No. 1, pp. 49-59. ISSN 1804-1930. DOI 10.7160/aol.2020.120105.

Introduction

In the last decades, climate change and global warming have been becoming an urgent issue for policy and decision makers.

Ritchie (2017) suggest that livestock takes up nearly 80% of global agricultural land yet produces less than 20% of the world's supply of calories. Economic development exerts an increasing impact on land resources. Furthermore, the world population uses approximately 50 percent of the total habitable land for agriculture.

The Mediterranean region is predicted to suffer from increasingly severe droughts in the future due to climate changes, in addition to increased problems with soil salinity and increased temperatures (Jacobsen et al., 2012).

Portugal managed to fulfill its Kyoto Target for the period 2008–2012. In contrast, it reached 16 % higher level of emissions in 2011 compared to 1990 (PIA, 2013). In 2017, the Portuguese CO_2 emission was 4 % lower compared to 2000 (Statista, 2018) showing a decreasing tendency. However, the projected energy-related carbon dioxide emissions of Portugal might significantly decrease for 2050, the level of non-energy non-land use related emission remain relatively high.

Besides, recent statistics suggest that environmental pollution cause a serious problem in Portugal. Torres et al. (2018) revealed that Lisbon and its surroundings are the most critical areas of emissions.

Mourão and Martinho (2017) researched the externalities of agricultural activities related to greenhouse gas emissions for Portugal by analyzing data gathered since 1961. They concluded that the evolution of the output levels of livestock and the most representative animal production have significantly increased the level of CO_2 in the country.

Ministerial conferences such as Kyoto Protocol (1997) and Paris Agreement (2015) stimulated

the empirical research on climate change using econometric tools applied on time series or panel data.

According to recent empirical studies, agriculture is responsible for approximately one-third of the greenhouse gas emission in the world. In other words, climate change has become a global concern stimulating the interest of the academic community. Recent articles (Balogh and Jámbor, 2017; Hongdou et al., 2018; and Appiah et al., 2018) demonstrate that agricultural production is directly correlated with climate change. In this context, we present relevant empirical literature investigating the agriculture-specific factors (crop production, livestock production, and agricultural land) on environmental pollution.

In recent years, econometric studies (Shahbaz et al., 2013; Shahbaz et al., 2015; Leitão, 2015; Balogh and Jámbor, 2017; Hongdou et al., 2018; and Appiah et al., 2018) have used energy consumption, renewable energy, income per capita, foreign investment, international trade, and agricultural production as independent variables modelling the determinates of climate change.

Many studies have focused on the assessment of climate change based on the assumptions of the Kuznets environmental curve (Shahbaz et al., 2015; Mahmood et al., 2017; Och, 2017). Another category of studies evaluated the direct impact of agricultural productivity on CO_2 emissions (Mara, 2011; Edoja et al., 2016; Ullah et al., 2018; Sarkodie and Owusu, 2017; Hongdou et al., 2018; and Appiah et al., 2018). Our research follows the second line of studies and applies it to Portugal dioxide emissions.

Different econometric methods have been used to analyze the agricultural activity on climate change on time series (ARDL-Autoregressive Distributed Lag; VAR- Vector Autoregression, the VECM - Vector Error Correction Model, Granger´s causality). In this context, Hongdou et al. (2018) studied the relationship between ecosystem and climate change applied to China for the period 1960–2014. The authors used Granger causality, cointegration, and the Vector error correction model (VECM) as econometric tools for the analysis. The results demonstrated that fertilizes are positively correlated with CO_2 emissions, and crop production (rice and cereal) have a positive impact on climate change.

Sarkodie and Owusu (2017) applied unit root test, linear regression, and Autoregressive Distributed Lag (ARDL) for analyzing the environmental pollution in Ghana. Authors revealed a long-run cointegration between CO_2 emissions and agricultural sectors.

Marques et al. (2018) estimated an ARDL model for meat consumption of 77 countries with different level of economic development controlling for economic growth, sustainable development, and food consumption. The authors concluded that meat consumption has a negative effect on poor economies with significant environmental costs.

The long-run causality between carbon dioxide emissions, agricultural productivity, energy consumption, and land use was researched by Khan et al. (2018) for the Pakistan case between 1981 and 2015. Researchers demonstrated a long-run causality between variables by using the Vector Error Correction Model (VECM). Granger causality revealed a bidirectional causality between agriculture productivity and forest area.

The investigation realized by Waheed et al. (2018) studied the effect of renewable energy, agricultural production, and forest area on CO_2 emissions. The authors applied the ARDL model for the period 1990-2014. The results show that renewable energy and forest area negatively affect CO_2 emissions in the long run, explained by a decrease of CO_2 emissions. On the other hand, conversely agricultural production usually positively influences CO_2 emissions. In addition, Jebli and Youssef (2017) investigated the causal long-run relationship between renewable energy and carbon dioxide emissions as well as the link between agriculture activity and CO_2 emissions for the period 1980–2011. Employing a panel cointegration (OLS, FMOLS, DOLS, and Granger causality test) applied to Algeria, Egypt, Morocco, Sudan, and Tunisia, researchers confirmed bidirectional causality between agricultural activity and CO2 emissions.

Appiah et al. (2018) measured the effect of environmental pollution on climate change using OLS and FMOLS estimators and concluded that energy consumption is negatively correlated with CO_2 emissions. By contrast, crop production, livestock production, population, and income per capita had a positive effect on climate change.

As a rule, environmental models of the Kuznets curve (EKC) or economic growth models, regularly introduce energy consumption as an explanatory variable. In this context, Kais and Mbarek (2015) evaluate the relationship between carbon dioxide emissions, energy consumption and growth for the period 1980–2012

using panel cointegration, FMOLS, and DOLS estimators, Granger causality test, and Vector Error Correction (VECM) to Algeria, Egypt, and Tunisia. Regarding the econometric results, it is possible to infer that CO_2 emissions and energy consumption are cointegrated. Similarly, Kais and Mbarek (2015) demonstrate a unidirectional causality between energy consumption, economic growth and carbon dioxide emissions in the help of VECM.

The research proposed by Tan and Tan (2018) evaluates energy consumption, economic growth and carbon dioxide emissions applied to Malaysia for the period 1980–2014 demonstrates that there is a unidirectional causality between energy consumption and CO_2 emissions when the authors applied Granger causality and VECM. In this line, the study of Acheampong (2018) using a panel vector autoregression and a GMM-system reveals a positive impact of carbon dioxide emissions and energy consumption on economic growth in sub-Saharan Africa. On the one hand, the empirical results also confirm that energy consumption has a negative effect on growth in MENA countries. Moreover, a positive impact of energy consumption was suggested in MENA countries, a negative effect in Sub-Saharan Africa and Caribbean-Latin America on CO_2 emissions.

The paper examines the relationship between climate change and agriculture measured by carbon dioxide emissions (CO_2), crop production index and livestock production index, agricultural land referring to the period 1960–2015 in Portugal. The role of Portuguese energy consumption is also investigated. Following the recent literature (Appiah et al., 2018; Ullah et al., 2017; Sarkodie and Owusu 2017; and Hongdou et al., 2018) we apply time series econometric techniques (Unit Root Test, Autoregressive Distributed Lag – ARDL and Granger causality) for the analysis. Furthermore, we test the existence of the long-run relationship through cointegration between environmental pollution (CO_2 emissions) and Portuguese energy consumption, crop production, livestock production and agricultural land use.

This research aims to contribute to the literature in three ways. First, it presents a literature review of recent empirical studies on climate change. Second, it estimates the short and the long-run relationship between climate change and agricultural activity in Portugal. Finally, it provides policy implication to reduce the impact of agriculture on environmental pollution in Portugal.

The article is designed as follows. Section 2 presents the materials and methods. The econometric results are illustrated in section 3. The final section concludes.

Materials and methods

This research analyzes the Portuguese agricultural factors (crop production, livestock production, and agricultural land), and energy consumption on climate change for the period 1960-2015. The econometric models as Autoregressive Distributed Lag (ARDL) and Granger Causality tests are used in this study. We also employ the ARIMA model and Newey-West Standard Errors regression as a complementary methodology. The time series variables were collected from the World Bank (2018) and the Foodand Agriculture Organization (FAO) data.

The dependent variable is carbon dioxide emissions (CO_2 emissions), representing climate change. The explanatory variables selected in this investigation are energy consumption (EC), crop production index (Crop), livestock production index (Livestock), and agricultural land use (Land).

Based on the recent empirical works (Appiah et al., 2018; Ullah et al., 2018; Hongdou et al., 2018; and Sarkodie and Owusu, 2017) the following function is established in an equation 1:

$$CO_2 = f\,(EC, Crop, Livestock, Land) \quad (1)$$

According to equation 1, we regress the effects of agricultural production quantities on carbon dioxide emissions. Considering the model, we specify an equation 2. All variables are presented in a logarithm form.

$$LnCO_2 = \beta_0 + \beta_1 LnEC + \beta_2 LnCrop + \beta_3 LnLivestock + \beta_4 LnLand + u_t \quad (2)$$

where

CO_2 represents the dependent variable and is measured by carbon dioxide emissions (expressed in kilotons), collected by the World Bank.

The independent variables are the following:

EC - signifies the electric power consumption (kWh per capita), according to the World Bank, the explanation of this variable represents the production of power plants and their transmission. The source of this variable is the World Bank and IEA Statistics.

Crop - denotes crop production index from FAO production index and World Bank.

Livestock - represents the livestock production

index. According to the World Bank, the description of this proxy contains meat, milk, cheese and eggs, raw silk, wool, hides, and skins. The variable is derived from the World Bank and the FAO databases.

Land - Agriculture land, i.e. according to the description of the World Bank is the arable land area, sourced by FAO and World Bank.

u_t - captures the error term.

Based on the empirical literature, we formulate the next hypotheses for Portugal:

H_1: There is bidirectional causality between energy consumption and CO_2 emissions.

According to the literature Ozturk and Acaravci (2011), Kais and Mbarek (2015), Tan and Tan (2018) the variables of energy consumption and carbon dioxide emissions are cointegrated. Balogh and Jámbor (2017) also demonstrate that energy consumption stimulates climate change.

H_2: Agricultural production positively associated with climate change through CO_2 emission in Portugal.

Some empirical studies such as Sarkodie and Owusu (2017), Ullah et al. (2018), Hongdou et al. (2018), Khan et al. (2018) found a positive correlation between agricultural production and climate change. These studies highlight that intensive agricultural land use without sustainable practices encourages climate change. Seeing this argument, we attempt to test whether Portuguese agriculture employs sustainable practices. Table 1 displays description of the independent variables.

	Expected Sign	Source
EC	Positive effect on CO_2	World Bank (2018)
Crop	Positive effect on CO_2	FAO and World Bank (2018)
Livestock	Positive effect on CO_2	FAO and World Bank (2018)
Land	Positive effect on CO_2	FAO and World Bank (2018)

Source: author´s elaboration

Table 1: Description of the independent variables.

The relationship between variables is discovered by Granger causality. Augmented Dickey-Fuller test (ADF) employed to evaluate the stationarity and the adequacy of the variables used in this research. Our study also applies the ARDL model bounds test proposed by Pesaran et al. (2001), Kripfganz and Schneider (2016; 2018) to assess long-run cointegration between factors of CO_2 emission.

Equation (3) presents the ARDL model based on Ozturk and Acaravci (2011), Sarkodie and Owusu (2017), and Matthew et al. (2018):

$$\begin{aligned}\Delta LnCO_2 = {} & \beta_0+\beta_1\Delta LnCO_{2t-1} + \beta_2\Delta LnEC_{t-1} \\ & +\beta_3\Delta LnCrop_{t-1} + \beta_4\Delta LnLivestock_{t-1} \\ & + \beta_5\Delta LnLand_{t-1} + \Sigma^n_{t=1}\beta_1\Delta LnCO_{2t-1} \\ & + \Sigma^n_{t=0}\beta_2\Delta LnEC_{t-1}+\Sigma^n_{t=0}\beta_3\Delta LnCrop_{t-1} \\ & + \Sigma^n_{t=0}\beta_4\Delta LnLivestock_{t-1} + \Sigma^n_{t=0}\beta_5\Delta LnLand_{t-1} \\ & + \gamma ECM_{t-1}+e \end{aligned} \quad (3)$$

In equation 3, all variables are expressed in logarithm form.

Δ represents the change in operator;

ECM_{t-1} denotes the error correction term;

γ illustrates the adjustment of short and long run.

According to the literature, the ARDL model assumes two conditions (Pesaran et al., 2001, Shahbaz et al., 2015, and Matthew et al., 2018):

H_0: $\beta_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5$, no relationship exists in the long-run.

H_1: $\beta_0 \neq \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5$, a long-run relationship exists.

Results and discussion

Results are calculated by STATA software. Table 2 presents the correlation for all variables used in this investigation. The correlation coefficients indicate that independent variables are associated positively with carbon dioxide emissions.

Table 3 reports the unit root test using Augmented Dickey-Fuller (ADF) with trend. Thus, the null hypothesis of the test indicates that variables have unit root (are stationary alternatively). According to the result of unit root tests, all variables are stationary. Moreover, the rejection of hypothesis

	$LnCO_2$	*LnEC*	*LnCrop*	*LnLivestock*	*LnLand*
$LnCO_2$	1.000				
LnEC	0.975	1.000			
LnCrop	0.934	0.846	1.000		
LnLivestock	0.555	0.713	0.262	1.000	
LnLand	0.957	0.875	0.991	0.298	1.000
Observations = 55					

Source: author´s elaboration based on World Bank database (2018).

Table 2: Correlation between variables.

demonstrates that the time series are integrated into this research.

Augmented Dickey-Fuller test	*ADF at Level*	
Variables	Statistic	P-value
LnCO$_2$	-6.356***	0.000
LnEC	-6.287***	0.000
LnCrop	-6.568***	0.000
LnLivestock	-6.271***	0.000
LnLand	-6.540***	0.000

Note: *** Statistically significant at 1%
Source: author´s elaboration based on World Bank database (2018)

Table 3: Unit root test: ADF (Augmented Dickey-Fuller) with the trend.

At the first step, we present the estimates obtained from the ARIMA method (Table 4) and the Newey-West Standard Errors regression (Table 5). The coefficient of energy consumption (*EC)* is statistically significant at 1 % level and have a positive effect on CO_2 emissions (H_1). This result is supported by previous studies of Ozturk and Acaravci (2011), Shahbaz and Leitão (2013), Kais and Mbarek (2015), Tan and Tan (2018) confirm that energy consumption, in particular, fossil energies (non-renewables) increases carbon dioxide emissions and consequently accentuates climate change. Moreover, we can affirm that the results are according to the literature and with the hypothesis formulated.

Variables	*Coef.*
LnEC	1.000*** (0.000)
LnCrop	-0.020 (0.766)
LnLivestock	0.001*(0.064)
LnLand	0.315** (0.021)
C	-0.010* (0.05)
Observations	53
AR	0.604 [0.931]
MA	-0.306 [0.657]
Sigma	0.01 [0.000]
Wald Chi^2(4)	630.25
Prob>Chi^2	0.000
Log Likelihood	132.2685

Note: *** ignificant at 1%, ** at 5 %, and * 10 %
Source: author´s elaboration based on World Bank database (2018)

Table 4: Agricultural Factors and Energy Consumption with ARIMA model.

The coefficients of the livestock production index (*LnLivestock*), along with agricultural land use (*LnLand*) induce a positive impact on carbon dioxide emissions (H_2). These results are in line with Hongdou et al. (2018), Sarkodie and Owusu (2017), and Khan et al. (2018).

The econometric results also allow to infer that serial correlation test (AR) is 0.931, and Sigma (white-noise) is statistically significant. When we apply the Newey-West Standard Errors regression (Table 5), the results are slightly different, but as the previous estimator, energy consumption (*LnEC*), livestock production index (*LnLivestock*), and agricultural land (*LnLand*) follow the same tendency, i.e. proving that these independent variables increase carbon dioxide emissions. Except for the coefficient of crop production index (*LnCrop*) that shows a negative association with CO_2 emissions, in this case, the results obtained are in contrast with the expectations.

Variables	*Coef.*
LnEC	0.405*** (0.000)
LnCrop	-0.348** (0.021)
LnLivestock	0.004*** (0.000)
LnLand	0.802*** (0.000)
C	-0.137*** (0.000)
Observations	55
F(4,50)	174330.96
Prob>F	0.000

Note: *** ignificant at 1%, ** at 5 %,
Source: author´s elaboration based on World Bank database (2018)

Table 5: Agricultural Factors and Energy Consumption with Newey-West Standard Errors regression.

Table 6 presents the results using ARDL model. The estimator permits to consider the short and long-run effects of components. The adjustment coefficient or error correction coefficient [ADJCO2(-1)] demonstrates that there is a long-run relationship between variables. The lagged variable of CO_2 emissions is statistically significant at 1% level. In the long run, the coefficient of carbon dioxide emissions presents a negative sign, showing that CO_2 emissions decrease over time in Portugal. Sarkodie and Owusu (2017), Hongdou et al. (2018), and Kais and Mbarek (2017) also found a negative tendency of CO2 emissions. The empirical studies highlight the importance of dynamic models, allowing us to confront the short and long-run effects. A dynamic analysis indicates that carbon dioxide emissions tend to decline in the long run. We observe that countries are increasingly aware of the importance of reducing carbon dioxide emissions and polluting activities.

The estimated coefficients of energy consumption (*LnEC*), livestock production (*LnLivestock*), and agricultural land (*LnLand*) present a positive impact on CO_2 emissions in the long run (LR). The coefficients of livestock production (*LnLivestock*), and agricultural land (*LnLand*)

are statistically significant at 1% level. Hongdou et al. (2018), Beşer and Beşer (2017), Sarkodie and Owusu (2017) support our results showing that animal husbandry and agricultural production stimulate climate change and greenhouse effects.

Variables	*Coef.*
ADJCO2 (-1)	-0.533*** (0.000)
Long Run (LR)	
LnEC	0.266* (0.061)
LnCrop	-0.548*** (0.000)
LnLivestock	0.008*** (0.000)
LnLand	3.946*** (0.000)
Short Run (SR)	
ECD1	1.315*** (0.000)
LD	0.801** (0.021)
L2D	0.273(0.342)
L3D	0.928*** (0.004)
$LnCropD_1$	0.212*(0.090)
LD	0.178**(0.020)
LnLivestock	-0.003** (0.023)
LD	-0.001 (0.359)
L2D	-0.002** (0.039)
L3D	-0.002* (0.078)
$LnLandCD_1$	-1.175* (0.067)
LD	-1.322* (0.047)
L2D	-0.142 (0.373)
L3D	-0.514*** (0.004)
C	-7.551*** (0.003)
Adj. R^2	0.612

Note: *** ignificant at 1%, ** at 5 %, and * 10 %, and * 10 %
LD represenbts Lag
Source: author´s elaboration based on World Bank database (2018)

Table 6: Agricultural Factors and Energy Consumption with Autoregressive and Distributed Lag (ARDL) model.

In the long run, the variable of crop production index is statistically significant at 1% level with a negative effect on CO_2 emissions. However, in short-run (SR), the crop production index (*LnCrop*) indicates a positive impact on CO_2 emissions, this result was supported by previous studies such as Ullah et al. (2018), Appiah et al. (2018), Sarkodie and Owusu (2017). Furthermore, the crop production index appears to increase carbon dioxide emissions thus contributing to climate change. By contrast, in the long run, it might reduce CO_2 emissions.

In the short run, livestock production index, and agricultural land variables indicate a negative effect on carbon dioxide emissions. The energy consumption (*LnEC*) has a positive association with CO_2 emissions in the short and long-run as well, confirming H_1 and showing that fossil energy use stimulates climate change as suggested by Kais and Mbarek (2017), Beşer and Beşer (2017), and Leitão (2015).

Table 7 allows evaluating the long-run cointegration between the variables used in this research. We apply the ARDL bounds test established by Persaran and Shin (1999), Kripfganz and Schneider (2016, 2018). Considering the results, we can infer that the variables are cointegrated in long-run, i.e., there is a relationship (a common trend) between dependent and explanatory variables. We can also complement this information with Table 8, where the stability of the model is evaluated.

Table 8 shows the diagnostic of ARDL model. According to the results, the model is stable, i.e., no serial correlation based on the statistics of Durbin-Watson (2.073) and Breusch-Godfrey Lagrange Multiplayer (LM) test (0.595). The White test (0.431) points out that the assumption of homoscedasticity can be accepted.

Pesaran, Shin, and Smith (2001) bounds test								
F = 4.153 t = -4.278								
sample (4 variables, 47 observations, 14 short-run coefficients)								
Kripfganz and Schneider (2018) critical values and approximate p-values								
	10%		5%		1%		p-value	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F	2.501	3.909	3.041	4.651	4.328	6.407	0.012	0.080
T	-2.435	-3.541	-2.802	-3.970	-3.547	-4.835	0.002	0.029

Source: author´s elaboration based on World Bank database (2018)

Table 7: Agricultural Factors and Energy Consumption with ARDL: bounds test.

Durbin-Watson d-statistic
(20, 47) = 2.073539
Breusch-Godfrey LM test for autocorrelation [H0: no serial correlation]
Prob > chi^2 = 0.5955
White's test for Ho: homoscedasticity
chi^2(46) = 47.00
Prob > chi^2 = 0.4313

Source: author´s elaboration based on World Bank database (2018)

Table 8: Diagnostic of ARDL model.

Table 9 shows the results of the Granger causality. There is bidirectional causality between carbon dioxide emissions (CO_2) and crop production index (Crop). The results confirm that crop production causes climate change in accordance with the previous studies of Appiah et al. (2018), Hongdou et al. (2018), Ullah et al. (2017), and Sarkodie and Owusu (2017. In this context, Appiah et al. (2018) using the Pooled Mean Group (PMG) causality estimator revealed a positive relationship between crop production and carbon dioxide emissions. Moreover, Hongdou et al. (2018:24497) found a positive value (2.439) while Sarkodie and Owusu (2017:199) also suggested a positive association (5.8990) with climate change.

There is a unidirectional causality between CO_2 emissions and livestock production index and it holds for agricultural land. Consequently, land use change (such as deforestation, soil erosion, arable land) without paying special attention to the concept of sustainable development, i.e., intensive fertilizer uses, and machine-intensive farming significantly stimulates carbon dioxide emissions.

We also observe that there is a unidirectional causality between energy consumption (*EC*), crop production index (*Crop*), and agricultural land (*Land*). In conclusion, agricultural land has a unidirectional causality with crop production index indicating that crop production needs more agricultural land area. Finally, the livestock production induces a unidirectional causality with agricultural land suggesting the significant role of animal farming and land intensive meat production through CO_2 emission on climate change.

Null Hypothesis	Chi^2	Df	Prob > chi^2
$LnCO_2$ does not Granger Cause LnEC	10.837***	2	0.004
LnEC does not Granger Cause $LnCO_2$	3.6552	2	0.161
$LnCO_2$ does not Granger Cause LnCrop	8.2834**	2	0.016
LnCrop does not Granger Cause $LnCO_2$	6.0277**	2	0.049
$LnCO_2$ does not Granger Cause LnLivestock	14.867***	2	0.001
LnLivestock does not Granger Cause $LnCO_2$	0.404	2	0.817
$LnCO_2$ does not Granger Cause LnLand	133.46***	2	0.000
LnLand does not Granger Cause $LnCO_2$	0.833	2	0.659
LnEC does not Granger Cause LnCrop	6.3557**	2	0.042
LnCrop does not Granger Cause LnEC	0.784	2	0.676
LnEC does not Granger Cause LnLivestock	1.6207	2	0.445
LnLivestock does not Granger Cause LnEC	1.652	2	0.438
LnEC does not Granger Cause LnLand	314.05***	2	0.000
LnLand does not Granger Cause LnEC	3.1875	2	0.203
LnCrop does not Granger Cause LnLivestock	3.699	2	0.157
LnLivestock does not Granger Cause LnCrop	0.244	2	0.885
LnCrop does not Granger Cause LnLand	2.3267	2	0.312
LnLand does not Granger Cause LnCrop	23.393***	2	0.000
LnLivestock does not Granger Cause LnLand	56.102***	2	0.000
LnLand does not Granger Cause LnLivestock	2.7939	2	0.247

Note: *** ignificant at 1%, ** at 5 %, and * 10 %, and * 10 %

Source: author´s elaboration based on World Bank database (2018)

Table 9: Agricultural Factors and Energy Consumption with Granger Causality.

Table 10 exhibits the Johansen cointegration test using the criteria of trace methods. Based on the test, the hypothesis of no cointegration is rejected (rejection of the hypothesis at 0.05 % level).

	Trace	0.05	
Eigenvalue	Statistic	Critical Value	Prob.**
0.458575	81.72113	69.81889	0.0042
0.323034	49.20290	47.85613	0.0371
0.301677	28.52577	29.79707	0.0695
0.145174	9.494848	15.49471	0.3216
0.022044	1.181417	3.841466	0.2771

Note: Trace test indicates 2 cointegration equations at 0.05 level.
Source: author´s elaboration based on World Bank database (2018)

Table 10: Johansen cointegration test (Trace methods).

Conclusion

The article investigated the short and the long-run relationships between Portuguese carbon dioxide emissions and agricultural activity, energy consumption, using ARDL, ARIMA model, Newey-West regression and Granger causality for the period of 1960-2015.

The Augmented Dickey-Fuller (ADF) unit root test demonstrated that the variables used in this investigation are stationary. Employing the ARDL model, the lagged variable of CO_2 (adjustment coefficient) presented a negative sign with statistically significance, i.e., in the long-run, we observed that carbon dioxide emissions decreased in Portugal in line with previous studies (Sarkodie and Owusu 2017; Hongdou et al., 2018; and Kais and Mbarek, 2017). The agricultural activity measured by three variables (crop production index, livestock production index, and agricultural land use) revealed a long-run causal relation with CO_2, i.e., agricultural activity significantly affects climate change in Portugal. Waheed et al. (2018), Jebli and Youssef (2017), and Appiah et al. (2018) also confirmed a positive association between these variables.

Furthermore, our results indicate that energy consumption had a positive impact on Portuguese CO_2 emissions when we apply the ARDL model in the short and long-run supporting the result of Kais and Mbarek (2015), Tan and Tan (2018). Moreover, the econometric results verified with Newey-West regression offers some similarities with the autoregressive distributed lag model. Thus, energy consumption has a positive correlation with carbon dioxide emissions.

The findings of the research allow evaluating the different agricultural sectors and the impacts of energy efficiency on climate change measured by carbon dioxide emissions. The results suggest that increasing agricultural production and energy efficiency associated with economic growth but it does increase carbon dioxide emissions too. Since these factors stimulate global warming, environmental degradation and pose a risk for human health, it emphasizes the importance of the topic in the economics literature.

In line with international empirical literature such as Edoja et al. (2016), Sarkodie, and Owusu, (2017), the data published by the EPA (2018) and Eurostat (2018), we attempt to provide some policy recommendations for Portugal. The Portuguese agriculture needs to take measures to achieve a higher level of sustainable development, intending to reduce the effect of animal husbandry and intensive crop production practice to diminish CO_2 emission. Although organic farming has higher production costs, it is an alternative way to encourage sustainable agricultural practices by reducing environmental pollution in agriculture. Furthermore, substituting beef meat with another livestock sector (e.g. pork or poultry) possibly will reduce the effects of agriculture on climate change (Desjardins et al., 2014). Besides, we also suggest changes in agricultural practices e.g. the reduction of pesticides and fertilizers with special attention to ammonia levels as reported by EPA (2018), Eurostat (2018).

Regarding the directions for future research, it seems interesting to extend the study to the Euro-Mediterranean countries. Moreover, we suppose that it will be exciting to test this group of countries with static and dynamic panel methods.

Corresponding authors
Jeremiás Máté Balogh, PhD, assistant professor
Corvinus University of Budapest, 8 Fővám tér, 1093 Budapest, Hungary
Phone: +36 30 318-6332, E-mail: jeremias.balogh@uni-corvinus.hu
ORCID:0000-0001-9081-0071

References

[1] Acheampong, A., O. (2018) "Economic growth, CO_2 emissions and energy consumption: What causes what and where?", *Energy Economics*, Vol. 74, pp. 677-692. ISSN 0140-9883. DOI 10.1016/j.eneco.2018.07.022.

[2] Appiah, K., Du, J. and Poku, J. (2018) "Causal relationship between agricultural production and carbon dioxide emissions in selected emerging economies", *Environmental Science and Pollution Research*, Vol. 25, pp. 24764-24777. E-ISSN 1614-7499, ISSN 0944-1344. DOI 10.1007/s11356-018-2523-z.

[3] Balogh, J. M. and Jambor, A. (2017) "Determinants of CO_2 emission: A global evidence", *International Journal of Energy Economics and Policy*, Vol. 75, No. 5, pp. 217-226. ISSN 2146-4553

[4] Beşer, M. K. and Beşer, B. H. (2017) "The relationship between energy consumption, CO_2 emissions and GDP per capita: A revisit of evidence from Turkey", *The Journal of Operations Research, Statistics, Econometrics and Management Information Systems*, Vol. 5, No 3, pp. 353-367. E-ISSN 2148-2225. DOI 10.17093/alphanumeric.353957.

[5] Desjardins, R. L., Worth, D. E., Vergé, X. P. C., VanderZaag, A., Janzen, H., Kroebel, R. and Dyer, J. A. (2014) "*Carbon Footprint of Agricultural Products - A Measure of the Impact of Agricultural Production on Climate Change*", Agriculture and agro-food Canada [Online]. Available: http://www.wamis.org/agm/meetings/teco14/S5-Desjardins.pdf [Accessed: 10 Feb, 2019].

[6] Edoja, P. E., Aye, G. C. and Abu, O. (2016) "Dynamic relationship among CO_2 emission, agricultural productivity and food security in Nigeria", *Cogent Economics and Finance*, Vol. 4, pp. 1-13. E-ISSN 2332-2039. DOI 10.1080/23322039.2016.1204809.

[7] Eurostat (2018) "*European Union's Agriculture, Greenhouse gas emission statistics*" [Online]. Available: https://ec.europa.eu/eurostat/statistics-explained/index.php/Archive:Agriculture_-_greenhouse_gas_emission_statistics [Accessed: 15 Jan, 2019].

[8] EPA (2018) "United States Environmental Protection Agency. Greenhouse gas emission data". [Online]. Available: https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data [Accessed: 18 Jan. 2019].

[9] Food and Agriculture Organization (FAO) Data [Online]. Available: http://www.fao.org/faostat/en/#home [Accessed: 18 Jan, 2019].

[10] Hongdou, L., Shiping, L. and Hao, L. (2018) "Existing agricultural ecosystem in China leads to environmental pollution: an econometric approach", *Environmental Science and Pollution Research*, Vol. 25, pp. 24488–24499. E-ISSN 1614-7499, ISSN 0944-1344. DOI 10.1007/s11356-018-2461-9.

[11] Jebli, M., B. and Youssef, S. B. (2017) "The role of renewable energy and agriculture in reducing CO_2 emissions: Evidence for North Africa countries", *Ecological Indicators*, Vol. 74, pp. 295-301. ISSN 1470-160X. DOI 10.1016/j.ecolind.2016.11.032.

[12] Kais, S. and Mbarek, M. B. (2017) "Dynamic relationship between CO_2 emissions, energy consumption and economic growth in three North African countries", *International Journal of Sustainable Energy*, Vol. 36, No. 9, pp. 840-854. E-ISSN 1478-646X. ISSN 1478-645. DOI 10.1080/14786451.2015.1102910.

[13] Khan, M. T. I., Ali, Q. and Ashfaq, M. (2018) "The nexus between greenhouse gas emission, electricity production, renewable energy and agriculture in Pakistan," *Renewable Energy*, Vol. 118, pp. 437-451. ISSN 0960-1481. DOI 10.1016/j.renene.2017.11.043.

[14] Kripfganz, S. and Schneider, D. C. (2018) "*Response surface regressions for critical value bounds and approximate p-values in equilibrium correction models*", Manuscript, University of Exeter and Max Planck Institute for Demographic Research. [Online]. Available: www.kripfganz.de/research/Kripfganz_Schneider_ec.html [Accessed: 8 Feb, 2019].

[15] Kripfganz, S. and Schneider, D. C. (2016) "Ardl: Stata module to estimate autoregressive distributed lag models", Presented July 29, 2016, at the Stata Conference, Chicago [Online]. Available: Available: fmwww.bc.edu/repec/chic2016/chicago16_kripfganz.pdf [Accessed: 8 Feb, 2019].

[16] Leitão, N. C. (2015) "Energy Consumption and Foreign Direct Investment: A Panel Data Analysis for Portugal", *International Journal of Energy Economics and Policy*, Vol. 5, No. 1, pp. 138-147. ISSN 2146-4553.

[17] Mara, F. P. O. (2011) "The significance of livestock as a contributor to global greenhouse gas emissions today and in the near future", *Animal Feed Science and Technology*, Vol. 166-167, pp. 7-15. ISSN 0377-8401. DOI 10.1016/j.anifeedsci.2011.04.074.

[18] Marques, A. C., Fuinhas, J. A. and Pais, D. F. (2018) "Economic growth, sustainable development and food consumption: Evidence across different income groups of countries", *Journal of Cleaner Production*, Vol. 196, pp. 245-258. ISSN 0959-6526. DOI 10.1016/j.jclepro.2018.06.011.

[19] Mahmood, H. and Alkhateeb, T. T. Y. (2017) "Trade and Environment Nexus in Saudi Arabia: An Environmental Kuznets Curve Hypothesis", *International Journal of Energy Economics and Policy*, Vol. 7, No. 5, pp. 291-295. ISSN 2146-4553.

[20] Matthew O., Osabohien, R., Fasina, F. and Fasina, A. (2018) "Greenhouse Gas Emissions and Health Outcomes in Nigeria: Empirical Insight from ARDL Technique", *International Journal of Energy Economics and Policy*, Vol. 8, No. 3, pp. 43-50. ISSN 2146-4553.

[21] Mourão, P. R. and Domingues Martinho, V. (2017) "Portuguese agriculture and the evolution of greenhouse gas emissions - can vegetables control livestock emissions?", *Environmental Science and Pollution Research*, Vol. 24, No. 19, pp. 16107–16119. E-ISSN 1614-7499, ISSN 0944-1344. DOI 10.1007/s11356-017-9257-1.

[22] Och, M. (2017) "Empirical Investigation of the Environmental Kuznets Curve Hypothesis for Nitrous Oxide Emissions for Mongolia", *International Journal of Energy Economics and Policy*, Vol. 7, No. 1, pp. 117-128. ISSN 2146-4553.

[23] Ozturk, I. and Acaravci, A. (2011) "Electricity Consumption and real GDP Causality Nexus: Evidence from ARDL Bounds Testing Approach for 11 MENA Countries", *Applied Energy*, Vol. 88, No. 8, pp. 2885-2892. ISSN 0306-2619. DOI 10.1016/j.apenergy.2011.01.065.

[24] Pesaran, M. H., Shin, Y. and Smith, R. J. (2001) "Bounds testing approaches to the analysis of level relationships", *Journal of Applied Econometrics*, Vol. 16, pp. 289-326. ISSN 1099-1255. DOI 10.1002/jae.616.

[25] Pesaran, M. H. and Shin, Y. (1999) "An autoregressive distributed lag modeling approach to cointegration analysis", In: Strom, S. (editor) "*Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium*". Ch. 11. Cambridge: Cambridge University Press. E-ISBN 9781139052221.

[26] PIA (2013) "Portuguese Environmental Agency Portuguese National Invert Report on Greenhouse Gases 1990–2011", Submitted under the United Nations Frame- work convention on Climate change and the Kyoto.

[27] Ritchie, H. (2017) "*How much of the world's land would we need in order to feed the global population with the average diet of a given country? Our World in Data*". October 3, 2017 [Online]. Available: https://ourworldindata.org/agricultural-land-by-global-diets [Accessed: 20 Jan. 2019].

[28] Shahbaz, M., Dube, S., Ozturk, I. and Jali, A. (2015) "Testing the environmental Kuznets curve hypothesis in Portugal", *International Journal of Energy Economics and Policy,* Vol. 5, No. 2, pp. 475- 481. ISSN 2146-4553.

[29] Shahbaz, M., Hye, A. M. Q, Tiwari, A. K. and Leitão, N. C. (2013) "Economic growth, energy consumption, financial development, international trade and CO_2 emissions in Indonesia", *Renewable and Sustainable Energy Reviews*, Vol. 25, pp. 109-121. ISSN 1364-0321. DOI 10.1016/j.rser.2013.04.009.

[30] Shahbaz, M. and Leitão, N. C. (2013) "Portuguese carbon dioxide emissions and economic growth: A time series analysis", *Bulletin of Energy Economics*, Vol. 1, No. 1, pp. 1-7.

[31] Sarkodie, S. A. and Owusu, P. A. (2017) "The relationship between carbon dioxide, crop and food production index in Ghana: By estimating the long-run elasticities and variance decomposition", *Environmental Engineering Research*, Vol. 22, No. 2, pp. 193-202. E-ISSN 2005-968X, ISSN 1226-1025. DOI 10.4491/eer.2016.135.

[32] Statista (2018) "Carbon Dioxide emissions in Portugal from 2000-2017 (in million metric tons of CO_2)". [Online]. Available: https://www.statista.com/statistics/449812/co2-emissions-portugal/ [Accessed: 15 Jan. 2019].

[33] Tan, C. C. and Tan, S. (2018) "Energy Consumption, CO_2 Emissions and Economic Growth: A Causality Analysis for Malaysian Industrial Sector", *International Journal of Energy Economics and Policy*, Vol. 8, No. 4, pp. 254-258. ISSN 2146-4553.

[34] Torres, P., Ferreira, J. Monteiro, A., Costa, S., Pereira, M. C., Madureira, J., Mendes, A. and Teixeira, J. P. (2018) "Air pollution: A public health approach for Portugal", S*cience of The Total Environment*, Vol. 643, pp. 1041-1053. ISSN 0048-9697. DOI 10.1016/j.scitotenv.2018.06.281.

[35] Ullah, A., Khan, D., Khan I. and Zheng, S. (2018) "Does agricultural ecosystem cause environmental pollution in Pakistan? Promise and menace", *Environmental Science and Pollution Research,* Vol. 25, No. 2, pp. 1-18. E-ISSN 1614-7499, ISSN 0944-1344. DOI 10.1007/s11356-018-1530-4.

[36] Waheed R., Chang, D., Sarwar, S. and Chen, W. (2018) "Forest, agriculture, renewable energy, and CO_2 emission", *Journal of Cleaner Production*, Vol. 172, pp. 4231-4238. DOI 10.1016/j.jclepro.2017.10.287.

[37] World Bank (2018) "*World Development Indicators' data".* [Online]. Available: http://datatopics.worldbank.org/world-development-indicators/ [Accessed: 20 Feb. 2019].

Agris on-line Papers in Economics and Informatics

Volume XII Number 1, 2020

Does Agricultural Trade Competitiveness Matter? The Case of the CIS Countries

Tamás Mizik, Péter Gál, Áron Török

Corvinus University of Budapest, Hungary

Abstract

The paper aims to analyse the comparative advantage patterns of agriculture in the Commonwealth of Independent States. It is relatively understudied in the literature, especially in Central Asia. Agriculture still plays an important role in the region but in a different way than before. Despite that, the majority of the CIS countries are net food importers. Based on the revealed comparative advantage (RCA) index, country-level analysis shows that Moldova, Kyrgyzstan and Armenia have the highest Balassa indices in the region, and Belarus, Ukraine and Azerbaijan are also having some comparative advantage. Product level analysis pointed out that the region's major agricultural export products groups are cereals. It is important to emphasise that the top five product groups have high, between 3.0-4.4, RCA values. It implies that the regional trade structure is consistent with comparative advantages. However, stability and duration tests show that these are not persistent, since survival chances fell appreciably from 2000-2003 to 2012-2015.

Keywords

CIS, agri-food trade, trade structure, revealed comparative advantages.

Mizik, T., Gál, P. and Török, Á. (2020) "Does Agricultural Trade Competitiveness Matter? The Case of the CIS Countries", *AGRIS on-line Papers in Economics and Informatics*, Vol. 12, No. 1, pp. 61-72. ISSN 1804-1930. DOI 10.7160/aol.2020.120106.

Introduction

The Commonwealth of Independent States (CIS) was established after the collapse of the Soviet Union. The transition from centrally planned to market economies has caused and is still causing difficulties. Agricultural production and trade have been among the most important areas affected by policy changes (Lerman et al, 2004; Csaki and Forgacs, 2008). As agriculture in these countries is still an important sector in many ways, such as agricultural value added or employment, the in-depth analysis of the sector is justified by itself. There is a lack of comprehensive analysis of CIS countries agriculture in the related literature (Kožar et al, 2016).

The time horizon of the analysis covers 16 years, from 2000 to 2015. Right before that, fundamental changes took place and the former Soviet countries faced severe distortions caused by market transition and privatisation (Buchenrieder et al., 2009). From 2000, economic growth has been accelerated, mostly driven by the energy sector, therefore agriculture became relatively less and less important in the Central Asian countries (Mogilevskii and Akramov, 2014). According to Ahrend (2004), it is particularly true for Russia between 1997-2003, where revealed comparative advantage was limited to some raw materials and energy-based products. It is the same for Kazakhstan, where only low value added raw materials showed comparative advantage, and agricultural and food industrial products showed weakening competitive position (Madiyarova et al., 2018). However, this sector still plays an important role in the CIS countries compared to the developed world. For example, in the analysed period, the share of agriculture in the gross domestic product (GDP) decreased from 5.8% to 5.1% in Russia or from 14.5% to 12.1% in Ukraine, but it was only 1.1% in the USA and decreased from 2.5% to 1.4% in the EU (World Bank WDI, 2019). It is worth mentioning that Russia and Ukraine have been able to restructure their agricultural trade flows to new markets by 2001, while other CIS countries mainly traded amongst themselves (Freinkman et al., 2004). It is important to distinguish between CIS and non-CIS countries as the ideal skills are different in the CIS: such as the importance of personal relationships, Russian fluency or lack

of need to meet international standards (Gorton and White, 2009).

Several studies using different types of Balassa-type indices can be found at country level. One of the OECD's (Organisation for Economic Co-operation and Development) book analysed agricultural comparative advantage at the country level (Liapis, 2011). Among the CIS countries only Kazakhstan and Ukraine had agricultural comparative advantage in 1997 on the aggregated agricultural level. However, this list was even shortened to Ukraine in 2007. Liefert (2002) concluded that Russian agricultural output has comparative disadvantage compared to agricultural input in 1996-1997. He used domestic resource cost (DRC) and social cost-benefit ratio (SCB). Cimpoies (2013) used the Balassa index and found relative trade advantage for Moldova between 2007 and 2011 and 10 positive values out of the 24 agri-food products. The results indicated that Moldova has some advantage in diary, vegetable, tobacco and beverages production. On the other hand, values decreased dramatically for sugar or oilseeds due to old technologies, low quality and inefficiency. Karasova (2016) calculated cluster comparative advantage for different Ukrainian products and cereals and oilseed (mainly sunflower) were found to be highly competitive in 2014. Ishchukova and Smutka (2013) have obtained high and stable Balassa values for Russia in cereals (around 4), oilseeds (almost 3) and tobacco (around 2) sector between 1998 and 2010. It is worth mentioning that regional values showed huge differences, far lower RCA values for the same product in the European Union (EU) than in CIS. One reason is geographical location, because transport cost per unit is higher for these bulk products. In terms of primary and processed products, the former ones resulted in slightly higher values (e.g., 1.2 compared to 0.9 in 2010). These results are in line with Zhemoyda and Gerasymenko (2009). They also obtained higher Russian and Ukrainian revealed comparative advantages for raw materials between 2000 and 2004. Benesova et al. used RCA, RC (revealed competitiveness) and Lafay index to analyse the Russian agricultural trade between 2000 and 2014 (Benesova et al., 2017). Raw materials, especially cereals due to the great soil abundance, showed higher RCA values as well as promising future opportunities. Ainur and Diana found decreasing Kazakh agri-food performance based on Lafay index between 2001 and 2012 (Amirbekova and Madiyarova, 2015). Khabiti (2008) obtained the same results by using RCA for 1999-2006. Mostly energy and some manufactured goods were competitive. The trade structure of the country was in line with these results, since these products were exported while uncompetitive agricultural goods were imported.

Wijnands et al. (2015) carried out a comprehensive study on the competitiveness of CIS and EU agri-food chains and found low competitiveness in almost all CIS food sectors by using EU's major food producers as a benchmark. Based on relative net trade advantage (RTA), the analysed CIS countries showed high values for raw materials, especially for pork and poultry (Russia, Kazakhstan), cereals and oilseeds (Ukraine), potatoes (Ukraine and Belarus) and tomatoes (Belarus in 2013. Regarding processed products, again Ukraine performed the best (strong values for processed products out of cereals, oilseeds) followed by Belarus (above-average values for pork, potatoes and tomatoes based processed products). The overall conclusion of the study was that the major factor behind the competitiveness of CIS agri-food sector was low prices due to cheap resource endowments. It was strengthened by Maryam at al. (2018) results, where natural resource-based Russian products had a comparative advantage. Maslova et al. (2019) used an integrated indicator, including export price and export share to measure the trade performance of the Eurasian Economic Union (Armenia, Belarus, Kazakhstan, Kyrgyzstan, and Russia). According to their result, the Kazakh and Russian grain production proved to be competitive due to the low domestic prices and production growth.

As a conclusion to the introduction, the major characteristics of the literature review are summarised in Table 1.

The paper focuses on the international trade patterns of the CIS countries in 2000-2015. The analysed economies are Armenia, Azerbaijan, Belarus, Kazakhstan, Kirgizstan, Moldova, Russia and Ukraine[1], while Uzbekistan, Tajikistan and Turkmenistan are excluded due to lack of appropriate data. The paper is structured as follows. First, the description of methods and data used is presented, followed by the main characteristics of CIS agriculture and trade. The third part of the paper analyses the comparative advantages of CIS agricultural trade together with their stability and duration. The final part concludes.

[1] It should be noted that Ukraine has never had full CIS membership.

Author	Time horizon	Analysed country	Research tool	Comparative advantage
Ahrend (2006)	1997-2003	Russia	RCA	Yes, for raw materials and energy-based products
Ainur and Diana (2015)	2001-2012	Kazakhstan	Lafay index	Yes, for some sectors, but decreasing
Benesova et al. (2017)	2000-2014	Russia	RCA, RC and Lafay index	Yes, for raw materials, especially cereals
Cimpoies (2013)	2007-2011	Moldova	RCA	Yes, 10 out of 24 agri-food products
Ishchukova and Smutka (2013)	1998-2010	CIS	RCA	Yes, for bulk products and higher for raw materials
Karasova (2016)	2014	Ukraine	Cluster comparative advantage	Yes, especially for cereals and oilseeds
Khabiti (2008)	1999-2006	Kazakhstan	RCA	Yes, mainly for energy and manufactured goods, but decrasing
Liefert (2002)	1996-1997	Russia	DRC, SCB	Yes, for the input not the output
Liapis (2011)	1997 and 2007	OECD	RCA	Yes, but only for Ukraine
Madiyarova et al., 2018	2001-2016	Kazakhstan	RCA	Yes, only for raw materials
Maryam at al. (2018)	2015	BRICS	RCA	Yes, for natural resource-based Russian products
Maslova et al. (2019)	2012-2016	EAEU	Integrated indicator	Yes, for Kazakh and Russian grain
Wijnands et al. (2015)	2013	CIS	RTA	Yes, but mostly for raw materials and for only Ukrainian processed products
Zhemoyda and Gerasymenko (2009)	2000-2004	Russia and Ukraine	RCA	Yes, for raw materials

Source: Authors' elaboration

Table 1: Summary of the studies on the regional agricultural comparative advantage.

Materials and methods

The paper employs the seminal work of Balassa (1965). Balassa's measurement of revealed comparative trade advantage is based on the concept of Ricardian trade theory. The original index of revealed comparative advantage defined as follows (Balassa, 1965):

$$B_{ij} = RCA_{ij} = \left(\frac{X_{ij}}{X_{it}}\right) \Big/ \left(\frac{X_{nj}}{X_{nt}}\right),$$

where X means exports, i indicates a given country, j is a given product, t is a group of products and n is a group of countries. It follows that revealed comparative advantage (or disadvantage) can be calculated by comparing a given country's export share of its total exports with the export share in total exports of a reference group of countries. Normally "world" is the reference group. If the B index is higher than 1, the given country has a comparative advantage compared to the reference countries or, in contrast, a revealed comparative disadvantage if B is less than 1. RCA is an outstanding tool of descriptive trade statistics and can help to avoid misinterpretation of sectoral or country-level results (Deardorff, 2011).

The Balassa-index is criticised because it usually neglects the different effects of agricultural policies and exhibits asymmetric values. Trade structure is distorted by different state interventions and trade limitations. That is the reason why RCA calculation is based on exports data where this impact is smaller compared to the imports (Bojnec, 2001). The relatively long time series also helps to lower this possible distortion. Moreover, due to the asymmetric value of the B index, it extends from 1 to infinity if a country enjoys a comparative advantage, but in the case of comparative disadvantage, it varies between 0 and 1, which overestimates a sector's relative weight. Therefore, there are many other specifications of the RCA index available, but they are highly correlated (Jámbor and Babu, 2016). All in all, it can be a useful analytical tool in the detection of comparative advantages and predicting its dynamics in a changing environment, such as market changes (Hoang and Tran, 2019).

The stability and durability of the RCA index are also checked in two steps. First, Markov transition probability matrices are calculated and then summarized by using the mobility index, evaluating the mobility across countries and time. Second, following Bojnec and Fertő (2008), a survival function S(t) is estimated by using the non-parametric Kaplan–Meier product limit estimator, which pertains to the product level distribution analysis of the RSCA index. Following

Bojnec and Fertő (2008), a sample contains n independent observations (t_i; c_i), where $i = 1 \rightarrow n$, and t_i is the survival time, c_i is the censoring indicator variable with a value of 1 if a failure occurred, e.g., there is no longer a comparative advantage, and 0 otherwise. It is assumed that there are fewer failures than the number of data ($m < n$). Then, we denote the rank-ordered survival times as $t(1) < t(2) < \ldots < t(m)$. Let n_j indicate the risk of failure and let d_j denote the number of observed failures at t_j time. The Kaplan–Meier estimator of the survival function is then (with the convention that $\hat{S}(t) = 1$ if $t < t(1)$):

$$\hat{S}(t) = \prod_{t(i)<t} \frac{n_j - d_j}{n_j}.$$

First, we estimate a single survival function by pooling across all products and years and then we also present results by country. Survival of export relationships is also a precondition for trade deepening and export growth, as suggested by Besedes and Prusa (2011), who also give an excellent review on the mathematical specifications of the survival tests. An even more detailed description of survival tests can be found in the book of Cleves et al. (2004) who also use Stata as the authors of this article to make the necessary calculations. As evident from their works, survival tests have a number of assumptions such as the lack of independence or censored values. Moreover, these works also well describe the way Wilcoxon and log-rank tests are run and specified.

The paper employs CIS agricultural trade data of the World Bank World Integrated Trade Solution (WITS) database at HS-6 level between 2000 and 2015 on agricultural products (chapters 1-24, see Annex 1. in the Appendix for the name of the product categories) ending up in 38,770 observations. The paper concentrates on the export side of the revealed comparative advantage index (B or RCA index) to exclude imports, which is more likely to be influenced by agricultural policy interventions.

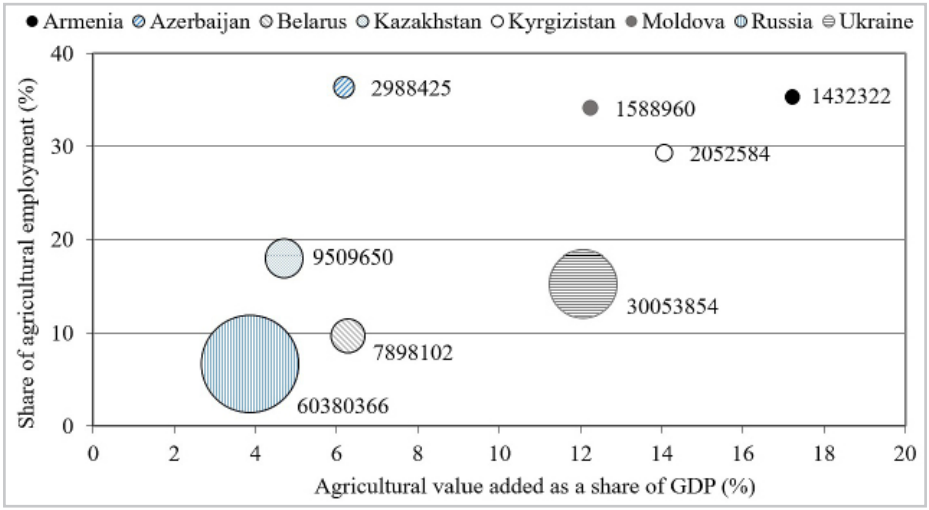
Results and discussion

CIS agriculture and trade

The fundamental production factor of the sector is agricultural land. Its highest share can be found in Kazakhstan (80%), Moldova (75%) and Ukraine (72%), out of which arable land is dominant in Ukraine (79%), Moldova (74%) and Belarus (66%) based on FAO (2019). In order to measure the relevance of agriculture, three indicators were used: value added as a share of GDP (%), the share of agricultural employment (%) and the size of agricultural production (million international dollar[2]). The following diagram summarises these indicators (Figure 1).

It is evident from the Figure 1 that agriculture

[2] International dollar is a theoretical currency used by FAO, World Bank, IMF or UN. It combines the exchange rate, purchasing power parity and international average prices of commodities. It shows the purchasing power that the US dollar had in the United States in the given year. Therefore, it is better for comparisons, but cannot be directly converted to other currencies simply by using exchange rates.



Note: The size of the circles reflects to the size of agricultural production measured in thousand international dollars. The middle of the circle shows x (agricultural value added as a share of GDP) and y (share of agricultural employment) values.
Source: Authors' composition based on World Bank WDI (2019) database and FAO (2019) database

Figure 1: Agricultural value added, agricultural employment and size of agricultural production in the CIS, 2015

plays an important role in the CIS region. This is especially true for Armenia where it is reflected in the high share of agricultural value added in GDP as well as the high share of employment (17.2% and 35.3% respectively). At the other end, Russian agriculture represents only 3.8% of GDP and 7.0% of employment. The case of Azerbaijan should also be highlighted here, where agriculture is a significant employer with 36.4% share, though it contributes to the national GDP only by 6.2%, implying serious labour efficiency problems. The share of agricultural employment was only 4.5% and 1.7% in the EU and USA respectively, while agricultural value added was even lower, only 1.4% (EU) and 1.1% (USA) in the same year (World Bank WDI, 2019). Generally, these indicators show decreasing trend, especially in the developed countries.

Regarding the size of agricultural production, figure 1 suggests that Russia and Ukraine have the largest production potentials, followed by Kazakhstan and Belarus. The sum of the remaining four countries' production is more or less equal to the Belarussian production.

The role of agriculture can also be measured by its share in total exports. It is evident from Table 2 that agriculture gives the most significant share in total exports in Moldova (44% in 2012-2015), followed by Ukraine (32%) and Armenia (26%). In other words, almost half, a third and a quarter of export revenue came from agriculture in these countries, respectively. Besides, it shows an increasing trend in Armenia due to the remarkable expansion of agricultural exports to total exports in the last four years, as well as in Ukraine, where the total exports declined by 30% from 2014 to 2015, while agricultural exports decreased only by 13% (World Bank Wits, 2019). In the case of Ukraine, this process was accelerated by the signed DCFTA[3] resulting in even lower EU trade barriers and increased investment supports after the global crisis (Borodina and Krupin, 2018). On the other hand, agricultural exports gave less than 7% of total exports in 2012-2015 in Russia, Kazakhstan and Azerbaijan. In the case of Russia, the embargo increased the agricultural performance due to the higher, strategic self-sufficiency, preferential agricultural credits and higher producer prices (Kalinina, 2017). This process was further strengthened by the governmental import substitution policy that came into force in 2010 and targeted high self-sufficiency rates like 95% for cereals, 90% for milk and dairy products or 85% for meat and meat products planned to be reached by 2020 (RPA, 2009). In light of these significant impacts, it seems to be very hard for exporters to regain the Russian agri-food markets in the future if at all. However, it should be kept mind in that only a small share of agricultural products are traded, e.g. 16.5% for the cereals (FAO, 2019), which is the major product of the region, meaning that most of the countries feed themselves.

As to CIS agricultural exports, continuous growth can be seen in every country, though to a different extent (Table 3). On the one hand, countries like Azerbaijan and Ukraine increased their agricultural exports more than seven times from 2000-2003 to 2012-2015, while on the other hand, respective growth in Moldova was "only" 2,5 times. However, it should be clearly seen that the magnitude of the Russian and Ukrainian agricultural export is much larger than any other countries in the region.

Analysing the agricultural trade balance gives further insights into the patterns described above (Table 4). First, the CIS region has traditionally been a net importer of agricultural goods. However, due to the notable expansion of Ukrainian exports as well as the huge decline in the Russian agricultural imports, the region achieved a surplus in 2014 and 2015 (1.1 and 9.4 billion USD, respectively).

[3] Deep and Comprehensive Free Trade Agreement.

Country	2000-2003	2004-2007	2008-2011	2012-2015
Armenia	14.10	14.20	18.13	25.61
Azerbaijan	4.83	3.90	2.20	3.44
Belarus	11.25	10.18	11.42	15.26
Kazakhstan	7.08	4.10	3.53	3.99
Kyrgyzstan	10.87	17.45	12.21	12.55
Moldova	63.84	50.02	43.95	44.26
Russia	7.61	6.15	5.71	6.52
Ukraine	12.89	13.26	20.47	31.81

Source: Authors' composition based on WTO (2019) database

Table 2: Share of agricultural exports in total merchandise exports, 2000-2015 (percent).

Country	2000-2003	2004-2007	2008-2011	2012-2015
Armenia	63	138	185	378
Azerbaijan	107	368	608	841
Belarus	925	1842	3342	5419
Kazakhstan	709	1373	2216	2823
Kyrgyzstan	57	153	222	236
Moldova	395	550	723	983
Russia	8572	16717	23845	30131
Ukraine	2340	5151	11302	17255

Source: Authors' composition based on WTO (2019) database

Table 3: Agricultural exports of the CIS, 2000-2015, million USD at current prices.

Country	2000-2003	2004-2007	2008-2011	2012-2015
Armenia	-152	-239	-551	-442
Azerbaijan	-163	-254	-670	-772
Belarus	-294	-249	75	825
Kazakhstan	106	-324	-882	-1366
Kyrgyzstan	9	-97	-394	-588
Moldova	225	175	76	228
Russia	-1135	-2822	-11927	-8744
Ukraine	796	1781	4942	10515
Total	-607	-2031	-9332	-345

Source: Authors' composition based on WTO (2019) database

Table 4: Agricultural trade balance of the CIS, 2000-2015, million USD at current prices.

Product group	2000-2003	2004-2007	2008-2011	2012-2015
Cereals	26.50	26.85	29.46	31.80
Animal or vegetable fats and oils	7.74	8.46	13.71	14.62
Dairy products	8.46	10.19	8.29	6.90
Fish	7.48	4.11	6.80	6.84
Oil seeds	5.47	3.25	5.78	5.81
Total	55.66	55.07	64.04	65.96

Source: Authors' composition based on World Bank WITS (2019) database

Table 5: Export share of the top five agricultural product groups in CIS exports, 2000-2015 (percent).

The latter impact was even higher as the Russian trade deficit declined from 15.0 billion USD (2010) to 363 million USD (2015). Second, in the period analysed, the agricultural trade deficit of the CIS countries has increased with four exceptions: Kazakhstan and Kyrgyzstan turned to be net importers from net exporters, while Belarus became a net exporter. Third, Moldova was able to keep its net exporter position with no significant changes over the analysed period. Finally, only Ukraine, Belarus and Moldova had an agricultural trade surplus in 2012-2015. These processes are part of the international specialisation, where countries try to concentrate on the production of goods in which they have absolute advantage (e.g., land abundant) or relative advantages compared to the other sectors of the economy.

As to agricultural exports by product, cereals were the most important agricultural commodities of the region, providing one-third of its exports (Table 5). Cereals were followed by animal or vegetable fats and oils, dairy products, fish and oilseeds in the period analysed. These product groups gave almost two-thirds of the value of agricultural exports of the region in 2012-2015, suggesting a high and increasing concentration of exports.

In the case of cereals, it should also be kept in mind that the average cereals yield in the region is much lower than in the major producers or trade partners. E.g. it was 5.5 t/ha in the EU, 5.9 t/ha in China or 7.4 in the USA, while among the CIS it varied between 1.3 t/ha (Kazakhstan) and 4.1 t/ha (Ukraine) in 2015 (FAO, 2019).

Revealed comparative advantages of CIS agriculture

The performance of CIS agriculture in international trade can be measured by calculating the Balassa indices described above. Moldova, Kyrgyzstan and Armenia had the highest Balassa indices in most of the years analysed, while Belarus, Ukraine and Azerbaijan enjoyed some comparative advantage at the same time (Table 6). However, Russia and Kazakhstan had a revealed comparative disadvantage in all periods except for 2000-2003. Note that RCA values has been diminishing from 2000-2003 to 2012-2015 in the vast majority of the cases and especially in Moldova and Azerbaijan. These results are generally in line with previous findings as described in the introduction section.

When analysing comparative advantages by products, further specialisation patterns became available (Table 7). It is apparent that all of the most important product groups identified in Table 5 had a comparative advantage in all periods analysed, though to a different extent. On the one hand, the very high comparative advantages of animal or vegetable fats and oils, as well as oilseeds, seem to have diminished significantly, while that of cereals declined only modestly. On the other hand, the comparative advantages of dairy and fish products have somewhat increased from 2000-2003 to 2012-2015.

Unstable competitive patterns were already justified by the results above. In order to further test its stability, the Markov transition probability matrices were used. It indicates relatively low mobility of the Balassa index for Kazakhstan, Azerbaijan, Russia and Armenia, implying stable patterns of comparative (dis)advantages. Besides these countries, more than 70% of product groups with a comparative advantage remained persistent for Kyrgyzstan, Moldova and Belarus, while the lowest mobility measures pertained to Ukraine, implying highly changing competitive potentials (Figure 2).

The duration tests also verified the changing structure of agricultural trade-based competitiveness. As it was described in the methodology section, the Kaplan–Meier estimator of the survival function was run on our panel dataset and the results confirm that in general, the survival times are not persistent over the period analysed (Table 8). Survival chances of 94-98% at the beginning of the period fell to 1-11% by the end of the period, suggesting that fierce competition exists in CIS agricultural trade.

The highest survival times exist for Moldova, while the lowest are for Russia, but results vary from country to country. However, there is no clear pattern observable between the change in survival times and the rank in CIS agricultural exports. The equality of the survival functions

Country	2000-2003	2004-2007	2008-2011	2012-2015
Armenia	8.80	4.96	7.47	9.15
Azerbaijan	11.59	6.75	1.08	1.69
Belarus	1.71	2.27	2.34	2.17
Kazakhstan	1.05	0.75	0.74	0.76
Kyrgyzstan	9.35	9.46	6.86	9.31
Moldova	33.79	29.54	22.22	18.50
Russia	0.29	0.25	0.27	0.36
Ukraine	2.95	3.05	1.98	2.01

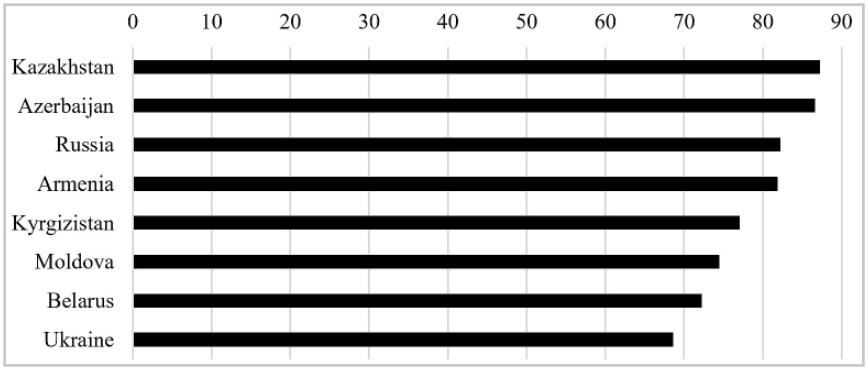
Source: Authors' composition based on World Bank WITS (2019) data

Table 6: Balassa indices for CIS countries agricultural exports by country, 2000-2015.

Product group	2000-2003	2004-2007	2008-2011	2012-2015
Cereals	26.50	26.85	29.46	31.80
Animal or vegetable fats and oils	7.74	8.46	13.71	14.62
Dairy products	8.46	10.19	8.29	6.90
Fish	7.48	4.11	6.80	6.84
Oil seeds	5.47	3.25	5.78	5.81

Source: Authors' composition based on World Bank WITS (2019) database

Table 7. Balassa indices for CIS countries agricultural exports by the most important product groups, 2000-2015.



Source: Authors' composition based on World Bank WITS (2019)

Figure 2: The mobility of Balassa indices, 2000-2015, by country, %.

Years	Survivor function	Armenia	Azerbaijan	Belarus	Kazakhstan	Kyrgyzstan	Moldova	Russia	Ukraine
2000	0.95	0.98	0.96	0.95	0.95	0.95	0.97	0.94	0.96
2001	0.90	0.96	0.92	0.90	0.89	0.90	0.95	0.88	0.91
2002	0.86	0.93	0.89	0.85	0.84	0.85	0.92	0.82	0.87
2003	0.81	0.90	0.85	0.80	0.79	0.81	0.89	0.76	0.82
2004	0.76	0.85	0.80	0.74	0.74	0.76	0.86	0.70	0.77
2005	0.71	0.83	0.75	0.69	0.68	0.72	0.82	0.64	0.72
2006	0.66	0.77	0.70	0.64	0.62	0.68	0.78	0.59	0.67
2007	0.61	0.72	0.64	0.60	0.56	0.63	0.74	0.53	0.62
2008	0.55	0.66	0.57	0.55	0.50	0.58	0.71	0.47	0.56
2009	0.49	0.60	0.51	0.50	0.44	0.52	0.65	0.41	0.50
2010	0.44	0.54	0.43	0.45	0.39	0.45	0.60	0.36	0.44
2011	0.37	0.47	0.37	0.38	0.33	0.38	0.54	0.30	0.37
2012	0.30	0.41	0.30	0.30	0.25	0.30	0.48	0.23	0.29
2013	0.22	0.33	0.22	0.23	0.17	0.20	0.39	0.16	0.22
2014	0.13	0.23	0.13	0.14	0.08	0.10	0.28	0.09	0.13
2015	0.03	0.08	0.02	0.04	0.01	0.06	0.11	0.01	0.03

Source: Authors' composition based on World Bank WITS (2019)

Table 8: Kaplan-Meier survival rates for Balassa indices and tests for equality of survival functions in CIS agricultural trade, 2000-2015.

across regional countries can be checked by using two non-parametric tests (Wilcoxon and log-rank tests). Results of the tests show that the hypothesis of equality across survivor functions can be rejected at the 1% level of significance, meaning that similarities in the duration of comparative advantage across most important regional agricultural exporters are absent (Table 8).

From a trade policy perspective, it is important to know and to interpret correctly these results. Political and economic regionalisation is creating new trade patterns, acting towards harmonization of member states' trade policies. The Eurasian Customs Union and preferential trade agreements with the EU play a key role in realizing comparative advantages on the agri-food markets. Most of the CIS countries are relying heavily on Russia in their agricultural trade, while some of them were able to diversify their export markets (Kožar et al., 2016). In either case, identifying the changing nature of competitive potentials is key to future success.

Conclusion

The analysis of the CIS region with different versions of Balassa indices is topical and can be found in many studies. One of their common points is that revealed comparative advantages are limited to mostly raw materials due to the resource endowments, especially in Kazakhstan and Russia. On the country level, high RCA values can be noticed for Belarus, Moldova and Ukraine.

According to the basic indicators (value added, employment or contribution to the total exports), agriculture still plays an important role in the region, especially in Armenia, Kyrgyzstan and Moldova. As to the share of the sector in total exports,

Moldova, Ukraine and Armenia led the way with almost half, third and quarter of every foreign exchange earned via export was coming from agriculture in these countries, respectively. Most of the analysed CIS countries are net importers of agricultural goods, but Belarus became net exporter while Moldova was able to maintain its export surplus during the analysed period. Ukraine is showing continuous and significant growth in agricultural exports, which, strengthened by the huge decline in Russian agricultural imports, transformed the CIS region from a net importer, into a net exporter of agricultural goods. The major agricultural export commodity of the region is undoubtedly cereals, providing almost a third of total agricultural exports. Taking into consideration the relatively low regional yields, it indicates a great potential for further growth in cereals production.

Regarding country-level revealed comparative advantages, Moldova, Kyrgyzstan and Armenia had the highest Balassa indices in the majority of the years analysed for agricultural trade. Belarus, Ukraine and Azerbaijan had some comparative advantage at the same time. These values reflect on the importance of agriculture in the economies of these countries, which is proportionally related to the size of natural resources, like in case of Azerbaijan or Kazakhstan. All of the most important product groups had RCA values above 1 in all periods analysed, implying that the export of agricultural products of the CIS countries corresponds with their revealed comparative advantages. Cereals, animal or vegetable fats and oils, and oilseeds had decreasing values, while dairy products and especially fish were facing increasing revealed comparative advantages. However, it has not turned out to be persistent according to stability and duration tests run on our panel dataset, implying highly changing competitive potentials and fierce regional competition on the agri-food markets. These results are in line with the existing literature, as mostly raw materials have a comparative advantage which generally shows a decreasing trend. Further research might be carried out to analyse and understand the possible reasons behind the results presented above, as well as to compare CIS to other neighbouring countries in this regard. On the agricultural policy level, using revealed comparative advantages can help to better understand the country's export specialisation and international trade performance, which can be the key to future success.

Acknowledgements

This work was supported by the National Research, Development and Innovation Office under grant number 119669, titled "Competitiveness of Agriculture in International Trade: A Global Perspective". The authors gratefully acknowledge the financial support.

Corresponding authors
Tamás Mizik
Corvinus University of Budapest, 1093 Budapest, Fővám tér 8., Hungary
Phone: +36-1-4825368, E-mail: tamas.mizik@uni-corvinus.hu

References

[1] Ahrend, R. (2006) "Russian Industrial Restructuring: Trends in Productivity, Competitiveness and Comparative Advantage", *Post-Communist Economies*, Vol. 18, No. 3, pp. 277-295. E-ISSN 1465-3958, ISSN 1463-1377. DOI 10.1080/14631370600881770.

[2] Amirbekova, A. and Madiyarova, D. (2015) "Assessment of the Competitiveness of Kazakhstan's Exports", *Mediterranean Journal of Social Sciences*, Vol. 6, No. 6, pp. 443-447. E-ISSN 2039-2117, ISSN 2039-9340.

[3] Balassa, B. (1965) "Trade Liberalization and Revealed Comparative Advantage", *Manchester School of Economic and Social Studies*, Vol. 33, No. 2, pp. 99-123. E-ISSN 1467-9957. DOI 10.1111/j.1467-9957.1965.tb00050.x.

[4] Benesova, I., Maitah, M., Smutka, L., Tomsik, K. and Ishchukova, N. (2017) "Perspectives of the Russian agricultural exports in terms of comparative advantage", *Agricultural Economics – Czech*, Vol. 63, No. 7, pp. 1-13. E-ISSN 1805-9295, ISSN 0139-570X.

[5] Besedes, T. and Prusa, T. J. (2011) "The role of extensive and intensive margins and export growth", *Journal of Development Economics*, Vol. 96, No. 2, pp. 371-379. ISSN 0304-3878. DOI 10.1016/j.jdeveco.2010.08.013.

[6] Bojnec, Š. (2001) "Trade and revealed comparative advantage measures: regional and central and east European agricultural trade", *Eastern European Economics*, Vol. 39, No. 2, pp. 72-98. E-ISSN 1557-9298, ISSN 0012-8775.

[7] Bojnec, Š. and Fertő, I. (2008) "European Enlargement and Agro-Food Trade", *Canadian Journal of Agricultural Economics*, Vol. 56, No. 4, pp. 563-579. E-ISSN 1744-7976. DOI 10.1111/j.1744-7976.2008.00148.x.

[8] Borodina, O. and Krupin, V. (2018) "Is it Possible to Utilise the Agricultural Potential of Ukraine under the Current Agrarian System?", *EuroChoices*, Vol. 17, No. 1, pp. 46-51. E-ISSN 1746-692X. DOI 10.1111/1746-692X.12151

[9] Buchenrieder, G., Hanf, J. H. and Pieniadz, A. (2009) "20 Years of transition in the agri-food sector", *German Journal of Agricultural Economics*, Vol. 58, No. 7, pp. 285-293. ISSN 21914028.

[10] Cimpoies, L. (2013) "Agri-food Trade – A Path to Agricultural Development of Moldova", *Scientific* Vol. 13, No. 2, pp. 49-56. E-ISSN 2285-3952, ISSN 2284-7995.

[11] Cleves, M. A., Gould, W. W. and Gutierrez, R. G. (2004) "*An Introduction to Survival Analysis using Stata*", Stata Press, USA, 308 p. ISBN 1881228843.

[12] Csaki, C. and Forgacs, C. (2008) "Agricultural Economics and Transition: What was expected, what we observed, the lessons learned", *Proceedings of Joint IAAE-EAAE Seminar* held in Budapest, September 2007. IAMO, Halle, 326 p.

[13] Deardorff, A. V. (2011) "Comparative advantage: The theory behind measurement", pp. 27-40. In: *OECD: Globalisation, Comparative Advantage and the Changing Dynamics of Trade*. OECD Publishing, Paris, France, 347 p. DOI 10.1787/9789264113084-3-en.

[14] FAO (2019) "Faostat". [Online]. Available: http://www.fao.org/faostat/en/#data [Accessed: 16 May 2019).

[15] Freinkman, L., Polyakov, E. and Revenco, C. (2004) "Trade Performance and Regional Integration of the CIS Countries", In: *World Bank Working Paper No. 38*: 69 p. ISBN 978-0-8213-5896-2. DOI 10.1596/0-8213-5896-0.

[16] Gorton, M. and White, J. (2009) "Export strategies and performance in the CIS: case study evidence from the dairy sector", *Post-Communist Economies*, Vol. 21, No. 4, pp. 475-494. E-ISSN 1465-3958, ISSN 1463-1377. DOI 10.1080/14631370903339864.

[17] Héberger, K. (2010) "Sum of ranking differences compares methods or models fairly", *TrAC Trends in Analytical Chemistry*, Vol. 29, No. 1, pp.101-109. ISSN 0165-9936. DOI 10.1016/j.trac.2009.09.009.

[18] Héberger, K. and Kollár-Hunek, K. (2011) "Sum of ranking differences for method discrimination and its validation: comparison of ranks with random numbers", *Journal of Chemometrics*, Vol. 25, No. 4, pp. 151-158. ISSN 1099-128X. DOI 10.1002/cem.1320.

[19] Hoang, V. V. and Tran, K. T. (2019) "Comparative Advantages of Alternative Crops: A Comparison Study in Ben Tre, Mekong Delta, Vietnam", *AGRIS on-line Papers in Economics and Informatics*, Vol. 11, No. 1, pp. 35-47. ISSN 1804-1930. DOI 10.7160/aol.2019.110104.

[20] Ishchukova, N. and Smutka, L. (2013) "Revealed comparative advantage of Russian agricultural exports", *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis (Czech Republic)*, Vol. 61, No. 4, pp. 941-952. E-ISSN 2464-8310, ISSN 1211-8516. DOI 10.11118/actaun201361040941.

[21] Jambor, A. and Babu, S. (2016) "*Competitiveness of Global Agriculture: Policy Lessons for Food Security*", Springer, 199 p. ISBN 978-3-319-44876-3. DOI 10.1007/978-3-319-44876-3.

[22] Kalinina, K. (2017) "3 years of embargo in Russia: The winners and losers", *Russia Beyond*, August 6 [Online]. Available: https://www.rbth.com/business/2017/08/06/3-years-of-embargo-in-russia-the-winners-and-losers_816898 [Accessed: 16 May 2019].

[23] Karasova, N. (2016) "Comparative advantages in international trade of Ukraine's agriculture", *Management Theory and Studies for Rural Business and Infrastructure Development*, Vol. 38, No. 3, pp. 230-238. E-ISSN 2345-0355. DOI 10.15544/mts.2016.18.

[24] Khatibi, A. (2008) "*Kazakhstan's revealed comparative advantage vis-à-vis the EU-27*", Ecipe Working Paper No. 3., 12 p. [Online]. Available: http://ecipe.org/publications/kazakhstan2019s-revealed-comparative-advantage-vis-a-vis-the-eu-27/ [Accessed: 1 April 2019].

[25] Kožar, M., Pintar, M., Volk, T., Rednak, M., Rac, I. and Erjavec, E. (2016) "Agriculture and agricultural policy in Eastern European Neighbourhood", *155th EAAE Seminar*, Kiev, Ukraine, September 19-21, 2016.

[26] Lerman, Z., Csaki, Cs. and Feder, G. (2004) "*Agriculture in transition: Land policies and evolving farm structures in post-Soviet countries*", Lanham, Lexington Books. 254 p. ISBN 978-0-7391-0806-2.

[27] Liapis, P. S. (2011) "Changing patterns of trade in processed agricultural products", pp. 121-150. In: *OECD: Globalisation, Comparative Advantage and the Changing Dynamics of Trade*. OECD Publishing, Paris, France, 347 p. ISBN 9789264113084. DOI 10.1787/9789264113084-en.

[28] Liefert, W. (2002) "Comparative (dis?)advantage in Russian agriculture", *American Journal of Agricultural Economics*, Vol. 84, No. 3, pp. 762-767. E-ISSN 1467-8276, ISSN 0002-9092. DOI 10.1111/1467-8276.00334.

[29] Madiyarova, D., Amirbekova, A., and Syrlybayev, M. (2018) "Comparative advantages of Kazakhstan assessed by the Balassa Index: consistently competitive exports are limited to raw materials with low added value", *Journal of Business and Retail Management Research*, Vol. 12, No. 3, pp. 201-210. E-ISSN 2056-6271, ISSN 1751-8202. DOI 10.24052/JBRMR/V12IS03/ART-18.

[30] Maslova, V., Zaruk, N., Fuchs, C., and Avdeev, M. (2019) "Competitiveness of Agricultural Products in the Eurasian Economic Union", *Agriculture*, Vol. 9, No. 3, 14 p. ISSN 2077-0472. DOI 10.3390/agriculture9030061

[31] Maryam, J., Banday, U. and Mittal, A. (2018) "Trade intensity and revealed comparative advantage: an analysis of Intra-BRICS trade", *International Journal of Emerging Markets*, Vol. 13, No. 5, pp. 1182-1195. ISSN 1746-8809. DOI 10.1108/IJoEM-09-2017-0365.

[32] Mogilevskii, R. and Akramov, K. (2014) "Trade in Agricultural and Food Products in Central Asia", University of Central Asia, Working paper No. 27, 28 p. DOI 10.2139/ssrn.2946713.

[33] RPA (2009) "Doctrine of Food Security, Strategy of National Security of the Russian Federation till 2020 (In Russian) (enacted by the RF President Decree No. 537 of May 12, 2009)", Russian Presidential Administration. [Online]. Available: http://kremlin.ru/acts/6752 [Accessed: 23 April 2019].

[34] Vigneau, E. and Qannari, E. M. (2003) "Clustering of variables around latent components", *Communication in Statistics- Simulations and Computation*, Vol. 32, No. 4, pp. 1131-1150. E-ISSN 1532-4141, ISSN 0361-0918. DOI 10.1081/SAC-120023882.

[35] Wijnands, J. H. M., van Berkum, S. and Verhoog, D. (2015) "Competitiveness of CIS and EU agrifood chains, Quantifying Porter's diamond", LEI Wageningen University, 74. p. DOI 10.13140/RG.2.1.3657.7360.

[36] World Bank WDI (2019) "World Development Indicators" [Online]. Available: http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators [Accessed: 16 May 2019].

[37] World Bank WITS (2019) "World Integrated Trade Solution database". [Online]. Available: http://wits.worldbank.org/ [Accessed: 10 May 2019].

[38] WTO (2019) "Time series database". [Online]. Available: http://stat.wto.org/StatisticalProgram/WSDBStatProgramHome.aspx?Language=E [Accessed: 10 May 2019].

[39] Zhemoyda, O. and Gerasymenko, N. (2009) "Concentration of agriculture and competitive advantages of East-European countries", *Conference proceeding of the 113th EAAE Seminar "A resilient European food industry and food chain in a challenging world"*, Chania, Crete, Greece, September 3-6.

Appendix

Product groups by HS2 classification	Code
Live animals	1
Meat and edible meat offal	2
Fish and crustaceans, molluscs and other aquatic invertebrates	3
Dairy produce, birds' eggs, natural honey, edible products of animal origin not elsewhere specified or included	4
Products of animal origin, not elsewhere specified or included	5
Live trees and other plants, bulbs, roots and the like, cut flowers and ornamental foliage	6
Edible vegetables and certain roots and tubers	7
Edible fruit and nuts, peel of citrus or melons	8
Coffee, tea, mat and spices	9
Cereals	10
Products of the milling industry, malt, starches, inulin, wheat gluten	11
Oil seeds and oleaginous fruits, miscellaneous grains, seeds and fruit, industrial or medicinal plants, straw and fodder	12
Lac, gums, resins and other vegetable saps and extracts	13
Vegetable plaiting materials, vegetable products not elsewhere specified or included	14
Animal or vegetable fats and oils and their cleavage products, prepared edible fats, animal or vegetable waxes	15
Preparations of meat, of fish or of crustaceans, molluscs or other aquatic invertebrates	16
Sugar and sugar confectionery	17
Cocoa and cocoa preparations	18
Preparations of cereals, flour, starch or milk, pastrycooks' products	19
Preparations of vegetables, fruit, nuts or other parts of plants	20
Miscellaneous edible preparations	21
Beverages, spirits and vinegar	22
Residues and waste from food industries, prepared animal fodder	23
Tobacco and manufactured tobacco substitutes	24

Source: World Bank WITS database (2019)

Annex 1: HS2 classification of the agricultural product groups.

Agris on-line Papers in Economics and Informatics

Volume XII Number 1, 2020

Individual-level Employment Transitions in Rural Viet Nam

Quang-Thanh Ngo[1], Thuy-Khanh Hong Thai[2], Van-Tien Cao[3], Anh-Tuan Nguyen[1], Ngoc-Hieu Hoang[1], Ngoc-Danh Nguyen[3]

[1] University of Economics and Law, Vietnam National University Ho Chi Minh City (VNU-HCM), Vietnam

[2] Nguyen Tat Thanh University, Ho Chi Minh City, Vietnam

[3] University of Economics Ho Chi Minh City, Ho Chi Minh City, Vietnam

Abstract

Structural transformation in rural areas is a key issue in economic development. While much of the literature on structural transformation has so far focussed on household- or commune levels or even higher aggregate levels, little is known about the individual member level. The paper aims at examining factors that affect the individual-level employment rural transitions in Viet Nam, namely: (1) non-transient farm; (2) positive transient farm; (3) out-of-wage transition; (4) transitory farm-household work; and (5) transitory wage-household work. By taking advantage of the Viet Nam Access to Resources Household Survey with data on 2,698 individuals for two years, 2008 and 2016, using multivariate probit models estimated by generalized structural equation method, we find that individual-level human capital and social capital are important factors affecting employment transition status in the rural area. In addition, changes in individual and household characteristics and local climate conditions at commune level are important to influence various types of employment transitions. These results have implications for the development policy on rural transition in developing countries, highlighting the importance of recognizing the positive aspects of changes in individual-, household-, and commune-levels for rural transformation. Promotion of education attainment is necessary at both individual- and household-level to spur the transition out of farming. Broadened policy mechanisms which support and encourage non-farm employment at the household level are also needed. Likewise, development initiatives that focus on increasing the human and social assets of the individual farmers and farming households are more likely to be successful in supporting livelihood diversification and reducing vulnerability.

Keywords

Individual-level employment transitions; non-transient farm (persistent farm); positive transient farm; out-of-wage transition; transitory farm-household work, transitory wage-household work; rural transformation.

Ngo, Q.-T., Thai, T.-K. H., Cao, V.-T., Nguyen, A.-T., Hoang, N.-H. and Nguyen, N.-D. (2020) “Individual-level Employment Transitions in Rural Viet Nam", *AGRIS on-line Papers in Economics and Informatics*, Vol. 12, No. 1, pp. 73-91. ISSN 1804-1930. DOI 10.7160/aol.2020.120107.

Introduction

Structural transformation in rural areas is a key issue in economic development and may take place at several levels (see, for example, Ellis and Harris (2004); Lanjouw and Lanjouw (2001); Reardon et al. (2001)). At the micro-level, it can be the result of decision-making by individual households or even household members (see the most recent research, for example, Newman and Kinghan (2015)). On the other hand, at the aggregate level such as a commune or province, government policies can affect the direction and speed of transformation (see, for example, Ulrik (2015)).

While a large number of studies on structural transformation so far focuses on household or commune level or even higher aggregate level, for example, Barrett et al. (2001), Berdegué et al. (2001), Bezemer and Davis (2002), Coppard (2001), Davis (2003), Deininger and Olinto (2001), Lanjouw and Lanjouw (2001), and Tarp (2017), little is known about the individual member level (which is mostly due to a lack of suitable datasets). Households are differential by their members with different human, financial, and physical assets

and economic activities involved and therefore by targeting at individual members of households as individual members of the rural society, policy can bring effective support to enhance the opportunities to participate into non-farm employment in the rural area.

This current study takes advantage of the Viet Nam Access to Resources Household Survey (VARHS) in 2008-2016 with intensive information on individual-level employment. The final dataset is compiled by using the individual identification in combination with the information on age and gender, besides the common use of household identification and results in 2,699 individual-level observations in two years: 2008 and 2016. The current paper arms at examining factors that affect the individual-level employment rural transitions in Viet Nam. The current paper, thus, tries to examine the following research questions: (1) To what extent do individual characteristics determine patterns of structural transformation in the rural area at individual level in Viet Nam? and (2) What are the roles of changes in individual characteristics, household characteristics, and local climate conditions at commune level in determining patterns of structural transformation in the rural area at individual level in Viet Nam?

Our primary hypothesis is that: (1) individual characteristics play crucial roles in individual-level transition statuses, namely: (a) non-transient farm (or persistent farm: The one is in farming during the whole studied period), (b) positive transient farm (the one moves from agriculture to wage/salary sector), (c) out-of-wage transition (the one moves out of wage/salary sector to farming or to household business), (d) transitory farm-household work (the one moves from household work to agriculture), and (e) transitory wage-household work (the one moves from household work to wage/salary sector); and (2) while initial individual characteristics have effects on individual-level transition status, changes in individual/household characteristics and local climate conditions at commune level also determine patterns of structural transformation at individual level in the rural area of Viet Nam.

In general, this research has two objectives. First, it aims to contribute to the literature of employment transformation at the individual levels (a)-(e) previously described. To date, there has been very little analysis of employment transformation at individual level. Second, it provides evidence to deepen understanding of structural transformation in Viet Nam, particularly the factors that determine individuals' movements into and out of the farming sector, moving into the wage/salary sector and household businesses and why some individuals remain in farming. It also points out the factors that determine individuals' movements into farming, wage/salary sector and household businesses.

The rest of the paper is organized as follows. Section 2 describes materials and the methods. Section 3 discusses the empirical results.

Materials and methods

Data source and sampling

The data on diverse aspects of rural employment were collected from VARHS datasets. VARHS is a result of a joint project conducted by the Central Institute for Economic Management (CIEM) of the Ministry of Planning and Investment (MPI), the Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD), the Institute of Labour Science and Social Affairs (ILSSA), and the Development Economics Research Group (DERG) of the University of Copenhagen (CIEM, DOE, ILSSA, and IPSARD, 2009).

The VARHS focuses on building on the substantial database of markets of land, labour, and employment. The employment module consists of individual-level information on types of jobs (i.e. farming, non-farm or non-agriculture), and information on demographic characteristics, education, occupation, and industry for all employed persons.

The VARHS was carried out in the rural areas of twelve provinces in Viet Nam: (1) four (ex-Ha Tay, Nghe An, Khanh Hoa and Lam Dong); (2) five (Dak Lak, Dak, Nong, Lao Cai, Dien Bien and Lai Chau); and (3) three (Phu Tho, Quang Nam and Long An). These three province groups represent the main geographical differences in Viet Nam (Figure 1). By using VARHS in five years 2008, 2010, 2012, 2014, and 2016, the research gains a dataset of 2,698 individuals in two years: 2008 and 2016.

Source: Authors' creation

Figure 1: Site surveys.

From a truly unique five-wave panel of rural household-level dataset in 2008-16 with 2,131 observations in Viet Nam and a five-wave panel of rural commune-level dataset in 2008-2016 with 2,090 observations, we construct a sample of individual-level employment transitions in two years, 2008 and 2016, with 2,698 observations. The procedures are as follows:

Step 1: Separate individual-level datasets are created: 2008 (with 9,009 observations), 2010 (8,934), 2012 (8,379), 2014 (8,222), and 2016 (7,979 observations). Information includes position in the household, marriage status, gender, age, political-social membership, educational level, and employment status. Individual-level employment statuses include, exclusively: (1) wage/salary sector, (2) agriculture, (3) household business, (4) common properties resources. Individual-level employment statuses also includes: (5) household work, and (6) unemployed, which are not necessarily exclusive from each other. Household identification (including codes of province, district, commune, and household) is also kept.

Step 2: Using a combination of the age and gender as an individual identification, besides the common use of household identification, a consolidation of individual-level datasets with household- and commune-level dataset is conducted. At this stage, several yearly household identifications have been used and finally, a five-wave and individual-level panel dataset with a maximized number of observations of 5,072 is obtained. The process goes further by dropping duplicated observations determined by a combination of household identification, individual identification, and age information in five waves of surveys, and the final five-wave and individual-level panel dataset have 4,611 observations. This dataset contains individuals who come from different households and belong to the same households as well.

Step 3: A sample of individual-level employment transitions between 2008 and 2016 is derived from the full set of five-wave and individual-level panel dataset of 4,611 observations. As a transitional stage, a sample including only individuals in 2008 who belong to one of these statuses: (1) farming, (2) household business, (3) wage/salary sector, and (4) household work, is refined and resulted in 2,698 observations. More detailed definitions of employment transitions are presented in the following section. The final dataset contains individuals who come from different households as well as individuals who belong to the same households.

Methods

Definitions

In our definition, employment includes: (1) working for a wage/salary sector outside the household; (2) participating in household production related to agriculture, forestry and aquaculture (or farm); (3) doing trading, services, transportation, or other business (self-employed) for the household (or non-farm, non-wage activities, not housework); (4) using common property resources to generate income for the household (hunting, fishing in the sea or lakes not on your property, gathering honey and berries, gathering forestry products etc.); and (5) doing housework or chores (cleaning, collecting firewood, washing clothes, cooking, etc.).

The current study follows the "spell" approach, which is widely used in poverty studies in identifying and measuring chronic and transient poverty (income- and consumption-based poverty) on the basis of panel data (Yaqub, 2000). The spell approach focuses on the number or length of spells

of poverty experienced by households (Hulme and Shepherd, 2003).

The spell approach, in the current paper, is employed by categorizing employment transitions in rural Viet Nam as non-transient farm (or persistent farm, defined as an individual to be in agriculture throughout the survey period), positive transient farm (defined as a farming individual to be employed in wage/salary sector), out-of-wage transitory (defined as an individual to move from wage/salary sector to farming or to household business), transitory farm household work (defined as an individual to move from household work to agriculture), and transitory wage household work (defined as an individual to move from household work to wage/salary sector) (Table 1).

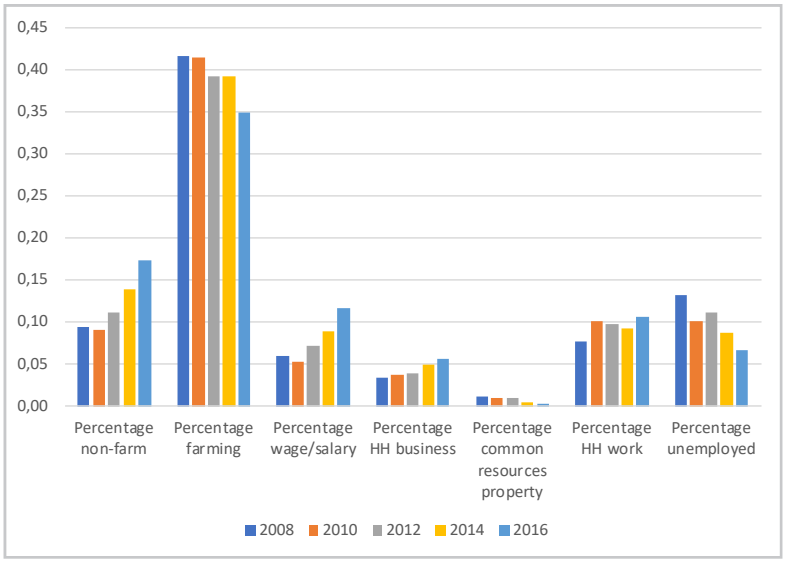
Figure 2 reports some summary statistics relating to individual's employment status for individuals included in the five-wave panel, treating the different waves as separate cross sections. The first column shows that the proportion of non-farm employment increases gradually over time with about 1.5 per cent per year. Income diversification and diversification of activities are important trends in rural of Viet Nam.

The next set of columns relates to the proportion of individuals involved in certain activities. A large majority of individuals work as farmers in each of the years. However, the proportion does decline gradually over time with about 2 per cent per year. In the third column, the proportion of working in wage/salary sector increases in the period of 2008-16 with about 2 per cent per year in the latest 3 years, namely 2012, 2014, and 2016. In the fourth column, the proportion of household enterprises increases in the period of 2008-16 with less than 1 per cent per year. In the fifth column, the proportion of engagement in common resource property decreases in the period of 2008-16 until nearly zero percent. The last column in Figure 2 relates to the percentage of unemployment with a decline of nearly 1 per cent per year during the period. In general, what is clear from Figure 1 is the importance of non-farm activities from the individual level. That in itself

Transition type	2008-2016
(1) Non-transient farm (or persistent farm)	Being farm during the whole period
(2) Positive transient farm	From agriculture to wage/salary sector
(3) Out-of-wage transition	From wage/salary sector to farming or to HH business
(4) Transitory farm-household work	From household work to agriculture
(5) Transitory wage-household work	From household work to wage/salary sector

Source: Authors' compilation from VARHS 2008-2016. HH: Household

Table 1: Definition of transitions in the rural area.



Source: Authors' calculation from VARHS 2008-2016

Figure 2: Statistic description of transition status, 2008-2016.

is a signal of the success of rural transformation in Viet Nam. However, the analysis to date is only conducted at an aggregate level and does not exploit the panel features of the data set; the remainder of this paper now analyses these three activities separately and in more detail.

Methods of analysis

The current paper estimates factors associated with the individual-level employment transitions. The basic model is identified as follows (Model 1):

$$Trans_{ijk} = \{INDI_i^0 \alpha + \text{INCOME}_j^0 \beta + \alpha_k + u_i + e_{ijk} \geq 0\} \quad (1)$$

Where: the script *ijk* denotes individual *i* in household *j* and commune *k*. While 0 denotes the year 2008, *1* denotes the year 2016. α_k is cluster specific effect which change across clusters and it is assumed that $\alpha k \sim [0, \sigma^2_k]$. ε_{ijk} has zero mean and constant variance, and u_i is an individual specific fixed effect.

Trans is individual's transitions in the rural area as defined in Table 1, in which: 1 is non-transient farm (or persistent farm), 2 is positive transient farm, 3 is out-of-wage transition, 4 is 'transitory farm-household work', 5 is 'transitory wage-household work'.

INDI is a vector of individual characteristics in 2008, including marital status, age, and educational attainment, social capital (social network), according to Walter and Heinrichs (2015), Simoes et al. (2016), Liu and Liu (2016), Barrett et al. (2001), Coppard (2001), Deininger and Olinto (2001), Reardon et al. (2001), and Reardon (1997). A positive and significant association between education levels and non-farm income at individual level has been empirically established in different developing country contexts (see for example, Barrett et al. (2001); Coppard (2001); Deininger and Olinto (2001); Reardon et al. (2001)). Better educated individuals are likely to possess skills which facilitate successful involvement in non-farm activities, including the ability to manage a business, process relevant information, adapt to changing demand patterns, and liaise with public and private service providers. They are also likely to have greater aspirations with regard to working outside agriculture. Being married and having young children and elderly parents is likely to reduce the propensity of females participate in the labour market. Nevertheless, the availability of domestic help can enable mothers to go out to work. In contrast, being married, being heads of households, and having children and elderly parents are likely to compel males to participate in the labour market.

INCOME is household income in 2008 (Barrett et al. (2001); Coppard (2001); Deininger and Olinto (2001); Reardon et al. (2001); Reardon (1997)).

The factors affecting the probability of choosing a particular employment status could also affect the probability of choosing another type of employment. Consequently, the error terms of employment choice functions are correlated. This unique characteristic requires the application of the so-called seemingly (un)related regression models, which need to be jointly estimated from several regression models, where the error terms associated with the dependent variables are assumed to be correlated across the following equations. Therefore, the empirical basic model of employment transition includes a set of five simultaneous equations which can be further elaborated as follows:

$$\begin{cases} Trans_{ijk1} = [Trans_{ijk} = 1] = INDI_{i1}^0 \alpha + INCOME_{j1}^0 \beta + \alpha_k + u_i + e_{ijk1} \\ Trans_{ijk2} = [Trans_{ijk} = 2] = INDI_{i2}^0 \alpha + INCOME_{j2}^0 \beta + \alpha_k + u_i + e_{ijk2} \\ Trans_{ijk3} = [Trans_{ijk} = 3] = INDI_{i3}^0 \alpha + INCOME_{j3}^0 \beta + \alpha_k + u_i + e_{ijk3} \\ Trans_{ijk4} = [Trans_{ijk} = 4] = INDI_{i4}^0 \alpha + INCOME_{j4}^0 \beta + \alpha_k + u_i + e_{ijk4} \\ Trans_{ijk5} = [Trans_{ijk} = 5] = INDI_{i5}^0 \alpha + INCOME_{j5}^0 \beta + \alpha_k + u_i + e_{ijk5} \end{cases} \quad (1\text{-ALT})$$

Since dependent variables in model 1-ALT are discrete ones, we estimate model 1-ALT by using gsem (generalized structural equation model) command in Stata applied for multivariate probit models (Huber, 2013; Huber, 2014).

The second objective of the current study is to examine the roles of changes in individual characteristics, household characteristics, and local climate conditions at the commune level in determining patterns of structural transformation in the rural area at individual level in Viet Nam. Therefore, we seek for the effects of changes related to individual, household characteristics, and local climate conditions at the commune level between 2008 and 2016, respectively. A set of extension models of transitions in rural area are named as Models 1A, 1B, and 1C as follows:

$$Trans_{ijk} = \{INDI_i^0 \alpha + INCOME_j^0 \beta + \Delta INDI_i^{1-0} \delta_1 + \alpha_k + u_i + e_{ijk} \geq 0\} \quad (1A)$$

$$Trans_{ijk} = \{INDI_i^0 \alpha + INCOME_j^0 \beta + \Delta HHC_i^{1-0} \delta_2 + \alpha_k + u_i + e_{ijk} \geq 0\} \quad (1B)$$

$$Trans_{ijk} = \{INDI_i^0 \alpha + INCOME_j^0 \beta + \Delta CLIMATE_i^{1-0} \delta_3 + \alpha_k + u_i + e_{ijk} \geq 0\} \quad (1C)$$

in which, $\Delta INDI_i^{1-0}$, ΔHHC_i^{1-0}, and $\Delta CLIMATE_i^{1-0}$ are vectors of changes in individual characteristics (INDI), household characteristics (HHC), and local climate conditions (CLIMATE) at the commune level during 2008-2016, respectively. The initial variables represent the individual conditions ($INDI_i^0$) and changes in individual characteristics ($\Delta INDI_i^{1-0}$), changes in household characteristics (ΔHHC_i^{1-0}), and changes in local climate conditions

($\Delta CLIMATE_i^{1-0}$) at the commune level as well may change the transition status in the future. For example, farms decide to be non-farms after changing their marital status or furthering their education. Meanwhile, a new policy issue might make the farms become non-farms.

HHC is a vector of household characteristics, including age of working-age members, the ratio of children, number of working-age members, and number of Vietnamese communist party member, shares of education levels among household members, social capital (social network), land endowments (land ownership in hectares), size of living house (in square meters), access to credit, and access to government transfer (see for example, Fafchamps and Minten (1998); Montgomery (1991); Rozelle et al. (1999); Banerjee (1983); Wu and Zhou (1996); Nee (1996); Bezemer and Davis (2002); Davis (2003); Coppard (2001); Rennings et al. (2001); Liu et al. (2018); Martin and Lorenzen (2016); Rigg et al. (2018); Sackey (2018)).

CLIMATE is a vector of the local climate conditions at the commune level, which is represented by the number of weather shocks (Doss et al. (2008); Povel (2015)) that the commune has experienced during the last three years (Barrett, 2014).

A similar operationalization as shown in model 1-ALT for extension models 1a, 1b, and 1c is conducted and we estimate the corresponding models, namely model 1A-ALT, 1B-ALT, and 1C-ALT.

Results and discussion

Statistical description

Table 2 presents an overall picture of rural transition during 2008-16, which is based on the 2,699 individuals in the five-wave panel between 2008 and 2016, looking in particular at the extent to which individuals move within a number of activities, namely: farming, wage, household business, and household work. While individuals persistently engaged in agriculture is dominant in the sample (16.30 percent), Table 2 shows variations of other activities by individuals. Individuals moving from agriculture to wage/salary sector account for 4.56 per cent, while moving to household work is 13.78 per cent in the sample. Similarly, individuals moving from wage/salary sector to household work also account for 13.78 per cent in the sample. Individuals moving from wage/salary sector to both farming and household business are about 3.78 per cent. During the period, there are 7.97 per cent of individuals moving from household to farming, and 3.74 per cent moving from household to wage/salary sector, a little bit lower than the percentage of individuals moving from farming to wage/salary sector (4.56 percent).

Table 3 presents details of five forms of employment transition in the rural area in terms of individual characteristics in the initial year of 2008. In the following part, we compare possible employment transitions (from column 2 to 5) with persistent farming (in column 1).

Firstly, comparing persistent farming (column 1) and positive transient farm (column 2) in Table 3, we find that the former is less likely to be male, more likely to get married, more likely to be older, more likely to be the household head, and lives in a household with higher income per capita. Persistent farming (column 1) reports more probability to be a member of Farm Union. Membership in Communist Party of Vietnam (CPV) is likely to be the same between the two groups. Regarding education level, persistent farming (column 1) shows more probability to be 'unable to read and write', more likely to complete primary school, whereas positive transient farm (column 2) is more likely to finish upper secondary school, and can read and/or write (but never went to school) as well.

Secondly, like positive transient farm (column 2), 'out-of-wage' (column 3) shows more probability to be male, less likely to get married, less likely

From	To farming, %	To wage/salary sector, %	To HH business, %	To HH work, %	To other, %	Total, %
Farming	16.30 (440)	4.56 (123)	1.37 (37)	13.78 (372)	63.99 (1,727)	100.00 (2,699)
Wage/salary sector	2.56 (69)	1.44 (39)	1.22 (33)	13.78 (372)	80.99 (2,186))	100.00 (2,699)
HH business	0.59 (16)	1.11 (30)	1.11 (30)	1.30 (35)	95.89 (2,588)	100.00 (2,699)
HH work	7.97 (215)	3.74 (101)	0.59 (16)	0.70 (19)	87.00 (2,348)	100.00 (2,699)

Note: HH: household; Number of observations in parentheses
Source: Author's estimation from VARHS 2008-2016

Table 2: Summary of transition in rural area (2008-16).

Variable	Persistent farming	Positive transient farm (From agriculture to wage/salary sector)	Out-of-wage (From wage/salary sector to farming or household business)	Transitory farm-HH work (From HH work to farming)	Transitory wage-HH work (From HH work to wage/salary sector)
	-1	-2	-3	-4	-5
Sex (=1)	0.37	0.71***	0.60***	0.41	0.44*
Married (=1)	0.88	0.35***	0.64***	0.44***	0.23***
Age (years)	46.15	27.64***	34.70***	41.74***	26.27***
Age squared (years)	23.00	9.58***	14.05***	23.78	12.40***
Head (=1)	0.38	0.20***	0.31	0.29**	0.13***
Cannot read and write (=1)	0.11	0.04**	0.02***	0.10	0.13
Completed primary (=1)	0.27	0.13***	0.17	0.38***	0.43***
Completed lower secondary (=1)	0.51	0.46	0.39**	0.34***	0.34***
Completed upper secondary (=1)	0.11	0.33***	0.42***	0.12	0.06*
Can read and write but no school (=1)	0.01	0.03*	0.00	0.05***	0.04**
CPV member (=1)	0.02	0.01	0.06***	0.02	0.01
In farmer group (=1)	0.16	0.07***	0.05***	0.07***	0.02***
Net total income per capita in 2008 (log)	8.85	8.46***	9.24***	8.67***	8.57***
Number of observations	437	123	110	372	216

Note: HH: Household; *** p<0.01, ** p<0.05, * p<0.1; all are non-parametric two-sample test: Mann–Whitney U test and compared with column (1). Total sample: 2,698
Source: Author's estimation from VARHS 2008-2016

Table 3: Transition in rural area: Initial year in 2008 (Percentage).

to be older. However, 'out-of-wage' (column 3) proves more possibility to live in a household with higher income per capita. 'Being the household head' is likely to be the same between the two groups. Persistent farming (column 1) reports more probability to be a member of Farm Union, whereas 'out-of-wage' (column 3) shows more possibility to be a member of CPV. With respect to education level, persistent farming (column 1) reveal more probability to be 'unable to read and write', whereas 'out-of-wage' (column 3) is more likely to finish upper secondary school.

Thirdly, both 'transitory farm-household work' (column 4) and 'transitory wage-household work' (column 5), in comparison with persistent farming (column 1), inform a less probability of getting married, of being older, being the household head, being a member of Farmer Union, and possess a lower income per capita household membership. With regard to education level, both 'transitory farm-household work' (column 4) and 'transitory wage-household work' (column 5) itemize more probability to complete primary school, to be 'can read and write but never went to school', whereas less likely to finish lower secondary school.

Table 4 presents details of employment transitions in the rural area in terms of changes between 2016 and 2008. We compare possible employment transitions (from columns 2 to 5) with persistent farming (in column 1).

Firstly, regarding to changes in individual characteristics between 2016 and 2008, we find that persistent farming is less likely to get married than other four types of transition. In addition, there is no difference between persistent farming and other transition form in terms of 'being married', 'being divorced', and 'being CPV member'. While positive transient farm (column 2) and out-of-wage transition (column 3) are different from persistent farming in terms of 'completed lower secondary', 'transitory farm-household work' and 'transitory wage-household work' are different from persistent farmers in terms of 'completed upper secondary'. Being a member of Farmer Union is associated with both 'transitory farm-household work' and 'transitory wage-household work'.

Secondly, with respect to changes in household characteristics between 2016 and 2008, change in household head leads to changes in four types of transition in comparison with persistent farming (column 1), while no matter what a change in CPV status of a household head or change in CPV member of a household, no transition of any type is observed. Regarding to demographic factors, increase in household size reports more probability to move out of wage/salary sector to either farming or household business (column 3). Timing effect of old age increases the probability to move from household work to either farming or wage/salary sector (columns 4 and 5). Higher

dependency ratio has higher change to move out of wage/salary sector to either farming or household business (column 3), or to move from household work to either farming or wage/salary sector (columns 4 and 5). Access to credit is found to be indifferent among types of employment transition. Changes in arable land increases the probability to move out of wage/salary sector to either farming or household business (column 3), whereas income increase is associated with a more possibility to be positive transient farm (column 2) or transitory wage-household work status (column 5). There is no difference in terms of assets such as durable asset value and housing size among types of transition. Political and social networks report a higher probability to be transitory wage-household work status (column 5). Natural and pest shocks are found to affect the move out of wage/salary sector to farming or household business (column 3).

Variable	Persistent farming	Positive transient farm (From agriculture to wage/salary sector)	Out-of-wage (From wage/salary sector to farming or HH business)	Transitory farm-HH work (From HH work to farming)	Transitory wage-HH work (From HH work to wage/salary sector)
	(1)	(2)	(3)	(4)	(5)
Changes in individual characteristics (dummy), from No (in 2008) to Yes (in 2016)					
Married	0.01	0.13***	0.05***	0.03***	0.03**
Divorced	0.00	0.00	0.00	0.03	0.00
Head of HH	0.02	0.00	0.01	0.02	0.01
Completed lower secondary	0.04	0.01*	0.00**	0.02	0.03
Completed upper secondary	0.03	0.05	0.04	0.06*	0.13***
CPV member	0.00	0.00	0.02	0.00	0.00
In farmer group	0.07	0.03	0.04	0.01***	0.01***
Changes in household characteristics (dummy), from No (in 2008) to Yes (in 2016)					
Head changed	0.00	0.02***	0.01**	0.01**	0.03***
Head being CPV member	0.01	0.00	0.02	0.00	0.00
Increase in primary degree	0.22	0.14*	0.28	0.21	0.22
Increase in lower secondary degree	0.40	0.37	0.35	0.39	0.46
Increase in upper secondary degree	0.45	0.58**	0.48	0.55***	0.62***
Increase in HH size	0.23	0.26	0.39***	0.25	0.24
Increase in average ages of working-age members	0.69	0.68	0.65	0.46***	0.46***
Increase in numbers working-age members	0.25	0.37**	0.28	0.59***	0.58***
Increase in the ratio of children	0.28	0.30	0.43***	0.41***	0.12***
CPV member(s) (Counting the HH head) of HH	0.01	0.01	0.04	0.00*	0.00
CPV member(s) (Not counting the HH head) of HH	0.01	0.01	0.03	0.00	0.00
Access to credit	0.01	0.02	0.02	0.01	0.00
Increased in arable land	0.19	0.18	0.08***	0.18	0.22
Loss in arable land	0.17	0.20	0.15	0.13*	0.17
Land per capita	0.19	0.18	0.08***	0.22	0.22
Increased in income	0.92	0.97*	0.88	0.91	0.88*
Increased in asset values	0.19	0.20	0.16	0.21	0.23
Increased in housing size	0.19	0.20	0.16	0.21	0.23
Political network member	0.05	0.06	0.03	0.08	0.09*
Having support from relatives	0.20	0.13*	0.17	0.19	0.09***
Natural shock	0.06	0.04	0.01**	0.05	0.07
Pest shock	0.04	0.02	0.00**	0.03	0.03

Note: HH: Household; *** p<0.01, ** p<0.05, * p<0.1; all are non-parametric two-sample test: Mann–Whitney U test and compared with column (1). Total sample: 2,698
Source: Author's estimation from VARHS 2008-2016

Table 4: Transitions in rural area between 2008 and 2016 (Percentage) (to be continued).

Variable	Persistent farming	Positive transient farm (From agriculture to wage/salary sector)	Out-of-wage (From wage/salary sector to farming or HH business)	Transitory farm-HH work (From HH work to farming)	Transitory wage-HH work (From HH work to wage/salary sector)
	(1)	(2)	(3)	(4)	(5)
Economic shock	0.02	0.02	0.01	0.02	0.01
Illness shock	0.02	0.02	0.01	0.02	0.01
Changes in commune characteristics (dummy), from No (in 2008) to Yes (in 2016)					
Flood, t-1	0.08	0.13	0.05	0.10	0.10
Drought, t-1	0.20	0.15	0.15	0.20	0.23
Typhoon, t-1	0.09	0.06	0.05	0.10	0.10
Land slide, t-1	0.04	0.08*	0.01*	0.05	0.07
Animal/livestock epidemics, t-1	0.15	0.10	0.18	0.15	0.14
Plant disease, t-1	0.11	0.11	0.15	0.07	0.07
Insects/rats, t-1	0.06	0.06	0.06	0.05	0.05
Flood, t-2	0.10	0.10	0.05	0.12	0.11
Drought, t-2	0.16	0.11	0.06***	0.16	0.21*
Typhoon, t-2	0.12	0.07*	0.07	0.12	0.11
Land slide, t-2	0.05	0.10*	0.03	0.03	0.07
Animal/livestock epidemics, t-2	0.15	0.12	0.20	0.15	0.15
Plant disease, t-2	0.10	0.09	0.15	0.07	0.08
Insects/rats, t-2	0.06	0.04	0.08	0.05	0.05
Number of observations	437	123	110	372	216

Note: HH: Household; *** p<0.01, ** p<0.05, * p<0.1; all are non-parametric two-sample test: Mann–Whitney U test and compared with column (1). Total sample: 2,698
Source: Author's estimation from VARHS 2008-2016

Table 4: Transitions in rural area between 2008 and 2016 (Percentage) (continuation).

Thirdly, with respect to changes in local climate conditions between 2016 and 2008, most of natural disasters in the previous year have no association with various types of employment transition, except for land slide with a clear effect on positive transient farm (column 2) and a move from wage/salary sector to farming or household business (column 3). In respect to natural disasters in the year before previous year, drought is found to be associated with a move from wage to farming or household business (column 3) and transitory wage-household work status (column 5) and typhoon and land slide with positive transient farm (column 2).

Empirical results and discussion

We turn now to a multivariate analysis of the factors associated with being engaged in transitions in the rural area. The likelihood of engaging in each of these activities is modelled as a function of many of the factors already considered in the sub-section of 'Methods of analysis', and province fixed effects. The model is fixed effect so as to handle the problem of unobserved variables at individual level as well.

Table 5 shows results of fixed-effects multivariate probit models for the likelihood of transitions in the rural area, taking into account the individual characteristics in the initial year of 2008 (Model 1-ALT). Table 6 presents results of taking into account the changes in individual characteristics (Model 1A-ALT). Table 7 highlights the effects of the changes in household characteristics (Model 1B-ALT). Table 8 gives more evidence by taking into account the changes in commune characteristics (Model 1C-ALT). We use command gsem (generalized structural equation model) in Stata to estimate multivariate probit models (Huber, 2013; Huber, 2014).

The right-hand side variables can largely be regarded as exogenous. We include gender, material status, head of household, CPV membership, membership of Farmer Union, and education level as well, the relevance of them are strongly suggested by the results in Table 3. In addition, age and the square of age are also in the model. Results of the set of regression models on the determinants of rural employment transitions are presented in Tables 5-8. The reported coefficients in Tables 5-8 are estimated of the effect of a marginal change in the corresponding regressor (or discrete change of a dummy variable from 0 to 1) on the probability of choosing one from five forms of employment transition.

We firstly discuss the results of Model 1-ALT of individual characteristics in Table 5. Columns 1, 2, 3, 4, and 5 show the results for (1) the choice by an individual to be in agriculture during the survey period, (2) the choice to be employed in wage/salary sector, (3) the choice to move out of wage/salary sector, the choice to move out of household work to (4) farming and (5) to wage/salary sector, respectively.

Regarding the gender, ceteris paribus, the results show that males have a lower probability of 2.7 per cent to be persistent farming than females (column 1); males are more likely to move to wage/salary sector than females (column 2) by 3.9 per cent (This is in line with most recent study by Sackey (2018)); males' probability to move out of wage/salary sector is 2.0 per cent more than that of females (column 3); and males have a lower probability by 0.6 per cent to move from household work to farming than females (column 4).

With regard to the marital status of individual, ceteris paribus, the results indicate that married individuals have higher probability of 6.3 per cent to be persistent farming compared to the unmarried ones (column 1); married individuals are less likely to move from agriculture to wage/salary sector than the unmarried ones (column 2), about 5.8 per cent; married individuals are less likely to move from household work to farming (column 4) and from household work to wage/salary sector (column 5) than the unmarried ones by 6.3 per cent and 3.5 per cent, respectively.

Age is found to have an inversed U-shaped effect on choices to be persistent farming (column 1), to move from agriculture to wage/salary sector (column 2), to move out of wage/salary sector (column 3). This is in line with study of Liu and Liu (2016), who find that age is an important influence of off-farm employment decision. Sackey (2018) also finds an inversed U-shaped relationship between age and non-farm employment. In addition, ages are found to have a U-shaped effect on choices to move from household work to being farm (column 4), to move from household work to wage/salary sector (column 5).

With respect to the status of household head, the results show no significant effect of headed individual on all of possible employment transitions.

In relation to the Farmer Union's membership of individual, the results prove that household-head individuals are 2.8 per cent more likely to be persistent farming, ceteris paribus. However, those household-head individuals are less likely to move out of wage/salary sector compared to other family members (column 3) or to move from household work to farming than other family members (column 4) by 3.7 per cent and 2.0 per cent respectively, ceteris paribus. Individual with CPV membership tends to leave farming (column 1) or be less likely to move from household work to farming (column 4), ceteris paribus, about 5.8 per cent and 1.2 per cent respectively.

In terms of educational levels, results in Table 5 suggest that individuals with primary, lower secondary school are more likely to be persistent in farming (column 1), ceteris paribus. In addition, individuals with lower and upper secondary school, and 'can read and write but never went to school' are more likely to move to wage/salary sector (column 2). This is in line with study of Liu and Liu (2016), and Sackey (2018), they find that education is an important influence of non-farm employment decision. Moreover, individuals with upper secondary school are more likely to move to out of wage/salary sector (column 3), ceteris paribus. Besides, individuals with lower and upper secondary school are less likely to move from household work to wage/salary sector (column 5), while holding all other variables in the model constant.

The results in Table 5 also reveal that individuals move out of wage/salary sector (column 3) when their households have higher income per capita level, and not to move to wage/salary sector (column 2), or not to move from household work to farming, ceteris paribus. Put it differently, income shocks may be associated with a move from agriculture to wage/salary sector or a move from household work to farming. This is in line with a most recent study in this field by Beck et al. (2018) (for the case of coffee farmers in the Central Highlands of Viet Nam).

Table 6 presents results of fixed-effects multivariate probit models for the likelihood of transitions in the rural area, taking into account the changes in individual characteristics (Model 1A-ALT). Results in Table 6 confirms similar findings for transition in the rural area as presented in Table 5. Table 6 further shows that, individuals with changes in marital status are more likely to move from agriculture to wage/salary sector (column 2). Accordingly, getting married is associated with about 4.2 percentage point higher probability that individuals move from agriculture to wage/salary sector. In addition, individuals with a completion of lower secondary school in the sample period are likely to have a probability

Variable	Persistent farming	Positive transient farm (From agriculture to wage/salary sector)	Out-of-wage (From wage/salary sector to farming or HH business)	Transitory farm-HH work (From HH work to farming)	Transitory wage-HH work (From HH work to wage/salary sector)
	(1)	(2)	(3)	(4)	(5)
Male (=1)	-0.0270*	0.0396***	0.0198**	-0.0066***	-0.0069
	(0.0153)	(0.0090)	(0.0097)	(0.0021)	(0.0110)
Married (=1)	0.0534**	-0.0582***	-0.0114	-0.0634***	-0.0345**
	(0.0237)	(0.0115)	(0.0135)	(0.0174)	(0.0142)
Age (years)	0.0136***	0.0066***	0.0052***	-0.0012***	-0.0107***
	(0.0025)	(0.0013)	(0.0017)	(0.0003)	(0.0014)
Age squared/100	-0.0119***	-0.0089***	-0.0072***	0.0024***	0.0120***
	(0.0026)	(0.0017)	(0.0022)	(0.0005)	(0.0015
Head of HH (=1)	-0.0208	-0.0144	0.0002		-0.0151
	(0.0157)	(0.0120)	(0.0112)		(0.0185)
CPV membership (=1)	-0.0583*	-0.0450	0.0151	-0.0116*	0.0508
	(0.0345)	(0.0355)	(0.0186)	(0.0060)	(0.0366)
Member of Farm Union (=1)	0.0281**	-0.0166	-0.0369**	-0.0197***	-0.0361
	(0.0127)	(0.0153)	(0.0160)	(0.0041)	(0.0277)
Completed primary (=1)	0.0376*	0.0101	0.0314	-0.0035	-0.0212
	(0.0205)	(0.0187)	(0.0234)	(0.0023)	(0.0162)
Completed lower secondary (=1)	0.0568***	0.0278*	0.0271	-0.0171***	-0.0438***
	(0.0220)	(0.0167)	(0.0215)	(0.0052)	(0.0164)
Completed upper secondary (=1)	0.0056	0.0483***	0.0605***	-0.0064**	-0.0864***
	(0.0269)	(0.0178)	(0.0219)	(0.0030)	(0.0231)
Can read and write but no school (=1)	-0.0796	0.0731**		-0.0155**	-0.0139
	(0.128)	(0.0286)		(0.0072)	(0.0319)
Net total income per capita in 2008 (log)	0.0045	-0.0141***	0.0125***	-0.0028***	-0.0011
	(0.0053)	(0.0034)	(0.0040)	(0.0008)	(0.0052)
Log Likelihood			-3271.6026		
Observations	2,698	2,698	2,698	2,698	2,698

Note: HH: Household; Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Method of estimation: fixed-effects multivariate probit models using gsem (generalized structural equation model) command in Stata (Huber, 2013; Huber, 2014)
Source: Author's estimation from VARHS 2008-2016

Table 5: Basic model of transitions in the rural area (marginal effect), 2008-16 (Model 1-ATL).

of higher 8.4 percentage point to be persistent in farming (column 1). Moreover, becoming a new member of Farmer Union in the sample period likely increases about 5.1 percentage point probability of being persistent farming (column 1).

Table 7 exposes results of fixed-effects multivariate probit models for the likelihood of transitions in the rural area, taking into account the changes in household characteristics (Model 1B-ALT). Results in Table 7 support similar findings for transition in the rural area as presented in Table 5. Table 7 also shows that individuals in household with an increase in the proportion of attaining primary school is likely to have a lower 2.7 percentage point probability to move to wage/salary sector (column 2), and individuals in household with an increase in the proportion of attaining lower secondary school is likely associated with a lower 4.03 percentage point probability to be in persistent farming (column 1), ceteris paribus.

With regard to change in demographic characteristics, individuals in household with an increase in the number of working-age

Variable	Persistent farming	Positive transient farm (From agriculture to wage/salary sector)	Out-of-wage (From wage/salary sector to farming or HH business)	Transitory farm-HH work (From HH work to farming)	Transitory wage-HH work (From HH work to wage/salary sector)
	(1)	(2)	(3)	(4)	(5)
Male (=1)	-0.0336*	0.0388***	0.0202**	-0.00001	-0.0093
	(0.0182)	(0.0090)	(0.0098)	(0.00001)	(0.0107)
Married (=1)	0.0391*	-0.0525***	-0.0082	-0.00001	-0.0387***
	(0.0229)	(0.0118)	(0.0139)	(0.00001)	(0.0145)
Age (years)	0.0149***	0.0064***	0.0051***	-0.00001	-0.0111***
	(0.0023)	(0.0013)	(0.0017)	(0.00001)	(0.0014)
Age squared/100	-0.0123***	-0.00850***	-0.00707***	-0.00001	0.0126***
	(0.0029)	(0.0017)	(0.0022)	(0.00001)	(0.0015)
Head of HH (=1)	-0.0284	-0.0142	0.0005		-0.0134
	(0.0193)	(0.0120)	(0.0114)		(0.0183)
CPV membership (=1)	-0.0884**	-0.0421	0.0154	0.00003	0.0427
	(0.0447)	(0.0350)	(0.0189)	(0.00002)	(0.0355)
Member of Farm Union (=1)	0.0326*	-0.0155	-0.0370**	0.00001	-0.0367
	(0.0197)	(0.0153)	(0.0163)	(0.00001)	(0.0273)
Completed primary (=1)	0.0525**	0.0105	0.0364	-0.0001	-0.0160
	(0.0246)	(0.0191)	(0.0236)	(0.0001)	(0.0162)
Completed lower secondary (=1)	0.0765***	0.0274	0.0329	-0.0001*	-0.0371**
	(0.0250)	(0.0173)	(0.0217)	(0.00001)	(0.0163)
Completed upper secondary (=1)	0.0112	0.0465**	0.0670***	-0.00001 (	-0.0747***
	(0.0313)	(0.0184)	(0.0224)	0.0001)	(0.0229)
Can read and write but no school (=1)	-0.0989*	0.0748***		-0.0001*	-0.0093
	(0.0585)	(0.0286)		(0.0001)	(0.0312)
Net total income per capita in 2008 (log)	0.0107	-0.0140***	0.0126***	-0.00002	-0.0019
	(0.0104)	(0.0034)	(0.0041)	(0.00002)	(0.0050)
Changes of individual characteristics between 2016 and 2008, from No (in 2008) to Yes (in 2016) (dummy)					
Married	0.0461	0.0419***	0.0056	0.00003	-0.0236
	(0.0623)	(0.0151)	(0.0203)	(0.00002)	(0.0251)
Completed lower secondary	0.0840**	-0.0250		-0.00005	0.0026
	(0.0364)	(0.0365)		(0.00004)	(0.0269)
Completed upper secondary	-0.0219	0.0137	0.0042	-0.00007	0.0151
	(0.0342)	(0.0177)	(0.0187)	(0.00005)	(0.0170)
Farmer Union member	0.0512*	0.0025	-0.0033		0.0070
	(0.0284)	(0.0204)	(0.0198)		(0.0318)
Log Likelihood			-3424.7907		
Observations	2,698	2,698	2,698	2,698	2,698

Note: HH: Household; Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Method of estimation: fixed-effects multivariate probit models using gsem (generalized structural equation model) command in Stata (Huber, 2013; Huber, 2014)

Source: Author's estimation from VARHS 2008-2016

Table 6: Extension model of transitions in the rural area (marginal effect): changes of individual characteristics in 2008-16 (Model 1A-ALT).

members is less likely to move from household work to farming (column 4). In addition, individuals in household with higher ratio of children under 16 and elderly members is more likely to move from agriculture to wage/salary sector (column 5) and to move from household work to farming (column 4), with an association of higher probability of about 1.8 percentage. Moreover, individuals in household with a change in household head is less likely to move from household work to farming (column 4), with an association of lower probability of about 0.3 percentage.

With respect to changes in social capital, individuals in household with CPV members is more likely to move out of wage/salary sector to household business or farming (column 3). An increase in CPV member of household

is associated with a higher probability of 4.5 percentage, ceteris paribus. In addition, an increase in supports from relatives is associated with a higher 0.2 percentage point probability of moving from household work to farming.

Regarding changes in land, individuals in household with increase land is less likely to move out of wage/salary sector to household business or farming (column 3) or to move from household work to farming (column 4). In addition, individuals in household with land loss is more likely to move from household work to wage/salary sector (column 5) or to become persistent farming (column 1).

Variable	Persistent farming	Positive transient farm (From agriculture to wage/salary sector)	Out-of-wage (From wage/salary sector to farming or HH business)	Transitory farm-HH work (From HH work to farming)	Transitory wage-HH work (From HH work to wage/salary sector)
	(1)	(2)	(3)	(4)	(5)
Male (=1)	-0.0426**	0.0407***	0.0182*	-0.0017***	-0.0099
	(0.0177)	(0.0089)	(0.0097)	(0.0005)	(0.0112)
Married (=1)	0.0520**	-0.0550***	-0.0085	-0.0054***	-0.0295**
	(0.0212)	(0.0119)	(0.0129)	(0.0013)	(0.0150)
Age (years)	0.0122***	0.0057***	0.0045***	-0.0005***	-0.0119***
	(0.0023)	(0.0013)	(0.0017)	(0.0002)	(0.0015)
Age squared/100	-0.0101***	-0.0078***	-0.0066***	0.0007***	0.0134***
	(0.0025)	(0.0017)	(0.0021)	(0.0002)	(0.0017)
Head of HH (=1)	-0.0169	-0.0143	0.0043		-0.0114
	(0.0192)	(0.0124)	(0.0116)		(0.0187)
CPV membership (=1)	-0.0798*	-0.0470	0.0156	0.0027***	0.0483
	(0.0449)	(0.0354)	(0.0188)	(0.0007)	(0.0370)
Member of Farm Union (=1)	0.0313	-0.0199	-0.0362**	0.0001	-0.0362
	(0.0199)	(0.0148)	(0.0154)	(0.0002)	(0.0267)
Completed primary (=1)	0.0388	0.0086	0.0424*	-0.0031***	-0.0217
	(0.0244)	(0.0187)	(0.0217)	(0.0009)	(0.0166)
Completed lower secondary (=1)	0.0599**	0.0234	0.0368*	-0.0020***	-0.0390**
	(0.0247)	(0.0170)	(0.0201)	(0.0006)	(0.0168)
Completed upper secondary (=1)	-0.0065	0.0389**	0.0670***	0.0005**	-0.0806***
	(0.0311)	(0.0177)	(0.0210)	(0.0003)	(0.0237)
Can read and write but no school (=1)	-0.100*	0.0793***		-0.0109***	-0.0162
	(0.0591)	(0.0276)		(0.0029)	(0.0320)
Net total income per capita in 2008 (log)	0.0062	-0.0123***	0.0115**	-0.0011***	-0.0028
	(0.0078)	(0.0032)	(0.0046)	(0.0003)	(0.0049)
Changes of household characteristics between 2016 and 2008, from No (in 2008) to Yes (in 2016) (dummy)					
Completed primary	-0.0153	-0.0273**	0.0125	0.0002	0.0067
	(0.0160)	(0.0107)	(0.0087)	(0.0002)	(0.0119)
Completed upper secondary	-0.0403***	0.0063	-0.0024	-0.00003	-0.0076
	(0.0144)	(0.0080)	(0.0078)	(0.0001)	(0.0113)
Household size	0.0198	-0.0117	0.0143	0.000185	0.0076
	(0.0184)	(0.0104)	(0.0094)	(0.0001)	(0.0130)
Mean of working ages	0.0111	0.0017	-0.0102	-0.0001	-0.0135
	(0.0146)	(0.0082)	(0.0081)	(0.0001)	(0.0100)
Number of working-age members	-0.0277	-0.0124	-0.0161	-0.0005*	-0.0049
	(0.0175)	(0.0093)	(0.0099)	(0.0002)	(0.0123)
The ratio of children under 16	-0.0218	0.0182*	0.0118	0.0018***	-0.0249
	(0.0179)	(0.0101)	(0.0096)	(0.0005)	(0.0161)

Note: HH: Household; Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Method of estimation: fixed-effects multivariate probit models using gsem (generalized structural equation model) command in Stata (Huber, 2013; Huber, 2014)
Source: Author's estimation from VARHS 2008-2016

Table 7: Extension model of transitions in the rural area (marginal effect): changes of household characteristics in 2008-16 (Model 1B-ALT) (to be continued).

Variable	Persistent farming	Positive transient farm (From agriculture to wage/salary sector)	Out-of-wage (From wage/salary sector to farming or HH business)	Transitory farm-HH work (From HH work to farming)	Transitory wage-HH work (From HH work to wage/salary sector)
	(1)	(2)	(3)	(4)	(5)
CPV member(s) (Counting the HH head) of HH	0.0176 (0.0579)	-0.0274 (0.0401)	0.0445* (0.0258)		-0.0538 (0.0519)
Land increased	0.0252	0.0182	-0.0225*	-0.0010***	0.0155
	(0.0197)	(0.0121)	(0.0134)	(0.0003)	(0.0153)
Land loss	0.0298*	0.0123	-0.00370		0.0287**
	(0.0181)	(0.0098)	(0.0099)		(0.0126)
Income increased	0.0369	0.0345*	0.0062	-0.0036***	-0.0217
	(0.0243)	(0.0190)	(0.0127)	(0.0009)	(0.0152)
Political network member	-0.0226 (0.0308)	-0.0200 (0.0185)	-0.0238 (0.0214)		0.0321 (0.0207)
Supports from relatives	-0.0027	-0.0089	0.00472	0.0002**	-0.0051
	(0.0171)	(0.0115)	(0.0098)	(0.0001)	(0.0157)
Natural shock	0.0134	-0.0063	-0.0309	-0.0016***	-0.0079
	(0.0460)	(0.0238)	(0.0279)	(0.0005)	(0.0263)
Pesticide shock	-0.0109	-0.0363		0.0012***	-0.0016
	(0.0576)	(0.0330)		(0.0004)	(0.0364)
Head of HH		0.0331	0.0004	-0.0031***	0.0335
		(0.0328)	(0.0413)	(0.0010)	(0.0321)
Log Likelihood			-3225.8514		
Observations	2,698	2,698	2,698	2,698	2,698

Note: HH: Household; Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Method of estimation: fixed-effects multivariate probit models using gsem (generalized structural equation model) command in Stata (Huber, 2013; Huber, 2014)
Source: Author's estimation from VARHS 2008-2016

Table 7: Extension model of transitions in the rural area (marginal effect): changes of household characteristics in 2008-16 (Model 1B-ALT) (continuation).

With regard to income per capita, individuals in household with an increase in per capita income is more likely to move from agriculture to wage/salary sector (column 2) with an association of higher probability of about 3.5 percentage and less likely to move from household work to farming (column 4) with an association of lower probability of about 0.4 percentage. Moreover, individuals in household with a change in household head is less likely to move from household work to farming (column 4), with an association of lower probability of about 0.3 percentage.

Regarding to shocks, individuals in household with natural shock is less likely to move from household work to farming (column 4) with an association of lower probability of about 0.2 percentage. Moreover, individuals in household with pesticide shock is more likely to move from household work to farming (column 4), with an association of higher probability of about 0.1 percentage.

Table 8 displays results of fixed-effects multivariate probit models for the likelihood of transitions in the rural area, taking into account the changes in commune characteristics (Model 1C-ALT). Results in Table 8 affirm similar findings for transition from agriculture as presented in Table 5. Table 8 also shows that individuals in commune with changes in natural shocks such as drought is less likely to move out of wage/salary sector to farming or household business (column 3), less likely to move from household work to farming (column 4). In addition, individuals in commune with changes in natural shocks such as typhoon is less likely to move from agriculture to wage/salary sector (column 2). However, individuals in commune with changes in natural shocks such as land slide occurred in the year before last year is also more likely to move to wage/salary sector from farming (column 2). Individuals in commune with changes in natural shocks such as land slide in the last year is more likely to move from household work to farming (column 4), whereas individuals in commune with changes in natural shocks such as land slide occurred in the year before last year is less likely to move from household work to farming (column 4).

Variable	Persistent farming	Positive transient farm (From agriculture to wage/salary sector)	Out-of-wage (From wage/salary sector to farming or HH business)	Transitory farm-HH work (From HH work to farming)	Transitory wage-HH work (From HH work to wage/salary sector)
	(1)	(2)	(3)	(4)	(5)
Male (=1)	-0.0336*	0.0401***	0.0203**	0.00003	-0.0097
	(0.0189)	(0.0088)	(0.0096)	(0.00002)	(0.0109)
Married (=1)	0.0386*	-0.0561***	-0.0091	0.00007*	-0.0418***
	(0.0231)	(0.0116)	(0.0133)	(0.00004)	(0.0151)
Age (years)	0.0161***	0.0063***	0.0050***	-0.0001***	-0.0109***
	(0.0027)	(0.0013)	(0.00168)	(0.00004)	(0.0014)
Age squared/100	-0.0135***	-0.0085***	-0.0070***	0.0001***	0.0124***
	(0.0030)	(0.0016)	(0.0021)	(0.00004)	(0.0015)
Head of HH (=1)	-0.0263	-0.0154	0.0010		-0.0131
	(0.0193)	(0.0119)	(0.0112)		(0.0187)
CPV membership (=1)	-0.0932**	-0.0465	0.0127	0.0006***	0.0437
	(0.0452)	(0.0357)	(0.0185)	(0.0002)	(0.0367)
Member of Farm Union (=1)	0.0295	-0.0180	-0.0370**	-0.0001**	-0.0365
	(0.0201)	(0.0151)	(0.0158)	(0.00005)	(0.0278)
Completed primary (=1)	0.0556**	0.0133	0.0371	-0.0007***	-0.0131
	(0.0249)	(0.0193)	(0.0235)	(0.0002)	(0.0164)
Completed lower secondary (=1)	0.0737***	0.0317*	0.0326	-0.0005***	-0.0379**
	(0.0255)	(0.0175)	(0.0217)	(0.0001)	(0.0165)
Completed upper secondary (=1)	0.0115	0.0518***	0.0651***	0.0003***	-0.0789***
	(0.0323)	(0.0185)	(0.0222)	(0.0001)	(0.0233)
Can read and write but no school (=1)	-0.0920	0.0808***		-0.0003**	-0.0086
	(0.0595)	(0.0287)		(0.0001)	(0.0317)
Net total income per capita in 2008 (log)	0.0109	-0.0139***	0.0124***	-0.0001***	-0.0021
	(0.0103)	(0.0035)	(0.0040)	(0.0001)	(0.0050)
Changes of local climate condition at the commune level between 2016 and 2008, from No (in 2008) to Yes (in 2016) (dummy)					
Land slide, t-1	0.0143	0.0123	-0.0413	0.0001*	0.0243
	(0.0368)	(0.0162)	(0.0324)	(0.00005)	(0.0206)
Drought, t-2	0.0224	-0.0182	-0.0414***	-0.0003***	0.0107
	(0.0184)	(0.0120)	(0.0129)	(0.00008)	(0.0119)
Typhoon, t-2	0.0177	-0.0312**	-0.0125	-0.00004	-0.0186
	(0.0210)	(0.0148)	(0.0130)	(0.00003)	(0.0157)
Land slide, t-2	-0.0266	0.0295*	0.00290	-0.0004***	-0.00143
	(0.0338)	(0.0154)	(0.0219)	(0.0001)	(0.0214)
Log Likelihood			-3249.3025		
Observations	2,698	2,698	2,698	2,698	2,698

Note: HH: Household; Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Method of estimation: fixed-effects multivariate probit models using gsem (generalized structural equation model) command in Stata (Huber, 2013; Huber, 2014)
Source: Author's estimation from VARHS 2008-2016

Table 8: Extension model of transitions in the rural area (marginal effect): changes of commune characteristics in 2008-16 (Model 1C-ALT).

Conclusion

This paper is the first attempt to analyse the employment transitions in the rural area of Viet Nam by using a unique individual-level dataset. Starting from the VARHS dataset with the five waves from 12 provinces of rural Viet Nam, compilation is further processed by using the individual identification in combination with the information on age and gender, besides the common use of household identification, and result in 2,698 individual-level observations in two years: 2008 and 2016. We find that initial individual-level human capital such as gender, marital status, age, and education attainment, and social capital such as member of social-political organization are important factors affecting employment transition status in the rural area. In addition, changes in individual, household characteristics and local climate conditions

at commune level are very important to affect various types of employment transition.

Specifically, in regard to changes in individual characteristics, individuals with changes in marital status are more likely to move from agriculture to wage/salary sector. In addition, individuals with completion of lower secondary school in the sample period are more likely to be persistent in farming. Besides, being a member of Farmer Union likely increases the probability of being persistent farming.

With respect to changes in household level, individuals in household with changes in the proportion of attaining primary school are less likely to move from agriculture to wage/salary sector, and individuals in household with changes in the proportion of attaining lower secondary school are less likely to be in persistent farming. In addition, with regard to change in demographic characteristics, individuals in household with an increase in the number of working-age members are less likely to move from household work to farming. Moreover, individuals in household with higher ratio of children under 16 and elderly members are more likely to move from agriculture to wage/salary sector and to move from household work to farming. Furthermore, individuals in household with a change in household head is less likely to move from household work to farming.

Besides, with respect to changes in social capital, individuals in household with CPV members are more likely to move out of wage/salary sector to farming or household business. In addition, individuals in household with supports from relatives are more likely to move from household work to farming.

On top of that, regarding changes in land, individuals in household with increased land are less likely to move out of wage/salary sector to household business or farming or to move from household work to farming. In addition, individuals in household with land loss are more likely to choose to move from household work to wage/salary sector or to become persistent farming.

With regard to income per capita, individuals in household with an increase in per capita income is more likely to move from agriculture to wage/salary sector and less likely to move from household work to farming. Moreover, individuals in household with a change in household head is less likely to move from household work to farming.

Regarding to shocks, individuals in household with natural shock is less likely to move from household work to farming. Moreover, individuals in household with pesticide shock is more likely to move from household work to farming.

Regarding changes in local climate conditions at the commune level, individuals in commune with changes in natural shocks such as drought is less likely to move out of wage/salary sector to farming or household business, less likely to move from household work to farming. In addition, individuals in commune with changes in natural shocks such as typhoon is less likely to move from agriculture to wage/salary sector. However, individuals in commune with changes in natural shocks such as land slide occurred in the year before last year is also more likely to move to wage/salary sector from farming. Individuals in commune with changes in natural shocks such as land slide in the last year is more likely to move from household work to farming, whereas individuals in commune with changes in natural shocks such as land slide occurred in the year before last year is less likely to move from household work to farming.

Results have implications for development policy for rural transition in developing countries, highlighting the importance of the positive aspects of changes in individual-, household-, and commune-levels for rural transformation. Promotion of education attainment is necessary at both individual- and household-level to spur the transition out of farming. Broadened policy mechanisms which support and encourage non-farm employment at the household level are also needed. Likewise, development initiatives that focus on increasing the human and social assets of the individual farmers and farming households are more likely to be successful in supporting livelihood diversification and reducing vulnerability.

Acknowledgments

The working version of this article was published as Ngo (2018). We would like to thank UNU-WIDER as the original commissioning institute. The copyright of the working paper has been transferred to Quang-Thanh Ngo and co-authors. The authors are grateful to Finn Tarp and Saurabh Singhal for their kind support and valuable comments.

Corresponding authors
Quang-Thanh Ngo, Ph.D.
University of Economics and Law (UEL), Vietnam National University Ho Chi Minh City (VNU-HCM)
Quarter 3, Linh Xuan Ward, Thu Duc District, Ho Chi Minh City, Vietnam
Phone: (84)816891111, E-mail: thanhnq@uel.edu.vn
ORCID: 0000-0001-8357-1957

References

[1] Banerjee, B. (1983) "The role of the informal sector in the migration process: A test of probabilistic migration models and labour market segmentation for India", *Oxford Economic Papers*, Vol. 35, No. 3, pp. 399-422. ISSN 0030-7653. DOI 10.1093/oxfordjournals.oep.a041604.

[2] Barrett, C. B., Reardon, T. and Webb, P. (2001) "Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications", *Food Policy*, Vol. 26, No. 4, pp. 315-331. ISSN 0306-9192. DOI 10.1016/S0306-9192(01)00014-8.

[3] Barrett, S. (2014) "Subnational Climate Justice? Adaptation Finance Distribution and Climate Vulnerability", *World Development*, Vol. 58, pp. 130-142. ISSN 0305-750X. DOI 10.1016/j.worlddev.2014.01.014.

[4] Beck, U., Singhal, S. and Tarp, F. (2018) "Commodity prices and intra-household labor allocation", *American Journal of Agricultural Economics*, Vol. 101, No. 2, E-ISSN 1467-8276, ISSN 0002-9092. DOI 10.1093/ajae/aay082.

[5] Berdegué, J. A., Ramírez, E., Reardon, T. and Escobar, G. (2001) "Rural nonfarm employment and incomes in Chile", *World Development*, Vol. 29, No. 3, pp. 411-425. ISSN 0305-750X. DOI 10.1016/S0305-750X(00)00102-9.

[6] Bezemer, D. and Davis, J. (2002) "*The rural non-agricultural economy in transition countries: findings from Armenia*", Natural Resource Institute Working Paper, NRI Report, 2678. [Online]. Available: https://gala.gre.ac.uk/id/eprint/11651/1/11651_Davis_The%20rural%20non%20agricultural%20economy%20in%20transition%20(working%20paper)%202002.pdf. [Accessed: 31 Jan. 2019].

[7] CIEM, DOE, ILSSA, and IPSARD (2009) "Vietnam Access to Resources Household Survey: Characteristics of the Vietnamese Rural Economy (2008 Survey)", Hanoi: Statistical Publishing House.

[8] Coppard, D. (2001) "*The rural non-farm economy in India: A review of the literature*", Natural Resource Institute Working Paper, NRI Report, 2662. [Online]. Available: https://gala.gre.ac.uk/id/eprint/11644/1/11644_Coppard_The%20rural%20non%20farm%20economy%20in%20India%20(working%20paper)%202001.pdf [Accessed: 31 Jan. 2019].

[9] Davis, J. R. (2003) "The rural-non-farm economy, livelihoods and their diversification: Issues and options", Natural Resource Institute Working Paper, NRI Report, 2753. ISSN 1556-5068. DOI 10.2139/ssrn.691821.

[10] Deininger, K. and Olinto, P. (2001) "Rural nonfarm employment and income diversification in Colombia", *World Development*, Vol. 29, No. 3, pp. 455-465. ISSN 0305-750X. DOI 10.1016/S0305-750X(00)00106-6.

[11] Doss, C., McPeak, J. and Barrett, C. B. (2008) "Interpersonal, Intertemporal and Spatial Variation in Risk Perceptions: Evidence from East Africa", *World Development*, Vol. 36, No. 8, pp. 1453-1468. ISSN 0305-750X. DOI 10.1016/j.worlddev.2007.06.023.

[12] Ellis, F. and Harris, N. (2004) "Development patterns, mobility and livelihood diversification", Keynote Paper for DFID Sustainable Development Retreat, University of Surrey, Guildford, UK. [Online]. Available: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.515.1085&rep=rep1&type=pdf [Accessed: 31 Jan. 2019].

[13] Fafchamps, M. and Minten, B. (1998) "*Returns to social capital among traders*", International Food Policy Research Institute (IFPRI) Discussion Paper, (23). [Online]. Available: https://ageconsearch.umn.edu/record/91851/files/pubs_divs_mtid_dp_papers_dp23.pdf [Accessed: 31 Jan. 2019].

[14] Huber, C. (2013) "Generalized structural equation modeling using stata", Presented at *the Italian Stata Users Group Meeting*, November 14-15.

[15] Huber, C. (2014) "Introduction to Structural Equation Modeling Using Stata", California Association for Institutional Research.

[16] Hulme, D. and Shepherd, A. (2003) "Conceptualizing chronic poverty", *World Development*, Vol. 31, No. 3, pp. 403-423. ISSN 0305-750X. DOI 10.1016/S0305-750X(02)00222-X.

[17] Lanjouw, J. O. and Lanjouw, P. (2001) "The rural non-farm sector: issues and evidence from developing countries", *Agricultural Economics*, Vol. 26, No. 1, pp. 1-23. E-ISSN 1574-0862, ISSN 0169-5150. DOI 10.1111/j.1574-0862.2001.tb00051.x.

[18] Liu, J. E., Dai, H., Li, M. and Li, M. S. (2018) "Personal networks and employment: a study on landless farmers in Yunnan province of China", *Asia Pacific Journal of Social Work and Development*, Vol. 28, No. 2, pp. 71-83. E-ISSN 2165-0993, ISSN 0218-5385. DOI 10.1080/02185385.2017.1408029.

[19] Liu, Z. and Liu, L. (2016) "Characteristics and driving factors of rural livelihood transition in the east coastal region of China: A case study of suburban Shanghai", *Journal of Rural Studies*, Vol. 43, pp. 145-158. ISSN 0743-0167. DOI 10.1016/j.jrurstud.2015.12.008.

[20] Martin, S. M. and Lorenzen, K. (2016) "Livelihood diversification in rural Laos", *World Development*, Vol. 83, pp. 231-243. ISSN 0305-750X. DOI 10.1016/j.worlddev.2016.01.018.

[21] Montgomery, J. D. (1991) "*Social networks and persistent inequality in the labor market*", Evanston: Center for Urban Affairs and Policy Research. [Online]. Available: https://www.ssc.wisc.edu/~jmontgom/socnetpersineq.pdf [Accessed: 31 Jan. 2019].

[22] Nee, V. (1996) "The emergence of a market society: Changing mechanisms of stratification in China", *American Journal of Sociology*, Vol. 101, No. 4, pp. 908-949. E-ISSN 1537-5390, ISSN 0002-9602. DOI 10.1086/230784.

[23] Newman, C. and Kinghan, C. (2015) "The rural non-farm economy", In Tarp, F. (ed.) "*Growth, Structural Transformation and Rural Change in Viet Nam: A Rising Dragon on the Move*", Oxford University Press. ISBN 97801-9879-6961. [Online]. Available: https://www.econstor.eu/bitstream/10419/162550/1/89081354X.pdf [Accessed: 31 Jan. 2019].

[24] Povel, F. (2015) "Measuring exposure to downside risk with an application to Thailand and Vietnam", *World Development*, Vol. 71, pp. 4-24. ISSN 0305-750X. DOI 10.1016/j.worlddev.2013.11.006.

[25] Ngo, Q.-T. (2018) "Individual-level employment transitions in rural Viet Nam", UNU-WIDER Working Paper, 154/2018.

[26] Reardon, T. (1997) "Using evidence of household income diversification to inform study of the rural nonfarm labor market in Africa", *World Development*, Vol. 25, No. 5, pp. 735-747. ISSN 0305-750X. DOI 10.1016/S0305-750X(96)00137-4.

[27] Reardon, T., Berdegué, J. and Escobar, G. (2001) "Rural nonfarm employment and incomes in Latin America: overview and policy implications", *World Development*, Vol. 29, No. 3, pp. 395-409. ISSN 0305-750X. DOI 10.1016/S0305-750X(00)00112-1.

[28] Rennings, K., Ziegler, A. and Zwick, T. (2001) "Employment changes in environmentally innovative firms", ZEW Discussion Paper No. 01-46, 24 p. DOI 10.2139/ssrn.329120.

[29] Rigg, J., Salamanca, A., Phongsiri, M. and Sripun, M. (2018) "More farmers, less farming? Understanding the truncated agrarian transition in Thailand", *World Development*, Vol. 107, pp. 327-337. ISSN 0305-750X. DOI 10.1016/j.worlddev.2018.03.008.

[30] Rozelle, S., Guo, L., Shen, M., Hughart, A. and Giles, J. (1999) "Leaving China"s farms: survey results of new paths and remaining hurdles to rural migration", *The China Quarterly*, Vol. 158, pp. 367-393. ISSN 0009-4439. DOI 10.1017/S0305741000005816.

[31] Sackey, H. A. (2018) "Rural Non-farm Employment in Ghana in an Era of Structural Transformation: Prevalence, Determinants, and Implications for Well-being", *Journal of Rural and Community Development*, Vol. 13, No. 3, pp. 57-77. ISSN 1712-8277.

[32] Simoes, N., Crespo, N. and Moreira, S. B. (2016) "Individual determinants of self-employment entry: What do we really know?", *Journal of Economic Surveys*, Vol. 30, No. 4, pp. 783-806. ISSN 0950-0804 / 1467-6419. DOI 10.1111/joes.12111.

[33] Tarp, F. (2017) "*Growth, Structural Transformation and Rural Change in Viet Nam: A Rising Dragon on the Move*", Oxford University Press. ISBN 97801-9879-6961. DOI 10.1093/acprof:oso/9780198796961.001.0001.

[34] Ulrik, B. (2015) "Local transformation in rural Vietnam: A commune level analysis", WIDER Working Paper, No. 2015/065. ISSN 17987237. ISBN 97892-9230-9534. [Online]. Available: https://www.econstor.eu/bitstream/10419/126362/1/834311461.pdf [Accessed: 31 Jan. 2019].

[35] Walter, S. G. and Heinrichs, S. (2015) "Who becomes an entrepreneur? A 30-years-review of individual-level research", *Journal of Small Business and Enterprise Development*, Vol. 22, No. 2, pp. 225-248. ISSN 1462-6004. DOI 10.1108/JSBED-09-2012-0106.

[36] Wu, H. X. and Zhou, L. (1996) "Rural-to-Urban Migration in China", *Asian-Pacific Economic Literature*, Vol. 10, No. 2, pp. 54-67. ISSN 0818-9935. DOI 10.1111/j.1467-8411.1996.tb00016.x.

[37] Yaqub, S. (2000) "*Poverty dynamics in developing countries*", Brighton: Institute of Development Studies. ISBN 18-5864-2388. [Online]. Available: http://www.ophi.org.uk/wp-content/uploads/ssYaqub-2000.pdf [Accessed: 31 Jan. 2019].

Agris on-line Papers in Economics and Informatics

Volume XII Number 1, 2020

CRM and its Importance for Business Competitiveness

Peter Stuchlý[1], Roderik Virágh[1], Marcela Hallová[1], Edita Šilerová[2]

[1] Faculty of Economics and Management, Slovak University of Agriculture in Nitra, Slovakia

[2] Faculty of Economics and Management, Czech University of Life Sciences Prague, Czech Republic

Abstract

This paper deals with the Customer Relationship Management (CRM) system with emphasis on the importance for the competitiveness of a business. The aim of the present article is to seek whether a business pursues customer value on a regular basis regardless of its size. Monitoring customer value can thus be one of the criteria that measure the success of implementing an overall customer relationship management concept in a particular business. CRM system is also used in agribusiness.

Keywords

CRM systems, CRM implementation criteria, customer value, business size, agribusiness, competitiveness.

Stuchlý, P., Virágh, R., Hallová, M. and Šilerová, E. (2020) "CRM and its Importance for Business Competitiveness", *AGRIS on-line Papers in Economics and Informatics*, Vol. 12, No. 1, pp. 93-98. ISSN 1804-1930. DOI 10.7160/aol.2020.120108.

Introduction

As claimed by Látečková et al. (2018) the development of information and communication technologies (ICT) is currently conditioned by the development of industry, society and many other factors. ICT play important roles in the development of enterprises and automation of their processes. The deployment of information systems and information technology as claimed by Hallova and Hanova (2019) has become a prerequisite for the success of businesses in all areas of economic activity today. Information available from business data enables managers and employees to make quick and accurate decisions so they can efficiently manage operations and respond quickly to business opportunities or threats. Wessling (2003) claims that CRM is not a new philosophy in relation to customers, nor is it a breakthrough and omniscient information technology. It is a comprehensive methodology of creating economically advantageous and beneficial relationships with customers with an emphasis on targeted qualification of personnel, methods of social psychology and interaction. Mccarthy and Perreault (1995) claim that the focus of our attention is on the customer whose relationship with the business is to be organized. Also, Goldenberg, (2008) defines CRM as an approach of a business that integrates people, processes and technologies towards maximizing customer relationships, or as a system that is increasingly using the Internet to provide the closest possible coordination with customers. In CRM, quality is important, as stated by Kretter (2008), which directly affects a product or service. Quality can be defined as "independence from errors". Customer-oriented businesses orient quality in accordance with customer satisfaction. Šimek et al. (2008) state that any long-term relationship must be based on mutually beneficial cooperation. Starting the CRM implementation process as claimed by Storback and Lehtinen (2002) must therefore be based on the established strategy of the business, what means consistently analyse existing business processes and metrics, by means of which we identify and serve the customer and check whether the business relationship is really mutually beneficial.

Vaněk et al. (2011) argue that the benefits of CRM can be seen in streamlining processes and providing sales representatives, marketing and management with better, more detailed customer information. Depending on the area of application, we distinguish CRM into four basic groups: 1. Active CRM, 2. Operational CRM, 3. Collaborative CRM, 4. Analytical CRM. (Novotný et al., 2010). Active CRM as claimed by Pour et al. (2015) is based on an active centralized database that supports process automation.

Operational CRM provides support for business processes (also called front office). Every contact or action with a customer is recorded in his history, which is recorded by CRM and each company employee can draw from this database of history and use the information about the customer for further work with such customer. Cooperative CRM covers direct contact with the customer. It contains various communication channels, not only the Internet, but also IVR (Interactive Voice Response), which is an automated answer for telephone communications. Analytical CRM analyses customer data. These analyses are targeted to:

- designing and implementing targeted marketing activities and campaigns leading to higher efficiency,
- customer behaviour analysis is used to support decision making on products and services (e.g. setting appropriate prices),
- management decisions such as financial forecasts or customer profitability analysis.

Lošťáková et al. (2009) state that choosing the right CRM strategy is an important decision. Recently, three types of CRM strategy have been implemented: The first level of customer relationship marketing is called mass personalization, where an individual customer is identified by name, address, or previous purchases.

This information is then used to create a system of individual marketing communication with target customers, so they have the impression that the company cares about them individually, even though they are offered standard products Janšto et al. (2019). Therefore, a certain level of database marketing is of course necessary. This strategy is widely used by banking institutions and mail order businesses. Another type, as Basl and Blažíček (2008) claim, is mass customization, which is based on the fact that some customers are willing to pay more for the special benefits they can co-create to some extent. Customers have the impression that they have the option of using premium services while choosing from a standard range. This strategy is used by furniture manufacturers on a modular principle. Differentiated customization respects the different needs and requirements of customers and they have “tailored” not only products or services, but also the way of distribution and communication - the entire marketing mix. This strategy emphasizes close cooperation among entities.

Bruhn and Mahyera (2003) argue that striving to respect different customer needs and wishes is part of a differentiated strategy. Individual products are tailored to each customer. There is close cooperation between the manufacturer and its customer. Value for the customer is created on the basis of mutual relationship. The strategy is used in B2B or B2C markets. The term B-2-B refers to business relationships and communication between two commercial companies that do not serve end-users on a mass scale. An important feature of the B-2-B model is, as stated by Zairi and Sinclair (1995), a greater emphasis on logistics and business provision than on customer acquisition compared to B-2-C. The term Business-to-Consumer (B-2-C), as claimed by Lošťáková et al. (2009), is used to identify business relationships and communications between business and end customers. They are realized by web applications, virtual shops on the Internet etc. Online business on the Internet, i.e. sale of goods, information, services and advertising space to end customers. The term Consumer-to-Business (C-2-B), as claimed by Burnett (2005), is used to designate shops in which a commercial transaction is initiated by a buyer wishing to obtain the best possible prices. The customer creates a request (demand) for a specific product at the proposed price. In return, the business partner will tell him if he is willing to accept this request.

The link between the information system and the business process, as claimed by Goldenberg (2008), is confirmed in the implementation of business information systems by the necessity to perform an "inventory" and to change all processes in the company affected by the new information system. Lošťáková et al. (2009) claims that in today's companies, it is almost all areas ranging from logistics, sales and technical departments, to employee records and all related activities - remuneration of merchants based on delivered goods, remuneration of technical workers based on repairs and installations performed, remuneration for BackOffice employees for their activities, to quantify all work and results in the form of reports in the hands of management. The result is not only to achieve better data availability, but also to the way and thus the processes that acquire and handle the data. Finally, this symbiosis of information systems with processes as claimed by Janšto et al. (2019) is also evidenced by foreign surveys, which show that the introduction of ERP systems, in addition to reducing costs and increasing quality, has made room for easier decision-making in managing and deciding on customer requirements and hence improving processes throughout the business.

Materials and methods

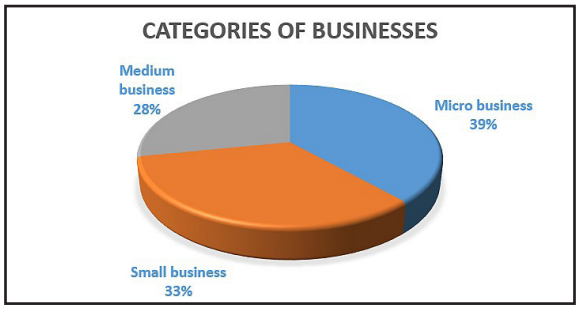
We solved this project between January 2019 and July 2019 and found out the following information. About 80 agricultural enterprises from western Slovakia were addressed. Only 43 questionnaires were filled in and returned. However, after checking and verifying the questionnaire information, only 39 questionnaires were included in the sample. Businesses were categorized according to the number of employees (Table 1).

Business category	Number of employees	Number of businesses	% ofbusinesses
Micro business	1 to 9	15	38.46
Small business	10 to 49	13	33.34
Medium business	50 to 249	11	28.20

Source: own elaboration

Table 1: Categories of businesses by number of employees.

Businesses are divided equally into three groups of micro, small and medium according to the number of employees. The sample is representative and takes into account the actual numbers of such large businesses (Figure 1).



Source: own elaboration

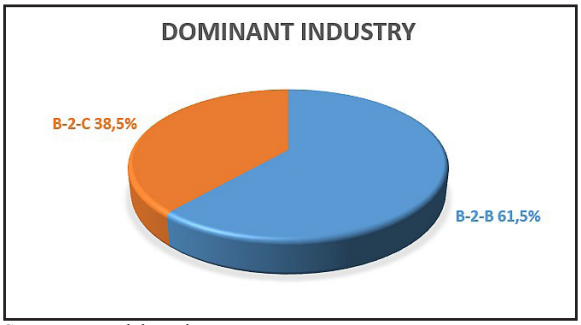
Figure 1: Division of businesses by category.

The questionnaire survey also examined the dominant sector. We investigated whether they are B-2-B (business to business) or B-2-C (business to customer) businesses. From the questionnaire it was found that 24 agribusinesses representing almost 61.5% of all respondents are engaged in trading with other businesses (the so-called B-2-B) and 15 agricultural enterprises representing almost 38.5% of respondents focusing on trading with end customers (the so-called B-2-C) (Table 2, Fifure 2).

Dominant industry	Number of businesses	% of businesses
B-2-B	24	61.5
B-2-C	15	38.5

Source: own elaboration

Table 2: Dominant industry.



Source: own elaboration

Figure 2: Breakdown of businesses by dominant sector.

In the questionnaire we examined the existence of dependence on individual questions. We used statistical methods to investigate the normality of the population distribution. These are skew and excess tests and, in the event of uncertainty, the Jarque-Berra test.

The skew and excess tests test the null hypothesis that random sampling comes from a population with a normal probability distribution of N(μ, σ). In this case, both the skew and the excess coefficients of the normal distribution are equal to zero, so estimates should also be close to zero.

$$S_k = \frac{\frac{1}{n}\sum(Xi-x)^3}{(\sqrt{\frac{1}{n}\sum(Xi-x)^2})^3} \quad (1)$$

$$E_k = \frac{\frac{1}{n}\sum(Xi-x)^4}{(\frac{1}{n}\sum(Xi-x)^2)^2} - 3 \quad (2)$$

For dispersion and mean value of these coefficients the following applies:

$$ES_k = 0 \quad (3)$$

$$DE_k = \frac{24n(n-2)(n-3)}{(n+1)^2(n+3)(n+5)} \quad (4)$$

$$EE_k = \frac{-6}{(n+1)} \quad (5)$$

$$DS_k = \frac{6(n-2)}{(n+1)(n+3)} \quad (6)$$

In the skew-based test, we reject the hypothesis about the normal probability distribution of the population if:

$\frac{|S_k|}{\sqrt{DS_k}} \supseteq z_\alpha$, where z_α can be found in the tables N(0,1) of the probability distribution.

In the excess-based test, the hypothesis about the normality of distribution is rejected if:

$\frac{|E_k - EE_k|}{\sqrt{DE_k}} \supseteq z_\alpha$, where z_α can be found in the tables N (0,1) of the probability distribution.

The Jarque-Berra test again examines the null hypothesis H0 that the selected set has a normal probability distribution of N (μ, σ). To test the hypothesis H0 we use the following formula:

$$\chi = \frac{S_k^2}{DS_k} + \frac{(E_k - EE_k)^2}{DE_k} \quad (7)$$

Where S_k is the skew selection coefficient and E_k is the excess selection coefficient. If the hypothesis H0 holds, χ has asymptotically χ^2 probability distributions with two degrees of freedom. It follows that we reject the hypothesis H0 if $\chi > \chi^2_{\alpha,2}$.

H0: The business pursues customer value on a regular basis regardless of its size.

Results and discussion

Firstly, it is necessary to test the normality of the population distribution. Table 2 shows the basic characteristics of data set A, which represents the size of the monitored agricultural enterprises and set B, which represents the monitoring of customer value in individual businesses (Table 3 and 4).

Characteristics	Data file A	Data file B
Sum of values	263	516
Sampling average	2.037	3.996
Selective variance	0.718	0.953
Standard deviation	0.868	0.986
Minimum value	1	1
Maximum value	3	6
Median	2	4
Modus	1	3
Excess	-1.605	0.401
Skew	0.123	- 0.738

Source: own elaboration

Table 3: Characteristics of data sets A and B.

On the basis of the above, we can say that we reject the hypothesis of the normality of the distribution of the population. We will use a nonparametric independence test to determine the relationship between monitoring value for business customers and its size.

We apply the independence test to a base file with a discrete probability distribution. In this way we test the hypothesis that random variables are independent. The test criterion in this case will be as follows:

$$\chi = \sum_{i=1}^{r}\sum_{j=1}^{s} \frac{\left(n_{ij} - \frac{n_{i.} * n_{.j}}{n}\right)^2}{\frac{n_{i.} * n_{.j}}{n}} \quad (8)$$

Assuming the hypothesis to be valid, the random variable χ asymptotically χ^2 has a probability distribution with (r-1) (s-1) degrees of freedom. It follows that H0 is rejected if $\chi > \chi_{\alpha,(r-1)(s-1)}$.

This test will be based on the data in Table 5 obtained from the questionnaire.

It is clear from the Figure 3 that there is a difference between agricultural enterprises of different sizes in whether they monitor customer value on a regular basis or only irregularly. Most businesses monitor customer value on a regular basis with longer time intervals and/or regularly, allowing them to identify customer needs and improve their goods or services. In order to build a relationship with customers, regular and constant monitoring of customer value is required.

Test results for normalization of population distribution		
	Data file A	Data file B
Skew-based tests		
Value	0.658744	3.777547891
Critical value	1.96	1.96
	H0 is not denied	H0 denied
Excess-based tests		
Value	3.851269	1.124578922
Critical value	1.96	1.96
	H0 denied	H0 is not denied
Test of selective combination of skew and excess		
Chí	14.58779	13.14788
Critical value	10.85	10.85
	H0 denied	H0 denied

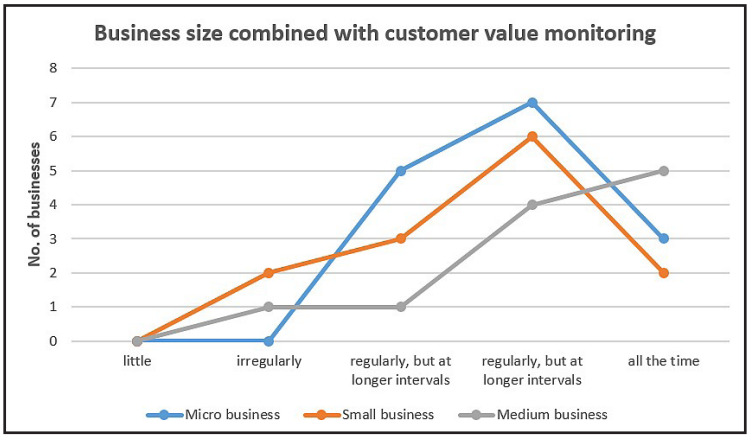
Source: own elaboration

Table 4: Results of the skew, excess as well as Jarque-Berra tests.

Business size	Monitoring Customer Value				
	little	irregularly	regularly, but at longer intervals	regularly	all the time
Micro business	*0*	*0*	*5*	*7*	*3*
Small business	*0*	*2*	*3*	*6*	*2*
Medium business	*0*	*1*	*1*	*4*	*5*

Source: own elaboration

Table 5: The business size combined with customer value monitoring.



Source: own elaboration

Figure 3: The business size combined with customer value monitoring.

Conclusion

It was necessary to test the null hypothesis that the size of the business does not affect whether the business regularly monitors customer value. The result of the independence test showed that there is a dependence between the monitored variables. The critical value from the tables is 15.5 and the calculated test criterion value is 22.1699, i.e., the critical value is less than the test criterion, which means that we reject the null hypothesis and can assert at a 95% significance level that the size of the business affects whether the business monitors value for the customer at regular intervals.

We also found that most businesses monitor customer value on a regular basis, even 25% of respondents still monitor it. As mentioned above, this approach allows to identify the customer's needs and improve the goods or services provided to him. It is this approach that can ensure that customers are satisfied with the goods or services provided and to a lesser extent are prone to reach for a competitor's product.

In conclusion, monitoring customer value can thus be one of the criteria that measure the success of implementing an overall customer relationship management concept in a particular agricultural enterprise. It is the monitoring of customer value that becomes one of the competitive advantages in a turbulent environment.

Acknowledgements

The results and knowledge included herein have been obtained owing to support from the following institutional grant. Internal grant agency of the Faculty of Economics and Management, Czech University of Life Sciences in Prague, grant no. 2019B0009 – “Life Sciences 4.0“.

Corresponding authors
Ing. Peter Stuchlý, PhD.
Department of Informatics, Faculty of Economics and Management
Slovak University of Agriculture, Tr. A. Hlinku 2, Nitra, 949 01, Slovakia
E-mail: peter.stuchly@uniag.sk

References

[1] Basl, J. and Blažíček, R. (2008) "*Podnikové informačné systémy*" (in Czech), Prague, Grada. ISBN 978-80-247-2279-5.

[2] Bruhn, M. and Mahyera, A. (2003) "*Relationship marketing: management of customer relationships*", Harlow, FT Prentice Hall. ISBN 0-273-67601-6.

[3] Burnett, K. (2005) "*Klíčoví zákazníci a péče o ně*" (in Czech), Prague, Computer Press, p. 382. ISBN 80-7226-655-1.

[4] Goldenberg, B. J. (2008) "*CRM in Real Time*", USA, p. 384. ISBN 978-0-910965-80-4.

[5] Hallová, M. and Hanová M. (2019) "Information and communication technology and their influence on businesses growth in Slovakia", In: *EMAN 2019 - economics and management, Belehrad: Association of Economists and Managers of the Balkans,* p. 143-148. DOI 10.31410/EMAN.S.P.2019.143.

[6] Janšto, E., Polakovič, P., Hennyeyová, K. and Slováková, I. (2019) "Analysis of the Current Support of E-marketing Activities in Selected Enterprises of the Wine Sector in Slovakia", *AGRIS on-line Papers in Economics and Informatics,* Vol. 11, No. 4, pp. 31-37. ISSN 1804-1930. DOI 10.7160/aol.2019.110403.

[7] Kretter, A. (2008) "*Marketing*", Nitra, Slovak University of Agriculture Nitra, p. 286. ISBN 978-80-552-0134-4.

[8] Látečková, A., Bolek, V. and Szabo, Ľ. (2018) "Information systems in agricultural enterprises: An empirical study in Slovak republic", *AGRIS on-line Papers in Economics and Informatics*, Vol. 10, No. 2, pp. 49-60. ISSN 1804-1930. DOI 10.7160/aol.2018.100205.

[9] Lošťáková, H. (2009) "*Diferencované řízení vztahů se zákazníky*" (in Czech), Prague, Grada, p. 268. ISBN 978-80-247-3155-1.

[10] McCarthy, J. and Perreault, W. (1995) "*Základy marketingu*" (in Czech), Prague, Victoria Publishing. ISBN 80-85605-29-5.

[11] Novotný, O., Pour, J., Maryška and M., Basl, J., (2010) "*Řízení výkonnosti podnikové informatiky*" (in Czech), Prague, Professional Publishing. ISBN 978-80-7431-040-9.

[12] Pour J., Gála, L. and Šedivá, Z. (2015) "*Podniková informatika*" (in Czech), Prague, Grada. ISBN 978-80-247-5457-4.

[13] Storbacka, K., and Lehtinen, J. (2002) "*Řízení vztahů se zákazníky*" (in Czech), Prague, Grada Publishing, p. 168. ISBN 80-7169-813-10.

[14] Šimek, P., Vaněk, J. and Jarolímek, J. (2008) "Information and communication technologies and multifunctional agri-food systems in the Czech Republic", *Plant, Soil and Environment*, Vol. 54, No. 12, pp. 547-551. ISSN 1214-1178. DOI 10.17221/426-PSE.

[15] Vaněk, J., Jarolímek, J. and Vogeltanzová, T. (2011) "Information and Communication Technologies for Regional Development in the Czech Republic – Broadband Connectivity in Rural Areas", A*GRIS on-line Papers in Economics and Informatics*, Vol. 3, No. 3, p. 67-76. ISSN 1804-1930.

[16] Wessling, H. (2003) "*Aktivní vztah k zákazníkum pomocí CRM*", (in Czech), Prague, Grada Publishing, p. 196. ISBN 80-247-0569-9.

[17] Zairi, M. and Sinclair, D. (1995) "Business process re-engineering and process management", *Business Process Management Journal*, Vol. 1, No. 1, pp. 161-173. ISSN 1463-7154. DOI 10.1108/14637159510798248.

Agris on-line Papers in Economics and Informatics

Volume XII Number 1, 2020

Level of Financial Literacy and Food Waste in Polish Households

Monika Szafrańska[1], Andrzej Krasnodębski[1], Zuzana Kapsdorferová[2]

[1] Department of Management and Economics of Enterprises, University of Agriculture in Krakow, Poland

[2] Department of Management, Slovak University of Agriculture in Nitra, Slovakia

Abstract

The aim of the presented research is to show on food waste and determine the level of financial literacy of food consumers as a factor affecting the probability of occurrence of food waste in Polish households in comparison with selected demographic and economic factors conditioning this phenomenon. The main source of data used for analysis and conclusions was primary information obtained from own research (n=1021, PAPI method). To analyze the data, total statistical indicators, the one-way analysis of variance (the F test) and the logistic regression were used. The conducted analysis demonstrates that among the elements creating financial literacy, only financial attitudes determine consumers' inclination to waste food. The higher the score obtained from this module, the less food is thrown away from households. From the group of factors that significantly determine the occurrence of food wastage, financial attitudes have the weakest impact. The strongest impact has respondent's education.

Keywords

Financial literacy, food waste, household awareness, natural resources, food chain.

Szafrańska, M., Krasnodębski, A. and Kapsdorferová, Z. (2020) "Level of Financial Literacy and Food Waste in Polish Households", *AGRIS on-line Papers in Economics and Informatics*, Vol. 12, No. 1, pp. 99-109. ISSN 1804-1930. DOI 10.7160/aol.2020.120109.

Introduction

Nowadays, there are ongoing discussions about food waste and food losses which is very urging problem of this planet. On one side we are fighting against hunger and on the other side we waste a lot of food. The problem with hunger will even grow in importance because of rising population in the world and the need to feed the population. The option to feed this world would not be only in increasing agricultural production, but also by decreasing of food losses and food waste. Forecasted recent calculations in a long time period vision shows that halving the food waste and food losses will occurs that instead of increasing agricultural production to 60% we will need increase the production only to 25% to enhance nutrition for 9 billion people in 2050. We have to pay high attention on responsibility for sustainability of natural resources.

30-40% of all agricultural products and food is never eaten. This is not persist in other industries. This causes at least two kinds of costs. The first one is the economic cost and the other is the environmental cost. To the first one mentioned does not belong only the costs related to the value of products, but also the costs for agricultural and food production, including of costs for human resources inputs, financial and material inputs, storage or transport, as well the storage of unused products and their handling. The environmental cost, are linked to the exhaustion of soil and water resources, externalities caused by utilization of pesticides and chemical fertilizers, but also this refers to the water and air pollution; into consideration has to be taken the employees 'and consumers health problems. The residues are leaving their significant signs on the environment. The food losses and food waste are responsible for additional 3.3 billion tons of greenhouse gasses, which are escaping to the atmosphere (FAO, 2014). The decline on the food losses is also considered as the meaningful tool for downsizing of GHG emissions, for the creation of which is paradoxically responsible agrifood sector, despite of its main task to ensure food security and food safety. Organization of United Nations considers the food losses and food waste as the real mean for the hunger eradication and for the attainment of the permanently increasing need for sustainable

food systems. Well, for a better economic situation of families with tighter budget, but not only those, as well as growing population in every year and environmental consequences connected with food waste, is important a free removal of the separated waste. The fact that food waste has an enormous impact on the economy as well as on environment, makes a problem of social and economic range. For this reason The European Parliament's Agriculture Committee has adopted a resolution committing members of the Commission to take radical steps to reduce food and food waste from a farm to fork by up to 50% by 2025. Upon this initial steps there must be developed a strategy and action plan to combat food waste

The question of the food losses and food waste represents very complex problem which is calling for participation of all participants of the food chain, if the significant results should be achieved in this field. Responsibility for sustainability of the natural resources for future generation is in our hands.

As already mentioned, food waste is a paradox of the modern food system. Estimates indicate that every year almost 1/3 of the amount of food produced by humans is wasted in the global food chain (FAO, 2011). At the same time, almost 821 million people are chronically undernourished due to lack of food (PCMP, 2019). Food waste implies only negative consequences, which can be classified into three categories: economic, environmental and social. From an environmental point of view, it is necessary to indicate the excessive use of water, land, energy and other resources needed for the production and distribution of food, and then for the disposal of unsold products (McCarthy and Liu, 2017; Richter and Bokelmann, 2018). Social consequences are global price increases that threaten food security, as well as increasing number of malnourished people both in developed and developing countries (Graham-Rowe et al., 2014). “On a global scale, the economic cost, based on 2009 producer prices, of the overall amount of food waste in year 2007 totalled about USD 750 billion” (FAO 2013, p. 55). Every year around 9 tonnes of food are wasted in Poland. The primary sources of wasted food in Poland are households, which account for 53 percent of all food thrown away, followed by food processing (19 percent), restaurants (12 percent), production (11 percent) and distribution (5 percent). The average Pole wastes 247 kg of food a year, putting Poland in fifth place in Europe, where the average is 173 kg per capita (PEI, 2019).

In developed countries, the greatest waste of food takes place at the end of the food chain, especially in terms of consumption. Reasons of food waste in households are manifold. Parfitt et al. (2010) and Koivupuro et al. (2012) believe that one of the main causes of food waste is incorrect in-store behaviors (impulsive buying, excessive purchase, promotions). Some scientists point to the lack of consumer knowledge of stocking food at home (Stefan et al., 2013; Plumb and Downing, 2013), bad habits related to food preparation: overcooking (Graham-Rowe et al., 2014), wrong interpretation of food label (Milne, 2013) or food provisioning routine (Evans, 2011).

This is due to cultural backgrounds, habits by which consumers are regulating their home food supplies, as well as due to absence of relevant information and knowledge, consumers are doing bigger shopping in comparison to their real needs, respectively that they do prepare more food, as they are able to consume. These all factors are leading to the fact that large amount of the prepared foodstuffs are ending in the waste. This everything is requiring qualified work with consumer awareness, in order to be more selective at decision-making during the food shopping and to deal with food in more responsible way. This is particularly important in the countries with higher living standard where is obvious systematic access to the food shopping. In these countries the consumers should be guided to the smaller, but more frequent shopping. The preference to bigger food procurements is leading to the larger food wastes.

Food waste may be reduced by changing consumer reactions towards waste, increasing awareness of poverty and hunger, and highlighting the moral implications of waste, for example by using guilt (Ratinger et al., 2016). The greatest motivator for consumer to waste lower amounts of food is the opportunity to save money. According to Baker et al. (2009) this aspect is by far more important than the ecological one leading to reducing food waste.

Reducing food waste and its consequences require an understanding of the determinants of this phenomenon. Research on determining the factors affecting the level of food waste has been conducted for many years. The investigations most often focus on determining the influence of demographic and economic factors: income (Graham-Rowe et. al., 2014; Aschemann-Witzel et al., 2017; McCarthy and Liu, 2017; Macková et. al., 2019), consumer's age (Quested et al., 2011),

education (Cox and Downing, 2007) and number of persons in the household. (Baker et. al., 2009; Jőrissen et al., 2015). Although the mentioned studies broaden the knowledge about the factors influencing food waste by consumers, the role of one of the often speculated, important factors such as the appropriate level of financial literacy of consumers has not been considered. The literature lacks studies on the impact of the level of consumer financial literacy on food waste in households. So far, no similar scientific research in this area has been conducted in Poland. The research results presented in this paper fill this gap.

The aim of the presented research is to show on food waste and determine the level of financial literacy of food consumers as a factor affecting the probability of occurrence of food waste in Polish households in comparison with selected demographic and economic factors conditioning this phenomenon.

Materials and methods

The main source of data used for analysis and conclusions was primary information obtained from own research. The research was conducted in 2019 with the PAPI method, personally by the authors on a group of 1021 respondents.

The following formula was used to estimate the minimum number of samples (n) (Szreder, 2004):

$$n = \frac{\frac{1}{4} \cdot N}{N \cdot \frac{d^2}{z^2_{\alpha/2}} + \frac{1}{4}} \quad (1)$$

where:

N – population size,

$z^2_{\alpha/2}$ – the value of random variable Z of normal standard distribution,

d – statistical error.

In the studies it was assumed that the maximum statistical error of the results may amount to +/- 5%. The necessary minimum sample size was set at 544 persons. The study covered 1100 respondents. Following the rejection of inconsistent and incorrectly completed questionnaires, 1021 forms were further analysed. According to the Organisation for Economic Co-operation and Development and its International Network on Financial Education (OECD INFE), to assess the level of financial literacy, the minimum sample size should be 1000 respondents (OECD, 2011).

The selection of the sample for the study was deliberate. The survey involved persons who expressed their willingness to complete the questionnaire and declared that it would take decisions to buy food alone or together with other household members. Persons who did not make such decisions did not participate in the research.

The research was carried out in the Małopolskie Province. The province was selected for two reasons. First of all, the structure of the population of a selected province by gender and age corresponds to the structure of citizens by these characteristics for the whole country (the sample was statistically representative of the Polish population by gender and age). Secondly, it was the economic calculus that made the decision. It is cheaper to conduct regional research.

The structure of the sample in terms of gender and age corresponded to the structure of the population of the Malopolskie Province and Poland in 2016 (GUS, 2017). Demographic characteristics of the sample can be seen in the Table 1.

Specification		%
Gender	Female	52
	Male	48
Age	18-35 years	24
	36-50 years	32
	51-65 years	28
	66 years and more	16
Education	Vocational	18
	Secondary	50
	University	32
Number of persons in the household	1	5
	2	13
	3	21
	4	33
	5 and more	28
Place of residence	Village	46
	A city of up to 100,000 inhabitants	30
	City over 100,000 inhabitants	24
Average net income per capita in the household	Up to PLN 500	5
	PLN 501-1000	25
	PLN 1001-1500	22
	PLN 1501-2000	21
	PLN 2001-3000	20
	Over PLN 3000	7

Source: own calculations

Table 1: Demographic characteristics of respondents.

The questionnaire form consisted of five parts. The first part was a certificate (6 questions: age,

education, number of persons in the household, place of residence, average net income per capita in the households). The following parts concerned particular components of financial literacy: basic financial knowledge (7 questions), financial behaviours (9 questions) and financial attitudes (3 questions). A set of questions proposed by the OECD INFE (2011) was used to assess the level of financial literacy of adults. The application of the OECD INFE methodology made it possible to compare the results of the study with the results presented by other authors who also used this method. The OECD INFE has defined financial literacy as follows: "A combination of awareness, knowledge, skill, attitude and behaviour necessary to make sound financial decisions and ultimately achieve individual financial wellbeing" (OECD, 2011, p. 3). The OECD INFE methodology (OECD, 2016) was used to calculate the overall indicator characterising the level of financial literacy. The target value of the index is the sum of the results obtained in the three modules forming the respondent's financial literacy: financial knowledge (0-7 points), financial behaviours (0-9 points) and financial attitudes (1-5 points). In total, the respondent could obtain a minimum of 1 credit point (0+0+1 point) and a maximum of 21 points (7+9+5 points). The last part of the questionnaire included questions about food waste in respondents' households. The questionnaire was pre-tested on a sample of n=40 participants. Only minor changes were made based on the pre-test.

To analyze the data, total statistical indicators: mean (M), minimum, maximum and standard deviation (SD), the one-way analysis of variance (the F test) and the logistic regression were used.

The basis for the one-way analysis of variance is the possibility of breaking the sum of squares of the total variance for all observation results into two components:

- sum of squares describing the variability inside the samples,
- sum of squares describing the variability between groups (populations).

To estimate the value of the F test, the following formula was used (Stanisz, 2011):

F = *MS* between groups : *MS* inside groups (2)

where:

MS – Mean Squares.

The values of the F test above unity indicate the need to reject the H_0 hypothesis.

The H_0 hypothesis assumes that the averages in separate groups of respondents are the same

H_0: $\mu_1 = \mu_2 = ... = \mu k$

μ - the average value characterizing the population;

against the H_1 alternative hypothesis assuming that at least two averages differ from each other

H_1: $\mu_1 \neq \mu_2$ *lub* $\mu_1 \neq \mu_3$ *lub,* $\mu_2 \neq \mu_3$.

If the analysis of variance (the F test) does not show significance between the analyzed averages, no further tests are carried out. However, when the H_0 hypothesis is rejected in the analysis of variance, it is necessary to carry out a more detailed study of the differences between the means of individual groups (post-hoc tests) (Stanisz, 2011). In order to establish statistically significant differences between the average mean, a RIR Tukey post-hoc test was performed.

On the other hand, the logistic regression model enables modelling and simulation of the probability of an event described by a dichotomous variable, depending on various independent variables. In order to carry out the analysis properly, the studied population was divided into two groups (households wasting food and households where this phenomenon does not occur). The model did not consider the amount of food waste, its value or kind of wastes.

The logistic regression model takes on a general form (Stanisz, 2011):

$$P = \frac{e^Y}{1+e^Y} = \frac{1}{1+e^Y} \quad (3)$$

$$Y = a_0 + b_1 X_1 + ... + b_k X_k \quad (4)$$

where:

e^Y- parameter,

Y – dependent variable,

a_i, $i = 0,\ldots,k$ – regression coefficients,

$X_1, X_2, ..., X_k$ - independent variables.

Using the model, the odds indicator (W) can be determined from the formula:

$$W = \frac{P_i}{1-P_i} \quad (5)$$

The odds indicator is the ratio of the probability of occurrence P_i (i = 1,2,…k) of a given event in the k-th unit to the probability of its non-existence. All the hypotheses were verified with a horizontal significance of α=0.05.

Apart from primary sources, Polish and foreign literature on the subject was also used to achieve the goal. The results of the research were presented in a descriptive and tabular form.

Results and discussion

In order to carry out a statistical analysis, the studied population was divided into two groups: those who declare to throw away food and those who do not waste food. 45% of respondents admitted to wasting food in their households. Test results are consistent with those from other tests. According to the Kantar Millward Brown Institute's 2018 report, just over 40% of Polish society throws away food (Banki Żywności, 2018).

The main reasons for food throwing away by respondents were overdue expiry date (46%) and excessive shopping (37%). Among the reasons for throwing away food, respondents also indicated the lack of idea for the use of ingredients in the household (10%), the purchase of qualitatively bad products (4%) and the lack of a shopping list (3%).

In the surveyed households, bread was most often thrown away. Such a response was indicated by almost every second respondent. The results of the presented research are consistent with the results of other scientists, who also show that the product most often thrown away is bread (Deloitte, 2017; Banki Żywności, 2018). The group of products most often wasted also includes cold cuts (37%), vegetables (37%) and fruit (32%). Every fourth person indicated yoghurt (26%) and every eighth person indicated milk (14%). The basket also included ready meals (11%), cheese (9%) and meat (8%). Eggs (3%) and fish (2%) were the least frequently indicated.

The overall financial literacy indicator and its three modules have been calculated for the entire population, as well as for the group of people wasting food and respondents whose households did not experience this phenomenon.

According to the conducted research, the respondents were characterized by an average level of financial literacy. The average score obtained is 12.6 points (SD=2.9). The lowest score obtained is 3 points, the maximum is 20 points. The average result obtained for the studied group was consistent with the average result obtained for the adult population of Poland (OECD INFE, 2016). Compared to other EU countries, Poland has one of the lowest levels of financial literacy in the European Union. Statistical analysis shows that people who waste food have a slightly lower level of financial literacy compared to respondents who declared that they do not throw away food. The average score for the first group was 12.5 points, while for those who indicated that food is not wasted in their farms it was 12.7 points. The conducted analysis did not show a statistically significant difference between the average result of financial literacy of people who do not waste food and respondents who throw away food (Table 2).

One of the elements creating financial literacy is basic financial knowledge. The level of financial knowledge of the respondents was assessed by means of 7 questions. These questions concerned the calculation of the interest rate, the mechanism of compound interest rate, inflation, diversification of the financial portfolio or the relationship between the amount of risk and the rate of return. The respondent received 1 credit for each correct answer. Respondents could obtain 0 points in this part of the test at least and 7 points at most.

On average, respondents answered 5 questions correctly (17% of respondents). Almost 2% of the surveyed population did not answer any question correctly, and almost 15% of consumers achieved the maximum score (7 points). Respondents best dealt with the question about the relationship between risk and rate of return on financial instruments. In this case, the highest number of correct answers was given (91%). The question that caused the most problems

Specification	Wasting food		the F test	p
	Yes M (SD)	No M (SD)		
Finacial literacy	12.5 (2.8)	12.7 (3.1)	F=0.413	p=0.521
Financial knowledge	4.0 (1.9)	4.3 (2.0)	F=1.763	p=0.185
Financial behaviours	5.9 (1.8)	6.0 (1.8)	F=0.525	p=0.469
Financial attitudes	2.4 (3.1)	2.6 (2.8)	F=5.448	p=0.020*

Note: * statistical significance at p<0.05
Source: own calculations

Table 2: Average results obtained by respondents in the financial literacy modules.

to the respondents concerned the compound interest rate. Only 4 out of 10 persons knew the correct answer to this question.

The average score achieved by the tested group is 4.1 points (SD=2.0). This result is consistent with the results achieved for Poland in OECD INFE surveys (2016). As shown in Table 2, there was no statistically significant difference in the average result for the module "Financial knowledge" between people wasting food and respondents who declared that in their households food is not thrown away. The average score for the first group is 4.0 points, while for the second group it is 4.3 points.

Another module that creates financial literacy are financial behaviours. Financial behaviours means the deliberate or unintentional management of personal finances during a defined period of time. Respondents' financial behaviour was assessed by 9 questions. These questions concerned the degree of independence in daily financial decision-making, the ability to draw up a household budget, active saving, the willingness to pay bills on time, prudent shopping and setting financial targets. For each rational behaviour the respondents could get 1 point. The minimum result from this part is 0 points, the maximum - 9.

The average score for the tested group is 5.9 points (SD=1.8). This result is higher than presented in the literature. In the already quoted OECD INFE studies, the average score for Poland in this module is 4.4 points (OECD INFE, 2016). The above discrepancy may result from the fact that OECD studies were conducted in 2015, and as noted by E. Kieżel and A. Burgiel (2017) and M. Musiał (2018), the level of financial literacy of Poles is systematically increasing.

In this module, respondents most often received 6 points (21% of persons). Less than 1% of the surveyed population did not score any points in this part. Every twentieth respondent received a maximum number of points. Among the financial behaviors mentioned in the questionnaire, the highest number of positive declarations (81%) received the statement "I pay my bills on time". On the other hand, the least positive answers were found in the case of the question on regular household income and expenditure records. Only 1/3 of the respondents prepared a household budget. Most of the respondents have never heard of such a practice. Awareness of the budgets of a consumer should be the basis for rational spending planning for each person.

Financial attitudes are the last element of financial literacy. The questionnaire included three questions to assess respondents' attitudes towards money and financial planning. The claims made in the questionnaire were "I tend to live for today and let tomorrow take care of itself", "I find it more satisfying to spend money than to save it for the long term", "Money is there to be spent" (OECD, 2016, p. 50). In order to assess attitudes, the five-point Likert scale was used, where 1 meant that the respondent fully agrees with the statement, 5 – completely disagrees. The content of the questions concerned attitudes in the short term, so if the respondent did not agree with the statement (answers 4 and 5) it meant that he or she had such an attitude in the long term (attitudes desirable from the point of view of rationality of consumer behaviours). The points marked by the respondents were summed up and the value obtained was divided by 3. The minimum number of points in this module was 1 and the maximum number was 5.

The average result obtained by the respondents is 2.6 points (SD=2.9). Most respondents from this part of the test received 2 points (36%). The minimum score (1 point) was obtained by 13% of respondents, the maximum score (5 points) by 3% of respondents.

The statistical analysis demonstrated significant differences in the average result of this financial literacy module between people who do not waste food and consumers who throw food away (Table 2). Consumers wasting food were more likely to adopt a more consumption-oriented approach to spending money than those not wasting food. They were more satisfied with spending money than with saving it for the future. More than 40% of the people in this group thought that money was meant to be spent. For comparison, in the group of people declaring that they do not throw away food, this attitude was shown by less than 30% of the respondents.

Due to the fact that among the elements creating financial literacy only consumer financial attitudes influence their tendency to waste food, in order to determine the likelihood of the impact of financial literacy on food waste in households, only this financial literacy module was taken into account in the built model.

To determine the probability of the financial attitudes impact on the tendency to waste food in comparison with other determinants, seven demographic and economic factors were used

to build the model (independent variables). The characteristics of these variables are given in Table 3.

The results of the logistic regression model estimation for seven independent variables are presented in Table 4.

For the model obtained, the chi-square value (44.206) is statistically highly significant (p=0.000). As can be seen from the results sheet (Table 4), the variables: financial attitudes (X_1), education (X_4), place of residence (X_5) and average net income per capita in the respondent's household (X_7) significantly affect consumers' willingness to waste food. Other factors such as gender (X_2), age (X_3) and the number of persons in the household (X_6) turned out to be insignificant (level $p<0.05$). Therefore, a simpler model without these variables was considered at a later stage of the study. Only statistically significant determinants were taken into account in the analysis. The obtained values are presented in Table 5.

Symbol of the variable	Name of the variable	Unit of measure
Y	Wasting food	Dependent variable (1 – Yes, 0 - No)
X_1	Financial attitudes (FA)	Independent quantitative variable (scale 1-5 points)
X_2	Gender	Independent qualitative variable (1- Female, 0 - Male)
X_3	Age	Independent qualitative variable (scale 1-4)
X_4	Education	Independent qualitative variable (scale 1-3)
X_5	Place of resindence	Independent qualitative variable (1 - village, 2 – a city of up 100,000 inhabitants, 3 – city over 100,000 inhabitants)
X_6	Number of persons in the household	Independent quantitative variable
X_7	Average net income per capita in the households	Independent qualitative variable (scale 1-6)

Source: own calculations

Table 3: Characteristics of variables used for logistic regression analysis (seven independent variables).

Symbol of the variable	Name of the variable	Parameter rating	Significance	Odds ratio W
X_1	Financial attitudes (FA)	-0.276	0.010*	0.758
X_2	Gender	0.260	0.242	1.296
X_3	Age	0.040	0.359	1.042
X_4	Education	-0.505	0.000*	0.604
X_5	Place of residence	0.272	0.033*	1.313
X_6	Number of persons in the household	-0.080	0.386	0.923
X_7	Average net income per capita in the households	-0.294	0.000*	0.745
-	Constant	0.892	0.242	2.439

Note: * statistical significance at $p<0.05$
Source: own calculations

Table 4: Evaluation of the logistic regression model parameters describing selected factors influencing the probability of food waste in Polish households (7 variables).

Symbol of the variable	Name of the variable	Parameter rating	Significance	Odds ratio W
X_1	Financial attitudes (FA)	- 0.260	0.015*	0.771
X_4	Education	0.515	0.000*	0.598
X_5	Place of residence (Place)	0.298	0.015*	1.347
X_7	Average net income per capita in the households (Income)	0.277	0.001*	0.758
-	Constant	1.004	0.042*	2.728

Note: * statistical significance at $p<0.05$
Source: own calculations

Table 5: Evaluation of the logistic regression model parameters describing selected factors influencing the probability of food waste in Polish households (four variables).

Taking into account the estimated model factors, the logistic regression model for four independent variables takes the following form:

$$P(Y=1)=\frac{e^{1.004-0.260FA+0.515EDUCATION+0.298PLACE+0.277INCOME}}{1+e^{1.004-0.260FA+0.515EDUCATION+0.298PLACE+0.277INCOME}}$$

Parameter a_0 = 1.004 is the logarithm of the odds indicator for the base level. Analysis of model parameters from b1 to b4 includes analysis of coefficient signs. The sign of the coefficient "-" means that the predicted probability of food waste decreases for each unit increase of the independent variable (in the presented model these are financial attitudes, b_1 = - 0.260). The sign "+" of the coefficient means the increase in the likelihood of food waste along with the increase of each unit increase of the independent variable (in the discussed model variables: education; b_2 = 0.515, place of residence; b_3 = 0.298 and income, b_4 = 0.277).

Among the factors taken into account in the model, the probability of wasting food in households is most strongly influenced by the respondent's education. The higher the respondent's education, the higher the share of people who waste food. According to the model, the logarithm of the odds indicator waste food increases by 0.515 for each increase of this variable by one unit (by one level of education). The odds ratio W = 0.598, which means that an increase in education by one level increases the probability of wasting food by 0.598 times. The results obtained are consistent with the results presented in the literature, which show that the best educated people are the "highest" food wasters (Stefan et al., 2013). In their research (2007) Cox and Downing obtained opposite results. According to these authors, families with low incomes tend to waste a bigger amount of food.

As may be seen in subject literature, there is an unusually strong correlation among the education level and income, and the influence of these factors on food waste in households (Porfino et al., 2017). Therefore, the analysis was conducted to investigate the inclination for food wasting by the respondents on the same level of income but with different level of education. As results from the investigations, in the first four groups, identified on the basis of income, the higher the level of education, the smaller the share of food wasting persons. On the other hand, in the other two respondent groups (households where the average net income per capita was the highest), the problem of food waste was the most rarely noticed in the households of persons with secondary education. Food was most frequently thrown away by households of respondents possessing vocational and university education.

The tendency to waste food also depends on the place of residence. The larger the place of residence, the likelihood of food waste increases (the logarithm of the odds indicator – parameter rating=0.298). According to the odds ratio indicator (W=1.347), inhabitants of large towns throw food 1.3 times more often than those in small towns/ villages. This dependence should be connected with several facts. Firstly, rural households, and in particular farmers' households, have some of the lowest incomes in Poland. Secondly, rural dwellers use food waste to feed animals. According to law it is considered as a food waste (for example in Slovakia). Thirdly, food and especially bread in the Polish tradition and rural customs enjoys great respect, so the phenomenon of wasting food is less frequent. G. Porpino, J. Parente and B. Wansink (2017), who studied Brazilian households, also noticed a positive relationship between tradition and culture and limiting food waste.

Another factor that increases the likelihood of food wastage is income. The higher the respondent's income, the higher the share of consumers who waste food. According to the model, the logarithm of the odds indicator waste food increases by 0.277 (parameter rating) for each increase of this variable by one unit (by PLN 500/EUR 120). The odds ratio W = 0.758, which means that an increase in average net income per capita in the households by one level increases the probability of wasting food by nearly 0.8 times. D. Baker, J. Fear and R. Denniss (2009) also observed the impact of consumer income on the tendency to waste food. In their research they estimated the value of food thrown away in Australian households. For households with an income not exceeding $40,000 per year, the value of food thrown away is $518 a year. This compares with food waste of $635 a year for Australian households with an income between $40,000 and $80,000. The households earning more than $80,000 a year are wasting $803 in food annually.

Studies conducted by M. Setti, L. Falasconi and M. Vittuari (2016) on the group of 1,403 Italian food consumers show that there are complex relationships between per capita income and household food waste behavior. Lower income class consumers show a greater attitude to waste certain food typologies. Mid-to-low income consumers purchase higher amounts of lower quality products, therefore waste more food.

Slightly weaker than income, the likelihood of wasting food is affected by consumers' attitudes towards money. A negative estimation of the parameter for the variable FA (financial attitudes) indicates that an increase in this value results in a decrease in the probability of wasting food in households (parameter rating = -0.260). At the adopted indications (Y=1 means food wastage, Y=0 the phenomenon does not occur), the calculated odds ratio W=0.771 informs that the probability of food wastage decreases by 0.8 times in the group of people characterized by a higher level of FA.

Conclusion

In the conducted research the relationship between the level of consumer financial literacy and their tendency to waste food was analyzed. According to the F test, the general level of financial literacy does not significantly affect the fact that food is wasted in consumers' households ($F=0.413$, $p>0.05$). Both persons with a low and medium level of financial literacy and consumers with a high level of financial competence wasted food equally.

The overall financial literacy indicator consists of three modules: basic financial knowledge, financial behaviours and financial attitudes. The conducted analysis demonstrates that among the elements creating financial literacy, only financial attitudes determine consumers' inclination to waste food. The higher the score obtained from this module, the share of people not wasting food is increasing. The influence of financial attitudes on consumers' tendency to waste food or limit this phenomenon results from different consumer attitudes towards money, spending and saving. These attitudes may be modified as a result of conscious educational activities in the field of personal finances concerning effective and rational management of household budget, including spending on food, which will reduce the problem of food waste

The methodology used in the research allowed to identify a set of the most important demographic and economic determinants influencing the fact of wasting food by consumers in their households. It also indicates which of these factors are the most important and which are of marginal importance. Factors that significantly influence consumer behavior related to food wastage were the place of residence, net income per capita in the consumer's household, education level and financial attitudes. The level of education has the strongest impact on the likelihood of wasting food. The higher the education, the higher the tendency to waste food. From the group of factors that significantly determine the occurrence of food wastage, financial attitudes have the weakest impact. The factors that do not determine the tendency to waste food were: gender, age and the number of people in the household.

Because of selected data analysis method, the investigations took into account only the fact whether food waste occurred in a given household or not. In subsequent analyses it would be important to determine also the dependence between the amount of wastes and determinants of the food waste level, but also to study the relationship between the percentage of wasted food in relation to the households' incomes. The kind of wastes should be also considered.

In the studies discussed above, consumers' financial attitudes were assessed by means of three questions (core questionnaire OECD INFE). Due to the fact that financial attitudes are the only module of financial literacy that determines consumers' inclination to waste food, an interesting direction of research would be a detailed analysis of consumer financial attitudes towards their inclination to waste food. The planned research should use one of the internationally recognized scales that measure consumers' attitudes towards money, such as the Money Attitude Scale (MAS) concept by K. Yamauchi and D. Templer, Money Beliefs and Behaviour Scale (MBBS) by A. Furnhama or The Love of Money Scale by T. Li-Ping Tang.

Corresponding authors
Ing. Monika Szafrańska, PhD.
University of Agriculture in Cracow, Al. Mickiewicza 21, 31-120 Cracow, Poland
Phone: +48 12 662 43 72, E-mail: m.szafranska@ur.krakow.pl
ORCID: 0000-0002-4948-7636

References

[1] Aschemann-Witzel, J., Jensen, J., Jensen M. and Kulikovskaja V. (2017) "Consumer behaviour towards price-reduced suboptimal foods in the supermarket and the relation of food waste in households", *Appetite*, Vol. 116, pp. 246-258. ISSN 0195-6663. DOI 10.1016/j.appet.2017.05.013.

[2] Baker, D., Fear, J. and Denniss, R. (2009) "What a waste - an analysis of household expenditure on food", *Policy Brief*, Vol. 6, pp. 1-24. ISSN 1836-9014.

[3] Banki Żywności (2018) "*Report of the Federation of Polish Food Banks 2018 - I'm not wasting food*" [Online]. Available: https://bankizywnosci.pl/wp-content/uploads/2018/10/Przewodnik-do-Raportu_FPBZ_-Nie-marnuj-jedzenia-2018.pdf [Accessed: 9. Sep. 2019] (In Polish).

[4] Cox, J. and Downing, P. (2007) "*Food Behaviour Consumer Research: Quantitive Phase*", Retail Programme - Food Waste: Final Report, Wrap, Banbury, UK, [Online]. Available: http://www.wrap.org.uk/sites/files/wrap/Food%20behaviour%20consumer%20research%20quantitative%20jun%202007.pdf [Accessed: 9. Sep. 2019].

[5] Deloitte (2018) "*Poland in the lead of the EU countries wasting the most food*". [Online]. Available: https://www2.deloitte.com/pl/pl/pages/press-releases/articles/Polska-w-czolowce-panstw-UE-marnujacych-najwiecej-zywnosci.html [Accessed: 9. Sep. 2019] (In Polish).

[6] Evans, D. (2011) "Blaming the consumer – once again: the social and material contexts of everyday waste practices in some English households", *Critical Public Health*, Vol. 21, pp. 429-440. ISSN 0958-1596. DOI 10.1080/09581596.2011.608797.

[7] FAO (2011)"*Global food loses and food waste. Extent, causes and prevention*", FAO, Rome. ISBN 978-92-5-107205-9.

[8] FAO (2013) "*Food wastage footprint Impacts on natural resources*". [Online]. Available: http://www.fao.org/3/i3347e/i3347e.pdf [Accessed: 3. Nov. 2019].

[9] FAO (2014) "*The Food Losses and Food Waste in Europe and in Central Asia*", FAO Regional Conference for Europe and Central Asia, 2014, Bucurest, Romania. [Online]. Available: http://www.fao.org/about/meetings/erc29/en/ http://www.wrap.org.uk/sites/files/wrap/Food%20behaviour%20consumer%20research%20q [Accessed: 9. Sep. 2019]

[10] Graham-Rowe, E., Jessop, D. and Sparks P. (2014) "Identifying motivations and barriers to minimizing households food waste", *Resources, Conservation and Recycling*, Vol. 84, pp. 15-23. ISSN 0921-3449. DOI 10.1016/j.resconrec.2013.12.005.

[11] GUS (2017) "Statistical Yearbook of the Republic of Poland", *Zakład Wydawnictw Statystycznych*, Warszawa, ISSN 1506-0632.

[12] Kieżel E. and Burgiel A. (2017) "*Economic knowledge of consumers and the rationality of their behaviours*", Wydawnictwo C. H. Beck, Warszawa. ISBN 978-83-812-8042-6. (In Polish).

[13] Jőrissen, J., Priefer, J.and Bräutigam, K. (2015) "Food waste generation at household level: results of a survey among employees of two European research centers in Italy and Germany", *Sustainability,* Vol. 7, No. 3, pp. 1-21. ISSN 2071-1050.

[14] Koivupuro, H.-K., Hartikainen, H., Silvennoinen, K., Katajajuuri, J.-M., Heikintalo, N., Reinikainen, A. and Jalkanen L. (2012) "Influence of socio-demographical, behavioural and attitudinal factors on the amount of avoidable food waste generated in Finnish households", *International Journal of Consumer Studies*, Vol. 36, pp. 183-191. ISSN 1470-6431. DOI 10.1111/j.1470-6431.2011.01080.x.

[15] Macková, M., Hazuchová, N. and Stávková, J. (2019) "Czech consumers' attitudes to food waste", *Agricultural Economics – Czech*, Vol. 65, pp. 314–321. ISSN 1805-9295. DOI 10.17221/364/2018-AGRICECON.

[16] McCarthy, B. and Liu, H. (2017) "Food waste and the 'green' consumer", Australasian Marketing Journal , Vol. 25, pp. 126-132. ISSN 1441-3582. DOI 10.1016/j.ausmj.2017.04.007.

[17] Milne, R. (2013) "*Food Waste and Sustainable Food Waste Management in the Baltic Sea Region*", Springer, Hamburg, Germany. ISBN 978-3-319-10906-0.

[18] Musiał, M. (2018) "Effectiveness of personal finance management in Poland", Rozprawy i Studia, Wydawnictwo Naukowe Uniwersytetu Szczecińskiego, Szczecin, ISSN 0860-2751. (In Polish).

[19] OECD INFE (2011) "*Measuring Financial Literacy Questionnaire and Guidance Notes for Conducting an Internationally Comparable Survey of Financial Literacy*" [Online]. Available: www.oecd.org/finance/financial-education [Accessed: 9. Sep. 2019].

[20] OECD INFE (2016) "*International Survey of Adult Financial Literacy Competencies*", [Online]. Available: www.oecd.org/finance/financial-education [Accessed: 9. Sep. 2019]

[21] Parfitt, J., Barthel, M. and Macnaughton S. (2010) "Food waste within food supply chains: quantification and potential for change to 2050", *Philosophical Transactions of the Royal Society Biological Sciences*, Vol. 365, pp. 3065-3081. ISSN 1563-0447. DOI 10.1098/rstb.2010.0126.

[22] PCPM (2019) "*Children on the edge of death*". [Online]. Available: https://pcpm.org.pl/dzieci-na-krawedzi-smierci-szesc-agend-onz-apeluje-o-pomoc-w-walce-z-masowym-niedozywieniem.html [Accessed: 9. Sep. 2019].

[23] Plumb, A. and Downing, P. (2013) "*Consumer Attitudes to Food Waste and Food Packaging*", Waste & Resources Action Programme, Barbury, UK. ISBN 978-1-84405-465-7.

[24] Porpino, G., Parente, J. and Wansink, B. (2017) "Food Waste Paradox: Antecedents of Food Disposal in Low-Income Households", *International Journal of Consumer Studies*, Vol. 39, No. 6, pp. 619-629. ISSN 1470-6423. DOI 10.1111/ijcs.12207.

[25] Quested, T., Parry, A., Easteal, S. and Swannell, R. (2011) "Food and drink waste from household in the UK", Nutrition Bulletin, Vol. 36, No. 4, pp. 460-467. ISSN 1467-3010. DOI 10.1111/j.1467-3010.2011.01924.x

[26] PEI (2019) "*Poland occupies fifth place in EU for food waste*" [Online]. Available: https://www.thefirstnews.com/article/poland-occupies-fifth-place-in-eu-for-food-waste-7074 [Accessed: 3. Nov. 2019]

[27] Ratinger, T., Tomka, A. and Boskova I. (2016) "Sustainable consumption of bakery products; a challenge for Czech consumers and producers", *Agricultural Economics – Czech*, Vol. 62, pp. 447-458. ISSN 1805-9295. DOI 10.17221/244/2015-AGRICECON.

[28] Richter, B. and Bokelmann, W. (2018) "The signigicance of avoiding household food waste – A means-end-chain-approach", *Waste Management*, Vol. 74, pp. 34-42. ISSN 0956-053X. DOI 10.1016/j.wasman.2017.12.012.

[29] Setti, M., Falasconi, L. and Vittuari, M. (2016) "Italian consumers' income and food behavior", *British Food Journal*, Vol. 118, No. 7, pp. 1731-1746. ISSN 0007-070X. DOI 10.1108/BFJ-11-2015-0427.

[30] Stanisz, A. (2011) "*Intelligibe statistic course*", StatSoft Polska Sp z o.o., Kraków. ISBN 83-88724-18-5. (In Polish).

[31] Stefan, V., van Herpen, E., Tudoran, A. A. and Lähteenmäki L. (2013) "Avoiding food waste by Romanian consumers: The importance of planning and shopping routines", *Food Quality and Preference*, Vol. 28, pp. 375-381. ISSN 0950-3293. DOI 10.1016/j.foodqual.2012.11.001.

[32] Szreder, M. (2004) "*Methods and techniques of opinion polls*", Polskie Wydawnictwo Ekonomiczne, Warszawa. ISBN 83-208-1515-0. (In Polish).

Agris on-line Papers in Economics and Informatics

Volume XII Number 1, 2020

Towards Future Oriented Collaborative Policy Development for Rural Areas and People

Miloš Ulman[1], Pavel Šimek[1], Jan Masner[1], Pavel Kogut[2], Tuula Löytty[3], Patrick Crehan[4], Karel Charvát[5], Antoni Oliva[6], Stein Runar Bergheim[7], Milan Kalaš[8], Denis Kolokol[8], Tommaso Sabbatini[8]

[1] Department of Information Technologies, Faculty of Economics and Management, Czech University of Life Sciences Prague, Czech Republic

[2] 21C Consultancy Limited, United Kingdom

[3] Smart & Lean Hub Oy, Finland

[4] Crehan, Kusano & Associates, Belgium

[5] Czech Center for Science and Society, Czech Republic

[6] 22SISTEMA, Spain

[7] Asplan viak internet a.s., Norway

[8] Kajo s. r.o., Slovakia

Abstract

Rural areas in Europe are at risk due to depopulation, failing generation renewal, and a multitude of influences ranging from market-based, regulatory, to societal and climate changes. As a result, current rural policy is no longer keeping pace with these changes. We propose an advanced rural policy development framework in order to deliver more accurate foresight for rural regions, contributing to new and enhanced policy interventions. The proposed framework combines new quantitative and qualitative epistemological approaches, previously unused unstructured data with traditional research information, grassroot perspective with expert knowledge, current situation analysis with forward looking activities. We argue that by using the proposed methods, policy teams will be able to enhance the effectiveness of their policy making processes, while rural stakeholders will be given the opportunity to become valuable policy influencers and solution co-creators. The ability to quickly experiment and understand the impact of a variety of policy solutions will result in saved time and costs. The framework is part of an ongoing experimental verification and testing in twelve pilot regions across Europe and Israel.

Keywords

Rural areas, policy, European Union, foresight, text mining, system dynamics modelling.

Ulman, M., Šimek, P., Masner, J., Kogut, P., Löytty, T., Crehan, P., Charvát, K., Oliva, A., Bergheim, S. R., Kalaš, M., Kolokol, D. and Sabbatini, T. (2020) “Towards Future Oriented Collaborative Policy Development for Rural Areas and People", *AGRIS on-line Papers in Economics and Informatics*, Vol. 12, No. 1, pp. 111-124. ISSN 1804-1930. DOI 10.7160/aol.2020.120110.

Introduction

Rural areas are under pressure. Over the past twenty-five years, rural regions have experienced a rapidly shrinking population as people, especially young adults, have migrated to cities (Westhoek, van den Berg and Bakkes, 2006; Wiebe et al., 2018). The impact of this demographic shift is profound. European Commission reports that only 5.6% of all European farms are run by people younger than 35 while more than 31% of all farmers are older than 65 (DG Agri, 2017). This imbalance creates difficulties for generational renewal and raises concerns about the loss of valuable skills and knowledge as older, more experienced workers leave the sector. Skills needed to operate a farm have rapidly shifted to highly intensive brain work and business acumen. Additionally, market-based, regulatory and social changes have a strong bearing on how agricultural producers conduct their business. Climate change and environmental degradation increase farmers’ responsibility for conservation of natural resources (Van Herzele et al., 2013). In addition to the down hill of agriculture, also the other earning options suffer from the population shift from rural to urban areas e.g. tourism, well-being, bio-based industry. The implication is that

current rural policy is no longer keeping pace with the changing world as well as it used to.

Decision makers have the ability to steer change and in so doing reduce the negative impact thereof, however this requires advanced knowledge of how a particular action, or inaction, will affect people and places, at present and in the future. Generating such knowledge/insight is easier said than done. First, it is difficult to obtain if parties work in isolation from each other; the outcome is best if the effort is a collective one. Despite a growing recognition that societal goals are best achieved when multiple actors join in the policymaking process, a truly participatory setup remains more an exception than the norm (Bourgeois et al., 2017). Second, the required knowledge must shed light on the current state of affairs as well as on what is yet to come, providing a 360-degree view that is rarely present in today's policymaking (Wiebe et al., 2018). This means having a good understanding of what different rural stakeholders want and need; whether measures aimed at addressing these needs are adequate; how the present situation may evolve under different circumstances in the coming decades; what driving forces will be most influential and why; and how will all this affect planet, people, profits and land-use?

The use of text mining is only starting to gain traction in other domains while in rural policy making it is virtually non-existent (Kayser and Blind, 2017). The quantitative-qualitative nexus in futures exploration, despite some signs of strengthening in recent years, continues to be marked by a strong polarisation when it comes to methodological choices. In futures research, a long-standing divide remains in place between strictly quantitative and more qualitative approaches (Fontela, 2000). Outlook studies that report on future developments in specific sectors tend to be based on either one or the other, with little common ground in between. Whilst a hybrid approach has been tested in the past (Greiner et al., 2014; Fortes et al., 2015), it wouldn't be an overstatement to say that a practice of combining the two has yet to hit the mainstream.

This paper aims to propose an advanced rural policy development framework in order to deliver more accurate foresight for rural regions, contributing to new and enhanced policy interventions to improve rural attractiveness as a place to live and work for newcomers and current rural inhabitants. Further, we formulate following research questions.The first question is how to design a participatory policy co-creation process that is able to combine inputs from experts, policymakers and all relevant rural stakeholders. The second question is how text mining of publicly accessible data can assist with evaluation of the current state of rural development and contribute to modelling future scenarios. Third question is how to integrate both qualitative and quantitative research approaches in foresight in order to overcome its limitations.

The paper is organized as follows. First, we present the PoliRural framework and its baseline in the Materials and methods section. This is followed by a detailed description and discussion of five components of the framework in the Results and discussion section. A summary of paper contributions and future research are presented in the Conclusion.

Materials and methods

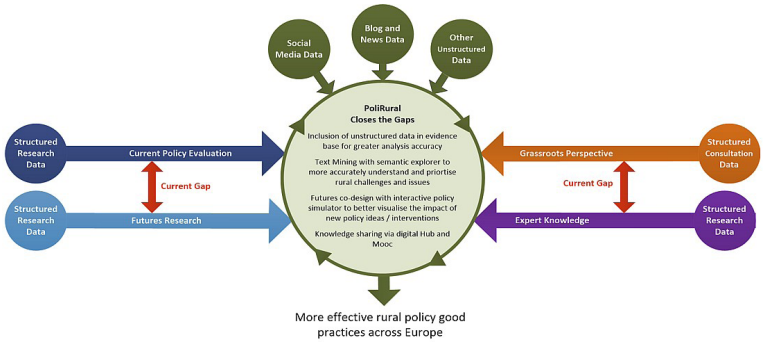
This paper reports on rural policy making approaches and use of text mining. We used desk research to collect data on issues and challenges of rural policy making with a particular attention paid to the current state in the European Union. This served as an input for the design of a new framework called PoliRural. The proposed framework combines new quantitative and qualitative epistemological approaches, previously unused unstructured data with traditional research information, grassroot perspective with expert knowledge, current situation analysis with forward looking activities. The software-based components have been developed and tested as proof-of-concept.

PoliRural framework aims to create innovative and complex rural policy simulators that can be applied by any region to gain insights on the effectiveness of existing measures, as well as the potential impact of new co-designed interventions in a broader context of factors that affect rural places and people. The visualisation of the interplay between rural policy making, futures research and text mining is presented at Figure 1. This will serve as a baseline for creation of an advanced rural policy development framework and tools.

Results and discussion

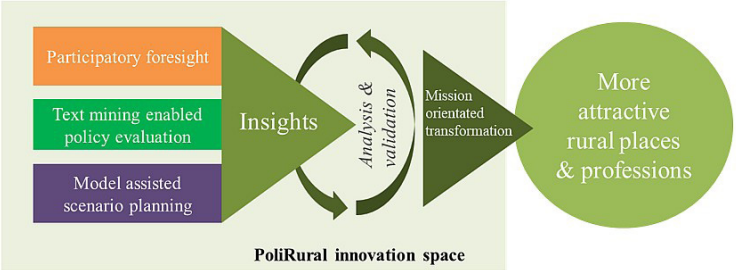
In this section, we present the proposed PoliRural framework consisting of five major components:

- participatory foresight for rural policy making,
- text mining enabled policy evaluation,
- model-assisted scenario planning process,
- mission oriented transformation,
- PoliRural innovation hub.



Source: own processing

Figure 1: PoliRural framework baseline.



Source: own processing

Figure 2: Components of the PoliRural framework.

The ultimate goal of the PoliRural framework is to increase the attractiveness of rural areas for living, investment, job creation, employment, recreation, cultural heritage (Figure 2).

Assumptions and interdisciplinary considerations

There has been a growing recognition that the practice of foresight can be more inclusive and that citizens can play a bigger role in re-imagining the future. Futures is a growing discipline, with practitioners building expertise by undergoing academic training, participating in conferences and acquiring membership in professional bodies. Despite this strengthening professionalism, futurists themselves are concerned that the lack of diversity in their ranks leads them to envision disproportionately optimistic or pessimistic futures (Nikolova, 2014).

The recognition of the limits of expert foresight is growing alongside efforts by governments, including the EU, to harness the collective capacity of a society to create greater public value (Staman et al., 2017). Furthermore, engagement of a wider range of stakeholders including citizens in foresight exercises is even more justified in the context of policy initiatives aimed at systemic transformation for solving societal problems. Citizens are indeed considered as holders of knowledge needed to understand 'wicked' (i.e. complex and multifaceted) problems. Their engagement is increasingly seen as crucial for ensuring the wider acceptance, adoption and diffusion of solutions purporting to address societal needs (Bourgeois et al., 2017). In the current context of rising populism and the growing perception of democratic deficit at different levels of government, citizen participation in the policymaking process in general and foresight in particular can lend to policies precisely the kind of legitimacy they need.

Another source of potential legitimacy is evaluation of data since it can provide a well-performing policy the evidence base needed to justify its implementation. However, providing a complete evidence base is easier said than done, not least because of the data tsunami – a term describing overwhelming data volumes for example in telecommunication networks (Zander and Mähönen, 2013), medicine (Ackerman, 2014) or astronomy (Berriman and Groom, 2011). Typically, evaluations focus on a small subset of existing data, excluding much of what is available online and offline due to resource and access constraints. Policy makers are challenged by the ever-increasing amount of data at their disposal to help orient policy through evaluation of its success or failure. All policy fields, from agriculture to transport, are affected by the data tsunami and text mining offers timely access to important information which would

otherwise be practically impossible to extract manually.

But even those evaluations that draw on all available sources have their limits. Due to their reliance on historic performance, evaluations can only be applied to policies that have been around for some time in order to assess the impact thereof. How can then one assess the impact of a new policy that needs to replace or update the one which was found to be underperforming? The foresight discipline has an answer, although it differs between scenario-oriented practitioners and those who advocate a more quantitative approach. Both approaches have their advantages and limitations.

The scenario technique is a method for systematically studying a system to create consistent scenarios of the future. An extensive and in-depth critical discussion of scenario building techniques is provided in Bourgeois et al (2017). Scenarios can broaden one's view of the various states that a system may take by presenting alternative futures. Threats and opportunities are jointly identified by stakeholders so that strategies can be based upon advanced knowledge of what may happen to the current state of affairs in several years or indeed decades. Popular though it may be, the scenario method is often criticised on two major grounds (Brose et al., 2013). First, the system's feedback structure is not analysed in great detail. Second, once the scenarios are generated, there is generally little or no information on how the envisaged changes will affect the system as a whole. These are precisely the two aspects that are addressed by the rival method i.e., system dynamics.

System dynamics is based on the idea that the behaviour of a given system and its subsystems can be expressed through the continuous interaction between agents. Dynamic systems modelling examines causes and effects over time, accepting that complex interactions and feedback between subsystems do not occur simultaneously and are not observable in the same space (Bryden, 2010). Systems thinking seeks to understand any system by examining the linkages and interactions between elements that comprise the entire system. The prevailing belief is that parts of a system can be better understood in the context of relationships with each other and with other systems, rather than in isolation (Skyttner, 2005). Although system dynamics proponents claim that they offer better insights into the impacts and interrelationships within a system, their critics argue that they adopt too deterministic view of the future, which frankly is too elusive for any model to capture.

Regardless of what foresight approach is taken, the success of a new policy can be still undermined if it is grounded in old thinking, such as that when the effort is excessively focused on particular sectors – as in traditional industrial policy – rather than on problem-specific societal challenges.

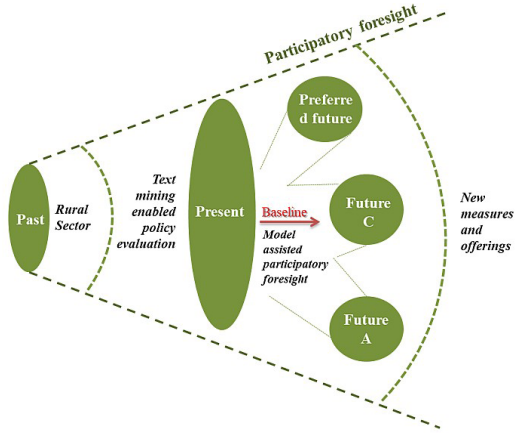
Participatory foresight for rural policy making

We argue that when foresight activity is implemented in a truly participatory way, the result becomes a process of collective learning among participants, leading to a stronger commitment to final results. The PoliRural framework interprets participatory foresight as a powerful combination of strategic anticipatory intelligence, sense-making, visioning, scenario development, systems modelling all coupled with deep participatory engagement that is not limited to the expert community (Bourgeois et al., 2017). As such, foresight is no longer to be treated as a luxury. Indeed, more than ever before, foresight has become an essential prerequisite for proactive, informed and collective actions to stimulate participation of a wider set of actors. For this to happen, the relationship must be underpinned by a shared agenda, an emphasis on value sharing rather than argument, consultative practices based on the principles of inclusion, courtesy and respect.

The main focus of PoliRural foresight is on gaining a well-rounded understanding of change, of how it is happening in the world, how it will play out in the studied regions, and how local/regional policy decisions can influence it for the benefit of grassroot communities. It involves learning an arcane vocabulary relating to macro, meso and micro-trends, trend-breaks and weak signals, drivers and enablers of change and game changers. It is not to be confused with forecasting. It is about understanding not predicting. Tools such as text mining can highlight issues for exploration. Dynamic system modelling can help understand how these issues will evolve. It provides a basis for exploring alternative futures based on scenarios using a participative approach that supports high levels of stakeholder engagement (Hines and Bishop, 2013). Ideal results are obtained when foresight is combined with or embedded in a real and timely local policy process.

The chosen foresight approach will also be strategic and modular. Strategic because it will capture all the required information and facilitate a logical flow between the main stages; modular because at various steps different methods and techniques will be integrated to achieve specific objectives, enabling regional stakeholders to effectively carry

out project activities from start to finish. Inspired by the Framework Foresight method (Hines and Bishop, 2013), we propose the participatory foresight for rural policy making as follows: (1) baseline development from the current situation analysis which culminates in the evaluation of existing policy measures and recommendations for alternative policy options; (2) exploration of future trends and the impact of proposed policy options across space and time, in multiple scenarios and using qualitative and quantitative techniques and tools; (3) implementation by regional stakeholders of selected policy options from the long-list provided using a mission-oriented approach (Figure 3).



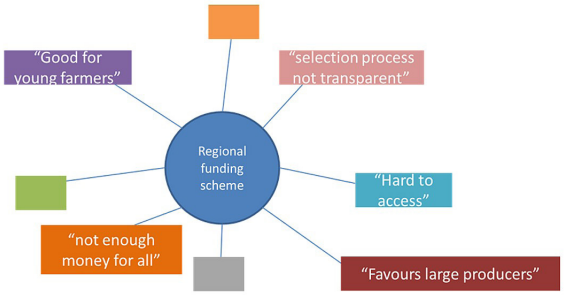
Source: adapted from Hines and Bishop (2013).

Figure 3: Participatory foresight for rural policy making.

Text mining enabled policy evaluation

We argue that text mining is a technique which is feasible for overcoming the cognition burden that every policy maker faces due to the data tsunami phenomena. Text mining can help to process vast amounts of information from structured and unstructured sources and discover new knowledge at a low cost. Text mining applications can save time on data collection and information processing, allowing decision makers to focus on more important tasks like service delivery. Arguably, the greatest benefit of text mining, when viewed through the prism of participatory foresight (Kayser and Blind, 2017), is that it enhances policy deliberation among citizens, since the application of text-mining techniques to online content found on forums or social media can increase the chances of citizens' voices being heard by decision makers (Chun et al., 2010; Ahn and Bretschneider, 2011).

Text mining will be extensively used at the first foresight stage called current situation analysis. The evaluation will be multi-source and multi-method, aggregating findings from survey and textual analysis to provide an overview of the current situation that is more complete than the one based on either method alone (Figure 4). The tool itself will be based on heavy-duty knowledge extraction using deep neural networks trained on the large corpus of texts (e.g., EU documents, scientific journals) and adapted to work with regional libraries and languages. Regional libraries are repositories that will contain documents and links to publicly accessible data. The repositories will be curated by researchers in collaboration with policy makers. One of the outputs that this text mining process produces is a semantic tree which can be explored interactively on the PoliRural platform (see PoliRural Innovation Hub section). We will use ANNOY and HDBSCAN for clustering (Melo et al., 2016) and novel Word Mover's Distance for sentence and paragraph similarity analysis (Ye et al., 2016).



Source: own processing

Figure 4: Theoretical text mining.

PoliRural text mining solution has several components. The main part is a set of web crawlers for scraping textual information from online sources using different protocols. Currently, these crawlers collect information from the European Publication Office, Bookshop, EURLEX, CORDIS, DG JRC PUBSY via a number of interfaces (SPARQL, SOAP, OAI, FTP, HTTP) with the help of bespoke harvesters. It is expected that the text mining solution will target only publicly available data sources.

As of today, the harvested repository contains 37 GB of plain text, 6.9 billion tokens and 650,000 unique phrases with cardinality above 20. Tokens are semantic units that result from cutting text into pieces. Depending on the tokenisation strategy used, the results can be quite different e.g., [O'Neill], [Oneil], [neil], [O,neil],[O',neil]. The entire collection passes through the text processing chain based on the open source Python libraries (NLTK, Spacy, Textacy, Tensorflow,

Gensim, Facebook Fasttext). The chain is designed to clean text from artefacts while extracting the relevant metadata i.e. title, year, author, source. The text is then parsed into sentences and phrases before being converted into vectors. Named entities are extracted from the available text using semantic parsing, a multilevel rule-based POS and DEP labelling with entity-type identification. Named entity recognition (NER) locates and classifies named entities found in text into predefined categories such as the names of persons, organizations, locations; expressions of times, quantities, monetary values, percentages, etc (Lin et al., 2019). We will use open source NER algorithms as well as domain specific NER classifiers trained on the PoliRural content repository. Part-of-speech (POS) tagging assigns parts of speech to nouns, verbs, adjectives etc. in order to disambiguate the meaning (Stevenson and Wilks, 2001), while syntactic dependency (DEP) is used to describe the type of syntactic relation that connects the child to the head (Nivre, 2008).

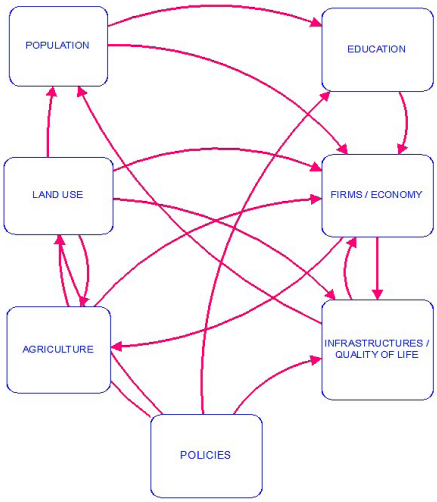
New language models are trained using various Python open-source libraries (e.g., Spacy, Tensorflow, Gensim). This feature is particularly relevant for PoliRural given the fact that it will be employed in a multilingual environment. Newly trained, domain-specific language models can be used for word- or sentence-similarity identification. The text mining tool is also designed to interact with social media. The sources, however, will be limited to platforms that have a public API and offer advanced filtering which is currently Twitter. Data from the streaming API will be stored in the persistent queue which can process large quantities of real-time content. Textual information will then enter the same processing pipelines as described above.

Model-assisted scenario planning process

PoliRural will apply both quantitative and qualitative foresight approaches to create a social learning tool that can help facilitate the discussion among rural stakeholders about the present and particularly future state of agriculture, forestry and other sectors in primary production and beyond. Due to its combined value, the solution is expected to improve decision-making under uncertainty which seems to characterise today's politics, e.g. economic and societal impacts of Covid-19 pandemic, Brexit, etc. To be truly useful for strategic planning, a new innovative solution will be created in a transparent way. It will be developed for rural areas in cooperation with rural experts and stakeholders, which is an approach promoted by increasing number of studies, e.g., Bryden (2010), Bourgeois et al., (2017), Kano, Fujita and Tsuda (2019). The new solution will capture key facets of rural regions, explain relationships among multiple factors affecting primary production and illustrate potential industry trends and likely impacts of external shocks. Rural stakeholders – government bodies, grassroot community organisations, academia and research institutes – will able to explore, experiment and visualise what the future may hold in their region. The collaborative process will challenge assumptions, remove prejudices, stimulate debateand improve communication, ultimately helping everyone involved reach a consensus position. This, in turn, would criticallyinform the formulation of new policies and priorities that can make rural areas more resilient, sustainable and competitive.

One could argue that success and innovation in rural areas is determined by their ability to transform the available capital (human, social, cultural) into new activities and income opportunities. This transformation is sometimes done by farmers themselves, and sometimes by entrepreneurs, or even community organisations not necessarily involved in farming. Policies can be more or less successful in encouraging such transformation, depending in part on the institutional structures and modes of governance at regional levels. Any model that wants to mirror a rural system must therefore consider a whole range of influencing factors and interactions between them.

PoliRural is no exception. Its model will be designed to accommodate a wide range of capitals, policies, demographic, socio-economic and governance mechanisms that might influence the territorial development in different rural and political contexts. The base model (Figure 5) will serve as the conceptual framework for the construction of different regional models. A reappraisal will be carried out when the project starts, but at the time of writing the base model is conceived to include seven modules, each of them adaptable to the local reality of the selected pilot regions. The seven modules are interrelated as shown in Figure 5 (stocks and variables with a discontinuous line indicate they are defined in another module).



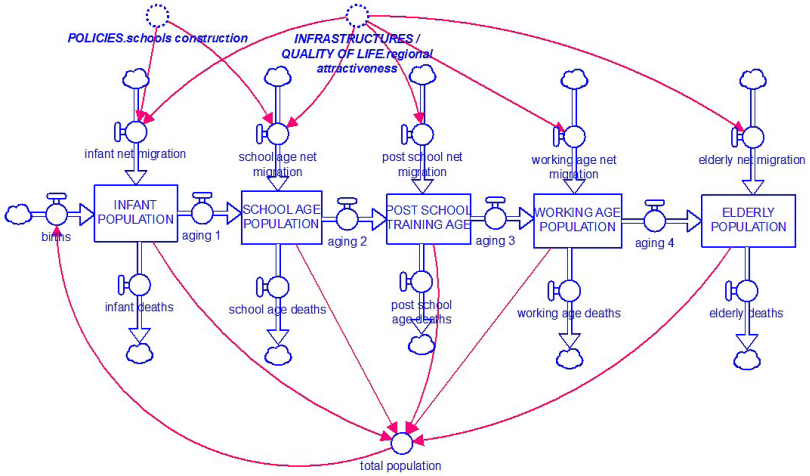
Source: own processing

Figure 5: PoliRural base.

The population module (Figure 6) is based on the aging chain and considers migration in and out in each of the cohorts in which the chain is divided. Depending on data availability, either fertility rate or population growth rate will be used as a source. In the initial base model, attractiveness is considered as having an effect on in/out migration. The precise composition of this variable will be defined according to regional contexts.

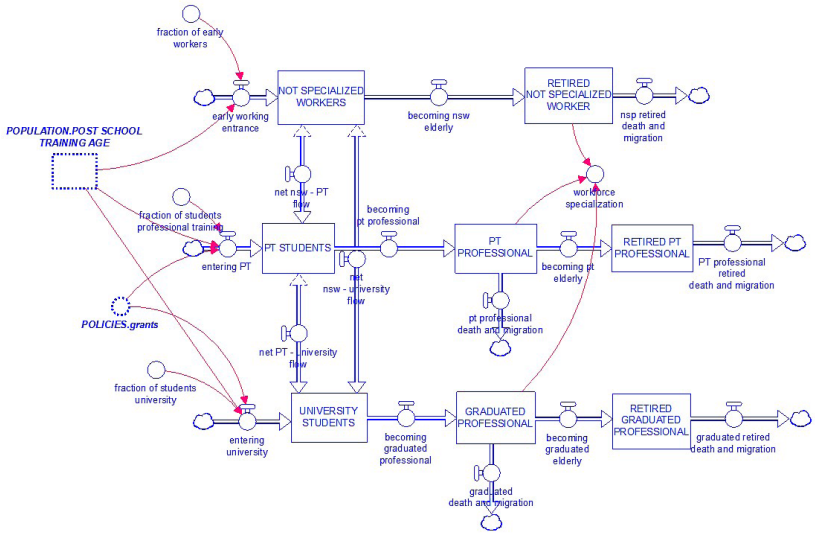
The education module (Figure 7) has a structure of a triple aging chain. Currently, the main output is conceived to be workforce specialisation, which in turn affects the economy module. The model is designed in a way so that different education programs and policies can be easily tested.

The land use module (Figure 8) is concerned with forest land, agricultural land, degraded



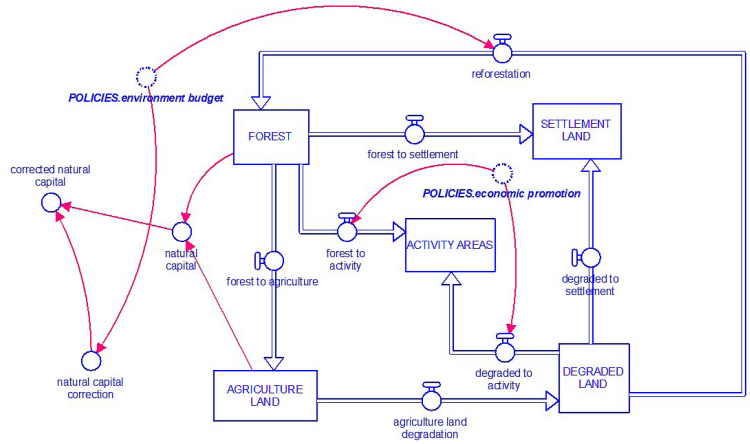
Source: own processing

Figure 6: Population module.



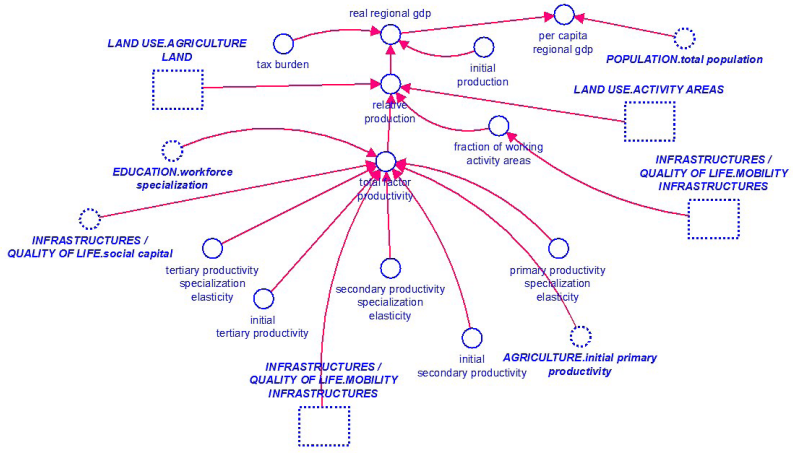
Source: own processing

Figure 7: Education module.



Source: own processing

Figure 8. Land use module.



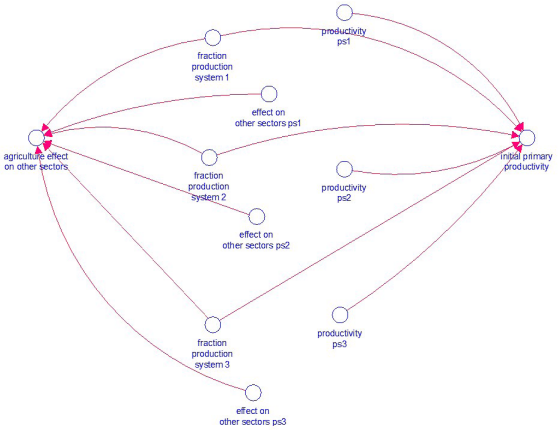
Source: own processing

Figure 9. Economy module.

land, settlements land and various activity areas. The main outputs to consider are natural capital and agricultural land, as the unit of agricultural production.

The economy module (Figure 9) is based in a simplified version of the Cobb-Douglas production function. In this version, however, capital is not considered as a production factor. Local perceptions of main problems in the economy and data availability will determine the module's final structure.

The agriculture module (Figure 10) has at its base the production system and basically considers the importance of the sector in rural areas. Each production system has different productivity ratios as well as different effects on the rest of the economy. Three production systems considered in the base model are different management, properties and use of resources. All are dependent on local practices and as such they differ in social impact, relation with the rest of the economy, profitability, environmental impact, among other things. Examples include intensive livestock farming, extensive farming, cereals, fruit trees, mixed farms.



Source: own processing

Figure 10. Agriculture module.

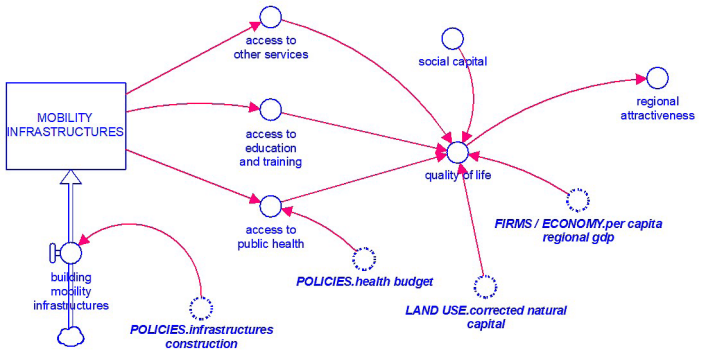
The quality of life and infrastructures module (Figure 11) considers access to basic services (education, health etc.) and infrastructures such as roads. The infrastructure's stock may be the number of people living within five minutes of a motorway, while quality of life is defined as a function of access to services, the social and the natural capital and the per capita regional gross domestic product. Quality of life is also defining the attractiveness of the area.

The policies module (Figure 12) is introduced to capture the effects of old and new policies on the different elements within a rural system. The example below considers regional budget and the proportion allocated to the main expenditures. As a consequence of budget allocation, other modules are affected by changes in the policies module. The budget-oriented approach is just one of several options that will be explored in more detail when the project starts.

The model's structure is qualitative to the extent that it reflects local reality, its inherent characteristics and specificities, whereas the statistical input fed into the model adds to its quantitative side. For the model to work as intended, deep domain expertise in system dynamics must interface with grassroot knowledge possessed by regional actors. The model views the present state of affairs as a product of interaction between different agents and sub-systems and tests the impact of proposed policies on these interactions over time under different scenarios. The three preliminary scenarios to be explored during workshops with regional stakeholders are:

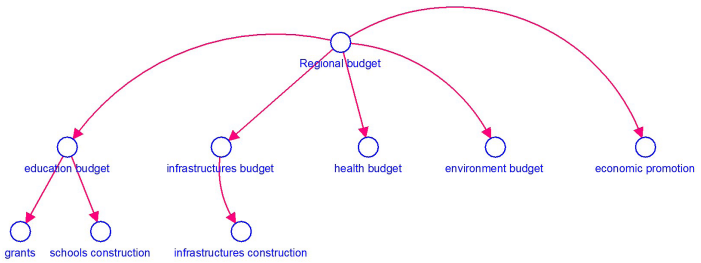
- Business as usual scenario (BAS). BAS shows the evolution of trends observed so far. The trends will reflect the main issues local communities consider to be important
- Local plausible scenarios. This group of scenarios is about the risks and opportunities that the community identifies as plausible in the near future. Scenarios will propose measures to promote opportunities and avoid the risks
- Policy change scenario. The policy change scenario focuses on programs and policies that can help improve local competitiveness and quality of life

In conceptualising and formalising the linkages between policies, farming and land use, production and education, economic and social performance of pilot regions until 2040, PoliRural will initially use Stella Architect which offers a practical set of tools for visualising and communicating how complex systems and ideas work overtime and space. Like other systems models, the core elements of the Stella model are stocks and flows (flows add to or subtract from stocks) and the feedback loop between the two. As the project progresses,



Source: own processing

Figure 11. Quality of life and infrastructure module.



Source: own processing

Figure 12. Policies module.

PoliRural will migrate to Open Source system dynamics software as a base to create a unique innovative software solution for rural policy making.

Mission oriented transformation

Being complex and multifaceted, rural challenges, such as ageing, declining population, unemployment, climate change, droughts, flooding, decreasing biodiversity and environmental degradation require a coordinated and targeted policy response. Traditional approaches that do not deliver in terms of innovation results and solutions should be replaced with a policy approach that can actively contribute to rural change in a direction that is favoured and can be shaped by rural communities. Mission-oriented policy, one of the central concepts of Horizon Europe (European Commission, 2018), offers such an approach. Mission initiatives are characterised by a well-defined goal, direction and timeline, and are typically focused on solving wicked and complex societal challenges and system transformation. Mission-oriented initiatives, being bottom-up, bold and ambitious, as well as cross-sector, cross-discipline and cross-actor oriented, differ in their design, governance and implementation from other types of policies (Fisher et al., 2018; Mazzucato, 2018). Policymakers and stakeholders in PoliRural study areas, supported by the wider PoliRural consortium, will experiment with mission concepts and elaborate mission modalities geared towards their specific rural challenges, needs and context.

PoliRural Innovation Hub

The aim of the PoliRural Digital Innovation Hub (DiH) is to offer a public user interface and introduction to the innovations of the project. To this end, the DiH entry point is built on a content management system. Furthermore, the DiH will provide four distinctive sections, or spaces, that cater for both internal and external users:

1. An interaction space with forums, dialogue and Wiki capabilities to support stakeholder interaction
2. A learning space for Massive Open Online Courses to facilitate dissemination and uptake of knowledge and methodology developed through the project
3. An experimentation space for testing analytics and visualization including text mining and system dynamics based on real data
4. A development and hosting space for creating virtual instances of the shared reference to be used by each pilot when developing their applications.

Below these high-level functional requirements there is a lot of implicit functionality that in some cases can be supplied by more than one technology component. In order to identify how the DiH can best serve the pilots, the work would need to start off by a detailed analysis of pilots in terms of context, data availability and requirements, analytics requirements and pre-existing tools and technologies that the DiH must be capable of interfacing with.

Relevant EU and international activities

As the PoliRural framework has been designed to be implemented as a research and innovation action project, we have identified a number of initiatives whose results are relevant for the project and as such will be incorporated in whole or in part into the modus operandi when the project starts. These initiatives fall under three main concepts outlined above (participatory foresight, text mining enabled policy evaluation and model assisted participatory scenario building) plus one is related to gender.

Participatory foresight

European Foresight Platform (EFP) is an initiative supported by the European Commission that aims to bring together different communities and individual professionals to share their knowledge about foresight, forecasting and other methods of future studies (EFP, 2010). EFP contains a wealth of information on foresight methodology which can also inform our framework.

Pastoral Properties Futures Simulator (PPFS), a dynamic systems model developed within a participatory action research partnership with the pastoral industry of Australia's Northern Territory (CDU, no date). The process behind PPFS development is well documented in a number of articles (Greiner et al., 2014), and its particularly qualitative elements are accompanied with tried and tested good practices which would be useful for implementation of the PoliRural framework.

Text mining enabled policy evaluation

AGROVOC is a vocabulary developed by FAO of over 35,000 concepts and 671,000 terms in different languages, covering areas such as nutrition, agriculture, fisheries, forestry and environment (AIMS, 2018). PoliRural will adopt AGROVOC as a tool for the initial word embeddings for language models which have not been fully trained i.e. trained on human annotated text only.

FASTPARSE is an ERC funded project that aims to develop fast parsers to improve the analysis and meaning of extracted textual data (Grupolys, 2017). FASTPARSE results will be used to improve PoliRural text mining, semantic explorer, specifically the text processing chain where text will be parsed into sentences and phrases before being converted into vectors.

OpenMinTed is an H2020 that sets out to create an open, service-oriented online infrastructure for text and data mining. OpenMinted results are interesting for PoliRural mainly from the sustainability point of view (ARIS, 2015). OpenMinTed platform will offer a space for PoliRural to publish its text mining tool for a wider uptake by the community. Specifically, PoliRural will be able to publish its content metadata and transfer standards, service metadata and pipelining, IPR and licensing restrictions.

PERCEIVE is an H2020 project that investigates how much citizens living in different parts of Europe feel European, and to what extent this feeling can be attributed to the implementation of the European Cohesion Policy (UNIBO, 2016). The project has developed a rigorous evaluation methodology that contains useful pointers for PoliRural's own evaluation task Also, the project results will feed directly into the quality of life module that will be developed as part of the system dynamics work stream.

Model-assisted scenario development

TOP-MARD was an FP6 project that used systems dynamics thinking and tools to create a policy model of multifunctional agriculture and rural development (CORDIS, 2013). The developed model provides solid conceptual, scientific and technical cues for building PoliRural own model.

The System Dynamics International Society is an international, non-profit organisation devoted to encouraging the development and use of system dynamics and systems thinking around the world. The society has a Special Interest Group (SIG) on Agriculture & Food that has developed many advanced models covering different aspects of the rural system, from agents to policies to social capital (SDS, 2018).

Conclusion

The paper attempted to make several important contributions. First, we analysed the limits of rural policy development and evaluation methods and proposed a new approach based on text mining. The text mining tool will feed additional data into the present situation evaluation and future scenarios modelling while relieving researchers from the cognitive burden. Second, inspired by the tried and validated Framework Foresight method, we proposed the participatory foresight for rural policy making approach that combines work with a broad spectrum of stakeholders on policy evaluation and needs analysis, text mining and system dynamics modelling. Third, we argue that future scenario models should be of qualitative nature but, at the same time, fed with quantitative statistical data. This will allow for interaction between domain experts and grassroot stakeholders which should guarantee high precision of the models. All projected contributions will be experimentally tested and verified in a research and innovation action project PoliRural. The project started in June 2019 for a three-year period and was financed under the Horizon 2020 programme.

Despite presenting the contributions based on research in progress, we are able to draw two practical implications for rural stakeholders, national and EU level policy makers. By adopting the proposed PoliRural framework, policy teams will be able to enhance the effectiveness of their policy making processes, while rural stakeholders will be given the opportunity to become valuable policy influencers and solution co-creators. The ability to quickly experiment and understand the impact of a variety of policy solutions will result in saved time and costs. The impact will be demonstrated and extrapolated from twelve pilot sites across Europe and Israel that will use the PoliRural framework and tools for real life policy scenarios, enabling measurement of both quantifiable and qualitative impact measures on the outcomes.

Acknowledgements

This research has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 818496. More details about the project are available at www.polirural.eu.

The results and knowledge included herein have been obtained owing to support from the following institutional grant. Internal grant agency of the Faculty of Economics and Management, Czech University of Life Sciences Prague, grant no. 2019MEZ0004 – "Machine Learning Classification model to Identify User Activities During Usability Testing".

Corresponding authors
Ing. Milos Ulman, Ph.D.
Department of Information Technologies, Faculty of Economics and Management
Czech University of Life Sciences Prague, Kamycka 129, 165 00 Prague - Suchdol, Czech Republic
Phone: +420 224 382 769, E-mail: ulman@pef.czu.cz

References

[1] Ackerman, M. J. (2014) “The medical data tsunami”, *The Journal of medical practice management: MPM*, p. 406. ISSN 8755-0229.

[2] Ahn, M. J. and Bretschneider, S. (2011) “Politics of e-government: E-government and the political control of bureaucracy”, P*ublic Administration Review*, Vol. 71, No. 3, pp. 414-424. DOI 10.1111/j.1540-6210.2011.02225.x.

[3] AIMS (2018) AGROVOC.

[4] ARIS (2015) "*OpenMinted*". [Online]. Available: http://openminted.eu/about/ [Accessed: Dec. 10, 2018].

[5] Berriman, G. and Groom, S. (2011) “How will astronomy archives survive the data tsunami?”, *Communications of the ACM,* pp. 52-56. ISSN 0001-0782. DOI 10.1145/2043174.2043190.

[6] Bourgeois, R., Penunia, E., Bisht, S. and Boruk, D. (2017) “Foresight for all: Co-elaborative scenario building and empowerment”, *Technological Forecasting and Social Change*, Vol. 124 (C), pp. 178-188. ISSN 0040-1625. DOI 10.1016/j.techfore.2017.04.018.

[7] Brose, A., Gausemeier, P., Vierhaus, I., Fügenschuh, A. and Selinger, G. (2013) “A system dynamic enhancement for the scenario technique”, *Proceedings of 11th Global Conference on Sustainable Manufacturing*, pp. 561-566, Universitätsverlag der TU Berlin.

[8] Bryden, J. M. (2010) "Using system dynamics for holistic rural policy assessments and data envelopment analysis for evaluation of comparative policy efficiency at regional level", *118th Seminar, August 25-27,* 2010, Ljubljana, Slovenia ,European Association of Agricultural Economists. DOI 10.22004/ag.econ.94618.

[9] CDU (no date) Pastoral Properties Futures Simulator.

[10] Chun, S., Shulman, S., Sandoval, R., Hovy, E. (2010) “Government 2.0: Making connections between citizens, data and government”, *Information Polity*, Vol. 15, No. 1, 2, pp. 1-9. ISSN 1570-1255. DOI 10.3233/IP-2010-0205.

[11] CORDIS (2013) Towards a Policy Model of Multifunctional Agriculture and Rural Development [TOP-MARD].

[12] DG Agri (2017) Young farmers in the EU – structural and economic characteristics.

[13] EFP (2010) "European Foresight Platform". [Online]. Available: http://www.foresight-platform.eu [Accessed: Dec. 10, 2018].

[14] European Commission (2018) "*Horizon Europe - the next research and innovation framework programme*". [Online]. Available at: https://ec.europa.eu/info/horizon-europe-next-research-and-innovation-framework-programme_en [Accessed: Dec. 5, 2018].

[15] Fisher, R., Chicot, J., Domini, A., Polt, W., Turk, A., Unger, M. and Goetheer, A. (2018) "*Mission-oriented research and innovation: Inventory and characterisation of initiatives-Study*", European Commission EC. ISBN 978-92-79-85793-5. DOI 10.2777/697082.

[16] Fontela, E. (2000) “Bridging the gap between scenarios and models”, *Foresight*, Vol. 2, No. 1, pp. 10-14. ISSN 1463-6689. DOI 10.1108/14636680010802447.

[17] Fortes, P., Alvarenga, A., Seixas, J. and Rodrigue, J. (2015) “Long-term energy scenarios: Bridging the gap between socio-economic storylines and energy modeling”, *Technological Forecasting and Social Change*, Vol. 91, pp. 161-178. ISSN 0040-1625. DOI 10.1016/j.techfore.2014.02.006.

[18] Greiner, R., Puig, J., Huchery, C., Collier, N. and Garnett, S. T. (2014) “Scenario modelling to support industry strategic planning and decision making”, *Environmental Modelling & Software*, Vol. 55, pp. 120-131. ISSN 1364-8152. DOI 10.1016/j.envsoft.2014.01.011.

[19] Grupolys (2017) Fast Parse.

[20] Van Herzele, A., Gobin, A.,Van Gossum, P., Acosta, L., Waas, T., Dendoncker, T. and de Frahan, B. H. (2013) “Effort for money? Farmers’ rationale for participation in agri-environment measures with different implementation complexity”, *Journal of Environmental Management*, Vol. 131, pp. 110-120. ISSN 0301-4797. DOI 10.1016/j.jenvman.2013.09.030.

[21] Hines, A. and Bishop, P. C. (2013) “Framework foresight: Exploring futures the Houston way,” *Futures*, Vol. 51, pp. 31-49. ISSN 0016-3287. DOI 10.1016/j.futures.2013.05.002.

[22] Kano, E., Fujita, Y. and Tsuda, K. (2019) “A Method of Extracting and Classifying Local Community Problems from Citizen-Report Data using Text Mining”, *Procedia Computer Science*, Vol. 159, pp. 1347-1356. ISSN 0016-3287. DOI 10.1016/j.procs.2019.09.305.

[23] Kayser, V. and Blind, K. (2017) “Extending the knowledge base of foresight: The contribution of text mining”, T*echnological Forecasting and Social Change*. Vol. 116, pp. 208-215. ISSN 0040-1625. DOI 10.1016/j.techfore.2016.10.017.

[24] Lin, J. C.-W., Shao, Y., Fournier-Viger, P. and Hamido, F. (2019) “BILU-NEMH: A BILU neural-encoded mention hypergraph for mention extraction”, *Information Sciences*, pp. 53-64. ISSN 0040-1625. DOI 10.1016/j.ins.2019.04.059.

[25] Mazzucato, M. (2018) “*Mission-oriented research & innovation in the European Union*”, Brussels: European Commission. ISBN 978-92-79-79918-1.

[26] Melo, D., Melo, D., Toledo, S., Mourão, F., Sachetto, R., Andrade, G., Ferreira, R., Parthasarathy, S. and Rocha, L. (2016) “Hierarchical Density-Based Clustering Based on GPU Accelerated Data Indexing Strategy”, *Procedia Computer Science*, pp. 951-961. ISSN 1877-0509. DOI 10.1016/j.procs.2016.05.389.

[27] Nikolova, B. (2014) “The rise and promise of participatory foresight”, *European Journal of Futures Research*, Vol. 2, No. 1, pp. 33. ISSN 21952248. DOI 10.1007/s40309-013-0033-2.

[28] Nivre, J. (2008) “Algorithms for Deterministic Incremental Dependency Parsing”, *Computational Linguistics*, pp. 513-553. E-ISSN 1530-9312, ISSN 0891-2017. DOI 10.1162/coli.07-056-R1-07-027.

[29] SDS (2018) "*Special Interest Groups (SIGs)*". [Online]. Available: https://www.systemdynamics.org/society-sigs [Accessed: Dec. 10, 2018].

[30] Skyttner, L. (2005) "*General systems theory: Problems, perspectives, practice*", World scientific. 2nd edition. ISBN 978-981-4479-98-1. p. 536. DOI 10.1142/5871.

[31] Staman, J., Berloznik, R., Weber, M., Salo, A., and Havas, A. (2017) "*Report of the Expert Group 'Strategic Foresight for R&I Policy in Horizon 2020'*", Background papers, Publications Office of the European Union. ISBN 978-92-79-68543-9. DOI 10.2777/768916.

[32] Stevenson, M. and Wilks, Y. (2001) “The Interaction of Knowledge Sources in Word Sense Disambiguation”, *Computational Linguistics*, pp. 321-349. E-ISSN 1530-9312, ISSN 0891-2017. DOI 10.1162/089120101317066104.

[33] UNIBO (2016) "*PERCEIVE*". [Online]. Available: https://www.perceiveproject.eu/about-the-project/ [Accessed: Dec. 10, 2018].

[34] Westhoek, H. J., van den Berg, M. and Bakkes, J. A. (2006) “Scenario development to explore the future of Europe’s rural areas”, *Agriculture, Ecosystems and Environment*, pp. 7-20. ISSN 0167-8809. DOI 10.1016/j.agee.2005.11.005.

[35] Wiebe, K., Zurek, M., Lord, S., Brzezina, N., Gabrielyan, G., Libertini, J., Loch, A., Thapa-Parajuli, R., Vervoort, J. and Westhoek, H. (2018) “Scenario Development and Foresight Analysis: Exploring Options to Inform Choices”, *Annual Review of Environment and Resources*, pp. 545-570.

ISSN 1543-4938. DOI 10.1146/annurev-environ-102017-030109.

[36] Ye, X., Shen, H., Ma, X. and Bunescu, R. C. (2016) "From Word Embeddings to Document Similarities for Improved Information Retrieval in Software Engineering", *2016 IEEE/ACM 38th International Conference on Software Engineering (ICSE)*, ACM, pp. 404-415. DOI 10.1145/2884781.2884862.

[37] Zander, J. and Mähönen, P. (2013) "Riding the data tsunami in the cloud: myths and challenges in future wireless access", *IEEE Communications Magazine*, pp. 145-151. E-ISSN 1558-1896, ISSN 0163-6804. DOI 10.1109/MCOM.2013.6476879.

SCIENTIFIC INFORMATION

Understanding food value chains and network dynamics

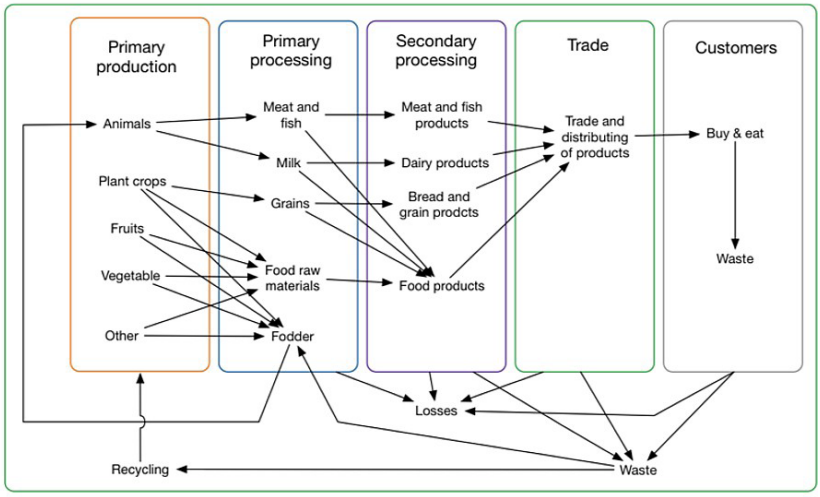
Horizon 2020 funded research and innovation project

The overall objective of the VALUMICS project is to **provide decision makers** throughout food value chains with a comprehensive suite of approaches and **tools** that will enable them to **evaluate** the impact of strategic and operational **policies** to enhance the r**esilience, integrity and sustainability** of food value chains for European countries

The VALUMICS project implements a **holistic approach** and **causality based system framework**, supported by new advances in theory, modelling and data gathering, which is required to capture and understand the dynamics and interactions in food systems

VALUMICS provides **improved understanding** and models **underpinning policy recommendations**, enabling advice aimed at decision makers with key roles and required capacity to enhance the resilience with respect to sustainability of strategic food value chains in Europe – key findings and results you can find on https://valumics.eu/.

The food value chain is comprised of the stages of the path of the food products starting with inputs, primary production, manufacturing, logistics and transportation, grocery and retail sectors until consumers:



VALUMICS key outcomes:

- **Improve knowledge on food chains** and their underlying drivers.
- Deliver a comprehensive **assessment** of all dimensions of the **sustainability, performance and resilience** of food chains and their contribution to jobs and growth, both territorially and at EU level.
- **Improve capacity to model** the sustainability and resilience of food chains.
- **Enhance capacity to assess the functioning of value chains**, upstream and downstream chain flows, and price transmission along the chain.
- Increase capacity to **map the occurrence of unfair practices** in the food chain and develop approaches to assess their impact.
- Clarify the development of **added value and profit margins** in food value chains and how these are distributed at each level.
- Increase understanding of how **consumers' demand and consumption patterns** affect the organization of food chains (and vice versa), and their sustainability and resilience.
- **Improve the capacity** of relevant policies and food chain stakeholders to improve food chain **sustainability and resilience**.

VALUMICS
Food Systems Dynamics

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 727243

Agris on-line Papers in Economics and Informatics

Volume XII Number 1, 2020

Editorial board

Agris on-line Papers in Economics and Informatics

The international reviewed scientific journal issued by the Faculty of Economics and Management of the Czech University of Life Sciences Prague.

http://online.agris.cz

ISSN 1804-1930