A composite fuzzy indicator for assessing farm household potential for non-farm income diversification

JANA FRITZSCH
Leibniz Institute of Agricultural Development in Central and Eastern Europe (IAMO),
Theodor-Lieser-Str. 2, 06120 Halle (Saale), Germany,
e-mail: fritzsch@iamo.de, phone: +49 345 2928129

Paper prepared for presentation at the EAAE 2011 Congress
Change and Uncertainty
Challenges for Agriculture,
Food and Natural Resources

August 30 to September 2, 2011
ETH Zurich, Zurich, Switzerland

Abstract

European politicians encourage the income diversification of rural households through various measures. Although being aware of farm households' potential for non-farm income diversification seems important for finely-targeting such policy measures, no attempt has thus far been made to summarise the various determinants of income diversification in a single figure. This contribution aims to close this gap.

A composite fuzzy indicator that measures farm household potential for non-farm income diversification is developed and applied to 1,053 farm households in Bulgaria, Hungary, Poland, Romania, and Slovenia. The indicator summarises the incentives of and capacities for non-farm income diversification on the individual household member level, and on the household and regional levels to a single measure using fuzzy logic methodology.

The composite fuzzy indicator performs well, and the results for the single farm households can easily be retraced. The indicator not only singles out the households that have the potential for non-farm income diversification, but also shows the reasons for this. Thus, the result for 1,053 farm households is not only that most of them have a high potential for non-farm income diversification, but also that the majority of these households are pushed in diversification due to the smallness of their farms. Only a few of the farm households act under pull conditions, i.e. diversification is not a necessity, but they could opt for profitable non-farm employment due to favourable age, education, and regional conditions.

Decision-makers could utilise the composite fuzzy indicator to finely-target diversification measures to the multifaceted conditions of farm households.

Keywords: composite indicator, fuzzy logic, rural non-farm income diversification, transition countries

JEL: C65, J24, Q12, R23

Acknowledgement

The author gratefully acknowledges the financial support of the European Community under the Sixth Framework Programme for Research, Technological Development and Demonstration Activities, for the Specific Targeted Research Project "SCARLED" SSPE-CT-2006-044201 (www.SCARLED.eu).

The views expressed in this publication are the sole responsibility of the author and do not necessarily reflect the views of the European Commission.

1. Introduction

The Directorate-General for Agriculture and Rural Development of the European Union (EU) stated in its annual Rural Development Report for 2009 that the importance of the primary sector[1] is declining for employment, as well as for the economy in the rural areas of the EU27 (DG Agri, 2009). Furthermore, statistical information from The World Bank (WDI, 2010) reveals a significant discrepancy between the share of employment in agriculture and its contribution to GDP in the New Member States of the EU. Indeed, this discrepancy indicates underemployment and hidden unemployment in the agricultural sector. Consequentially, recent Farm Structure Surveys show that a significant share of farms use less than 1 Annual Work Unit (AWU)[2] (Table 1). Given that the Farm Structure Surveys cover only farms the size of at least 1 European Size Unit (ESU)[3], it can be assumed that the real extent of under-employment in the agricultural sector is even higher.

Table 1: Share of agricultural holdings using less than 1 AWU in selected New Member States of the EU

	Share of holdings using less than 1 AWU (Number of agricultural holdings) *)		
	2002/2003 **)	2005	2007
Bulgaria	21% (157,300)	21% (118,100)	30% (117,800)
Hungary		57% (155,400)	58% (141,000)
Poland	22% (1,056,300)	27% (1,082,700)	29% (1,130,000)
Romania	53% (1,211,800)	55% (1,240,000)	54% (866,700)
Slovenia		36% (61,000)	44% (61,500)

Notes: *) Figures are from European Farm Structure Surveys that exclude agricultural holdings smaller than 1 ESU. **) Data for Romania and Poland are from 2002, and for Bulgaria from 2003.

Sources: Eurostat (2005a, 2005b, 2005c, 2006a, 2006b, 2006c, 2007a, 2007b, 2008a, 2008b, 2009a, 2009b, 2010c).

European politicians are aware of this development and have launched special policy measures to encourage the income diversification of rural households (Council Regulation (EC) No. 1698/2005). Likewise, farmers understand the need to diversify and develop non-farm income sources. However, differences in the share of farm households with non-farm income activities are striking between countries and regions (DG Agri, 2009; Eurostat, 2010d).

[1] The primary sector refers to agriculture, hunting, and forestry.

[2] "The total annual working time of the persons employed in agriculture is converted into 'annual work units' (AWU). One AWU is taken to be the minimum number of hours per year laid down in the national collective agreements. If the number of hours is not laid down in these agreements … the AWU is based on 1,800 working hours per year," (Eurostat, 2010a).

[3] "For each activity … on a farm (for instance wheat, dairy cow or vineyard), a standard gross margin (SGM) is estimated, based on the area (or the number of heads) and a regional coefficient. The sum of such margins in a farm is its economic size, expressed in European Size Units (ESU, 1 ESU is a 1,200-euro standard gross margin)," (Eurostat, 2010b).

Assuming that people act rationally, the reasons for these differences must be understood and addressed if a lively rural economy should be promoted. One reason is certainly that farm households have different potentials for non-farm income diversification. Although knowing farm households' diversification potential seems important for promoting structural change, no attempt has thus far been made to summarise this potential in a single figure. This contribution aims to close this research gap.

This paper discusses the determinants of non-farm income diversification (chapter 2), introduces the methodology and the data (chapter 3), proposes a composite fuzzy indicator for assessing farm household potential for non-farm income diversification (chapter 4), applies this indicator to 1,053 farm households in Bulgaria, Hungary, Poland, Romania, and Slovenia (chapter 5), and summarises the overall findings (chapter 6).

2. Determinants of non-farm income diversification of farm households

The determinants of non-farm income diversification of farm households have been widely discussed in recent years, and Barrett et al. (2001), Davis (2003), Ellis (1998), and Haggblade et al. (2007) have summarised experiences from studies in developing countries. With the transition from centrally-planned to market-oriented economies, non-farm income diversification also became an issue for farm households in Central and Eastern Europe. Research on the particular conditions of transition countries was done by Buchenrieder (2005), Chaplin et al. (2004, 2007), Csaki and Lerman (2002), Davidova et al. (2009), Gorton et al. (2008), Möllers (2006), and Möllers et al. (2008). In the meantime, the sustainable livelihood framework (Chambers and Conway, 1992; Scoones, 1998), combined with the demand-pull and distress-push concept from migration research, has become a widely accepted analytical framework for empirical non-farm income diversification studies. A comprehensive overview of this framework is provided by Reardon et al. (2007); the present study follows their framework and extends it by incorporating concepts from Frey (1999).

According to Reardon et al. (2007), the non-farm income diversification of farm households is determined by the incentives that the household faces, as well as its capacities. Incentives can be push or pull factors, while capacities are assets such as human, social, financial, organisational, and physical capital. Capacities are crucial for the way in which a household reacts to incentives. Reardon et al. (2007) distinguish between two observation levels, i.e. the household (micro) level and the regional (meso) level. For instance, farm size and labour capacity are capacity variables on the household level, while proximity to towns is a regional level capacity. Although non-farm income diversification is usually discussed on the household level (Ellis, 1998), it is nevertheless an individual household member that undertakes the activity. As Frey (1999: 5) points out in his economic model of human behaviour, "Individuals act. What happens on the social level is explained by the behaviour of persons… This does not mean at all that human beings are considered isolated; rather, their behaviour can only be understood as the result of interactions with their surroundings, other people and institutions." Following this point of view, an individual level is added to the household and the regional levels, which results in a matrix of incentives and capacities on the individual, household, and regional level that mark the borders of the decision space for a farm household. Table 2 summarises the determinants that are used in this paper to assess farm households' potential for non-farm income diversification.

Table 2: Determinants of non-farm income diversification on individual, household, and regional levels

	Individual level	Household level	Regional level
Incentives:			
Push factors	No future on farm	Size of household, Farm size	
Pull factors	Chances of finding a job on the local labour market		Purchasing power
Capacities	Age, Education	Farm size, Labour capacity	Proximity to urban centres

Farm size is an often-used variable in non-farm income diversification models; it is a household level capacity variable in the sense that households with large farms may have the financial resources to develop self-employment activities. But for the majority of farm households it is rather a push factor, because the smaller the farm the lower is the agricultural income, thus looking for additional non-farm income sources becomes necessary. Reardon et al. (2007) reviewed various studies and concluded that the effect of farm size is ambiguous in that households operating larger farms may be more able to start-up non-farm activities, but may be less interested in doing so due to a lower need for diversification. Csaki and Lerman (2002) found a strong negative correlation between farm size and non-farm income and conclude that households with a significant share of non-farm income in total household income own, on average, less than 4 ha of land. This finding is also supported by the findings of Chaplin et al. (2007) and Möllers (2006), who state that non-farm employment diversifiers have smaller farms.

The size of the household is a push factor on the household level. The bigger the household and the more people have to live from the farm's resources, the more likely it is that, when the farm is small, the household needs additional income sources. Chaplin et al. (2007) found that households with more children are more likely to diversify their income sources, and Möllers et al. (2008) found that the number of household members is positively correlated to non-farm income.

Labour capacity is a capacity variable on the household level and represents human capital. The labour capacity of a household determines a household's ability to earn additional income. Farming demands labour even on small farms, and child rearing and caring for the elderly add to this time demand. Thus, embarking on an additional, non-farm income activity requires abundant labour capacity in the household. This view is supported by Reardon et al. (2007), who see a high importance of household labour capacity for non-farm employment, as well as by Barrett et al. (2001), who stress that an abundant labour force is hired out.

On the individual level, age and education are important capacity variables for describing human capital. It is indisputable that elderly people do not tend to alter their living situation. However, people with low education may also find it difficult to obtain a waged job or to start up their own business due to insufficient skills. The high importance of education is confirmed by many studies; e.g. Chaplin et al. (2004), Ellis (1998), Möllers (2006), and Reardon et al. (2007) all see positive effects of education on households' diversification behaviour. Chaplin et al. (2007) state that non-farm diversifier households are headed by younger people.

The chance of finding a job on the local labour market is an individual level pull factor mainly influenced by age and education, but it goes beyond these two variables because in well-developed and prospering regions, even less-educated and elderly people may have a chance

of finding a job. However, in less-developed regions well-educated and younger people may not find a job because there is no labour demand. Thus, regional purchasing power is closely connected to this variable, which stands for a regional pull factor because it proxies the regional demand for labour and additional products or services from profit-oriented businesses. Reardon et al. (2007) stress the high importance of regional economic growth for the demand for labour and creating consumption, while Ellis (2000) and Barrett et al. (2001) emphasise the impact of (labour) market failures.

A strong individual level push factor is that a household member does not have a future on the farm because he will not inherit it, there already exists abundant labour on the farm, or he is not interested in agricultural work. For those people, looking for non-farm employment is the only straightforward strategy.

Proximity to urban centres is a regional level capacity. The less remote a region is, the less costly and therefore the more attractive is it to commute for waged employment. Even for self-employed activities there are better opportunities near urban centres to market products and services and to employ a skilled work force. The positive impact of closeness to urban centres on non-farm income diversification is stressed by Barrett et al. (2001) and Reardon et al. (2007).

All nine determinants must be summarised to one indicator to assess farm household potential for non-farm income diversification.

3. Methodology and data

The methodological challenge is to combine all determinants from Table 2 into one measure. In the literature, such measures are discussed as so-called composite indicators[4]. These indicators have attracted much attention in social sciences over recent years, especially for measuring complex concepts like well-being or quality of life (Noll, 2004). A prominent example for such a composite indicator is the Human Development Index (HDI) used by the United Nations Development Programme (Ravallion, 2010; UNDP, 2010). The pros and cons of composite indicators have been widely discussed (Nardo et al., 2005; Rahman, 2007). While proponents admire composite indicators for their ability to picture complex phenomena, antagonists stress the somewhat arbitrary way in which composite indicators are developed. Admittedly, constructing a composite indicator is a delicate undertaking. Therefore, Nardo et al. (2005) proposed an "ideal sequence" (p. 12) for formalising the procedure.

Agglomerating single determinants into a single measure is at the core of composite indicators. To accomplish this, the author proposes using a fuzzy logic approach, which stems from the fuzzy set theory developed by Zadeh (1965). The main advantage of fuzzy logic is that it works with linguistic rules that are similar to natural language. Thus, theory can be implemented one-to-one, and communicating the rationale behind the composite indicator is easy. Furthermore, the linguistic rules allow for implementing nonlinear relationships and switches. Another advantage of fuzzy logic is that it processes imperfect information by allowing statements that are partially true and false at the same time. Through this process, the impact of vague, imprecise, and uncertain data and outliers on the composite indicator value is smoothed.[5] The transformation of variable values (farm size=2 ha) to linguistic expressions (a small farm) is done by membership functions. Membership functions likewise define the degree to which a statement is true and false. Technical information for designing a fuzzy logic system can be found in fuzzyTECH (2007), Sivanandam et al. (2007), and Smithson and Verkuilen (2006).

[4] "A omposite indicator is formed when individual indicators are compiled into a single index, on the basis of an underlying model of the multidimensional concept that is being measured," (OECD, 2004).

[5] For a discussion of the difficulties to collect reliable data in household surveys see Davis and Bezemer (2003).

The utilised data are taken from farm household surveys and interviews with village officers in Bulgaria, Hungary, Poland, Romania, and Slovenia, as well as from Eurostat. A detailed description of the sampling method can be found in Buchenrieder et al. (2007). All data refer to year 2006. After excluding records with missing data and households with no members of an economically active age[6], i.e. pensioner's households, the final sample included 1,053 farm households: 201 Bulgarian, 210 Hungarian, 231 Polish, 199 Romanian, and 212 Slovenian households.

The database for the variables that measure the individual level determinants is comprised of single household members of at least 20 years old. Education refers to the highest formal degree that the household member attained, and was measured on a five-point scale (1: no schooling, 2: primary school, 3: middle school, 4: high school, 5: university). The chance of finding a job on the local labour market is a self-assessment on a five-point scale from very bad (1) to very good (5). The future on the farm is again a self-assessment. The household members were asked where they see themselves in 5 years. The answers were grouped into three categories (1: full-time farmer, 2: part-time farmer; 3: other).

Three variables stand for the determinants on household level. Farm size was measured in total available area of agricultural land, which includes permanently fallow land. The size of the household is the number of household members, including household members at an economically active age, children, and pensioners. Household labour capacity was measured in person equivalents, that is, the sum of all household members of an economically active age, plus the number of pensioners up to 69 years old, multiplied by 0.5, plus the number of pensioners between 70 and 74 years old, multiplied by 0.25 to account for their reduced but still existent labour capacity. Thereby, the author follows Harsche (2007), who stresses that due to limited income alternatives, elderly household members contribute to the operation of the farm, thus increasing household labour capacity.

At the regional level, two variables are selected. Purchasing power refers to the regional (NUTS 3[7] regions) purchasing power relative to the respective country's average. Figures are taken from Eurostat (2009c). Proximity to urban centres was measured as the distance in kilometres to the next large urban centre. This information was taken from the interviews of village officers.

All necessary information is easy to obtain because people are in general not reluctant to answer these respective questions, and the regional level information can also be found in official statistics or trip planners.

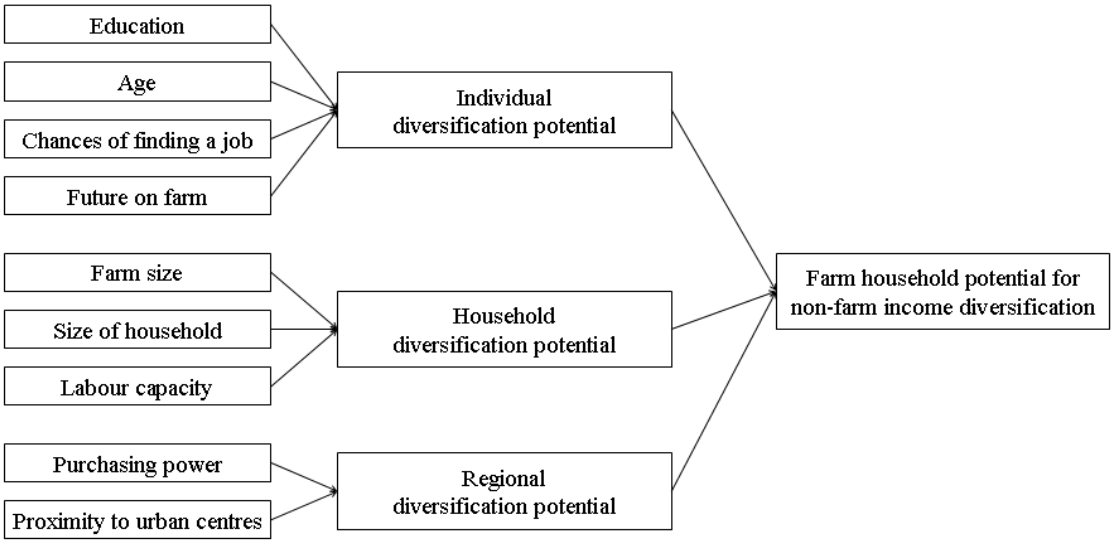
4. A composite fuzzy indicator for assessing farm household potential for non-farm income diversification

The composite fuzzy indicator for assessing farm household potential for non-farm income diversification is a combination of three intermediate indices: (i) individual diversification potential, (ii) household diversification potential, and (iii) regional diversification potential (Figure 1). Each intermediate index and the composite fuzzy indicator range between 0 and 1. Values near 0 show a low potential while values near 1 indicate a high potential for the household.

[6] People aged 20 to 64 years are in an economically active age.

[7] "The nomenclature of territorial units for statistics, abbreviated as NUTS … is a geographical nomenclature subdividing the territory of the European Union into regions at three different levels (NUTS 1, 2 and 3, respectively, moving from larger to smaller territorial units). Above NUTS 1 is the 'national' level of the Member State. NUTS areas aim to provide a single and coherent territorial breakdown for the compilation of EU regional statistics. The current version of NUTS (2006) subdivides the territory of the European Union and its 27 Member States into 97 NUTS 1 regions, 271 NUTS 2 regions and 1303 NUTS 3 regions," (Eurostat, 2010e).

Figure 1: Structure of the composite fuzzy indicator for assessing farm household potential for non-farm income diversification



In the following, the rationale behind each index implemented in the linguistic rules is described. They are given in their hierarchical order, i.e. a case that is covered by a rationale provided in a previous sentence is no longer touched by the rationale of following sentences.

Individual diversification potential

Very old people have, notwithstanding their education, chances of finding a job, and future prospects a low diversification potential. For all other household members, favourable labour market conditions and sufficient education results in a high individual diversification potential, irrespective of whether they have a future in agriculture. Accordingly, people facing unfavourable labour market conditions and possessing insufficient education have a low individual diversification potential. These three rules are straightforward. More uncertain is what happens when the educational level is insufficient, but the labour market conditions are favourable, and *vice versa*. In those cases, people who see their future in agriculture have a low individual diversification potential. When they do not have a future in agriculture, their individual diversification potential is high with only one exception; old people with sufficient education but unfavourable labour market conditions have a low individual diversification potential. For each household, the highest individual diversification potential of its members is taken to calculate the farm household potential for non-farm income diversification.

Household diversification potential

A high/low labour capacity results notwithstanding the farm size and the size of the household in a high/low household diversification potential. Households having a large/small farm have a low/high household diversification potential. Households having a farm of average size and a medium labour capacity have a high household diversification potential when the household is big but a low one when the household is small.

Regional diversification potential

Only the combination of low purchasing power and a long distance to the next large urban centre results in a low regional diversification potential; for all other combinations, it is high.

Farm household potential for non-farm income diversification

Farm households with a high household diversification potential have a high potential for non-farm income diversification unless they do not have at least one household member with a high individual diversification potential and the regional diversification potential is low. In the latter cases, the farm household potential for non-farm income diversification is low notwithstanding the high need for diversification. Otherwise, farm households with a low household diversification potential have a low potential for non-farm income diversification unless their individual and regional levels of diversification potential are high.

Due to fuzzy logic methodology, the composite fuzzy indicator is robust and insensitive towards outliers. All indices were implemented in fuzzyTECH.

5. Results

The composite fuzzy indicator from chapter 4 was used to calculate the potential for non-farm income diversification for 1,053 farm households in Bulgaria, Hungary, Poland, Romania, and Slovenia. Results show that nearly all households (95%) have a high[8] potential to diversify their income sources. Examining the results of the three intermediate indices, i.e. diversification potential on the individual, household, and regional levels, reveals that three-quarters of households have at least one household member that has a high potential to obtain non-farm employment; only 38 households (3.6%) do not face the need for diversification, and thus have a low household diversification potential; nearly 90% of households are located in regions with favourable diversification conditions.

In the following, the results are analysed by showing the interplay of the nine variables from Figure 1 with their intermediate indices and the resulting farm household potential for non-farm income diversification. Through this, the reasons why a household has a high potential for non-farm income diversification can be shown. Furthermore, it is demonstrated that the results of the composite fuzzy indicator can be retraced to its base information.

Farm households that have a high potential for non-farm income diversification (composite fuzzy indicator≥0.5, N=998)

(1) The largest group is that in which households have a high diversification potential on individual, household, and regional levels (N=687). The household member with the highest individual diversification potential is, on average, 35 years old[9], has finished high school, and sees his future as being outside agriculture. Households are comparably large (4 household members) and have plenty of labour capacity (3 person equivalents) that cannot be fully employed on the small farm (4 ha). The household is situated in a fairly well-developed region (84.4% purchasing power), and the next large urban centre is only 13 km away. Thus, income diversification is not only a necessity but also a feasible option.

(2) Households that have a high household and regional diversification potential, but a low diversification potential on an individual level, make up the second largest group (N=216). The main difference to (1) is the high age (58 years old) of the household member with the highest individual diversification potential, and his very poor chances of finding a job on the local labour market. Although diversification is a necessity for these households and the regional conditions are rather favourable, individual diversification potential indicates that the households can diversify only into poorly paid employment.

[8] The results for the indices are grouped in the two categories of 'low' and 'high'. The threshold value for separating the low/high-categories was 0.5, with all households with an index value smaller than 0.5 being in the low-category.

[9] Figures are median values.

(3) Households that have a high diversification potential on individual and household levels, but face unfavourable conditions on the regional level make up the third largest group (N=85). The main difference to (1) is that the households are situated in less-developed and remote regions (71% purchasing power and 60 km away from the next large urban centre). These households feel the necessity of diversifying and have at least one household member with a high individual diversification potential. Furthermore, the high labour capacity (3 person equivalent) allows for diversification even at the expense of commuting long distances.

(4) The last group of households with a high farm household diversification potential is characterised by a high diversification potential on both individual and regional levels, but has a low household diversification potential (N=10). The main difference to (1) – (3) is that the households in this group operate comparably larger farms (11.4 ha), have only 2 household members, and a low labour capacity (1 person equivalent). Households in this group act under pull conditions, and it is their choice whether they diversify or not.

Farm households that have a low potential for non-farm income diversification (composite fuzzy indicator<0.5, N=55)

(5) The group of households that have only a low diversification potential on individual, household, and regional levels is very small (N=3). The household member with the highest individual diversification potential is, on average, 52 years old, has no chances of finding a job on the local labour market, and sees his future in agriculture. The median household has a farm of 10 ha, two household members that live from that farm, but a labour capacity of only 1 person equivalent. At the regional level, the long distance to the next large urban centre (75 km) hampers waged employment, while the low purchasing power (71.3%) constrains the demand for products, services, and labour. Households in this group do not face the necessity of diversification, thus the low individual and regional diversification potentials do not negatively affect them.

(6) Farm households with a low individual and household diversification potential but a high regional diversification potential are in a comparable situation (N=21). Their main difference to the households in (5) is that they are located only 16 km away from the next large urban centre. But without the necessity of diversification on the household level and only a low individual diversification potential, the favourable regional conditions do not affect their diversification potential positively.

(7) The opposite is the situation in the group of households that have only a low individual and regional diversification potential, but a high diversification potential on the household level (N=27). Their main difference to the households in (5) is that the median household has only a small farm (2.1 ha), but must support more household members (3 persons). Households of this type act under push conditions, but with a low individual diversification potential and being 60 km away from the next large urban centre, there seems to be no way to non-farm employment.

(8) Farm households with a high individual diversification potential but a low diversification potential on the household and regional levels form the last group (N=4). These households are in a situation that is comparable to the households in (5) and (6). With no need for diversification and unfavourable regional conditions, the high individual diversification potential does not positively affect the farm household potential.

In sum, it could be said that the results can be interpreted reasonably well. The composite fuzzy indicator not only allows the determinants of non-farm income diversification to be summarised in a single figure, but also helps retrace the reasons for a low/high farm household potential for non-farm income diversification. Thus, the indicator seems feasible for identifying farm households that have a high potential for non-farm income diversification.

6. Conclusions

European politicians encourage the non-farm income diversification of rural households through various measures. Although being aware of farm households' potential for non-farm income diversification seems important for finely-targeting policy measures, no attempt has thus far been made to summarise the various determinants of non-farm income diversification in a single figure. This contribution proposes a composite fuzzy indicator for assessing farm household potential for non-farm income diversification. The indicator summarises the incentives of and capacities for non-farm income diversification on the individual household member level and on the household and regional levels to a single measure using fuzzy logic methodology.

The composite fuzzy indicator performs well, and the results for the single farm households can easily be retraced. It distinguishes farm households that have a high potential for non-farm income diversification from those with a low potential, and shows the reasons behind this. Results for 1,053 farm households in Bulgaria, Hungary, Poland, Romania, and Slovenia reveal that most farm households have a high potential for non-farm income diversification, but that the majority of these households are pushed to diversify due to the smallness of their farms. Only few farm households act under pull conditions, i.e. diversification is not a necessity, but household members could opt for profitable non-farm employment due to their favourable age, education, and regional conditions. The composite fuzzy indicator also singles out farm households that are trapped in a desperate situation due to their high need for diversification, combined with unfavourable chances of finding a job on the labour market and long distances to the next large urban centre.

The composite fuzzy indicator uses information that is easy to obtain. This information is agglomerated to a single measure using natural language, thus the rationale behind the indicator can be communicated to decision-makers and interested members of the general public. Decision-makers could use the composite fuzzy indicator to finely-target diversification measures to the multifaceted conditions of farm households.

References

Barrett, C., Reardon, T., Webb, T. (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.

Buchenrieder, G. (2005): Non-farm rural employment – review of issues, evidence and policies. *Quarterly Journal of International Agriculture*, Vol. 44, No. 1, pp. 5-18.

Buchenrieder, G., Möllers, J., Happe, K., Davidova, S., Fredriksson, L., Bailey, A., Gorton, M., Kancs, d'A., Swinnen, J.F.M., Vranken, L., Hubbard, C., Ward, N., Juvančič, L., Milczarek, D., Mishev, P. (2007): Conceptual framework for analysing structural change in agriculture and rural livelihoods. Deliverable 2.1 of the 6th Framework programme project SCARLED (Structural Change in Agriculture and Rural Livelihoods), http://www.scarled.eu/publications/deliverables.html, last access 12th January 2011.

Chambers, R. and Conway, G.R. (1992): Sustainable rural livelihoods: Practical concepts for the 21st century. IDS Discussion Paper 296, Institute of Development Studies, Brighton, UK.

Chaplin, H., Davidova, S., Gorton, M. (2004): Agricultural adjustment and the diversification of farm households and corporate farms in Central Europe. *Journal of Rural Studies*, Vol. 20, pp. 61-77.

Chaplin, H., Gorton, M., Davidova, S. (2007): Impediments to the Diversification of Rural Economies in Central and Eastern Europe: Evidence from Small-scale Farms in Poland. *Regional Studies*, Vol. 41, No. 3, pp. 361-376.

Csaki, C. and Lerman, Z. (2002): Land and Farm Structure in Transition: The Case of Poland. *Eurasian Geography and Economics*, Vol. 43, No. 4, pp. 305-322.

Davidova, S., Fredriksson, L., Bailey, A. (2009): Subsistence and semi-subsistence farming in selected EU new member states. *Agricultural Economics*, Vol. 40, supplement, pp. 733-744.

Davis, J.R. (2003): The rural non-farm economy, livelihoods and their diversification: Issues and options. NRI Report No. 2753, Natural Resources Institute, University of Greenwich at Medway, Kent, UK.

Davis, J.R. and Bezemer, D. (2003): Key emerging and conceptual issues in the development of the RNFE in developing countries and transition economies. NRI Report No. 2755, Natural Resources Institute, University of Greenwich at Medway, Kent, UK.

DG Agri (2009): Rural Development in the European Union: Statistical and Economic Information, Report 2009. European Union, Directorate-General for Agriculture and Rural Development, December 2009.

Ellis, F. (1998): Household Strategies and Rural Livelihood Diversification. *The Journal of Development Studies*, Vol. 35, No. 1, pp. 1-38.

Ellis, F. (2000): The Determinants of Rural Livelihood Diversification in Developing Countries. *Journal of Agricultural Economics*, Vol. 51, No. 2, pp. 289-302.

Eurostat (2005a): Structure of agricultural holdings - Poland 2002. Statistics in Focus, No. 35/2005, Office for Official Publications of the European Communities, Luxembourg.

Eurostat (2005b): Structure of agricultural holdings - Romania 2002. Statistics in Focus, No. 41/2005, Office for Official Publications of the European Communities, Luxembourg.

Eurostat (2005c): Structure of agricultural holdings - Bulgaria 2003. Statistics in Focus, No. 48/2005, Office for Official Publications of the European Communities, Luxembourg.

Eurostat (2006a): Farm Structure in Poland - 2005. Statistics in Focus, No. 10/2006, Office for Official Publications of the European Communities, Luxembourg.

Eurostat (2006b): Farm Structure in Slovenia - 2005. Statistics in Focus, No. 11/2006, Office for Official Publications of the European Communities, Luxembourg.

Eurostat (2006c): Farm Structure in Hungary - 2005. Statistics in Focus, No. 22/2006, Office for Official Publications of the European Communities, Luxembourg.

Eurostat (2007a): Farm Structure in Bulgaria - 2005. Statistics in Focus, No. 43/2007, Office for Official Publications of the European Communities, Luxembourg.

Eurostat (2007b): Farm Structure in Romania - 2005. Statistics in Focus, No. 60/2007, Office for Official Publications of the European Communities, Luxembourg.

Eurostat (2008a): Farm Structure in Poland - 2007. Statistics in Focus, No. 50/2008, Office for Official Publications of the European Communities, Luxembourg.

Eurostat (2008b): Farm Structure in Slovenia - 2007. Statistics in Focus, No. 87/2008, Office for Official Publications of the European Communities, Luxembourg.

Eurostat (2009a): Farm Structure Survey in Hungary - 2007. Statistics in Focus, No. 7/2009, Office for Official Publications of the European Communities, Luxembourg.

Eurostat (2009b): Farm Structure Survey in Romania - 2007. Statistics in Focus, No. 80/2009, Office for Official Publications of the European Communities, Luxembourg.

Eurostat (2009c): Online database of the European Union, indicator: DS-070716-table: Gross domestic product (GDP) at current market prices at NUTS level 3 (reg_e3gdp).

http://epp.eurostat.ec.europa.eu/portal/page/portal/region_cities/regional_statistics/data/database, last access 23rd June 2009.

Eurostat (2010a): Eurostat's Concepts and Definitions Database. http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=DSP_GLOSSARY_NOM_DTL_VIEW&StrNom=CODED2&StrLanguageCode=EN&IntKey=16417885&RdoSearch=BEGIN&TxtSearch=annual work unit&CboTheme=&IntCurrentPage=1, last access 4th January 2011.

Eurostat (2010b): Eurostat's Concepts and Definitions Database. http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=DSP_GLOSSARY_NOM_DTL_VIEW&StrNom=CODED2&StrLanguageCode=EN&IntKey=22669846&RdoSearch=BEGIN&TxtSearch=european size unit&CboTheme=&IntCurrentPage=1, last access 4th January 2011.

Eurostat (2010c): Farm Structure Survey in Bulgaria - 2007. Statistics in Focus, No. 16/2010, Eurostat, Luxembourg.

Eurostat (2010d): Europe in figures - Eurostat yearbook 2010. Publications Office of the European Union, Luxembourg.

Eurostat (2010e): Statistics explained - Glossary: Nomenclature of territorial units for statistics (NUTS). http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary:NUTS, last access 14th July 2010.

Frey, Bruno S. (1999): Economics as a Science of Human Behaviour. Towards a New Social Science Paradigm. Kluwer Academic Publisher, 2nd edition, Boston, USA.

fuzzyTECH (2007): fuzzyTECH 5.7 User's Manual. INFORM GmbH, Aachen, Germany.

Gorton, M., Douarin, E., Davidova, S., Latruffe, L. (2008): Attitudes to agricultural policy and farming futures in the context of the 2003 CAP reform: A comparison of farmers in selected established and new Member States. *Journal of Rural Studies*, Vol. 24, pp. 322-336.

Haggblade, S., Hazell, P.B.R., Reardon, T. (eds.): Transforming the rural nonfarm economy. Opportunities and threads in the developing world. John Hopkins University Press, Baltimore, USA.

Harsche, J. (2007): Bestimmungsfaktoren für das Erwerbsverfalten von Landwirten unter besonderer Berücksichtigung der Unternehmereigenschaften (Parameters affecting farmers' employment decisions related to different types of entrepreneurs). *Agrarwirtschaft* (German Journal of Agricultural Economics), Vol. 56, No. 2, pp. 125-136.

Möllers, J. (2006): Außerlandwirtschaftliche Diversifikation im Transformationsprozess – Diversifikationsentscheidungen und -strategien ländlicher Haushalte in Slowenien und Mazedonien (Non-farm diversification in the transition process - diversification decisions and employment strategies of rural households in Slovenia and Macedonia). Studies on the Agricultural and Food Sector in Central and Eastern Europe, Vol. 35, Leibniz Institute of Agricultural Development in Central and Eastern Europe (IAMO), Halle (Saale), Germany.

Möllers, J., Fritzsch, J., Buchenrieder, G. (2008): Farm and non-farm incomes of rural households in Slovenia. A Canonical correlation analysis. *The South East European Journal of Economics and Business*, Vol. 3, No. 2, pp. 39-48.

Nardo, M., Saisana, M., Saltelli, A., Tarantola, S., Hoffman, A., Giovanni, E. (2005): Handbook on Constructing Composite Indicators: Methodology and User Guide. OECD Statistics Working Papers 2005/3, OECD Publishing.

Noll, H.-H. (2004): Social Indicators and Quality of Life Research: Background, Achievements and Current Trends, in: Genov, N. (ed.): Advances in Sociological Knowledge

Over Half a Century. VS Verlag für Sozialwissenschaften, Wiesbaden, Germany, pp. 151-181.

OECD (2004): Glossary of Statistical Terms – Composite Indicator. http://stats.oecd.org/glossary/detail.asp?ID=6278, last access 27 January 2011.

Rahman, T. (2007): Measuring the well-being across countries. *Applied Economic Letters*, Vol. 12, No. 11, pp. 779-783.

Ravallion, Martin (2010): Troubling Tradeoffs in the Human Development Index. Policy Research Working Paper 5484, Development Research Group, The World Bank, Washington DC, USA.

Reardon, T., Berdegue, J., Barrett, C.B., Stamoulis, K. (2007): Household income diversification into rural nonfarm activities, in: Haggblade, S., Hazell, P.B.R., Reardon, T. (eds.): Transforming the rural nonfarm economy. Opportunities and threads in the developing world, pp. 115-140, Baltimore, USA: John Hopkins University Press.

Scoones, I. (1998): Sustainable rural livelihoods. A framework for analysis. IDS Working Paper 72, Institute of Development Studies, Brighton, UK.

Sivanandam, S.N., Sumathi, S., Deepa, S.N. (2007): Introduction to Fuzzy Logic using MATLAB. Springer, Heidelberg, Germany.

Smithson, M. and Verkuilen, J. (2006): Fuzzy Set Theory. Applications in the Social Sciences. Series Quantitative Applications in the Social Sciences, No. 07-147, Sage publications ,Thousand Oaks, Florida, USA.

UNDP (2010): The Real Wealth of Nations: Pathways to Human Development. United Nations Development Programme, Human Development Report 2010, New York, USA.

WDI (2010): World Development Indicators. The World Bank, http://data.worldbank.org/data-catalog, last access 26th April 2010.

Zadeh, L.A. (1965): Fuzzy sets. *Information and Control*, Vol. 8, pp. 338-353.