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Controlling in the Conditions of Czech Republic

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Abstract

The paper deals with the issue of controlling the Agriculture of the Czech Republic, using methods of activity-based costing. The basic premise of knowledge is based on a given topic, especially the nature of the method ABC (Activity Based Costing). The paper described the application of the ABC design method in Microsoft Excel applicable in the agricultural sector of the Czech Republic. The proposed application of the ABC method, using Microsoft Excel, is an alternative to using expensive costing ABC special software. Created ABC method application also demonstrates that if somebody wants to improve approach in the overheads management, so it can be used by using quite common user knowledge of Microsoft Excel.

Key words

Controlling, costs, agriculture production, activity based costing.

Anotace

Příspěvek se zabývá tématem controllingu v zemědělství České republiky za využití metody kalkulace nákladů podle činností. Základní východisko tvoří poznatková báze na dané téma, zvláště pak podstata použití metody ABC (Activity Based Costing). V příspěvku je popsaná konstrukce aplikace ABC metody v programu Microsoft Excel aplikovatelné v sektoru zemědělství České republiky. Navržená aplikace metody ABC pomocí programu Microsoft Excel představuje alternativu k použití kalkulace ABC k drahým speciálním softwarům. Vytvořená aplikace ABC metody zároveň demonstruje, že pokud nějaký subjekt chce zlepšit přístup v řízení režijních nákladů, tak může a to za použití docela běžných uživatelských znalostí programu Microsoft Excel.

Klíčová slova

Contgrolling, náklady, zemědělská výroba, kalkulace nákladů podle činností.

Introduction

The properties of the company system and the current requirements for the business management results in the need for a complex supplementary system in the process of management. The system, which fulfill all above mentioned requirements, can be considered controlling. Its need is induced by the outside world. It is due to the openness of the enterprise against comprehensive and dynamic surroundings, but also by the necessity of the internal harmonization.

In recent years numbers of publications aimed at controlling have increased. Expansion of technical literature as well as the number of authors who are concerned with this topic brings many different views on what ultimately controlling means. This fact became the stimulus for the realization of empirical research, which results are presented in publication from Eschenbach and coll. (2004).

Authors basically distinguish two possible views of understanding of the term controlling:

- understanding of the term in Anglo-Saxon language area, and
- understanding of the term in the German language area.

The Anglo-Saxon language range, in the understanding of the concept of controlling, is based on the basis of the word "control", which in normal speech represents over 50 different meanings. There are assigned meanings as "(1) to lead, manage, regulate; (2) to govern, manage, and (3) operate, control, control, in the noun form inspection, test, the need for supervision, examination, power, warrant, violence, restrictions, abstinence." From here is the definition of control

as a comparison of the plan – fact. Term controlling is used in many areas of specialized terminology. In today's economy of enterprises prevail cybernetic approach to interpretation of the term control as "the leadership, management and control processes", whereof controlling matches in American perception.

From the Anglo/American perspective controlling represents one of the basic- central functions of management in planning, organizing, etc., of what follows ,that it is not only the activity of the controllers. Benefit of controlling, in this sense, should therefore be ability to recognize impending current deviations from the plan and their successful removal by the management.

In the German language area, the authors suggest three most important interpretation of the term controlling: (1) "controlling as a comparison of the plan – the fact", (2) "controlling as the unity of the planning and review" and (3) "controlling as influence of behavior". To the application occurs mainly in accordance with the first and the second understanding. German literature distinguishes the functional and institutional variants of controlling. Most authors favors the American concept of the controlling in the sense that controlling means management of the enterprise in the framework of the predeterminated target orientation and this is a task of management. On the other hand this perception causes a problem in the definition of the concept of management.

From the perspective of institutional definitions are extended interpretations from functional view, where the part of authors would tend to the view that the controller will act in the role of the auxiliary instance providing services to the management, which is holder of functions of controlling and other part of authors understands controller itself is the holder of controlling function.

As well as in the case of the interpretation of the term controlling, there are many definitions of controlling. Below are listed some of them.

"Controlling is a tool, which has the task of coordinating the planning, control and ensuring the information data bases so that he worked to improve business results. Controlling is responsible for collecting the information, their processing and structuring for the needs of the enterprise management decision making "(Horváth, 2002).

"Controlling is a management exceeding a number of functions that supports corporate decision-making process and management through objective-oriented processing of information" (Preibler, 1994).

"Controlling is a system of rules that helps achieving business objectives, preventing surprises and early turn on the red light, when a danger requiring appropriate measures appears" (Mann, Mayer, 1992).

"Controlling represent a specific form of work with information and its role is not to control the real processes, but through the information about real processes to manage the whole enterprise" (Foltínová, Kalafutová, 1998).

Controlling as a new understanding of management, which is characterized by higher perfection comparing to existing management, characterized by Vysušil and Kavan (1999). The authors point to the fact that the management with the help of controlling can be improved in various ways:

1. Controlling acts as a complement to the earlier management, in which there are gaps, which helps to create a comprehensive management system.
2. Controlling can be understood also as a tool of control over the area of management functions, what eliminates their relative narrowness. Here it is not just about filling gaps, but to achieve a higher level of economic governance. This becomes a management system more transparent and therefore more manageable.
3. Controlling represent the new comprehensive and methodical well built system of management, and particularly the value or economic governance, even when the subject of its interests are also the technical approaches (the search for new technical products solutions, new production technologies, including new materials), if they bring economic effect.

Macík (1999) consider controlling for *"integration tool linking the individual management information systems, which include the strategic and tactical planning, accounting-financial and business, budgeting, calculation, operational accounting."*

In many of the definitions of the various authors there can be observed the common elements, of which stated the fact that it is the new approach or a management system within the enterprise, which should to assist in decision-making of the enterprise management and the supervisory staff.

Methods and tools of controlling can dramatically vary depending on how the overall concept of the controlling, as well as from the set of set tasks in the framework of controlling. However it can be said, that the controlling involves all of the tools and the methodological means used to achieve its mission. Particular application controlling forms may overlap each other, complement, but even to be applied independently of each other and in relation to different company management levels.

Foltínová and Kalafutová (1998) consider the internal controlling tools cost budgeting, calculations, standards and accounting.

Zralý (2006) rank among the methods and tools of controlling applications, the following forms of controlling:

- Procedural Management
- Activity Based Management (management of the activities),
- Activity Based Costing (costs calculation by activity),
- Balanced Scorecard (measuring the performance of the organization)
- Target Costing (method of target costs), and
- Methodology of the performance areas.

To the controlling tools also include the quality management, project management, reporting and other forms of controlling implementation.

The application of the controlling in the sector of agriculture with the assistance of the costs calculation by activity

One of the important sources of information about cost and profitability of produced commodities are total costs calculations. The calculations are a mathematical process, with the help of which the individual cost items are assigned by direct or indirect way to individual performances. As in other sectors of national economy, even in agricultural production plays costs calculation a significant role.

Currently used total costs calculation methods in agriculture of the Czech Republic are designed in the traditional way (Poláčková, J. et al.; 2010) and are not reflecting to the current market environment needs. Agricultural production is also characterized by a high overhead cost of agricultural products, which can be extremely difficult controllable until content structure of the individual cost items of calculation formula is not changed. As possible starting point to solve the problems of costs monitoring and evaluation are non-traditional total costs calculation methods and especially the method ABC (Activity Based Costing) as one of the controlling tools. This method found application already in many sectors of the economy. But there still remains a question mark, whether its usage is appropriate and beneficial even in agriculture.

Material and Methods

The methodological basis for the solution of the examined controlling issues and the possibilities of its use in the agriculture sector is the knowledge base of understanding controlling term, its definition of the content, tools, and methods of the controlling. More detailed analysis was concentrated on the area of the calculation of costs by activity as one of the toolbar controls. No less important part was also the identification and analysis of the problem areas in connection with the contents of the range, in the form of and certain other attributes of information serving the management. Synthesis of the above led to the evaluation of the input information and gained knowledge.

In the second constructive level, especially these methods were used:

- analysis of the technological process of selected performances and based on this definition of the activities, which constitute the basis for the application of the ABC method in agriculture,

- construction of the ABC method in Microsoft Excel, applicable in the agricultural sector for the compilation of the calculation of total cost by activity and minor supporting analyses, and

- practical implementation of the created program in the agricultural production subject, whose visual demo for livestock production is set out in the conclusion of the results.

Results

The essence of the method application of activity based costing

Activity based costing calculation represents a cost model, which describes the cost groups or cost centers within the organization. Those with the assistance of the costs drivers allocate costs to products or services on the basis of the events number or transactions included in the production process.

ABC method was formed on the basis of numerous critics of traditional calculations shortcomings, especially in the field of the allocation and apportionment of overhead costs. The traditional calculations do not reflect to causal link of costs incurred with the cost objects. As the founders of ABC calculation are considered Robin Cooper, Robert Kaplan and Thomas H. Johnson.

The essence of the ABC calculation lies in the fact that the entity engaged in production activity or providing a service is regarded as a summary of the processes that take place in the subject. These processes ensure the implementation of the basic mission of the individual subjects that have arisen for some purpose. Process in this sense represents the top describable unit within the enterprise, which results in a specific output in the form of production or supply of services. Individual processes are composed of activities, which are the result of the aggregation of the individual activities as the smallest describable level within the enterprise.

Referred structure in process hierarchy activity-action and their mutual interaction provides a detailed view of the organization as such. ABC allows you to monitor and assess incurred costs, with the assistance of procedural view of the production process in the causation and through each of the activities at the lowest level, further activities resulting from the merger of several consecutive activities, or activities which are comparable character and at the highest level of fundamental processes in the manufacture of a product or service. The main attention of the ABC calculation is concentrated on the activities level. Those sufficiently represent the cost formation cause, and so their monitoring and analysis can be costs controlled.

As the traditional approach to the total costs calculation, even the ABC method distinguishes between direct and indirect costs (overhead). When is use the ABC calculation, first the direct costs are assigned the performances directly (the procedure is exactly the same as in the traditional calculation) and indirect (overhead) costs to activities. In the second phase follows assignment of activities to the objects, which are the activities bearers. The calculation on the activities basis amends approach overhead costs assignment, so that it applies them only to those activities, which caused their creation and not equally or pre-defined ratio to all products, regardless of whether the product in question are related or not. There is a change of the overhead (indirect) costs to direct costs. This allows to build of individual performance costs calculation with greater accuracy and to provide the real image of the incurred costs.

The costs calculation on the activities basis assumes the following procedure in the case of interest of its implementation:

1. defining activities,
2. identification of cost drivers (costs bearers) and units,
3. assignment of the costs to activities,
4. assignment of the costs from the activities to the costs objects (outputs),
5. calculation of the cost of the products, services.

Defining the activities taking place on the basis of a detailed analysis of all processes, that the selected subject in the framework of its activities makes. This can be for example the production of the goods or providing services. Each production output has its sequence or technology. Here it should be realized that these are just minor activities, passing which leads to production of final outputs. Due to the fact that these activities could be quite a lot, it is appropriate the closely related activities or with similar characteristics join together into groups identified as activity. Then follow identification of cost drivers and their measurement units. Cost driver gives the answer to the question: "What caused or led to the emergence of the costs of the activity?" Cost drivers should be determined to be relevant and readily measurable. It lies in the ability to allocate them to the activities in adequate proportion, which activity consumed. With the help of cost drivers follow assignment of costs to set activities, which de facto represents the first stage of costs allocation. In the second phase is to assign the costs of activities to cost objects. The last step is to perform the costs calculation of individual products or services and an assessment of the achieved results of the calculation

The application of the ABC method in agriculture sector

Implementation of the costs calculation by activity requires detail to be aware of the ongoing processes in the Organization, and based on the decomposition of business processes to obtain the structure, processes, activities and individual activities, which allows a detailed view on the organization.

In each enterprise is existing differential quantities of final outputs in the form of products or services, at the acquisition of which is to be carried out by the numerous quantity of activities. The proposed model ABC calculation in agriculture considers a variant of the agriculture enterprise, which is engaged in plant production by growing wheat and oilseed and in livestock production milking and cattle fattening. In relation to those facts is necessary to set up activities and within them the range of partial actions that give default assumption for the application of activity based calculation methods. Defining activities and sub activities is divided into two lines, separately for plant production and livestock production.

Activities and sub activities for plant production:

A1: Acquisition of material for the plant production:

- purchase and transportation of seeds, seedlings, fertilizers, sprays and agrochemicals,
- the purchase of spare parts and maintenance for the plant production,
- the purchase of protective equipment,
- taking and control of the acquired material,
- processing of inventory control material (income, expenditure, inventory).

A2: Soil preparation:

- tillage (shallow, medium, deep, relaying of the soil profile)
- plowed farmyard manure and related activities such as loading, transport to property, littering

and plowing,
- plowed straw crop residues or "green manure",
- harrowing, dragging, treatment of soil cultivators, rolling, soil compaction, soil treatment combinators, bed of crops preparation.

A3: Sowing:
- preparation and transportation of seeds,
- treatment and loosening the soil before sowing,
- sowing.

A4: Care and fertilizing:
- spraying against weeds, pests, to regulate growth, antifungal prophylaxis,
- fertilizing (regeneration, quality and production)
- desiccation and sticking stand,
- watering..

A5: Harvest:
- transport on the field,
- itself harvest,
- shredding straw harvester or processing of livestock production.

A6: Post-harvest treatment of soil:
- plowing.

A7: Post-harvest treatment of product:
- loading grain in warehouses,
- transport on postharvest line
- cleaning,
- drying.

A8: Product realization:
- preparation of the product,
- loading,
- expedition to customers.

A9: Other unclassified activities of plant production:
- maintenance and repair of machinery and equipment
- modification, maintenance and construction of roads,
- maintenance and upkeep of hedges,
- repair and construction of storage sheds and parking.

A10: Business management:
- operation of buildings,
- operation of company cars,
- management of customer-supplier relationships,
- advertising,
- security administrative data processing (enterprise information system),
- quality control of production.

Activities and sub activities for livestock production:

A1: The acquisition of material for livestock production:
- purchase and transport of feed,
- analysis of feed ingredients,
- the purchase of spare parts and maintenance for livestock production,
- the purchase of protective equipment,
- taking and control of the acquired material,
- processing of inventory control material (income, expenditure, inventory).

A2: Milking:
- wash udder,
- massage of the udder,
- spatter first strike,
- itself milking.

A3: Preparation and storage of milk:
- filtration of milk,
- milk coolers,
- treatment and registration of milked milk,
- milk storage.

A4: Maintenance of a milking device:
- disinfection of teat canal,
- control of milking machines and vacuum ranges such as prevention of mammary gland diseases,
- flushing the milking establishment,
- repair and replacement of minor parts of the milking equipment.

A5: Treatment of the animals:
- treatment and performances vet,
- individual care,
- disease prevention,
- animal movement,
- breeding work, including measuring the activity of animals for breeding,
- treatment of hooves.

A6: Care about the welfare of animals:
- scavenging,
- ventilation,
- lighting,
- temperature control,
- cleaning of housing and yards,
- cleaning.

A7: Feeding:
- loading feed
- traffic feed
- loading and mixing of feed rations, importation and dispensing feed
- delivery and dosing of feed rations,
- import water
- operation and maintenance lines.

A8: Realization of the product:
- assistance with drawing milk tanks for transporting customers,
- assistance in loading the transport of animals.

A9: Other unclassified activities of livestock production:
- maintenance and repair of machinery and equipment,

- modification, maintenance and construction of roads,
- maintenance and upkeep of hedges,
- repair and construction of stables and paddocks,
- watching animals.

A10: Business management:
- operation of buildings,
- operation of company cars,
- management of customer-supplier relationships,
- advertising,
- security administrative data processing (enterprise information system),
- quality control animals.

Creating Application of ABC method in Microsoft Excel for the agricultural sector

The basic assumption for the construction of the ABC method application in Microsoft Excel is the possibility for agricultural enterprises to export data from used accounting software to Microsoft Excel, at least in rudimentary form. Based on consultations with experts, this assumption was confirmed and even if the farmers have mostly only old accounting software. ABC application is written in a simplified version for the base of selected performances (winter wheat, winter oilseed rape, dairy -milk production and fattening).

At construction of the ABC method application in Microsoft Excel was chosen the following procedure:

- Creating of single sheets in Microsoft Excel, which correspond to the ABC method application needs in agriculture in the following structure:
  - „CopyDataRV“,
  - „RezieRV_ABC“,
  - „RV_ABC_Kalkulace“,
  - „CopyDataZV“,
  - „RezieZV_ABC“,
  - „ZV_ABC_Kalkulace“,
  - „UctovaOsnova“.
- Creating a spreadsheet report in the individual sheets for data storage and calculations needed to calculations by means of ABC method, and
- To define the necessary links and correspondences in individual Excel sheet to automate the calculation.

Created worksheets in the application ABC in program Microsoft Excel perform different tasks and designated functions. Their description is given here, depending on each worksheet:

Worksheet: „CopyDataRV“ is used for copying data for plant production exported from the accounting of the organization. The data are in structure Account code (number sign analytical account), Amount in CZK (summarization according to the accounts) and Time (period). From this worksheet are data loaded into worksheet „RezieRV_ABC“.

Worksheet: „RezieRV_ABC“ consist of 2 parts A and B.

Part A represents a table where it is needed to define, with the help of costs drivers, breakdown of overhead costs in plant production to particular activity. It also includes checking, whether the overall costs distribution is complete and consists of 100% of all costs. If not, the control box turns into red. Once the control box gives the sum of 100% so the light turns from red to white. Into table, in part A, is also automatically taken over "Account Name" from the worksheet „UctovaOsnova“ which meets the above requirement for greater clarity for users of applications, who are not accountants and do not use the regularly application. Part A of the worksheet „RezieRV_ABC” should be defined by employee, who is responsible for accounts maintaining, in cooperation with an employee who has information about crops technological procedure and share of individual crops.

Part B contains a table, where after defining of the total costs breakdown on activities set out in part A of the table will be automatically calculated value in CZK for each activity of crop production. It also contains a breakdown by product (in this case, winter wheat and winter oilseed rape), where is needed to define percentage of the activity cost, either by technological intensity, the share of cultivated crop production or other specified criteria. This section should be completed by a employee, who has information about technological progress and performance of crops, their distribution within the crop, or other eventualities, associated with the process of crop production. Part B also includes automatic calculation of individual crops share in the activities to the value in CZK. All calculations are automatically marked as a grey box, where are defined formulas, and therefore they do not need to be filled. Marking activities in part B is automatically taken from the table in section A, so that in case of activity changes are automatically overwritten in part B. The product descriptions (% of costs and CZK) in part B is set, so that all activities from A2 cells to cells AXY are fixed on products marking in cells A1 activity cells. In the event of activity changes in A1 are automatically overwritten in other activities.

Worksheet: „RV_ABC_Kalkulace“ itself is intended to ABC calculation. Worksheet including a tabular section is designed so, that both could serve as a accounting basis for dividing of overhead costs to products. Possibility of its utilization is also in the form of the output process of overhead costs allocation over a certain time period needed for users of these information such as company management, business department, competent staff making decisions about product mix, further employees assessing production process and production results, etc.

This worksheet is set automatic activities takeover and their description from worksheet „RezieRV_ABC“ in part A, where at any change in the designation will also overwrite the current worksheet. In cells, expressing the value of the activity, for product in CZK is defined formula summarizing the values in CZK from sheet „RezieRV_ABC“ in part B with line number limited by 500 lines, because the analysis period may be different using individual accounts as well as their number.

In worksheet are grey cells, which are automatically calculated, based on the completion of production data (eg. area in hectares, production in tones, hectare yield). Worksheet contains a total overhead recalculation in CZK to the respective products.

Worksheet: „CopyDataZV“ is used in a similar way as the Worksheet "CopyDataRV" (see the description of the Worksheet "CopyDataRV"), except that it is oriented to livestock production (Figure No. 1).

Worksheet: „RezieZV_ABC“ takeover the data and calculates the same way as a worksheet RezieRV_ABC (see description of worksheet „RezieRV_ABC“). Difference is the content of the various activities that are typical for livestock production (Figure no. 2, 3, 4).

Worksheet: „ZV_ABC_Kalkulace“ is a target output of the ABC costing calculations for livestock production and is set to individual calculation is identical to the worksheet „RV_ABC_Kalkulace“ (see description of worksheet „RV_ABC_Kalkulace“) with regard to the specifics of livestock production (unit of production, scale, the production cycle, etc.) (Figure No. 5).

Worksheet: „UctovaOsnova“contains data on the structure of the account number, account name, possibly setting the value of drivers, if necessary, additional information (Figure No. 6). From this worksheet is automatically takeover the name of the account and the value of its driver into worksheets „RezieRV_ABC“ and „RezieZV_ABC“. In the case of any changes in such data, the specifics will override the everywhere, where there is a link to them.

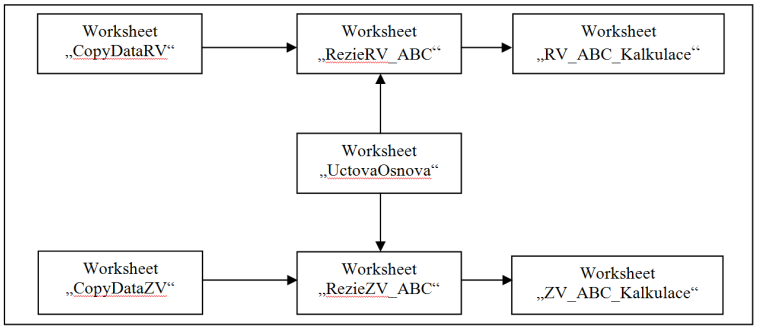
Continuity and relations of individual worksheets of the application ABC method in programe Microsoft Excel shows a Diagram No. 1.

Advantages of the designed application ABC methods are:

- cost-effective,
- clarity and simplicity in application control,
- flexibility and variability with the option at any time of the application to extend or define by changes in technology or product mix,
- the possibility of feedback to the source data including to the calculation,
- usability to the cost calculation in any stage of the production process,

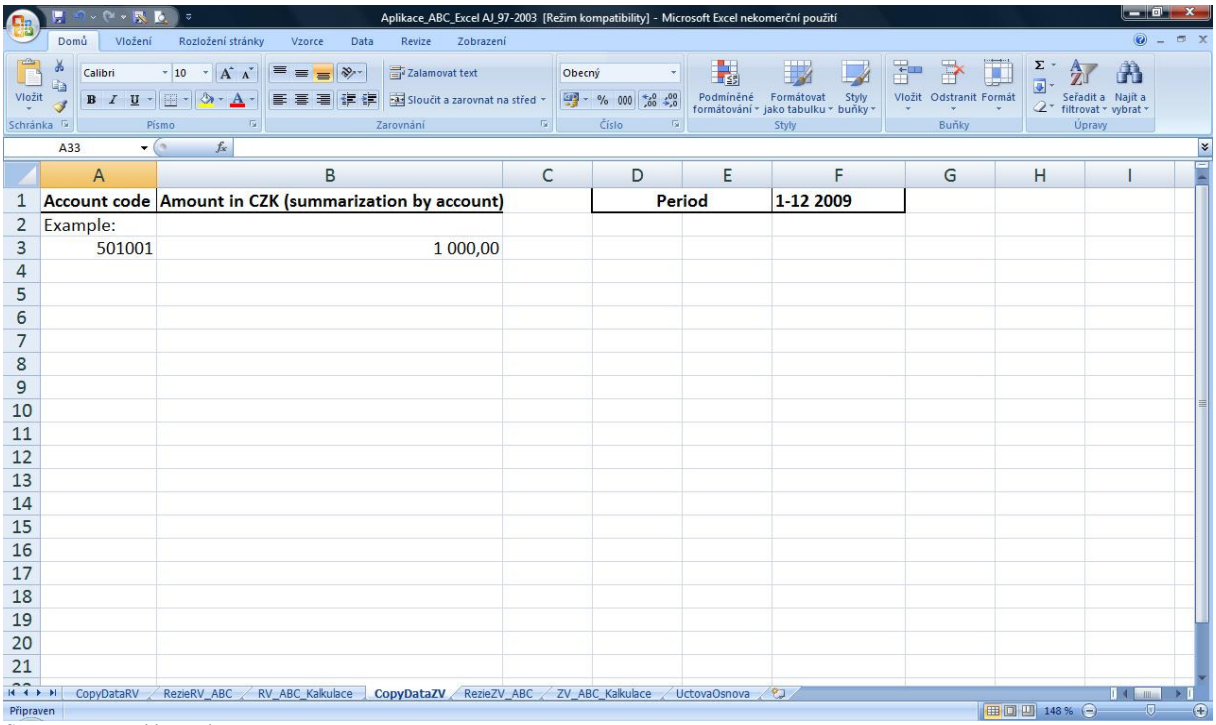
suitability of the information to solve various decision tasks (evaluation of the efficiency of the technological process, product composition, choice of used machinery and equipment in the production process or the security of certain activities, supply method, etc.). Created application of the ABC method in program Microsoft Excel is the basic version that can be adapted at any time and then fine-tune the specific conditions of the subject who has an interest in its implementation.

Worksheets illustration of the application ABC method in program MS Excel for the livestock production (Figure No. 1 – 6):



Source: prepared by author

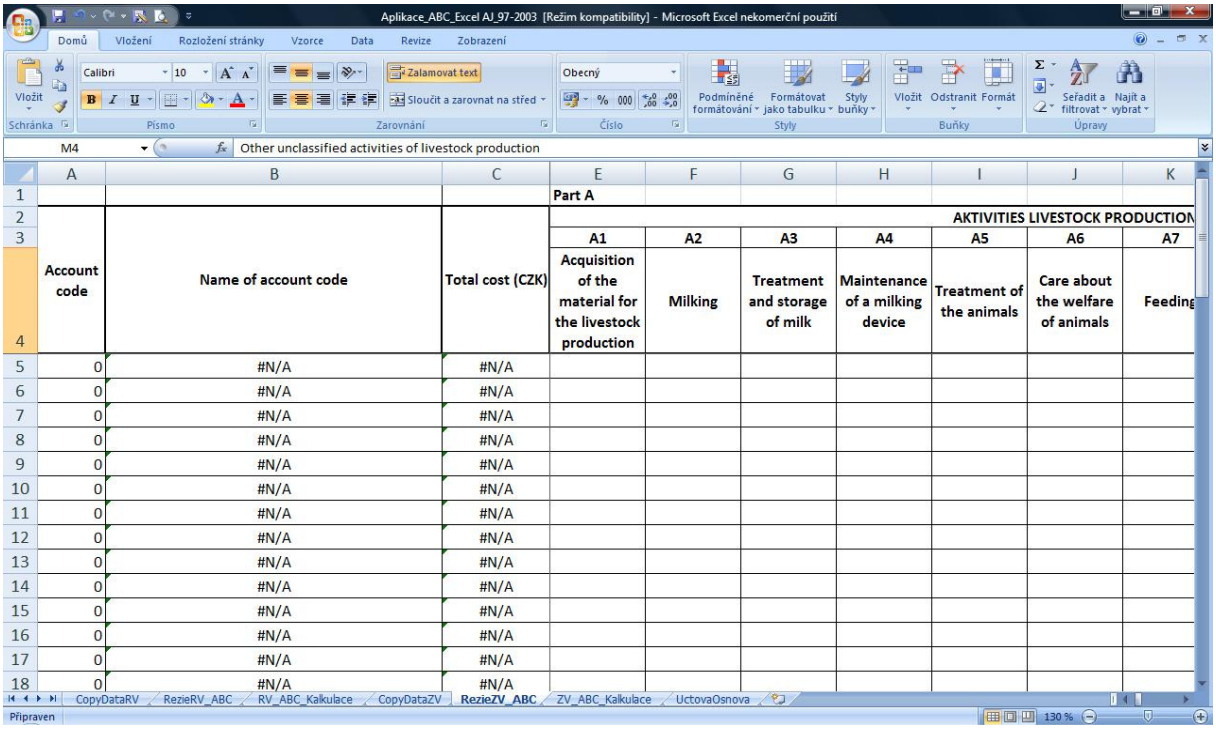
Diagram No. 1: Continuity and mutual relations of individual worksheets of application ABC method.



	A	B	C	D	E	F	G	H	I
1	**Account code**	**Amount in CZK (summarization by account)**		**Period**		**1-12 2009**			
2	Example:								
3	501001	1 000,00							

Source: prepared by author

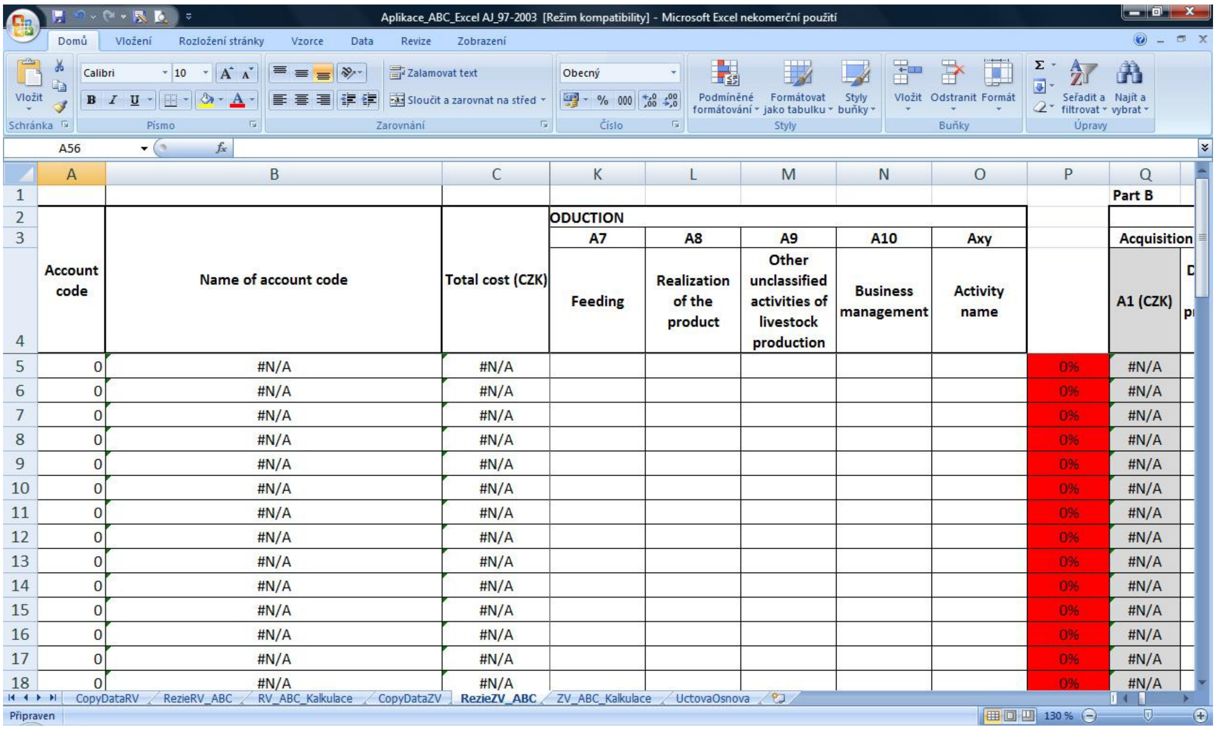
Figure No. 1: Worksheet „CopyDataZV“.



	A	B	C	E	F	G	H	I	J	K
1				**Part A**						
2										**AKTIVITIES LIVESTOCK PRODUCTION**
3				**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**
4	**Account code**	**Name of account code**	**Total cost (CZK)**	**Acquisition of the material for the livestock production**	**Milking**	**Treatment and storage of milk**	**Maintenance of a milking device**	**Treatment of the animals**	**Care about the welfare of animals**	**Feeding**
5	0	#N/A	#N/A							
6	0	#N/A	#N/A							
7	0	#N/A	#N/A							
8	0	#N/A	#N/A							
9	0	#N/A	#N/A							
10	0	#N/A	#N/A							
11	0	#N/A	#N/A							
12	0	#N/A	#N/A							
13	0	#N/A	#N/A							
14	0	#N/A	#N/A							
15	0	#N/A	#N/A							
16	0	#N/A	#N/A							
17	0	#N/A	#N/A							
18	0	#N/A	#N/A							

Source: prepared by author

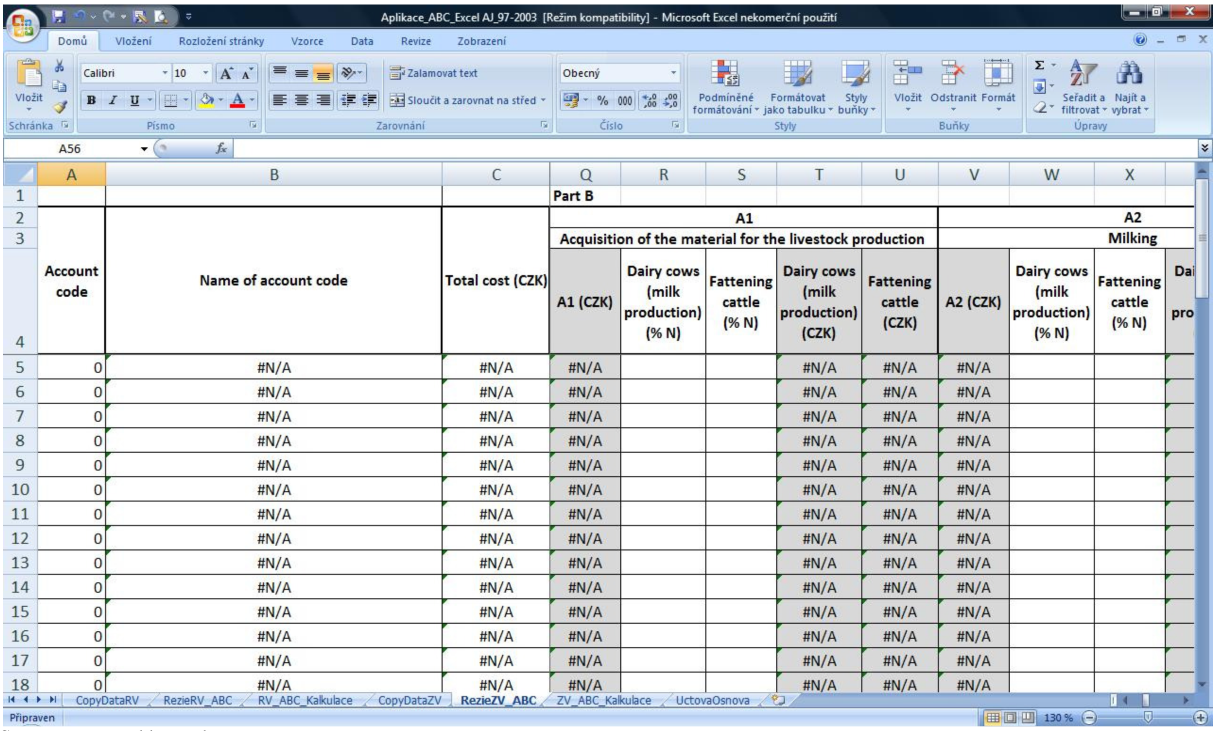
Figure No 2: Worksheet „RezieZV_ABC“, part A,



	A	B	C	K	L	M	N	O	P	Q
1										Part B
2				ODUCTION						
3				A7	A8	A9	A10	Axy		Acquisition
4	Account code	Name of account code	Total cost (CZK)	Feeding	Realization of the product	Other unclassified activities of livestock production	Business management	Activity name		A1 (CZK)
5	0	#N/A	#N/A						0%	#N/A
6	0	#N/A	#N/A						0%	#N/A
7	0	#N/A	#N/A						0%	#N/A
8	0	#N/A	#N/A						0%	#N/A
9	0	#N/A	#N/A						0%	#N/A
10	0	#N/A	#N/A						0%	#N/A
11	0	#N/A	#N/A						0%	#N/A
12	0	#N/A	#N/A						0%	#N/A
13	0	#N/A	#N/A						0%	#N/A
14	0	#N/A	#N/A						0%	#N/A
15	0	#N/A	#N/A						0%	#N/A
16	0	#N/A	#N/A						0%	#N/A
17	0	#N/A	#N/A						0%	#N/A
18	0	#N/A	#N/A						0%	#N/A

Source: prepared by author

Figure No 3: Worksheet „RezieZV_ABC“, part A, control conversion of drivers value.

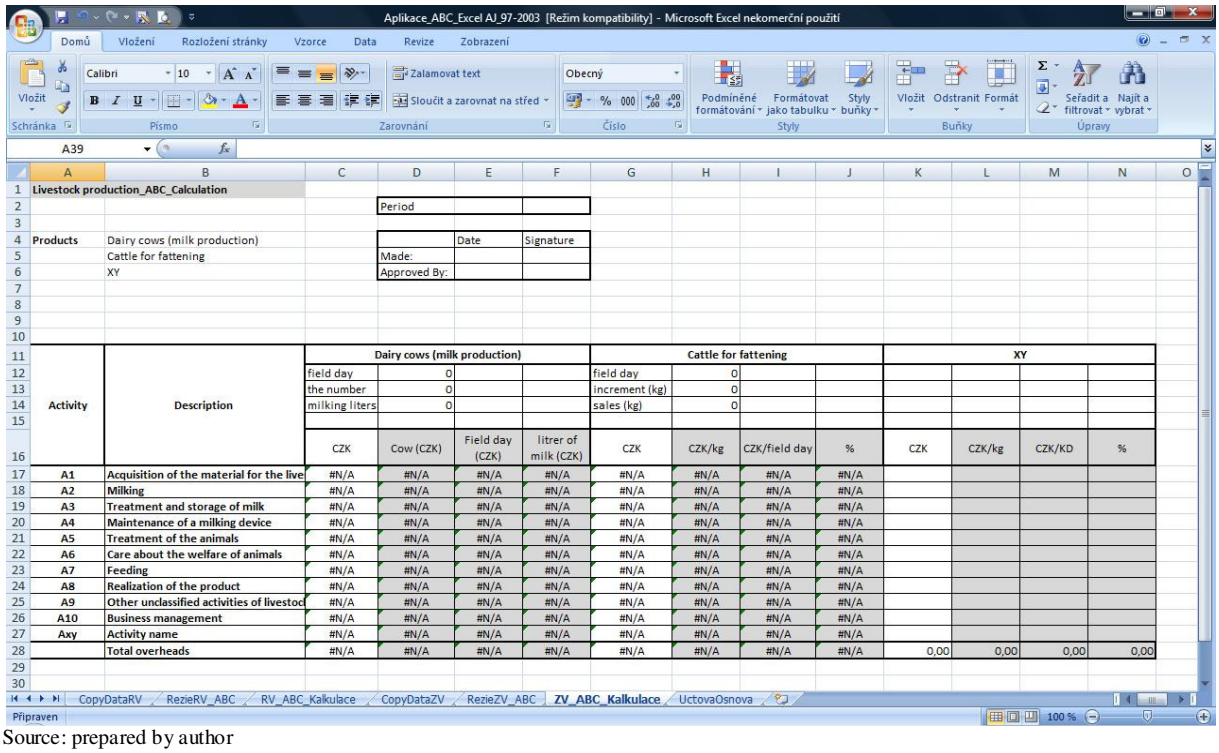


	A	B	C	Q	R	S	T	U	V	W	X
1				Part B							
2				A1					A2		
3				Acquisition of the material for the livestock production					Milking		
4	Account code	Name of account code	Total cost (CZK)	A1 (CZK)	Dairy cows (milk production) (% N)	Fattening cattle (% N)	Dairy cows (milk production) (CZK)	Fattening cattle (CZK)	A2 (CZK)	Dairy cows (milk production) (% N)	Fattening cattle (% N)
5	0	#N/A	#N/A	#N/A			#N/A	#N/A	#N/A		
6	0	#N/A	#N/A	#N/A			#N/A	#N/A	#N/A		
7	0	#N/A	#N/A	#N/A			#N/A	#N/A	#N/A		
8	0	#N/A	#N/A	#N/A			#N/A	#N/A	#N/A		
9	0	#N/A	#N/A	#N/A			#N/A	#N/A	#N/A		
10	0	#N/A	#N/A	#N/A			#N/A	#N/A	#N/A		
11	0	#N/A	#N/A	#N/A			#N/A	#N/A	#N/A		
12	0	#N/A	#N/A	#N/A			#N/A	#N/A	#N/A		
13	0	#N/A	#N/A	#N/A			#N/A	#N/A	#N/A		
14	0	#N/A	#N/A	#N/A			#N/A	#N/A	#N/A		
15	0	#N/A	#N/A	#N/A			#N/A	#N/A	#N/A		
16	0	#N/A	#N/A	#N/A			#N/A	#N/A	#N/A		
17	0	#N/A	#N/A	#N/A			#N/A	#N/A	#N/A		
18	0	#N/A	#N/A	#N/A			#N/A	#N/A	#N/A		

Source: prepared by author

Note: % N – % Cost

Figure No 4: Worksheet „RezieZV_ABC“, part B.



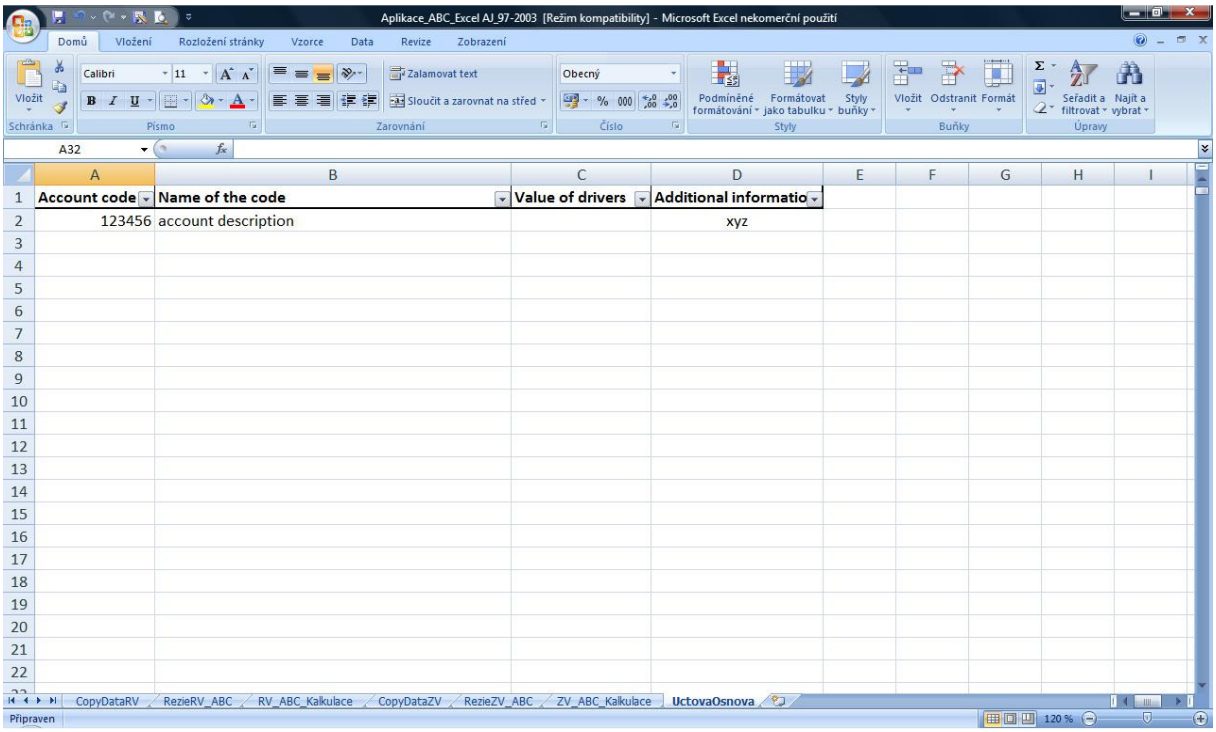
Livestock production_ABC_Calculation

Period	
Products	Dairy cows (milk production)
	Cattle for fattening
	XY
Date	
Signature	
Made:	
Approved By:	

Activity	Description	Dairy cows (milk production)				Cattle for fattening				XY			
		field day	0			field day	0						
		the number	0			increment (kg)	0						
		milking liters	0			sales (kg)	0						
		CZK	Cow (CZK)	Field day (CZK)	litrer of milk (CZK)	CZK	CZK/kg	CZK/field day	%	CZK	CZK/kg	CZK/KD	%
A1	Acquisition of the material for the live	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A				
A2	Milking	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A				
A3	Treatment and storage of milk	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A				
A4	Maintenance of a milking device	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A				
A5	Treatment of the animals	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A				
A6	Care about the welfare of animals	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A				
A7	Feeding	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A				
A8	Realization of the product	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A				
A9	Other unclassified activities of livestoc	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A				
A10	Business management	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A				
Axy	Activity name	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A				
	Total overheads	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0,00	0,00	0,00	0,00

Source: prepared by author

Figure No 5: Worksheet „ZV_ABC_Kalkulace“.



Account code	Name of the code	Value of drivers	Additional informatio
123456	account description		xyz

Source: prepared by author

Figure No 6: Worksheet „UctovaOsnova“.

Activity	Description	Dairy cows (milk production)				Cattle for fattening			
		field day	153 369			field day	2 786,00		
		the number	420			increment (kg)	1 173,00		
		milking liters	3 423 234			sales (kg)	1 928,00		
		CZK	Cow (CZK)	Field day (CZK)	liter of milk (CZK)	CZK	CZK/kg	CZK/field day	%
A1	**Acquisition of the material for the livestock production**	306 593,83	729,99	2,00	0,09	27 019,15	23,03	9,7	4,91
A2	**Milking**	1 112 426,56	2 648,63	7,25	0,32	0	0	0	0
A3	**Treatment and storage of milk**	246 731,05	587,45	1,61	0,07	0	0	0	0
A4	**Maintenance of a milking device**	323 602,20	770,48	2,11	0,09	0	0	0	0
A5	**Treatment of the animals**	621 523,05	1 479,82	4,05	0,18	89 379,25	76,2	32,08	16,26
A6	**Care about the welfare of animals**	1 217 580,90	2 899,00	7,94	0,36	139 273,59	118,73	49,99	25,33
A7	**Feeding**	1 184 658,89	2 820,62	7,72	0,35	176 119,98	150,14	63,22	32,03
A8	**Realization of the product**	68 822,30	163,86	0,45	0,02	25 406,34	21,66	9,12	4,62
A9	**Other unclassified activities of livestock production**	397 105,82	945,49	2,59	0,12	35 176,78	29,99	12,63	6,4
A10	**Business management**	1 059 111,43	2 521,69	6,91	0,31	57 421,52	48,95	20,61	10,44
Axy	**Activity name**	0	0	0	0	0	0	0	0
	Total overheads	6 538 156,02	15 567,04	42,63	1,91	549 796,61	468,71	197,34	100

Source: prepared by author

Table No. 1: Overheads calculation by the ABC method for the selected livestock outputs (cow-milk production and cattle fattening) for the year 2009

Implementation of the application ABC method in program MS Excel in the subject of agricultural primary production of Czech Republic - an example of the activity based overheads costing for livestock production (Table No. 1.):

Discussion

The competitive environment is more complicated, and individual players must make decisions efficiently, on time and on the basis of available, adequate and understandable information. The source of this information may be costing using ABC method, as a one of the controlling way. Benefits of applying activity-based costing in the agricultural sector of the Czech Republic is the possibility to better know and manage overhead costs, and improve the quality of information flow for the needs of decision-making processes such as: product mix, pricing, investment decisions, the capacity utilization rate, customer-supplier relationships, and others.

In the context of the assessment of application possibilities of controlling using by method ABC, there is a specific version of its application. Currently there are more software on the market, which include the processing of the activity-based costing. The problem is that these products are available from a price point of view only certain entities. Primary agricultural businesses often struggle with survival in these conditions and cannot afford to purchase special software.

Designed application of the ABC method using by program Microsoft Excel represents an alternative to the use calculation ABC of special expensive software. Created application ABC method also demonstrates that if somebody wants to improve access in the management overheads, so it possible using by common user knowledge of Microsoft Excel. Needs, however, to the knowledge of how the method ABC is working and what is its principle, further mutual cooperation of workers at each level to define the production activities with the assistance of the procedural approach. Created application of ABC method in program Microsoft Excel allows in a logical sequence overhead costs calculation by ABC method. Among its advantages include clarity of causation given activities consumed by the cost, flexibility in taking account of technological progress, product mix and the specific conditions of the subject that the application uses. The application allows calculation of costing, at any stage of completion of product manufacturing and thus continuously monitor the cost performance of the activities. The total output of the application ABC method in program Microsoft Excel can be called reports in the sense of data for decision making at various management levels of production. Application ABC method is possible can be expanded at any time, amend, modify or define the event of a change in the technological process of production, product mix, or the need for further follow-up recalculation. As disadvantage the application appears to need personal access of workers responsible for defining the drivers, the relation of different types of overhead costs to activities and define the cost allocation of activities for the products. The important role played the objective approach to application setting.

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The influence of crisis on the sector structure of economy focusing on agriculture.

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Abstract

The Czech Republic entered the crisis with relatively good starting conditions - showed no significant macroeconomic imbalances and financial system was not destabilized. However, the crisis has here also been and a decline in GDP in 2009 to 4.1% was mainly due to economic recession in the Euro zone. In many countries there has been a change in the sector scope. The Czech Republic belongs to the industrial-oriented countries and the significance of recession is also demonstrated by the development of industrial production and exports. Further economic increase depends mainly on exports, because there are many industries in the Czech Republic with foreign majority and a large part of their production goes abroad. Czech agriculture has been also facing adverse impacts of the crisis. These have occurred since the second half of 2008. The article analyses the contributions to GDP and trends in future years. There are also described changes in the sector economic structure with focus on agriculture.

Key words

GDP, crisis, economic performance, sector of agriculture.

Anotace

Česká republika vstoupila do krize s poměrně dobrými výchozími podmínkami – nevykazovala výraznější makroekonomickou nerovnováhu a finanční systém nebyl destabilizován. Nicméně krize se zde projevila také a pokles HDP v roce 2009 o 4,1% byl způsoben především díky ekonomické recesi v Eurozóně. V mnoha zemích došlo k sektorové změně. Česká republika se řadí k průmyslově orientovaným ekonomikám a významnost rozsahu recese dokládá také vývoj průmyslové výroby a exportu. Zpracovatelskému průmyslu u nás dominují velké firmy s majoritním zahraničním podílem a velká část jejich produkce směřuje do zahraničí. To ještě více zvyšuje závislost ekonomiky na exportu1. Také české zemědělství, podobně jako jiné sektory národního hospodářství, zaznamenalo nepříznivé dopady ekonomické krize. Ty se na agrárním trhu začaly projevovat již ve druhé polovině roku 2008. Následující příspěvek má za cíl analyzovat příspěvky jednotlivých složek HDP a trendy vývoje v budoucích letech. Následně je zde popsáno, jak se změnila sektorová struktura ekonomiky se zaměřením na zemědělství.

Klíčová slova

HDP, krize, ekonomický výkon, zemědělský sektor.

[1] Junková, S. Hospodářské krize – historie a možné dopady současné finanční krize na ČR. Disertační práce, Praha, 2010, s. 127-146.

Introduction

Gross domestic product (GDP) is a financial aggregate of the total value of goods and services newly produced in a given period and the area. Although it is not an ideal indicator, but it is most commonly used for the determination of economic performance. From the supply side of GDP, the production performance of economy can be measured for example as a Gross value added (GVA). Although the primary sector has the lowest share on GVA, his position is irreplaceable and that's why this article mainly deals with the agriculture.

The significant decrease of GDP may lead to national bankruptcy. Economists E. Borensztein and U. Panizza in "*The Costs in Sovereign Default*" examined the context between the GDP decline and the possibility of national bankruptcy. In their analysis the collapse of the state finances is associated to a GDP decline by 1,2. percentage points per year2. This is generally consistent with the conclusions of other economists – F. Sturzenegger and J. Zettlemeyer (2005). They estimated the GDP decline about 0,5-2,0. percentage points. This study indicates that the impact of state bankruptcy is only a short-term. There were tested also a dependence of other three periods on this event, but the test provided to be statistically insignificant. F. Sturzenegger and J. Zettlemeyer (2006) also mention that debt crises (solvency crises) "could be a result of large adverse shock to economic fundamentals[3]".

Material and methods

The aim of this paper is to describe following impacts of financial crisis4 on the development of GDP with focus on agriculture. In the analysis of changes in GDP growth will be also carried out the decomposition of GDP to components by expenditure approach. Based on the identification of the above mentioned goal, the paper is focused on estimating the potential further development of the examined macroeconomic aggregate and to describe the development of the GDP sector's changes. The sector studies began to be process relatively recently in the Czech Republic and their main purpose is to provide a detailed view of selected economic sectors. There are also examined all the factors that have the potential to influence the development of the sector in the coming years/future. This may include macroeconomic, technological, legislative, financial, procedural, demographic trends, or even competitive. The impact of crisis on GDP will be identified on the analysis of time series[5]. The purpose of time series analysis is to obtain information about the process that this numbers represent, identify the mechanisms and dynamics of the process, and subsequently to predict the possible future development of this process. For this purpose it was chosen the Box-Jenkins methodology. The basic element of this model is considered the random component that may be a correlated by a random variables. The core lies not in the construction of a systematic component (trend), as in the case of the classical model, but the focus is placed on the correlation analysis of more or less dependent observations, arranged in the form of time series. One of the categories in the model of the Box-Jenkins methodology is called autoregressive models (AR), which are based on the correlation analysis. Autocorrelation function can be simply described as the correlation functions of one variable at a time. It will help us to determine the regulation of the autoregressive process. The Seasonal autoregressive process of Procedure 1 was used in this paper for the calculation of the likely scenarios for the future development of GDP and its components (expenditure method). The seasonal component of time series means periodic fluctuations, which have systematic character. This variation in macroeconomic time series takes place during one calendar year and repeats each year in

[2] Borensztein, E., Panizza U. *The costs of sovereign Default*. IMF, IMF WP 08/238, October 2008, p.8.
[3] Sturzenegger F., Zettelmeyer, J.: Debt defaults and Lessons from a decade of crises. 2006, p. 42.
[4] According to IMF definition, the financial crisis is "*a potentially negative impact of the financial markets, which by the deterioration of the efficiency of markets can have adverse effect on real economy*". IMF here refers to **Frederic Mishkin** (2001), who claimed that the financial crisis is a failure of the financial markets in which the problems of moral hazard and adverse selection becomes more difficult to overcome. According to Mishkin as a direct consequence of the crises is the inability of financial institutions to fulfil one of their basic functions, namely the efficient money / finance transfer from their owners to the investors.

[5] The time series are observations which are materially and spatially similar and which are clearly structured in terms of time in the direction past-present. (Arlt, Arltová, 2003)

the same or modified form. Indisputable disadvantages of using these models remains that, for modeling future developments we have only a short time series, therefore, for the analysis were selected quarterly data. As the source of data were used data from the website of the Czech Statistical Office (ČSÚ) and Czech National Bank (ČNB) -the system of time series Arad.

Results

Due to the outcomes of the above mentioned studies of economists Borensztein E., Panizza U. (2008) and Sturzenegger F. (2005) and to the ongoing crisis, the GDP is currently widely watched indicator. Many institutions provide the estimates of GDP future development.

Current forecasts of real GDP growth in%

ČNB:

2010: 2,3%, 2011: 1,2%, 2012: 2,5%,

MFČR:

2010: 2,5%, 2011: 2,2%, 2012: 2,7%,

OECD:

2010: 2,0%, 2011: 3%,

IMF:

2010: 2,0%, 2011: 2,2%,

According to the used model, the forecast of annual real GDP growth for next three years is following:

2010: 2,1%, 2011: 2,6%, 2012: 2,0%.

In the last quarter of the year 2008 Czech economy entered into recession and in 2009 its total output fell by a dramatic 4.1% (see figure 1). The significant annual decline in GDP in 2009 was caused by already mentioned economic recession in the Euro zone. This fact causes adverse impacts in terms of reduction of domestic and international orders on the demand side of GDP, respectively lack in the domestic and external markets consumption. Negative impact on GDP growth was also contributed by a decrease in investments. If we examine the contribution of GDP components, we carry out decomposition of GDP. It can be calculated in three ways: (1) the production method, (2) the expenditure approach and (3) the income approach (Holman, 2004).

GDP by expenditure method

GDP by this method is calculated as an aggregate of expenditures, which is the sum of final consumption expenditures, gross capital formation and net exports (the difference between export and imports) (Holman, 2004).

Final consumption expenditures

Development of final consumption expenditure consists of household and government consumption. In the case of household consumption, we see a downward trend since 1996. According to the Czech Statistical Office (ČSÚ), this decline was particularly thanks to low growth in real wages and more recently the decline in employment. An important indicator of the weight of the agrarian sector in the national economy is the share of household expenditure on food, beverages and tobacco in total expenditure on goods and services. According to quarterly data in 2009, this proportion decreased to 22.1%, while actual expenses for food and non-expenditure were 19.3% of total expenditures[6].

The development of government final consumption expenditures becomes to decline slightly after 2006. Government, as well as households cut down on their expenses. In 2009 there was a significant increase in government consumption - the government tried through higher spending to alleviate the economic downturn. The prediction of the Ministry of Finance (MFČR) expects that the government will reduce the expenditures, according to the adopted stabilization measures and consolidation strategy in the coming years.

The figure below, which includes a prediction according to used model, shows expected flat development of this component of GDP

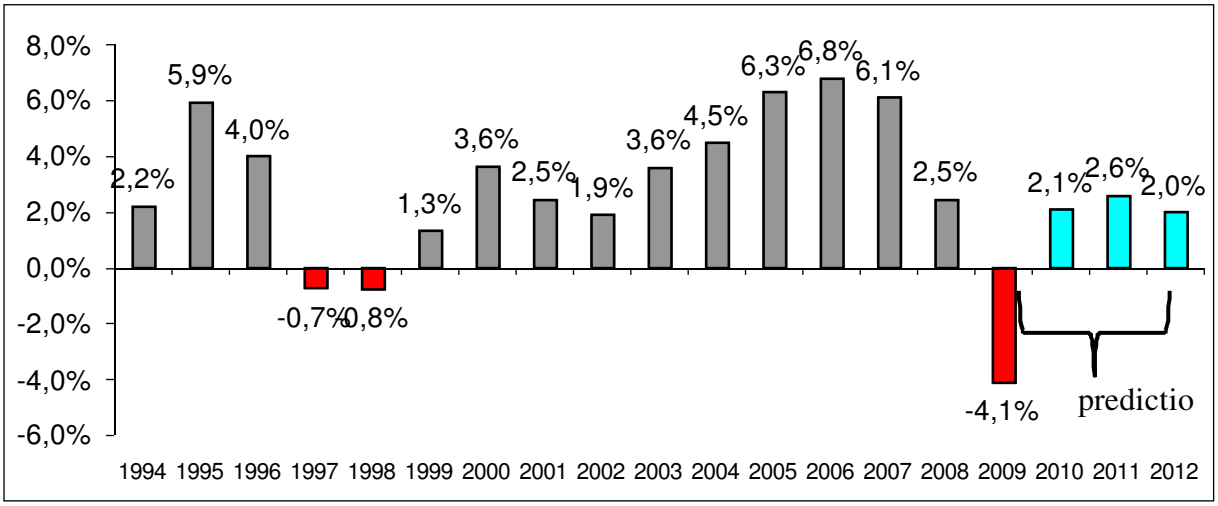
The forecast of annual final consumption expenditures for next three years, according to the used model which was described in methodology, is following:

2010: 0,64%, 2011: 0,58%, 2012: 0,60%.

The prediction of the Ministry of Finance is following:

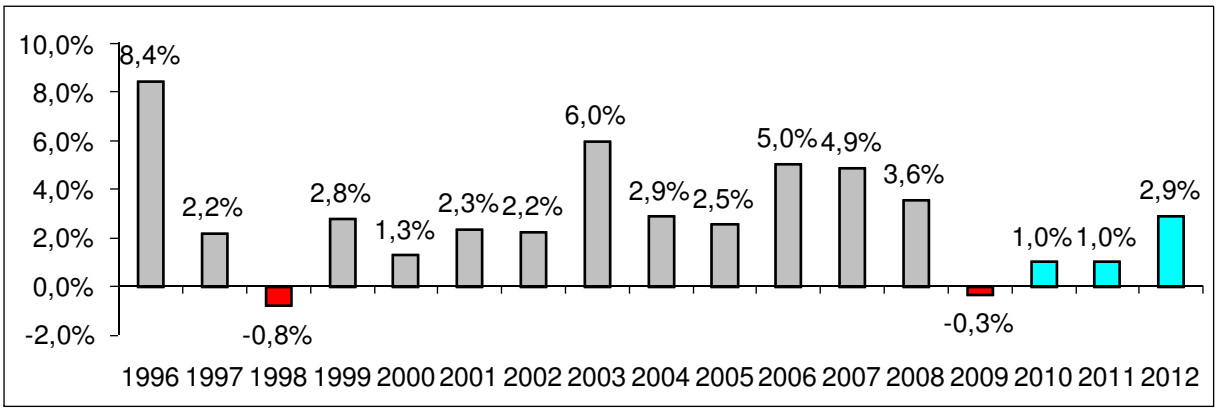
2010: 0,53%, 2011: 0,76%, 2012: -0,28%.

[6] Ústav zemědělské ekonomiky: Zelená zpráva 2009. p. 4.



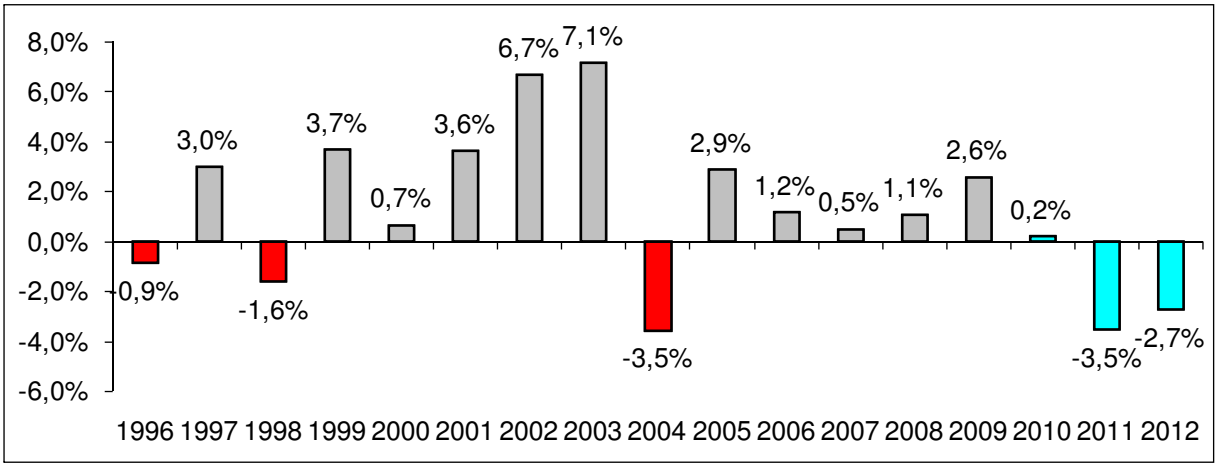
Source: data ČNB, ARAD time series, prediction-own

Figure 1: Annual Czech republic real GDP – year over year (YoY) development, in %.



Source: data CZSO, prediction by MFČR

Figure 2 Annual changes in consumption expenditures by household YoY, in %, 1996-2013.



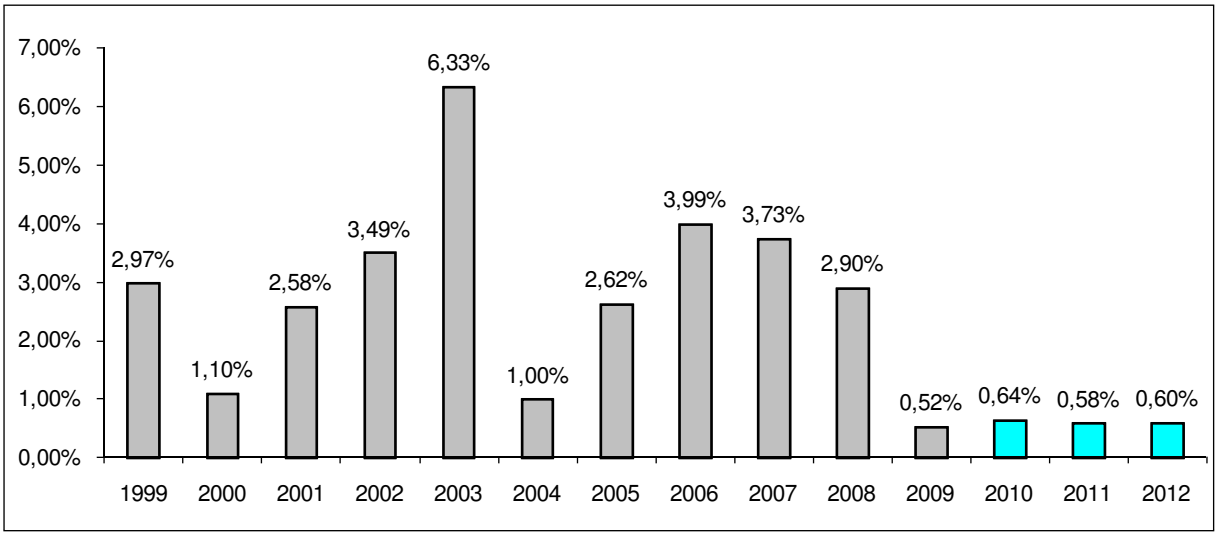
Source: data CZSO, prediction by MFČR

Figure 3 Annual changes in consumption expenditures by general government YoY, in %, 1996-2013.

Gross capital formation

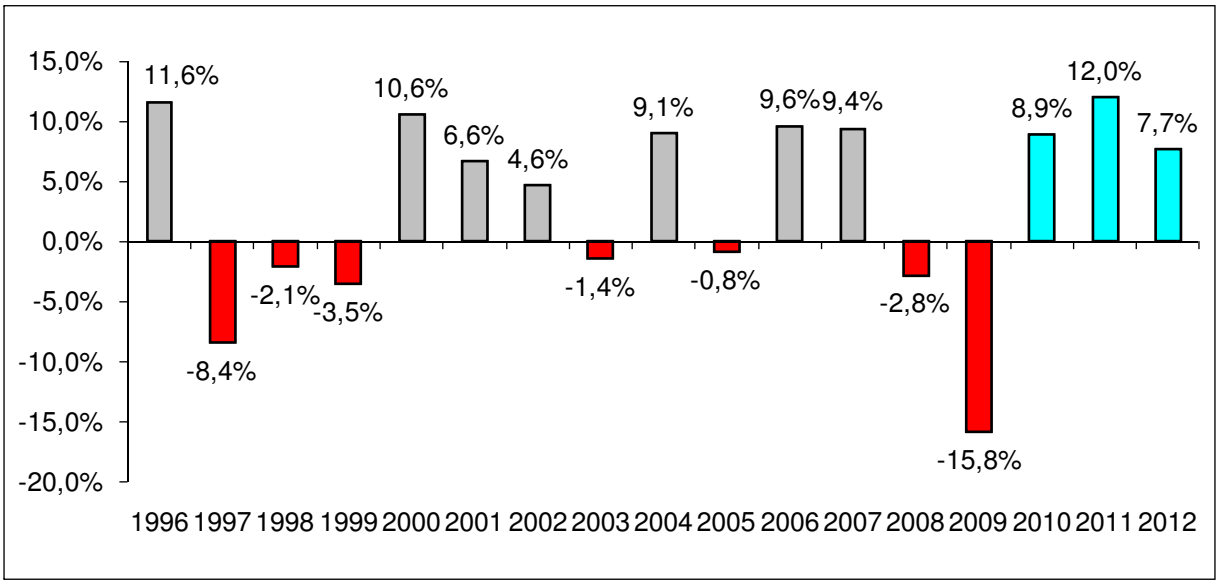
Gross capital formation and its evolution since 1996 is again reflected in the accompanying figure below. From it we see that gross capital formation fell for the first time in 1997 and 1998, during the banking crisis. Another decline followed in 2003 and 2005. The most significant annual decline occurred in 2009. This was mainly due to unfavourable external and internal environment development, which has dampened investment activity of firms. The decline in external and domestic demand, in turn, provoked a negative outlook on future business development. Another negative factor was the lack of funds caused by the increased caution of banks in granting new loans to firms. Moreover, households also decreased investment in housing, which was again due to limited access to obtain credit. Part of household also speculated on the decline in property prices.

Since the third quarter of 2009 has begun recovery in external demand. In this recovery is partially contributed to the so-called "scrap" of cars



Source: data CZSO, prediction-own

Figure 4 Annual changes in Final consumption expenditures YoY, in %, 1999-2012.



Source: data CZSO, prediction-own

Figure 5 Annual development YoY of Gross capital formation, in %, 1996-2012.

introduced in certain European countries7.

The forecast of annual Gross capital formation for next three years, according to the used model, is following:

2010: 8,9%, 2011: 12%, 2012: 7,7%.

The prediction of the Ministry of Finance is following:

2010: 7,0%, 2011: 3,6%, 2012: 3,6%.

Export and Import of goods and services

Export of goods and services

This component increases the value of GDP and its development shows the bellow attached figure. After 2006 there was a continuous decline in exports and reached its peak in 2009. This decline is attributed due to the openness of our economy, particularly the recession in the economies of our major trading partners.

The share of the agricultural exports on total exports grew from 4.3% to 4.9%. The main export commodities were in 2009 wheat, beer, rape, concentrated milk and cream etc.

In terms of geographical structure of exports has slowed the most in Slovakia, Germany, Poland, Austria, England, Italy and France. It was managed to increase exports to some Asian (e.g. Turkey) and African countries. Overall, however, Czech exports fell. There was also a structure change of exported commodities. With the introduction of the already mentioned most scrappage increased exports of vehicles, which raised exports and encourage domestic automobile production.

The forecast of annual Exports for next three years, according to the used model, is following:

2010: 13,3%, 2011: 9%, 2012: 6,7%.

The prediction of the Ministry of Finance is following:

2010: 14,5%, 2011: 11,3%, 2012: 10,2%.

Import of goods and services

The growth rate of imports also dropped most significantly in 2009. This decline is still limited demand of Czech firms and households for foreign goods. The reason was not only the ongoing downturn in the domestic economy, but also the depreciation of the Czech koruna, which began in the second half of 2008 and more expensive imports.

The share of the agricultural imports in total imports grew from 5.4% to 6.7%. The most imported agrarian commodities in 2009 were pork meat, bakery goods, chocolate, cheese, cheese preparations used for animal feed, coffee, etc. Growth tempo of total imports shows next figure.

In 2010 positively affects the external balance the recovery - especially in partner countries. For 2011 is expected a loss of imports for photovoltaic, because it's annual growth will be at a lower level than in the 2010th.

The forecast of annual Imports for next three years, according to the used model, is following:

2010: 14,5%, 2011: 12,9%, 2012: 10%.

The prediction of the Ministry of Finance is following:

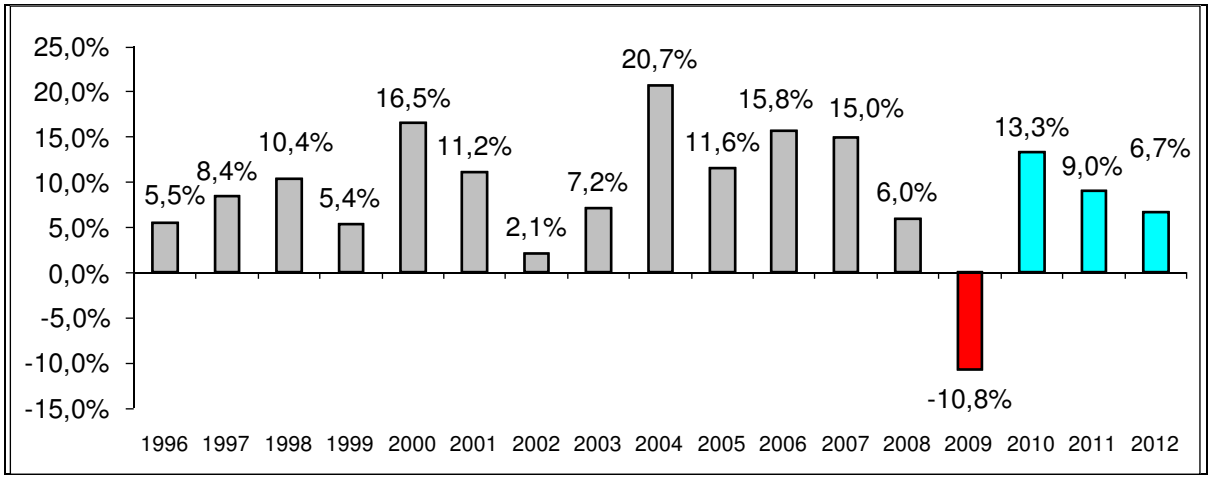
2010: 15,1%, 2011: 9,7%, 2012: 9,5%.

For 2010, the Ministry of Finance expected an increase in real GDP of 2.5%. It's one of the highest expectations from all mentioned institutions. Economic growth according to Ministry of Finance should be driven mainly by foreign trade; it is expected to revive the economies of our major trading partners.

Sector structure

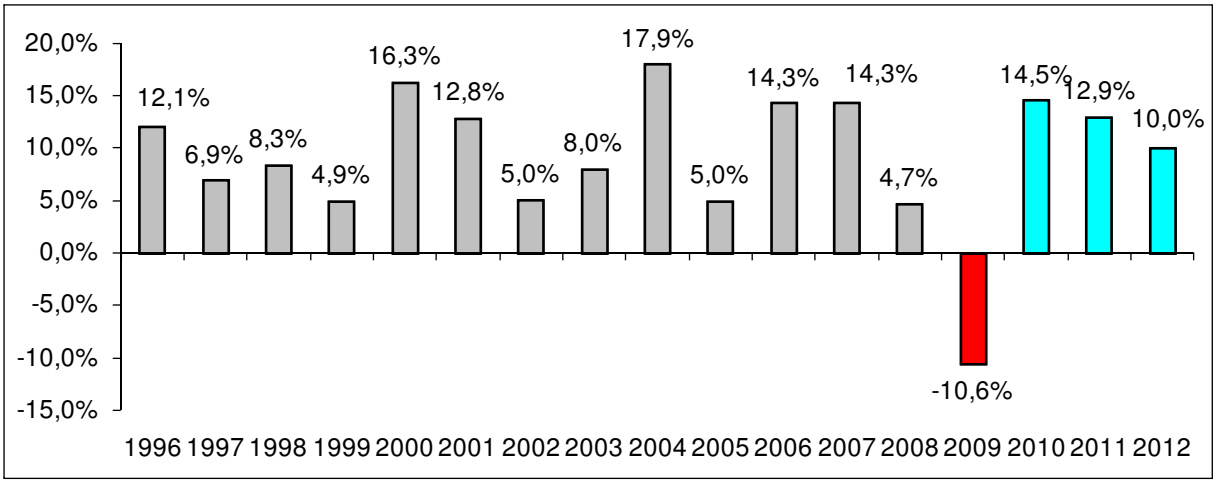
In 2008 and 2009 was due to the economic crisis reflected GDP a sector's change. Expressed as a percentage of GVA (Gross Value Added) at current prices, there was a decline of primary and secondary sector, and conversely an increase in the tertiary sector. In the case of the Czech Republic's share of the secondary sector is over the "benchmarks", the share of the tertiary sector under it, but its role is growing. According to the analysis method of manufacturing GDP, we can identify trends in selected sectors.

[7] The „scarp" of cars were introduced in countries like Slovak republic, Austria, Germany, USA, Great Britain, France, Italy, Luxembourg, Netherlands, Spain, Canada and in most countries it was valid for certain period (mostly during 2009, sometimes partly in 2010). In Canada it's valid till 03/2011.



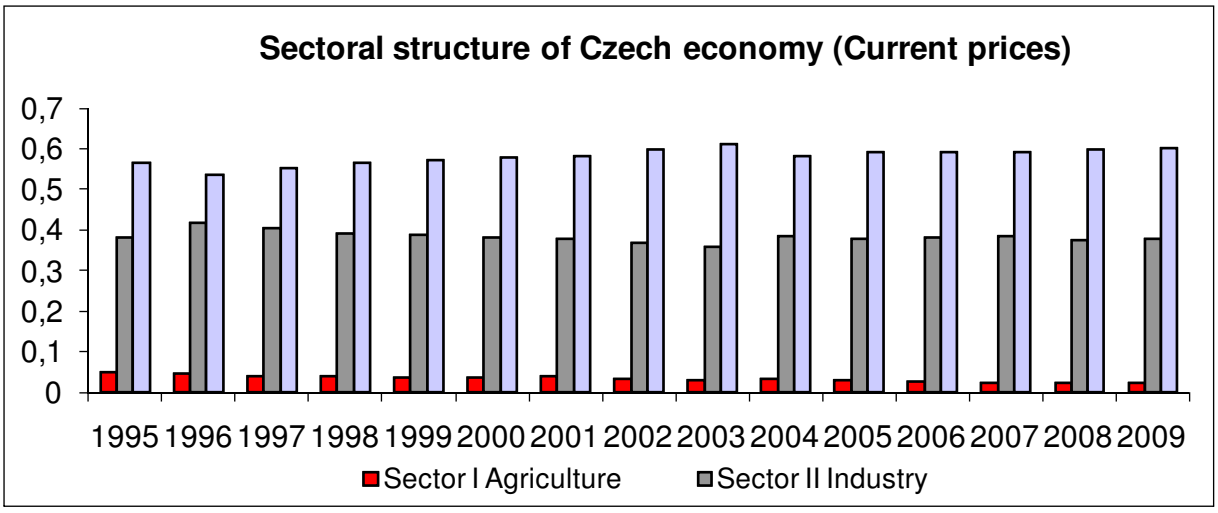
Source: data CZSO, prediction-own

Figure 6 Annual development of Exports YoY, in %, 1996-2012.



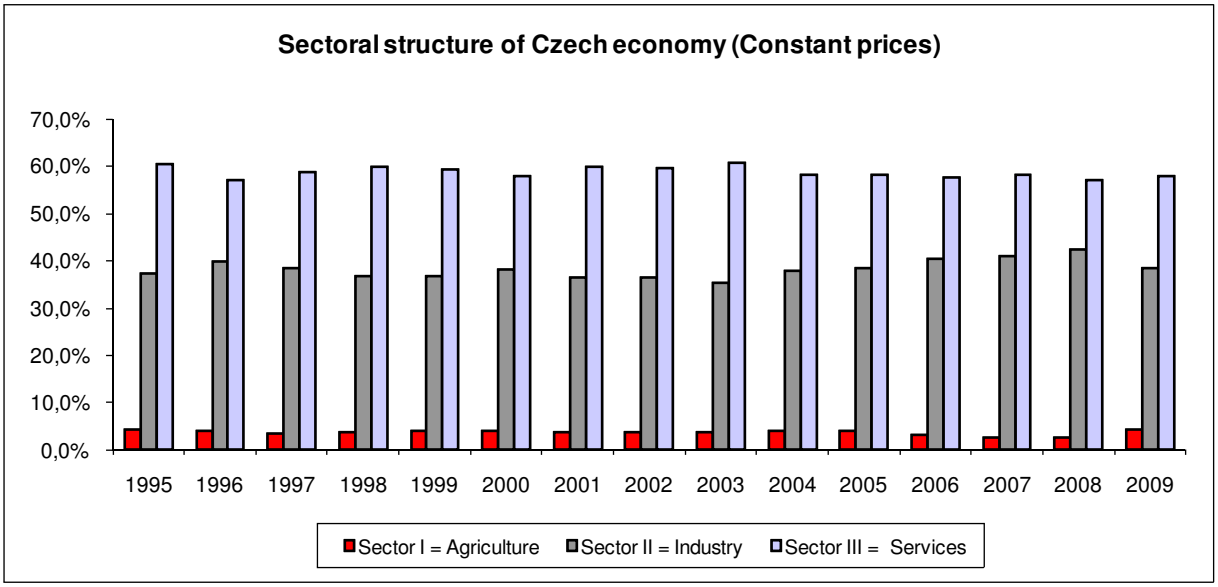
Source: data CZSO, prediction-own

Figure 7 Annual development of Imports YoY, in %, 1996-2012.



Source: data CZSO

Figure 8 Sectoral structure of Czech economy, YoY (Current prices) .



Source: data CZSO

Figure 9 Sectoral structure of Czech economy, YoY (Constant prices).

According to the share of GVA at constant prices of 2000, however, there was a decrease in the primary sector only in the years 2007-2008, in 2009, has recorded an increase, as seen from the graph below. The decrease is mainly due to the changing scope of domestic and foreign demand. In 2005 kick-started the weakening of its share in gross value added (in Constant prices) up to 2.6% in 2007, the lowest value in the period.

Primary sector

While the share of agriculture on total GVA (in Constant prices) increased by 1,5%, the share expressed in current prices showed a decline. The reason is the unfavourable evolution of prices of agricultural producers. An average annual decline was 24,8% which represents the largest drop recorded in the period since 1993. The largest contributions to changes in input prices have the price of feed, energy8 and lubricants (especially motor fuels[9)] and seeds and seedlings (mostly barley). Agricultural producer prices fell year over year (YoY) more than price of agriculture inputs[10]. Prices of inputs to agriculture fell by 7,4%. Prices of agricultural producers for crop production overall dropped by 32,2%, mainly due to a significant reduction in cereal prices by 41% and oilseeds by 35,3%. Prices of agricultural producers for animal production overall dropped by 33,1%.[11] It was observed in all food (or beverage) groups either decline in prices, or slowing the pace of price growth. Dynamic reduction of consumer prices was in the group, whose prices rose most importantly in 2008, i.e. bread, milk, dairy products, inc. eggs and oils and fats, as well as in fruit and fruit products.

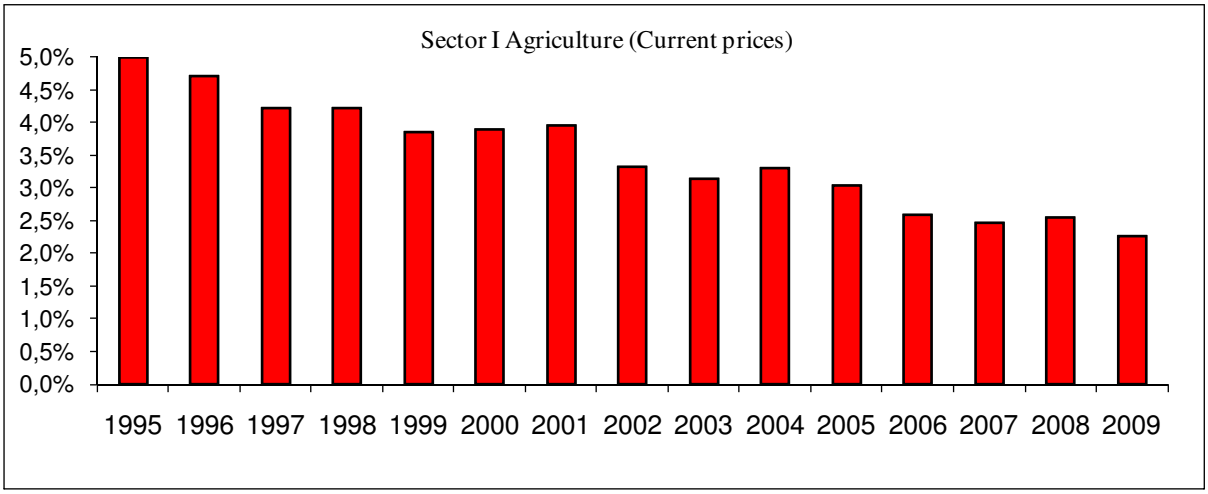
According to Economic accounts of agriculture (EAA) the 2009 crop production was 52,7% and the livestock production was 44,1% of the agricultural sector output. 2009 production in the agricultural sector in constant prices fell by 3,2% YoY, crop production fell by 1,9% and livestock fell by 4,8%.

Secondary sector

Unlike agriculture, the position of the other two sectors in the Czech economy stronger. The share of secondary sector (industry, mining, construction) in 2009 after four years of increases fell. Industry in total gross value added accounts for about 33%. The ongoing restructuring of the industry supported the dynamics of performance.

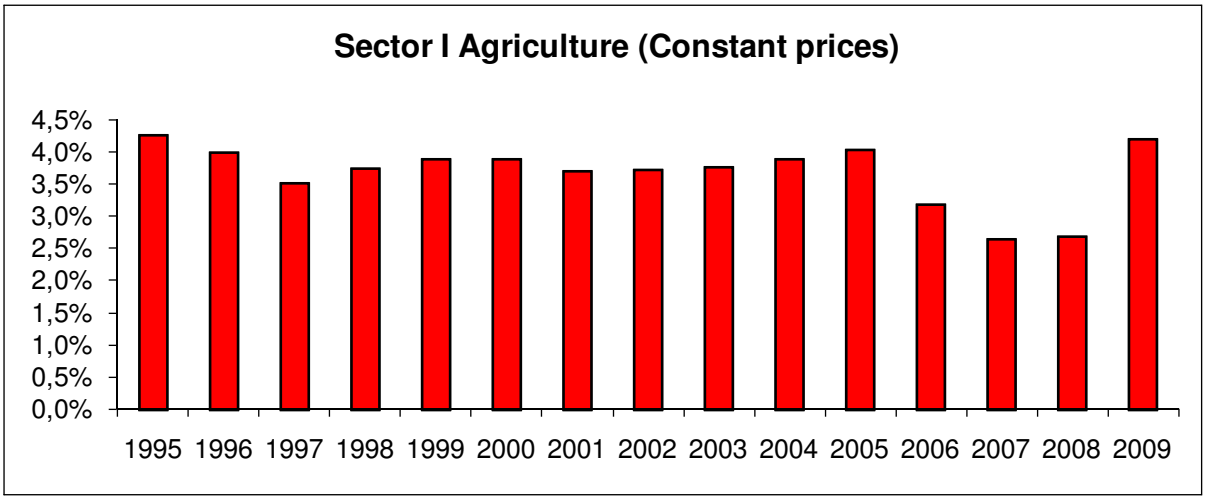
The industry faced cheaper competing imports from Asia, which pushed the heavy and light industry. On the other hand it increased areas with potential

[8] decline in natural gas prices, agricultural commodities and food prices on world markets.
[9] decline of world oil prices
[10] Ústav zemědělské ekonomiky: Zelená zpráva 2009. p. 3.
[11] Ústav zemědělské ekonomiky: Zelená zpráva 2009. p. 235-236.



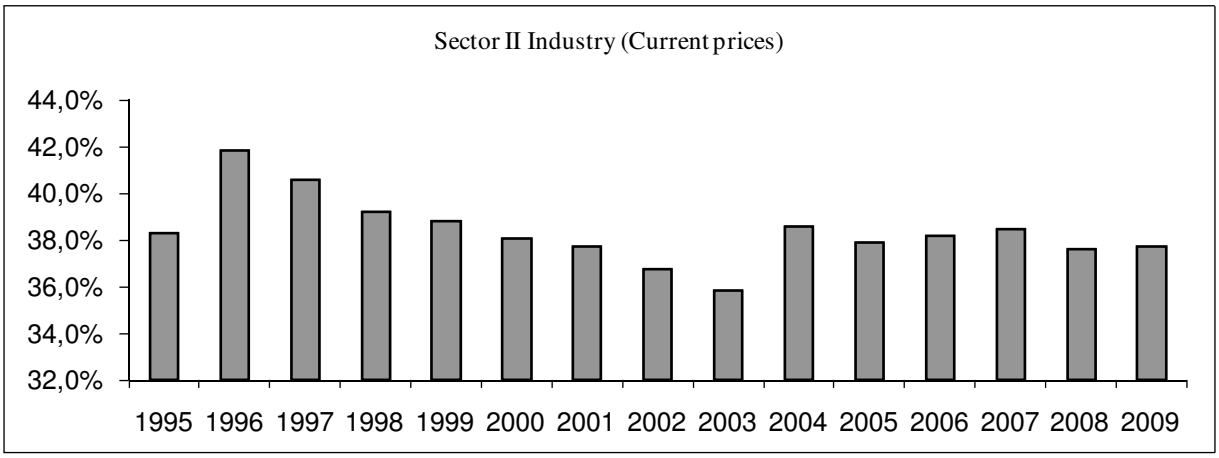
Source: data CZSO

Figure 10 Sector I – Agriculture, share on Gross Value Added YoY, in Current prices.



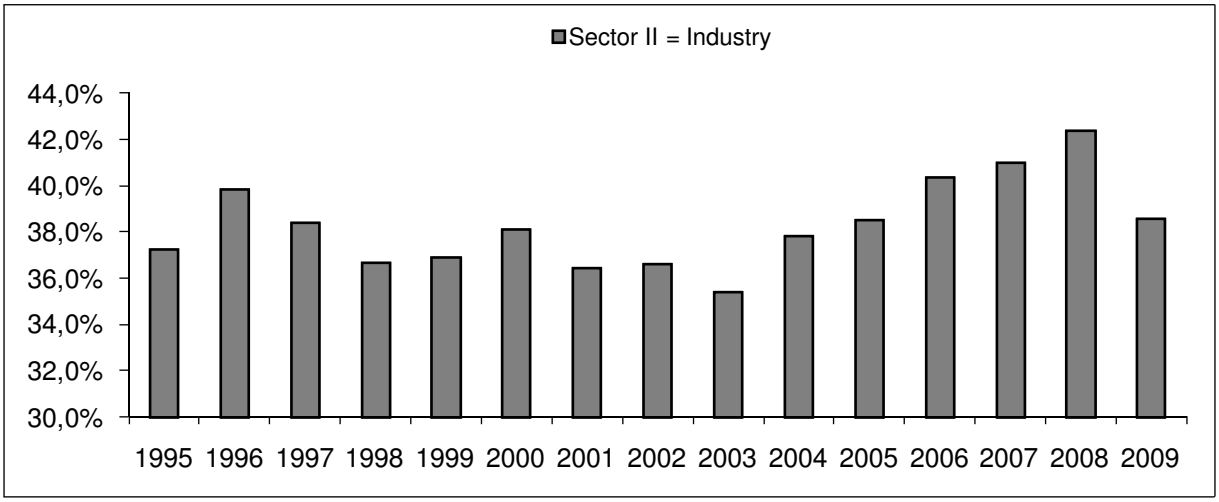
Source: data CZSO

Figure 11 Sector I – Agriculture, share on Gross Value Added YoY, in Constant prices.



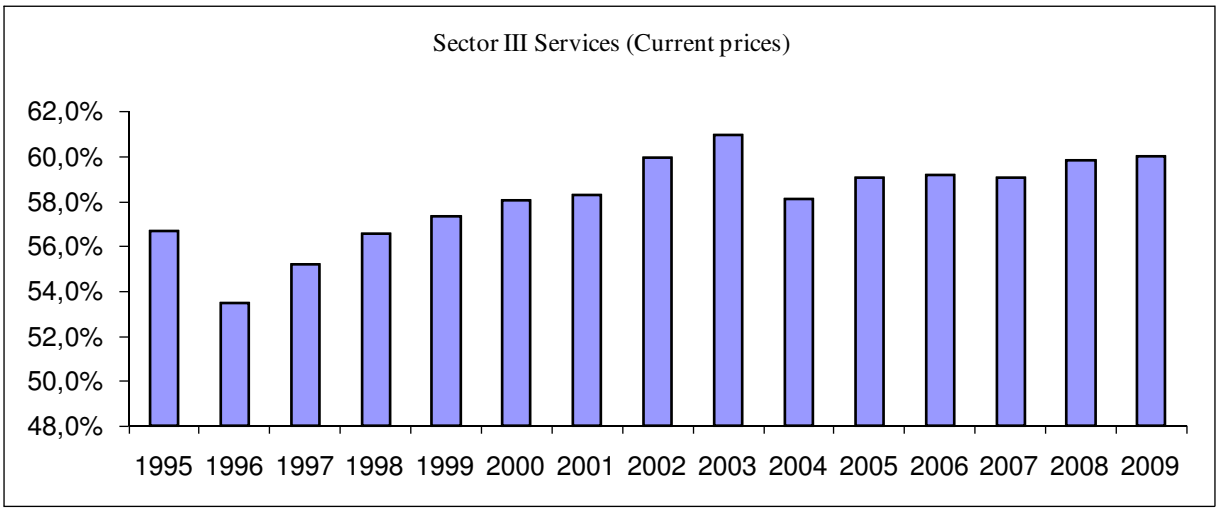
Source: data CZSO

Figure 12 Sector II – Industry, share on Gross Value Added YoY, in Current prices.



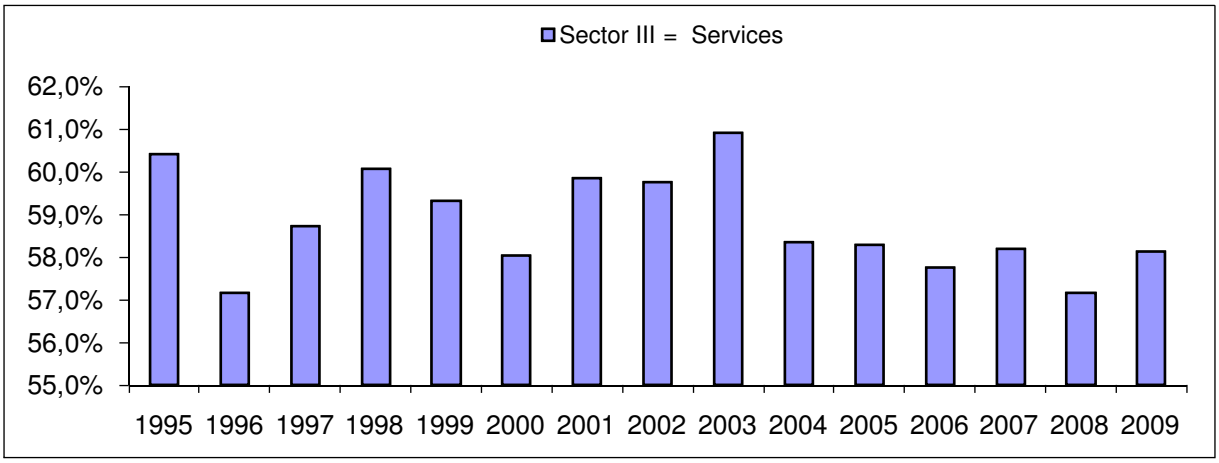
Source: data CZSO

Figure 13 Sector II – Industry, share on Gross Value Added YoY, in Constant prices.



Source: data CZSO

Figure 14 Sector III – Services, share on Gross Value Added YoY, in Current prices.



Source: data CZSO

Figure 15 Sector III – Services, share on Gross Value Added YoY, in Constant prices.

exports[12]. In the second half of 2008 has started to drop in industrial production in constant prices and continued also in 2009, when industrial production dropped by 13,5%. In 2009 there was a decline in industrial production in constant prices of 2000. The main reason is the slowdown in demand from abroad.

Food industry in the Czech Republic is still one of the key manufacturing sectors, although in 2009 was also influenced by the negative impact the current recession. However, the decline in the economic cycle in this sector was not as great as some other industries. Manufacturing sector in 2009 review of sales of own products and services in current prices, recording a decrease, even by 15,4%. Therefore the production of food and beverages dropped less. The share on manufacturing in 2009 increases to 9,8% (in 2008) this share was only 8,8%)[13].

Tertiary sector

On the contrary, the services sector, tertiary sector, strengthening its position in the menu structure and reaches almost 60% of the GVA. The reason was the change of investment opportunities, but also the structure of demand and lower energy intensity of services.

Conclusion

There are many theories that give a wider context of the crisis to internal or external conditions. For instance Irwing Fischer (1932) in his debt-deflation theory sees the cause of financial crisis in excessive credit expansion. Broader overview from Czech authors offers Musílek (2004).

Given the results presented above, the evolution of the Czech economy can have a V development however the bottom of 90% confidence interval admits that it might even lead to a further decline in GDP (W development). In addition, the selected model may be simplify in the sense that the GDP forecast is carried out only on the basis of previous values of GDP and does not take into account other variables that affect the GDP (GDP EU and especially Germany, the development of unemployment, indebtedness of the state, etc.).

In the second quarter of 2010 our main business partners thrive, so it is expected GDP growth in the second quarter. Net exports could therefore contribute positively to GDP growth. Fixed investment, inventories can also positively contribute to GDP growth, but their expansion is limited to permanent recovery in demand. On the contrary, the planned fiscal restraint should significantly affect household consumption. Since the solar boom ends and it can be assumed that fiscal restraint will last, I believe that the model predicted GDP growth for 2011 (2.6%) is unrealistic. I expect the value of annual growth may be around 2%. The forecast of GDP, especially in this turbulent period is very complex and development of W-shaped is still quite real. The difficulty of GDP prediction these days show a significant difference of predicted GDP values by above mentioned institutions.

Regarding agriculture, the fact that the demand for food is relatively independent, is the reason why the primary sector does not influence at what stage is the global economy - recession, depression or crisis. And this fact is emphasized in the conclusions of the medium-term outlook of the Organisation for Economic Cooperation and Development (OECD)[14], that agriculture is likely to survive the current economic situation better than any other sector. The increasing quality and environmental requirements of domestic and foreign demand in the Republic remains one of the main weaknesses of this sector.

[12] For example manufacture of transport equipments, electrical and optical equipments etc.

[13] Ústav zemědělské ekonomiky: Zelená zpráva 2009. p. 221-222.

[14] OECD – FAO: Agricultural Outlook 2009-2018, p. 32-48.

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Partial equilibrium model of Czech beef trade

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Abstract

The paper is focused on the modeling of a partial equilibrium on the beef market in the Czech Republic. The goal of the paper is a construction and a quantification of a partial equilibrium model of mentioned trade, used for simulation purpose and enabling delimitation of main determinants of beef supply and demand. Data was gained from standard statistical reports of the Ministry of Agriculture and from Statistics of Households Accounts from the year 1995 – 2009. Proposed model respects three levels of beef chain – farmer, processer and consumer. Simultaneously, it respects trade flows on an open market. From the functional point of view, it respects nonlinearity of suppose relationships. The model was quantified by OLS with respects of recursive relationship between endogenous variables. The model is robust enough to be used for simulations. The paper resulted from contribution to an institutional research project MSM 6046070906.

Key words

Beef, Partial Equilibrium Model, Czech Republic, Time Series, Panel Data.

Anotace

Příspěvek se zabývá modelováním dílčí rovnováhy na trhu s hovězím masem v České republice. Hlavním cílem předloženého příspěvku je konstrukce a kvantifikace modelu dílčí rovnováhy výše uvedeného trhu, využitelná pro simulační účely a umožňující vymezit hlavní determinanty nabídky a poptávky po hovězím mase. Použitá data byla získána ze Situačních a výhledových zpráv Ministerstva zemědělství ČR a ze statistiky rodinných účtů, a to za období let 1995-2009. Navržený model respektuje tři úrovně vertikály hovězího masa – zemědělského výrobce, zpracovatele a spotřebitele, zároveň zohledňuje otevřenost trhu. Z funkčního hlediska je respektován nelineární průběh uvažovaných funkcí. Odhad modelu byl proveden běžnou metodou nejmenších čtverců při zohlednění rekurzivních vazeb mezi endogenními proměnnými. Získaný model vykazuje dostatečnou robustnost pro analýzu trhu a případné simulační propočty. Předložený příspěvek je výstupem výzkumného záměru MSM 6046070906.

Klíčová slova

Hovězí maso, model dílčí rovnováhy, Česká republika, časová řada, panelová data.

Introduction

After 1989 significant changes in food consumption in the Czech Republic have occurred and the market has been exposed to a number of significant shocks, the consequence of which is fall of the overall demand for animal products regardless their different quality and dietetic value. Within their attempt to balance the excess of supply over demand, the agricultural producers are forced above all to reduce the numbers of farm animals, and to reduce thus their production. The mentioned development affects thus the cattle numbers significantly, which can be characterized with long-term downward tendency. In the course of the reference period 1995 – 2009 their fall by 33% occurs. The mentioned facts influence the supply of beef in the Czech Republic, which admittedly consists prevailingly of domestic production (86%), however, from the point of view of the structure,

significant drop in the share of domestic production and, to the contrary, significant increase in the share of the foreign trade can be experienced in the reference period. (Mach, Křístková, 2010).

Czech breeders contend with a number of significant problems, which do not contribute to satisfactory development of slaughter cattle production. In this respect, e.g. increased export of fattening cattle, which consequently necessitates increased import of beef, reduced consumption of concentrates in general, reduced consumption of bulk feed compared to growth in the areas with permanent grass stands, reduced utilization of slaughter capacity of the processing companies and coherent food industry. An unpleasant factor is also continuous beef consumption fall, which has its impulse in particular in the price development. Within the monitored period, beef became the most expensive meat commodity, which showed up in partial consumers' change-over towards cheaper types of meat. (Malý, Kroupová, 2006)

The main objective of the presented contribution is construction and quantification of partial equilibrium model of the above-mentioned market, utilizable for simulation purposes and enabling to define the main determinants of supply and demand for beef.

Material and Methods

The beef market analysis was based on the partial equilibrium model respecting three levels of the product vertical of the monitored commodity. The agricultural producers, the basic level of the mentioned vertical, were modeled as the entities offering live animals for the purpose of slaughter processing. Production behavior of the mentioned entities was assumed as depending on the price, for which they had realized their production in the previous period, but also from the price currently valid in the market. The mentioned variables explained numbers of cattle, of which beef production in live weight was derived subsequently. At the mentioned level, thus the farmers stand as the offering entities and the processors, the slaughterhouse in the case being considered, as the demanding entities.

The coherent vertical level is thus represented by slaughterhouses, as the case may be meat packing plants, the product of which is packaged fresh meat, which travels then to the consumers through a distribution chain. The processors' supply thus takes into account not only the yield, but also the existence of derived meat products (meat products and semi-finished products); however, these have not been taken into account any more in the presented model.

The beef market is modeled as an open one, thus the total beef supply in the consumer market consists of the aggregate of the packaged fresh meat gained from domestic production and of import of the foreign production. In the construction of the import function, the decisive influence of the import price and of the domestic currency exchange rate was assumed.

The part of the demand in the consumer market consisted in particular in domestic beef consumption, which was modeled at the level of households. The explanatory variables of the mentioned consumption were the consumer price of beef and the consumer's income. The aggregate demand was still supplemented with beef export depending on dominance of the export price over the domestic processing price. Also the inventories being created were classified to the part of the demand.

For the sake of clearness, the partial equilibrium model in the dynamic form can be defined with the following functional transcription:

$$S_t = f(CZV_t, CZV_{t-1}, S_{t-1}) \quad (2.1)$$

$$VZHM_t = f(S_t) \quad (2.2)$$

$$PM_t = f(VZHM_t) \quad (2.3)$$

$$IM_t = f(IC_t, K_t, IM_{t-1}) \quad (2.4)$$

$$SPD_t = f(SPCH_t, PR_t) \quad (2.5)$$

$$\mathrm{DS_t} = \mathrm{PD} * \mathrm{SPD_t} \quad (2.6)$$

$$\mathrm{EX_t} = \mathrm{f}\left(\frac{\mathrm{ECK_t}}{\mathrm{CPV_t}}, \mathrm{T}\right) \quad (2.7)$$

$$\mathrm{PM_t} + \mathrm{IM_t} = \mathrm{DS_t} + \mathrm{EX_t} + \mathrm{Z_t} \quad (2.8)$$

where:

S_t……..cattle numbers in period t,

$VZHM_t$……(agricultural) production of beef in live weight in period t,

CZV_t……farm price of beef in period t,

PM_t……..production of processed beef in period t,

IM_t……...import of processed beef in period t,

IC_t……import price of beef in period t,

K_t…….exchange rate CZK/USD in period t,

SPD_t…….consumption of beef in average household in period t,

$SPCH_t$……..consumer price of beef in period t,

PR_t……...average household income in period t,

DS_t……...domestic consumption of beef in period t,

PD.……...number of households,

EX_t……...beef export in period t,

ECK_t……....export price of beef in period t,

CPV_t…….....producer price of beef in period t,

T……...trend,

Z_t……..beef stocks in period t.

The basic analytical form of the above-mentioned model was power function applied to the relations 2.1, 2.2, 2.4, 2.5, 2.7. The remaining relations were modeled linearly.

The common method of least squares was used for estimation of the mentioned models; in case of power functions, this was applied to the linearized form. Compliance of the estimated models with the data, quantified with the determination coefficient, was tested using F-test. Statistical significance of the estimated parameters was subjected to t-test. Multicollinearity was tested with VIF-test (see Green, 2008), heteroskedasticity with Breusch-Pagan test (see Gujarati, 2003) and existence of autocorrelation of residuals was tested with Durbin-Watson test (for more details see: Hušek, 1999). Stability of parameters was tested by CUSUM test (see Cipra, 2008)

The function of the households' consumption requested specific estimation, since contrary to other functions this was not quantified from the data arranged in the time series but from the panel data. The mentioned facts, together with the proven heterogeneity of the panel data, stimulated construction of the consumption function in a form of a model of fixed and random effects, while the choice of suitable specification of the model was based on Hausman test (further see Green, 2008). The model of fixed effects was estimated using the common method of least squares and tested, besides the above-mentioned tests, also with Breusch-Pagan test, verifying the homoscedasticity (see Gujarati, 2003), and Godfrey Lagrange Multiplier test (further see Green, 2008) verifying non-existence of autocorrelation of residuals. The model of random effects was estimated by generalized method of least squares and tested with Baltagi-Li Joint test, which verifies the homoscedasticity and non-existence of autocorrelation of residuals in summary (see Baltagi et al., 2008). Presence of the individual phenomena was tested subsequently with Breusch-Pagan Lagrange Multiplier test (Green, 2008), verifying non-existence of group heteroskedasticity, and Wooldridge test of autocorrelation of the random component (see Wooldridge, 2003). Presence of autocorrelation, proven by the above-mentioned tests, was eliminated by Cochrane-Orcutt method (further Cipra, 2008), or by Prais-Winsten transformation (for more details, see Green, 2007), namely not only within the panel data models, but also in the models based on the time series. Estimations of the mentioned models were carried out in Limdep program, version 4.0.

Data

Quantification of the partial equilibrium model in the beef market was based above all on the data obtained from Situation and Forecast Reports published by the Ministry of Agriculture of the Czech Republic and arranged in the time series for the period of 1995 – 2009. Other data source was also the household budget survey kept by the Czech Statistical Office, of which the data was drawn on average beef consumption, weighted consumer prices and income of ten groups of employees' households in the mentioned period. The balanced panel contained thus 150 observations. The basic characteristics of the data used after the necessary adjustment for distant values are mentioned in table 2.1.

Results and discussion

The model estimation is performed in accordance with the limited information principle. For this reason, the attention in the following commentary shall be paid gradually to particular results of the quantification. The first evaluated relation is the functional link between numbers of cattle and level of the farmer's price, respecting the development dynamics of the mentioned variables. The estimation carried out, which is mentioned in table 3.1, can be written down in the following way:

$$\hat{S}_t = 5.1967 * CZV_{t-1}^{0.1856} * CZV_t^{-0.1906} * S_{t-1}^{0.8862}$$

It results from the above-mentioned facts that the farmer's price from the previous period and delayed values of the numbers influence the numbers of cattle positively, which is expected development according to the model assumptions, which is, in addition to that, confirmed also by the results of Moro et al., 2002. From the point of view of intensity of the impacts, one percent increase of the above-mentioned variables means on average ca. 0.19% increase in the numbers based on the impact of CZV_{t-1} or 0.89% increase in the numbers (impact of the delayed values of the numbers of cattle), ceteris paribus. Higher intensity of the delayed value of the numbers of cattle is expected since the internal delayed values of the variable being explained are considered. In spite of that, it is slightly surprising that the reaction is not flexible, which is, naturally in the context with the following variable, confirmation of negative development of the numbers of cattle. The mentioned unexpected direction of impact is evoked in the quantified model by the farmer's price of the current period, one percent increase of which is accompanied with reduced numbers of cattle on average by 0.2%, ceteris paribus. According to the general assumptions, the agricultural producer's buying-in price should be an unambiguously positively impacting regressor; however, the mentioned model reflects in full the actual market development, where in the monitored period the *CZV* (price of agricultural production) was increasing only slightly, however, the numbers of cattle were reduced significantly compared to this.

From the statistical point of view, it is possible to state that the parameters of the explanatory variables, with an exception of the constant, are statistically significant at the chosen significance level (α=0.05), tightness of dependence measured by the corrected determination coefficient is relatively very high (R^2=0.98), while conclusive evidence of the indicator was checked by F-test.

For verification of the econometric assumptions and achievement of other required characteristics of the estimation, Breusch-Pagan test of heteroskedasticity was carried out subsequently, whose p-value of quantified LM statistics confirms the presence of homoscedasticity. DW test did not prove the presence of autocorrelation of residuals. For verification of other required characteristics, the tests of stability of the estimated parameters (CUSUM test) and verification of the required normal distribution of the random component ut were carried out, the results of which are mentioned in graphs 3.1 and 3.2. In case of both tests, the required property of the estimation stability and normality of distribution of the random component was verified positively.

	Mean	Standard deviation	Skewness	Kurtosis	Minimum	Maximum
Cattle numbers (S) [mil.]	1.58	0.223589	0.868227	2.34669	1.36321	2.02983
Agricultural beef production (VZHM) [t live weight]	218131	52796.4	0.895666	2.30552	166900	322861
Farm price (CZV) [CZK/kg live weight]	19.4833	1.69745	-0.154042	1.31408	17.2313	21.7132
Beef import (IM) [t]	9379.88	6610.12	0.284161	1.52065	200	19300
Production of processed beef (PM) [t]	115137	24214.9	0.791099	2.19966	90100	163368
Producer price (CZV) [CZK/kg]	96.8167	9.59679	-0.0879509	1.76077	79.63	109.42
Total beef consumption (DS) [t]	86629	9578.83	0.11555	1.98635	70385.8	102644
Beef export (EX) [t]	19324	9961.92	-0.173365	1.63658	3964.26	33000
Beef consumption (SPD) [kg/month/household]	3.18604	0.926112	0.278936	2.84538	1.23	5.83
Consumer price (SPCH) [CZK/kg]	113.338	8.80935	0.415535	2.36	95.7118	137.238
Income (PR) [ths. CZK/month/household]	104.733	50.0314	1.578	6.21674	31.21	309.564

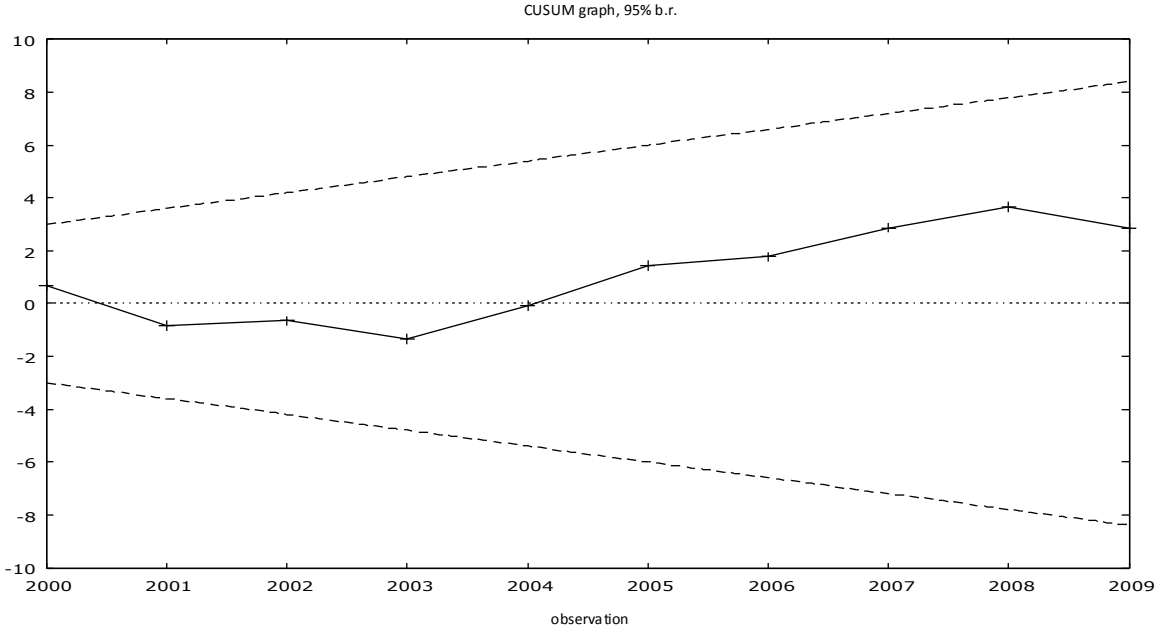
Source: own calculation

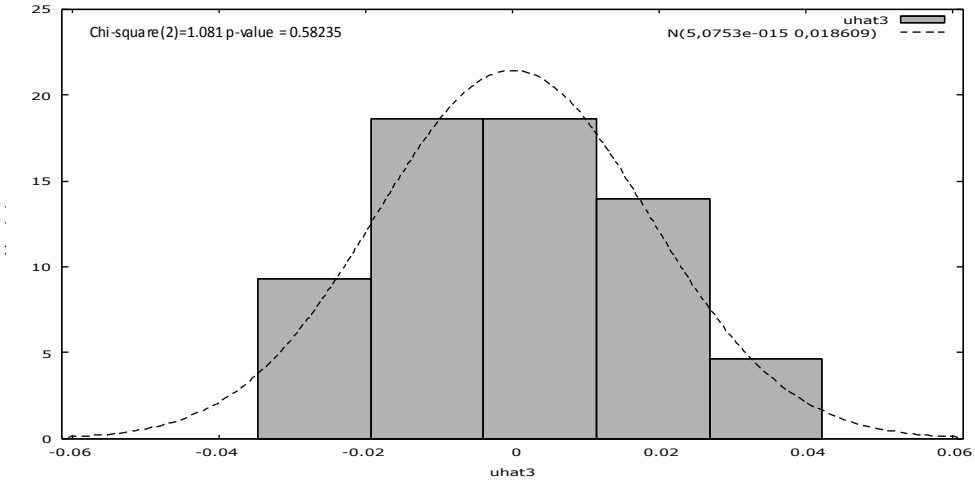
Tab. 2.1 – Deskriptive statistics of used variables.

	Parameter	Standard error	t-value	p-value
konst.	1.648	1.0701	1,54	0.1546
CZV_t	-0.1906	0.0634	-3.008	0.0132
CZV_{t-1}	0.1856	0.03808	4.873	0.0006
S_{t-1}	0.886229	0.0473439	18.72	0.0000
R^2	0.981079			
Kor. R^2	0.9754			
F (3,10)	145.8603			0.0000
LM	2.7165			0.4374
Durbin-Watson	1.53627			0.0586322

Source: own calculation

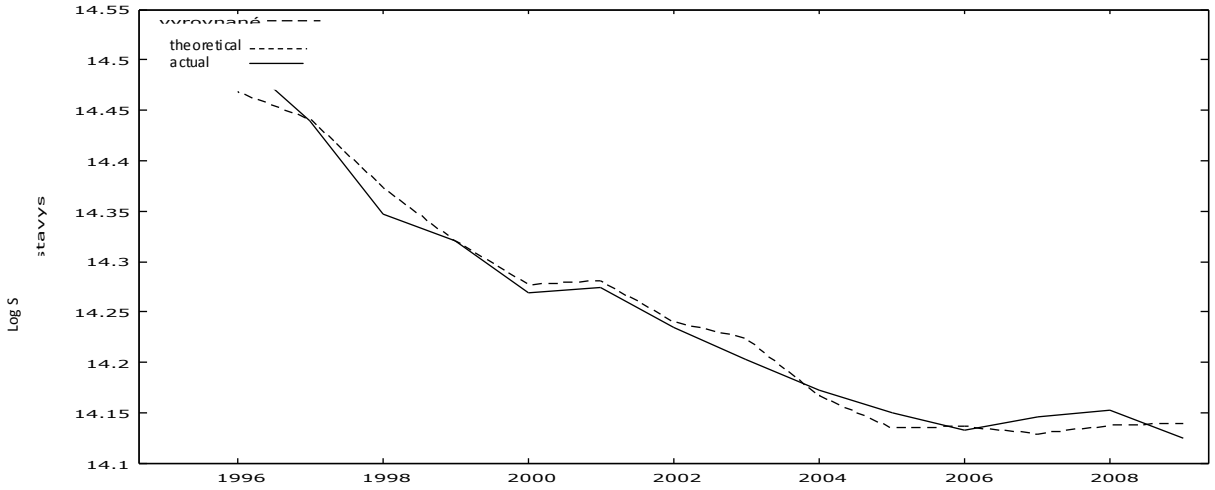
Tab. 3.1 – Results of estimation of linearized function of cattle numbers.





Source: own calculation

Graph 3.1 and 3.2 – Cusum test and normality test of residual (function of cattle numbers) .



Source: own calculation

Graph 3.3 – Actual and theoretical values of cattle numbers.

It is possible to conclude about certain quality of the estimation performed also from the compliance of the course of actual and theoretical values of the variable being explained, see graph 3.3.

Another estimation carried out was simple link between total numbers of cattle in the Czech Republic and beef production in tons of live weight at the primary producer's level. The specified relation interprets the necessary recalculation of cattle pieces to actual beef production in tons of live weight, while the levels of the parameters achieved, respecting the recursive relation between meet production and numbers of cattle after elimination of autocorrelation proven by DW test are summarized in table 3.2.

The estimated function has a following form:

$$\widehat{\mathrm{VZHM}}_t = 0.000005 * \hat{S}_t^{1.7135}$$

Expression of the influence of the numbers of cattle on production is, according to the expectation, positive with adequate intensity, since one percent increase of the numbers evokes ca. 1.7% increase in beef production, ceteris paribus. The described relation may be characterized as flexible, which is indicative of the fact, that if increase in the numbers of cattle occurs, then this probably happens at the very categories of fattening cattle, the consequence of which is more intensive growth of meat production in live weight. The value of the constant represents only technical recalculation of the pieces to the live weight in relative expression.

The performed model verification proved the statistical significance of the estimated parameters at the chosen significance level (α=0.05), the tightness of dependence measured by the corrected determination coefficient is also relatively very high (R^2=0.98), while conclusive evidence of the indicator was checked by F-test. Breusch-Pagan test confirmed absence of heteroskedasticity.

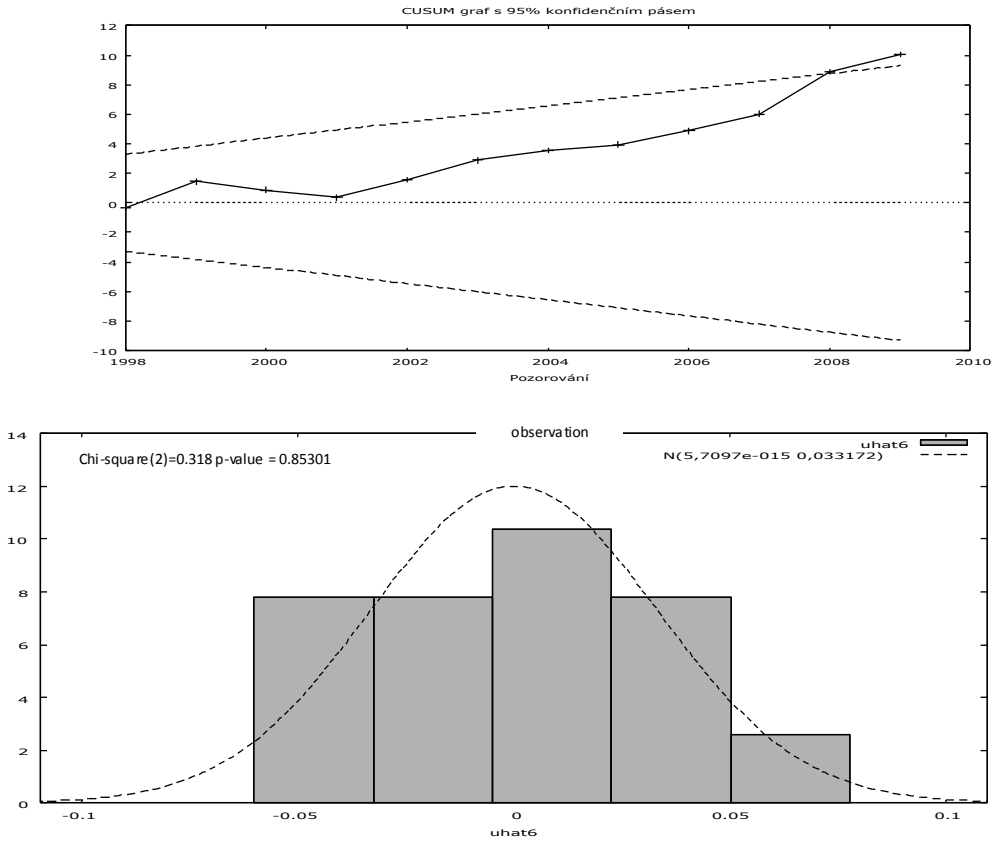
When evaluating the CUSUM stability test (see graph 3.4), it is possible to state that in the end of the period the estimation is already slightly unstable, since the testing statistics already exceed the confidence interval at α=0.05. To the contrary, the p-value of Jarque-Bera normality test (see graph 3.5) confirms the assumption of the normal distribution of the random component u_t.

	Parameter	Standard error	t-value	p-value
konst.	-12.1738	1.4488	-8.403	0
S_t	1.71354	0.10165	16.86	0
R^2	0.977947			0
Kor. R^2	0.976109			
F (1,12)	14911.56			0

Source: own calculation

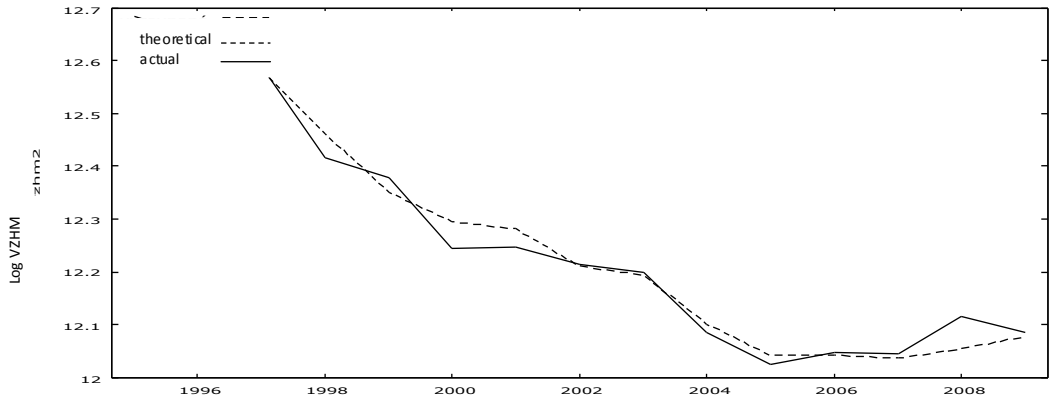
Tab. 3.2: Results of estimation of linearized function of agricultural beef production in live weight (elimination of autocorrelation)

CUSUM graph, 95% b.r.



Source: own calculation

Graph 3.4 and 3.5 – Cusum test and normality test of residual (function of beef production in live weight)



Source: own calculation

Graph 3.6 – Actual and theoretical values of beef production in live weight.

It is possible to become convinced of the estimation quality graphically from the following graph 3.6, which offers comparison of the course of actual and theoretical meat production values in live weight.

The coherent relation of the model drawn up above was the link between meat production and beef production in tons of live weight. The mentioned relation was not estimated explicitly within the model, but it was specified by means of a technical coefficient derived from the average values of the source data[15]. The stipulated value represents than

[15] The relation between the live weight of a piece and slaughter weight of a carcass may be described as technological, since the factors known in advance have decisive influence on its amount (in particular the breed, sex, age and subsequently the used technology of slaughter processing).

the slaughter processing coefficient or the relation between live and slaughter weight:

$$\widehat{PM}_t = 0.5239 * VZHM_t.$$

By means of the derived coefficient, it is thus possible to quantify subsequently the domestic production at the processor's level, i.e. the supply of the packaged fresh meat, which is further realized either through direct, or intermediated, logistic way in the consumer market, or it is utilized for production of meat products by another processing intermediary stage.

Within the framework of gradual quantification, the function of beef import was estimated subsequently[16]. The estimation performed is illustrated in table 3.3.

Transcription of the parameters into equational record of the original power function:

$$\widehat{IM}_t = 116634.5 * IC_t^{-0.2465} * K_t^{-1.45} * IM_{t-1}^{0.4631}.$$

It is obvious from the quantification that the import price and the exchange rate amount influence the monitored beef import negatively and the delayed import values themselves positively. In case of all variables, the direction of impact is in accordance with the expectations, since the higher the import price is, the more difficult it would be for the imported production to assert itself in the domestic market (from the point of view of the intensity, 1% increase in the import price evokes ca. 0.25% reduction of import, ceteris paribus). At the same time, the higher is the domestic crown exchange rate against the foreign currency, i.e. the "weaker" is the crown, the less gains the importer when importing foreign production priced in foreign currency after conversion from the stable domestic price (according to the results, one percent increase of the crown exchange rate (devaluation) leads to import reduction by 1.45%, ceteris paribus). Positive elasticity of import of the previous period documents actual increasing in beef import to the Czech Republic, whereas the parameter value may be interpreted as average interannual increase.

The parameters of the explanatory variables are statistically significant at the chosen significance level (α=0.05), with an exception of IC_t (import price), where significance was proven only at the level α=0.1. The tightness of dependence measured by the corrected determination coefficient achieves still a relatively high value (R^2=0.78), while conclusive evidence of the indicator was checked by F-test. The required characteristics of the random component were proven; see table 3.3 and graphs 3.7 and 3.8.

In the previous part of the text, the supply part of the partial beef market was modeled. However, also the demand part is equally important for creation of the partial equilibrium model; this is represented by domestic consumption, domestic inventories and beef export. Dependence of the beef consumption (in the form of average household consumption (*SPD*)) was expressed on the beef consumer price (since the consumer is able to react relatively very quickly, only the current period price was used) and on the consumer's income.

Compared to the previous relations and in order to ensure better quality of the estimation itself, the source data in the form of panel data were used (in particular, for the reason of higher count of the data). More detailed specifications and methodical aspects are mentioned above. The resulting quantification is described in table 3.4.

With regard to the estimation method (according to Hausman test, the method of fixed effects was chosen), both the values of the explanatory variable itself are described in the table of parameters, as well as the parameter values of dummy variables of particular income groups. For simplification of the record, the total value of the constant corresponding to an average household has been derived from the values of dummy parameters. The final equational record may be formulated:

$$\widehat{SPD}_t = 80.1634 * SPCH_t^{-0.8610} * PR_t^{0.3328}$$

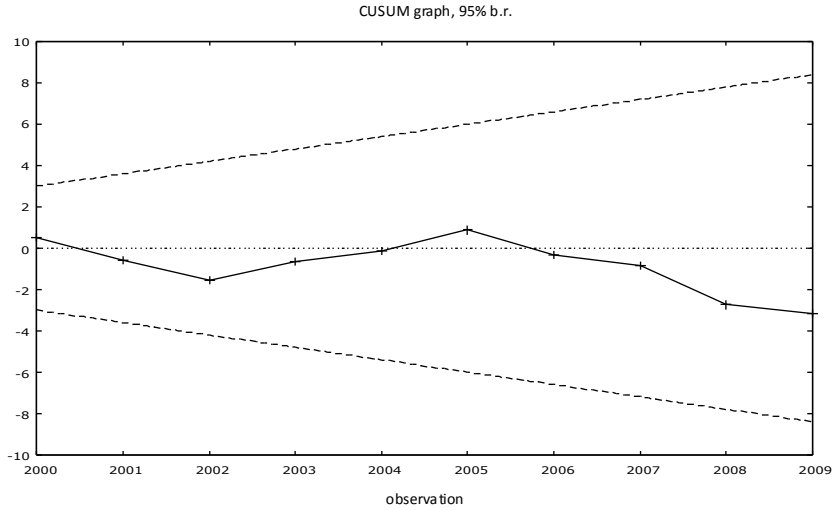
It is obvious from the output that the consumer price of beef impacts negatively according the assumptions, while the consumer's income impacts positively. Relatively high intensity of the price impact is slightly surprising – one percent increase of the price evokes 0.8% consumption fall, ceteris paribus, while foreign surveys mention flexibility 0.3% (Moro et al., 2002), 0.08% (Souza, 2008). The mentioned efficiency, in spite of the fact that still a non-flexible reaction is in question, is probably the consequence of high beef price compared to other meat types, i.e. the consumers react to potential increase of already high price very

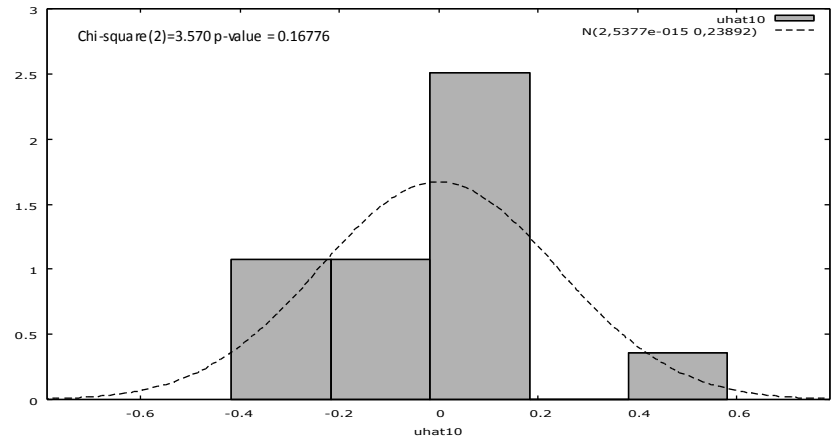
[16] The beef category was selected according to the customs tariff - TARIC nomenclature.

	Parameter	Standard error	t-value	p-value
konst.	11.6668	0.824947	14.14	0
IC_t	-0.246511	0.124948	-1.973	0.0768
IM_{t-1}	0.463097	0.109782	4.218	0.0018
K_t	-1.45016	0.222305	-6.523	0
R^2	0.830089			
R^2	0.779116			
F (3,10)	27.4731			0.000038
LM	0.632022			0.889064
Durbin-Watson	1.95838			0.167259

Source: own calculation

Tab. 3.3 – Results of estimation of linearized function of beef import.





Source: own calculation

Graph 3.7 and 3.8 – Cusum test and normality test of residual (function of beef import)

	Parameter	Standard error	t-value	p-value
$SPCH_t$	-0.86098959	0.414697	-2.076	0.0396
PR_t	0.32794477	0.147635	2.221	0.0278
I_1	3.98387			
I_2	4.19712			
I_3	4.33411			
I_4	4.38455			
I_5	4.44727			
I_6	4.45298			
I_7	4.45561			
I_8	4.48337			
I_9	4.5104			
I_{10}	4.52808			
ρ	0.486024			
R^2	0.4835			0.0000
LMBP	0.000296			0.9999
LM	330.7076			0.0000

Source: own calculation

Tab. 3.4 – Results of estimation of linearized beef consumption function

sensitively, and therefore the consumption fall is relatively higher than expected. The variable of the income then impacts according to the expectations; one percent increase of the income evokes 0.3% increase of consumption, ceteris paribus.

From the statistical-econometric point of view it is necessary to mention that the primary estimation was, according to the tests, burdened with autocorrelation of residuals, since the Baltagi-Li Joint aggregate test of heteroskedasticity and autocorrelation proved the presence of at least one of the mentioned phenomena. Therefore Breusch-Pagan Lagrange Multiplier test was carried out subsequently, which excluded heteroskedasticity, in consequence of which Prais-Winsten transformation (*Rhó*=0.486) was used subsequently in order to eliminate autocorrelations. In the following estimation, which is already the subject-matter of the commentary, all required characteristics are already complied with; see p-value in table 3.4. When assessing the statistical conclusive evidence, the parameters may be described as significant at the chosen significance level (α=0.05).

For the purpose of expression of the aggregate domestic consumption of beef, it was necessary to quantify the number of households. The mentioned procedure was carried out by means of quotient of the actual aggregate beef consumption and theoretical consumption value of an average household. The relation drawn up that enables to enumerate the theoretical total consumption value, the knowledge of which is necessary to set the market equilibrium is following:

$$\widehat{DS}_t = 2916117 * \widehat{SPD}_t.$$

The last quantified relation, which is necessary to be included in the partial equilibrium model, is illustration of export. When formulating the export function, according to the economic assumptions, the account was taken of the relation between the export price of beef expressed in CZK/t and domestic processing price also in CZK/t. The quotient variable expressed in this manner was specified as the main export determinant (similarly Moro et al., 2002). Based on the source data, estimation was carried out, the contents and characteristics of which are described in table 3.5.

After transfer of the linear form and expressing of the parameters, the resulting estimation may be recorded as follows:

$$\widehat{EX}_t = 4465.56 * \left(\frac{ECK_t}{CPVV_t}\right)^{0.7056} * T^{0.7529}$$

It is obvious from the equation that both explanatory variables impact the export amount positively. The positive time vector factor corresponds to the reality where the actual export values (in spite of ambivalence) were increasing in the monitored period. The positive parameter of the quotient of export and domestic prices expresses growth in export (on average by 0.7 %, ceteris

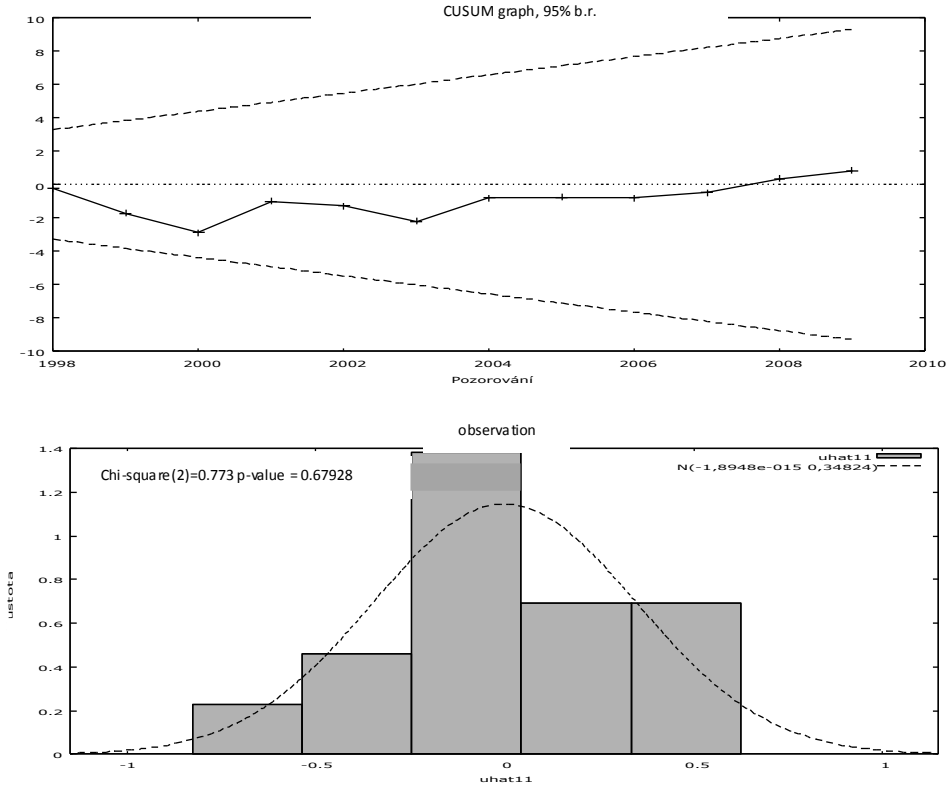
paribus) in case of one percent increase of the mentioned quotient. The achieved parameter value probably corresponds to the assumptions, since the higher is the export price compared to the domestic one, the more will be the potential exporter motivated to export. The mentioned facts are of course conditioned by other factors, namely e.g. by competition types in the international market, assumption of barrier-free access to foreign markets and also e.g. by the exchange rate development, since the export price was expressed after conversion to CZK.

The required statistical and econometric characteristics are documented by table 3.5 and graph 3.9 and 3.10.

	Parameter	Standard error	t-value	p-value
konst.	8.40415	0.155472	54.06	0.0000
(ECK_t/CPV_t)	0.705612	0.343412	2.055	0.0624
T	0.752864	0.0744056	10.12	0.0000
R^2	0.740509			0.0000
Kor. R^2	0.69726			
F(2,12)	55.65716			0.0000
LM	2.67352			0.262695
Durbin-Watson	2.34947			0.55798

Source: own calculation

Tab. 3.5 – Results of estimation of linearized function of beef export.



Source: own calculation

Graph 3.9 a 3.10 – Cusum test and normality test of residual (function of beef export)

Conclusion

Significant changes occurred in the beef market during last twenty years, which affected not only its extent but also its structure. On the part of the supply, long-term drop in the domestic production and increase of supply from foreign producers may be observed. Drop in the domestic production was connected with the drop in the numbers of cattle as a rule, which were reduced by 33% in the monitored period of 1995-2009. According to the presented research, their development was influenced by the level of the farmer's price, which showed the growth only by 120% during the whole monitored period, while the consumer price was increased by 146%. The mentioned fact impacted

not only fall of the demand for beef, which became the most expensive meat commodity, but it showed up also in growth of the import volume, which multiplied five times compared to the initial period of 1995, and on the other hand, also in increasing export of fattening cattle. In 2009 thus the import represented 14% of the overall beef supply in the Czech market, while this was influenced not only by the import price influencing the competitiveness of the imported goods in the Czech market but also by the exchange rate of the Czech crown. From the point of view of the demand, high consumers' sensitivity to the beef price was proven, which is one of the reasons for the falling consumption. The consumer reacts to one percent increase in the beef price by fall of the demanded quantity by 0.9%. The mentioned consumer behavior conditions high orientation of the Czech producers at foreign markets, which is declared by eight-time growth of the volume of beef export. The estimated model reflects the above-mentioned changes and declares the determinants of development of supply and demand for beef and also the basic links between the particular levels of the beef vertical, thus it is possible to be considered as a suitable tool for the analysis of the mentioned market and subsequent simulation calculations.

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Positive and Negative Aspects of Financial Economic Development in Selected Branches of the Food Industry of the CR in 2007 – 2009 as Revealed by Spider Analysis

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Abstract

The food industry as an important part of the agriculture sector markedly influences through its financial economic results development both in agriculture and in related links of the food chain. The objective of the present paper is to identify negative and positive these aspects of results obtained in this sector in 2007-2009 and to reveal some risks that can retard the agriculture sector and/or to indicate positive trends that will lead to its development. Some segments – manufactures influencing the results of the food industry as a whole in a pronounced way were selected for analysis. The graphical model Spider Analysis was used for an expeditious and objective evaluation of results in the branches of manufacture and their position within the studied sector for the given period.

Key words

Spider Analysis – food industry – profitability – liquidity – financing – assets.

Anotace

Potravinářský průmysl jako významné odvětví agrárního sektoru výrazně ovlivňuje svými finančně-ekonomickými výsledky jak vývoj v zemědělství, tak v navazujících článcích potravinového řetězce. Záměrem článku je ukázat negativa a pozitiva těchto výsledků v tomto sektoru v období 2007–2009, a tím přispět k odhalení rizik, která mohou retardovat agrární sektor, resp. naznačit pozitivní směry, které povedou k jeho rozvoji. Pro analýzu byly vybrány jeho některé segmenty – výroby, které výrazně ovlivňují výsledky celého potravinářského průmyslu. K poměrně pohotovému a přehlednému hodnocení výsledků výrobních oborů a jejich pozice v rámci zkoumaného odvětví za uvedené období byl využit grafický model Spider analýza.

Klíčová slova

Spider analýza - potravinářský průmysl - rentabilita - likvidita – financování – majetek.

Introduction

The team of authors is permanently engaged in analyses of the structure of food industry and its financial economic development in the CR. Some members of this team of authors investigated the development of business structure in this sector from retrospective and perspective aspects in the middle of this decade (Putičová, M., Mezera J. and Mejstříková, L. 2005). At present the problems of the food sector are solved in the framework of Research Plan MZE0002725101 "Analysis and Evaluation of Possibilities of Sustainability of Agriculture and Rural Areas of the CR in Conditions of the EU and European Model of Agriculture", and also in thematic and other projects of Ministry of Agriculture of the CR (hereinafter MoA CR) aimed at output and financial economic performance of the food industry. Methodological approaches and economic analyses used in agriculture both in the Institute of Agricultural Economics and Information (hereinafter IAEI) and at universities are applied and, first of all, economic indicators suitable for the processing industry are employed. Relevant

database and quality-based knowledge from the business sphere are valuable sources. The crucial importance of economic analyses is based on the complicated economic situation and position of the agriculture sector when it is desirable to seek positive segments in this sector – branches and manufactures that would lead to an increase in effectiveness in the years to come.

Material and Methods

On the basis on the given statistical data was applied model Spider Analysis. Despite its clear advantages this analysis is used very seldom. Blažková (2010) used it for evaluation of economic differentiation of subjects on particular processing stages within the wheat commodity chain in the Czech Republic with regard to agro-food market development. The graphical model Spider Analysis (Kubíčková D., Soukup J., 2006) was used in this paper to evaluate financial economic results of selected branches of manufactures in 2007-2009 and to compare them with the sector by means of ratio indicators. This "spider" model presents ratio indicators in an objective way, allowing for an expeditious evaluation of effectiveness of the given branch in the framework of the food industry. Both used graphs are based on two curves: one curve of the first of these graphs shows the values of ratio indicators of the evaluated branch for a selected base year (2007 and/or 2008 = 100%) and the other curve shows these values for a current year (2008 and/or 2009) in order to make a year-on-year percentage comparison. In the other graph the values of ratio indicators of the given branch in 2008 (and/or 2009) (one curve) are compared with the values of the sector representing 100% (the other curve). A year-on-year comparison of the used indicators was made in the Manufacture of Food Products (NACE 10), Manufacture of Beverages (NACE 11). Either of the two graphs of Spider Analysis is divided into four basic parts that show profitability, liquidity, financing structure and asset structure. In this paper the authors also used their own knowledge from the analysis of financial economic performance and effectiveness of the Czech food industry (Mejstříková, L. and Mezera, J. 2006).

The following table (Tab. 1) shows the selection of particular indicators and their construction.

Table 1 – Selected financial indicators and their construction:

Profitability ratios

- A1 – Return on equity (ROE) = net profit/equity capital*100
- A2 – Return on liabilities = net profit/total liabilities*100

Liquidity ratios

- B1 – Total liquidity = inventory + (financial assets + accounts receivable)/short-term liabilities + short-term credits
- B2 – Quick ratio = financial assets/(short-term liabilities + short-term credits)
- B3 – Current ratio = (financial assets + accounts receivable)/(short-term liabilities + short-term credits)

Financing structure

- C1 – Share of equity = equity /total liabilities*100
- C2 – Debt-to-equity ratio = (foreign capital + other liabilities)/equity*100

Asset structure

- D1 – Ratio of accounts receivable to assets = total accounts receivable/total assets*100
- D2 – Inventory turnover (days) = inventory/sales*365
- D3 – Accounts receivable turnover (days) = accounts receivable/sales*365

Statistical surveys carried out by the Czech Statistical Office (ČSÚ) are the basic database source for the analysis of food industry. Flow financial economic data are monitored by the quarterly statistical report ČSÚ-P3-04 for selected economic agents of sectors of manufacture (in industries, building industry, trade and selected services). Status and selected flow indicators are monitored by the quarterly report P6-04 on financial indicators. These are database files provided for analytical purposes on a contractual basis by the IAEI. To meet the requirement for the protection of personal data the year-on-year spider analysis of sector data of economically active enterprises in the Manufacture of Food Products and Manufacture of Beverages with 250 employees and more and selected enterprises with 50 employees and more for the periods 2007-2008 and 2008-2009 could be carried out only for 5 branches

of manufacture[17], for the Manufacture of Food Products (CZ-NACE 10), Manufacture of Beverages (CZ-NACE 11). On 1st Jan. 2008, Czech Statistical Office (ČSÚ) introduced the international statistical classification of economic activities CZ-NACE, which replaced the Sector Classification of Economic Activities (OKEČ). Accordingly, the method of data processing was modified while the introduced classification allows for better international comparisons. In the present paper the food industry sector is classified according to the new structure, i.e. CZ-NACE, as mentioned above to Manufacture of Food Products (CZ-NACE 10) and Manufacture of Beverages (CZ-NACE 11). CZ-NACE 10 is classified into groups according to branches.[18]

Results and discussion

Processing and preserving of meat and production of meat products (CZ-NACE 10.1)

This branch is a crucial one in the food industry structure because a significant part of agricultural production from animal sources is processed there. Its economic performance influences this production, especially from the aspect of its volume. A higher volume of processed animals will bring about a need of increasing the numbers of livestock. It is possible to increase the processing of animals in quantitative terms as well as in qualitative terms only if the meat industry is in good economic "condition". The increasing price pressure and the consumers´ expectations for meet safety and quality are the challenges the processor will soon face. Vertically integrated companies are expected to meet these challenges more efficiently which helps them to achieve the competitive advantage (Bavorova, 2010). This situation is valid not only for Germany but also for other countries including CZ.

Table 2 documents that profitability ratios in the studied branch worsened markedly year-on-year in 2008, which was a negative trend. Return on equity and return on liabilities also decreased in 2008. However, total liquidity and current ratio increased while quick ratio dropped moderately. In the financing structure the share of equity and debt-to-equity ratio decreased pronouncedly in 2008. There were also year-on-year changes in the asset structure in 2008. The ratio of accounts receivable to assets decreased, inventory turnover lengthened but accounts receivable turnover was substantially shorter. In 2009 profitability ratios, ROE and return on liabilities exceeded the 2007 levels. In the former year liquidity ratios except the quick ratio increased markedly. In the financing structure the share of equity continued to increase while the debt-to-equity ratio decreased. In 2009 the ratio of accounts receivable to assets rose but inventory turnover was shorter pronouncedly and accounts receivable turnover was also somewhat shorter. In comparison with the sector Manufacture of Food Products (NACE 10) as illustrated in Fig. 1, the branch in question lagged behind in profitability and was disadvantaged by debt-to-equity ratio in the evaluated period. Measures aimed at the utilization of capacities should be taken. Technical efficiency in the agriculture sector was studied by Čechura (2009), who concluded that a downward trend of technical efficiency reflecting unused capacities due to a drop in production as a result of keen competition could be observed mainly in the production, processing and preserving of meat from large farm animals.

[17] Processing and preserving of meat and production of meat products (CZ-NACE 10.1), Manufacture of dairy products (CZ-NACE 10.5), Manufacture of bakery, confectionery and other farinaceous products (CZ-NACE 10.7), Manufacture of other food products (CZ-NACE 10.8) and Manufacture of prepared animal feeds (CZ-NACE 10.9); these are mostly crucial food branches.

[18] Taking into account the relatively diversified representation of the particular classes and to allow for better evaluation of some manufactures, in the new classification system the original OKEČ 15.8 – Manufacture of other food products was classified to two groups: CZ-NACE 10.7 Manufacture of bakery, confectionery and other farinaceous products and CZ-NACE 10.8 – Manufacture of other food products.

Financial economic indicator	2007	2008	2009	Year-on-year difference 2008/2007	Year-on-year difference 2009/2008
Profitability ratios					
FA1 – Return on equity (ROE)	8.02	2.29	9.70	-5.73	7.41
A2 – Return on liabilities	3.10	0.91	4.00	-2.19	3.08
Liquidity ratios					
B1 – Total liquidity	0.79	1.42	1.78	0.63	0.36
B2 – Quick ratio	0.06	0.04	0.21	-0.02	0.17
B3 – Current ratio	0.64	1.06	1.45	0.42	0.39
Financing structure					
C1 – Share of equity	38.68	39.95	41.19	1.27	1.24
C2 – Debt-to-equity ratio	158.53	150.31	142.77	-8.22	-7.54
Asset structure					
D1 – Ratio of accounts receivable to assets	33.81	32.50	34.64	-1.31	2.15
D2 – Inventory turnover (days)	18.72	22.69	16.77	3.97	-5.92
D3 – Accounts receivable turnover(days)	73.91	64.85	62.43	-9.06	-2.41

Source: Czech Statistical Office, own calculations

Table 2: Year-on-year development of financial economic indicators in the branch Processing and preserving of meat and production of meat products (CZ-NACE 10.1) in 2007-2009 (%, percentage points /p.p.)

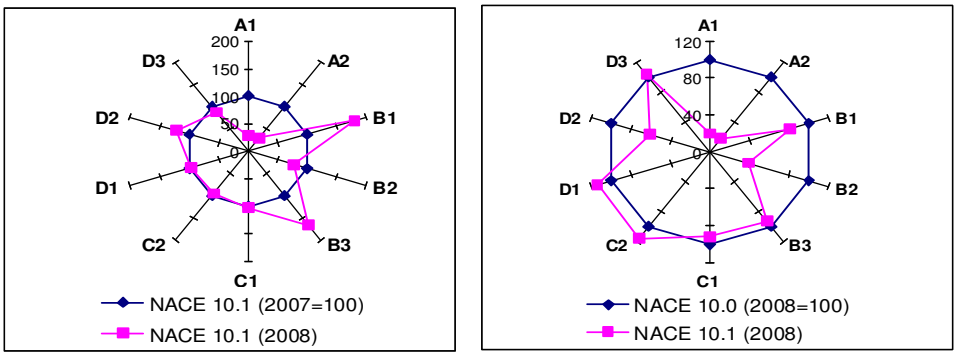

Figure 1: Year-on-year development of financial economic indicators in the branch Processing and preserving of meat and production of meat products (CZ-NACE 10.1) in the framework of CZ-NACE 10 in 2007-2008.

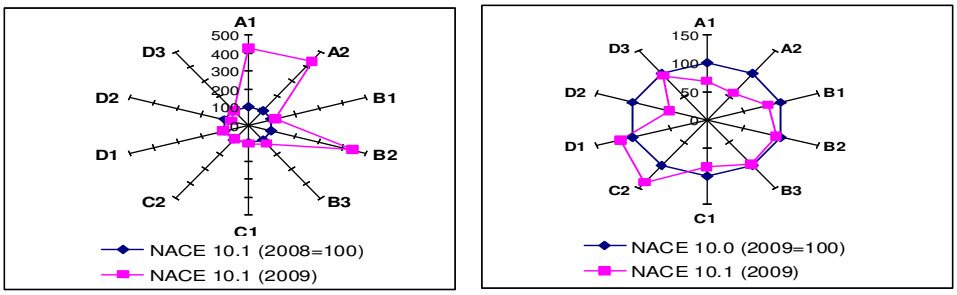

Figure 2: Year-on-year development of financial economic indicators in the branch Processing and preserving of meat and production of meat products (CZ-NACE 10.1) in the framework of CZ-NACE 10 in 2008-2009.

Manufacture of dairy products (CZ-NACE 10.5)

This manufacture is another processing branch closely related to agricultural produce of animal origin – cattle raising. The EU dairy industry is very dominant in the world market (Tacken, 2009). A quota system has been used in milk until now in the framework of the EU Common Agricultural Policy. However, the domestic dairy industry does not purchase total milk production when raw milk transported for its processing to another country accounts for 17.5% (Kopáček 2010). In the CR from the aspect of the ownership structure foreign companies participate in the dairy industry that achieve better economic results but the evaluated period fell into an economically difficult period that had impacts on the European dairy industry as a whole.

Year-on-year drop in profitability of this branch, as expressed by both ROE and return on liabilities, was pronounced in 2008 (Table 3), which was a negative trend. A more moderate year-on-year drop was recorded in all three ratios of liquidity. In the financing structure the share of equity of the branch decreased in the same year while the debt-to-equity ratio increased. In the asset structure the ratio of accounts receivable to assets decreased year on year in 2008 but inventory turnover lengthened while accounts receivable turnover shortened.

In 2009 profitability rose year on year again, namely both ROE and return on liabilities, but they did not reach the 2007 level. An increase was recorded in all three liquidity ratios in 2009. In the financing structure the share of equity increased and debt-to-equity ratio decreased markedly in the evaluated year. In the asset structure the ratio of accounts receivable to assets dropped, inventory turnover shortened in a pronounced way but accounts receivable turnover was moderately longer. In comparison with the sector Manufacture of Food Products (NACE 10) the branch showed very low profitability in 2008 that however improved above the sector level in 2009. As illustrated in Fig. 3, the branch markedly differed from the sector in quick ratio showing a higher value for the branch, and in debt-to-equity ratio, where the value of the branch was relatively high. The measures of dairy companies should be aimed at higher utilization of equity and the trend of a reduction in debt-to-equity ratio should continue.

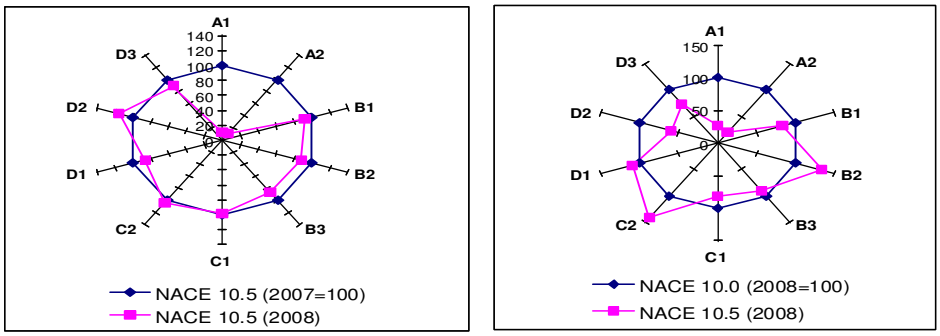

Figure 3: Year-on-year development of financial economic indicators in the branch Manufacture of dairy products (CZ-NACE 10.5) in the framework of CZ-NACE 10 in 2007- 2008.

Financial economic indicator	2007	2008	2009	Year-on-year difference 2008/2007	Year-on-year difference 2009/2008
Profitability ratios					
A1 – Return on equity (ROE)	28.23	2.99	16.51	-25.24	13.52
A2 – Return on liabilities	10.17	1.05	6.87	-9.12	5.82
Liquidity ratios					
B1 – Total liquidity	1.59	1.47	1.91	-0.12	0.44
B2 – Quick ratio	0.17	0.15	0.40	-0.02	0.25
B3 – Current ratio	1.20	1.04	1.50	-0.17	0.46
Financing structure					
C1 – Share of equity	36.03	35.24	41.62	-0.78	6.38
C2 – Debt-to-equity ratio	177.58	183.75	140.29	6.17	-43.47
Asset structure					
D1 – Ratio of accounts receivable to assets	36.27	31.28	30.95	-4.99	-0.33
D2 – Inventory turnover (days)	19.48	22.56	17.75	3.07	-4.81
D3 – Accounts receivable turnover(days)	52.18	46.51	47.82	-5.68	1.31

Source: Czech Statistical Office, own calculations

Table 3 : Year-on-year development of financial economic indicators in the branch Manufacture of dairy products (CZ-NACE 10.5) in 2007-2009 (%, p. b.).

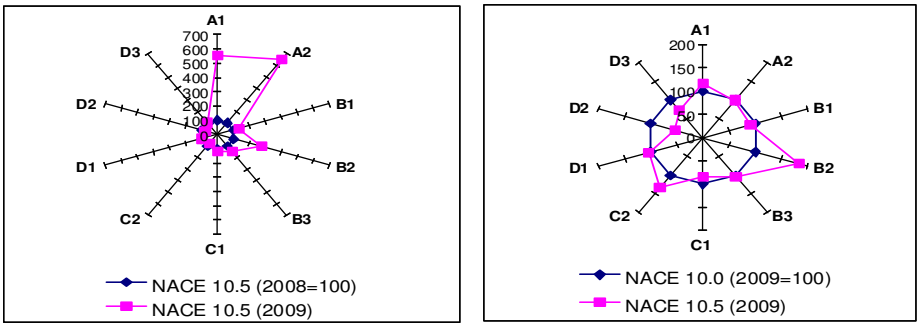

Figure 4: Year-on-year development of financial economic indicators in the branch Manufacture of dairy products (CZ-NACE 10.5) in the framework of CZ-NACE 10 in 2008-2009.

Manufacture of bakery, confectionery and other farinaceous products (CZ-NACE 10.7)

Bakery industry is an important sector of the food industry. Bakeries closely cooperate with milling and pasta industries, trade companies and specialized companies manufacturing currently essential bakery and confectionery mixtures (Tvrdoň 2010). Such cooperation takes place within one business in some cases. The economics of the evaluated manufacture is influenced to a large extent by flour prices that have shown a high volatility in recent years. With regard to the data set that is used in this analysis the economics of only a part of the enterprises engaged in this manufacture is interpreted. In addition, this manufacture also takes place in smaller firms with different economic results.

Table 4 documents that profitability ratios showed an upward year-on-year trend in 2008, similarly like liquidity ratios, which was a positive trend. Compared to the Manufacture of Food Products in total and Manufacture of Beverages in total, in 2009 ROE of the evaluated branch reached quite comparable values in the framework of the branch structure (NACE 10.7 12.49% and NACE 10 + NACE 11 14.17%).

While in 2000 and 2005 the ROE ratios for the bakery industry had low values in comparison with the food industry in total (4.5% compared to 15.1% in 2000 and 7.8% compared to 15.2% in 2005) and were influenced not only by realized profit but also by the range of equity financing, the lower indebtedness of the bakery industry could imply a decline of the ROE to some extent (Blažková 2010).

In the ratios of financing structure the share of equity increased year on year while the debt-to-equity ratio decreased. In the asset structure the ratio of accounts receivable to assets decreased moderately, and inventory turnover as well as accounts receivable turnover were also somewhat shorter in 2008. In 2009 profitability and liquidity ratios continued to increase with the exception of quick ratio. In that year in the financing structure the share of equity rose and debt-to-equity ratio decreased markedly. In the asset structure the ratio of accounts receivable to assets decreased, inventory turnover accelerated and accounts receivable turnover shortened. In comparison with the sector (NACE 10) the largest difference in the manufacture in question was determined in quick ratio when its value of this branch was pronouncedly higher in 2008 while it was contrariwise in 2009, which illustrated a negative fluctuation from the aspect of financial stability.

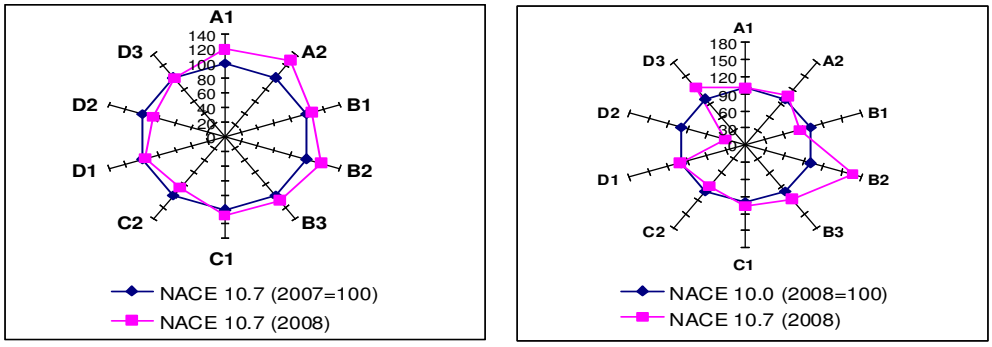

Figure 5: Year-on-year development of financial economic indicators in the branch Manufacture of bakery, confectionery and other farinaceous products (CZ-NACE 10.7) in the framework of the Manufacture of Food Products (CZ-NACE 10) in 2007- 2008.

Financial economic indicator	2007	2008	2009	Year-on-year difference 2008/2007	Year-on-year difference 2009/2008
Profitability ratios					
A1 – Return on equity (ROE)	9.71	11.59	12.49	1.88	0.90
A2 – Return on liabilities	4.17	5.38	7.87	1.21	2.49
Liquidity ratios					
B1 – Total liquidity	1.41	1.49	1.54	0.08	0.04
B2 – Quick ratio	0.16	0.19	0.07	0.03	-0.12
B3 – Current ratio	1.23	1.33	1.42	0.10	0.09
Financing structure					
C1 – Share of equity	42.94	46.43	63.04	3.50	16.61
C2 – Debt-to-equity ratio	132.89	115.36	58.62	-17.53	-56.74
Asset structure					
D1 – Ratio of accounts receivable to assets	30.05	29.08	26.00	-0.97	-3.09
D2 – Inventory turnover (days)	13.35	11.52	6.60	-1.83	-4.92
D3 – Accounts receivable turnover (days)	78.65	77.29	74.98	-1.37	1.31

Source: Czech Statistical Office, own calculations

Table 4: Year-on-year development of financial economic indicators in the branch Manufacture of bakery, confectionery and other farinaceous products (CZ-NACE 10.7) in 2007-2009 (%, p. b.).

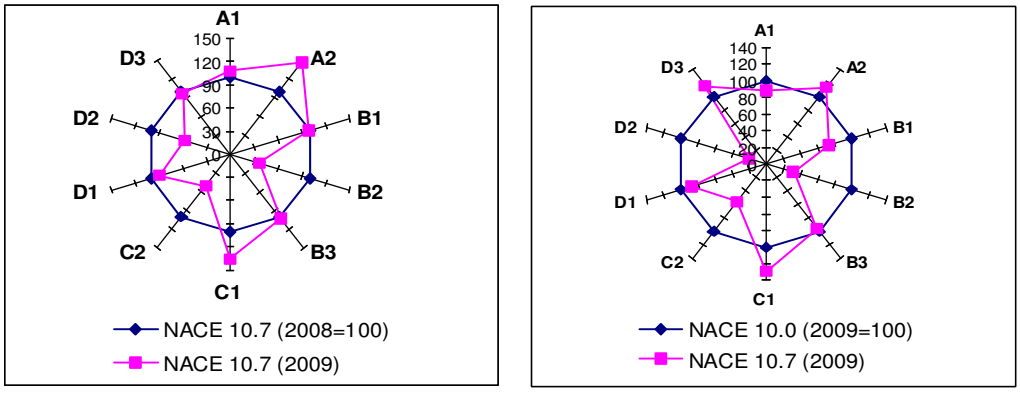

Figure 6: Year-on-year development of financial economic indicators in the branch Manufacture of bakery, confectionery and other farinaceous products (CZ-NACE 10.7) in the framework of the Manufacture of Food Products (CZ-NACE 10) in 2008- 2009.

Manufacture of other food products (CZ-NACE 10.8)

It is quite a large group of manufactures even though the Manufacture of bakery, confectionery and other farinaceous products was exempted from it when the CZ-NACE classification was adopted. First of all it includes manufactures connected with crop production such as manufacture of sugar, cocoa, chocolate and sugar confectioneries and manufacture of other food products not included elsewhere in statistical classification (e.g. soups, perishable prepared foods, sandwiches, food additives, etc.).

Table 5 illustrates that the profitability of this group of manufactures increased in 2008 but it dropped in 2009. Such development is connected with the overall economic situation when the impact of recession in 2009 was negatively reflected mainly in products of this group of manufactures because these are not mostly basic foods, so their manufacture decreased even though the producer prices did not vary very much.

In the evaluated years 2008 and 2009 liquidity ratios showed a moderate increase. In the financing structure the share of equity decreased in the evaluated years but the debt-to-equity ratio increased, which was a negative trend. On the contrary, in the asset structure the ratio of accounts receivable to assets fluctuated in the evaluated years but inventory turnover was shorter when this shortening was more pronounced in 2009, which was a positive feature. Accounts receivable turnover fluctuated in the evaluated period, and it shortened markedly. In spite of a decrease in profitability its level in the evaluated group of manufactures was higher compared to the sector (CZ-NACE 10). Although shortened, inventory turnover was longer in this group compared to the sector, which was partly connected with the fact that this assortment does not mostly include any goods with short turnaround time.

Manufacture of prepared animal feeds (CZ-NACE 10.9)

Even though it is destined for farm and domestic animals, from the aspect of statistical classification the manufacture of animal feeds is included in the processing industry, and in its framework in the manufacture of food products due to its character because it is the processing of agricultural production of plant origin. To characterize this manufacture in general with regard to the evaluated years, 3 177 thousand tons of feed mixtures were produced in the CR in 2007 while it was 2 979 thousand tons in 2008 and only 2 841 thousand tons in 2009, when the highest drop was recorded in feed mixtures for pigs.

Table 6 shows a decrease in profitability in the evaluated manufacture in the years of evaluation. The values of liquidity ratios did not vary very much in 2008 while they somewhat increased in 2009. In the financing structure the values of the share of equity rather varied: they rose particularly in 2009 whereas the debt-to-equity ratio markedly decreased in the year concerned, which was a positive trend. In the asset structure the ratio of accounts receivable to assets increased at a higher rate, inventory turnover shortened in a pronounced way but the accounts receivable turnover was markedly longer in 2009, which was a negative trend documenting the situation when accounts receivable decreased more slowly than sales.

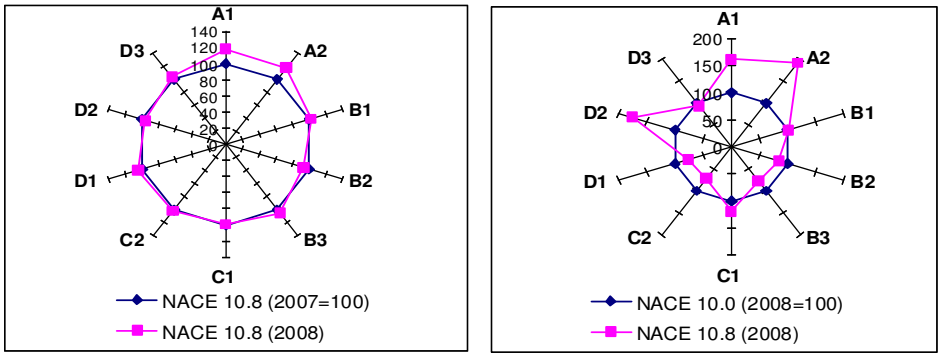

Figure 7: Year-on-year development of financial economic indicators in the branch Manufacture of other food products (CZ-NACE 10.8) in the framework of the Manufacture of Food Products (CZ-NACE 10) in 2007-2008.

Financial economic indicator	2007	2008	2009	Year-on-year difference 2008/2007	Year-on-year difference 2009/2008
Profitability ratios					
A1 – Return on equity (ROE)	15.85	18.73	18.14	2.88	-0.60
A2 – Return on liabilities	8.27	9.68	9.10	1.41	-0.58
Liquidity ratios					
B1 – Total liquidity	1.75	1.56	1.90	-0.19	0.34
B2 – Quick ratio	0.10	0.08	0.20	-0.02	0.12
B3 – Current ratio	0.84	0.78	0.98	-0.06	0.20
Financing structure					
C1 – Share of equity	52.18	51.67	50.16	-0.51	-1.51
C2 – Debt-to-equity ratio	91.66	93.55	99.38	1.89	5.83
Asset structure					
D1 – Ratio of accounts receivable to assets	20.78	21.72	20.86	0.94	-0.86
D2 – Inventory turnover (days)	68.83	66.12	62.07	-2.70	-4.06
D3 – Accounts receivable turnover (days)	56.15	58.04	52.02	1.89	-6.02

Source: Czech Statistical Office, own calculations

Table 5: Year-on-year development of financial economic indicators in the branch Manufacture of other food products (CZ-NACE 10.8) in 2007-2009 (%, p. b.).

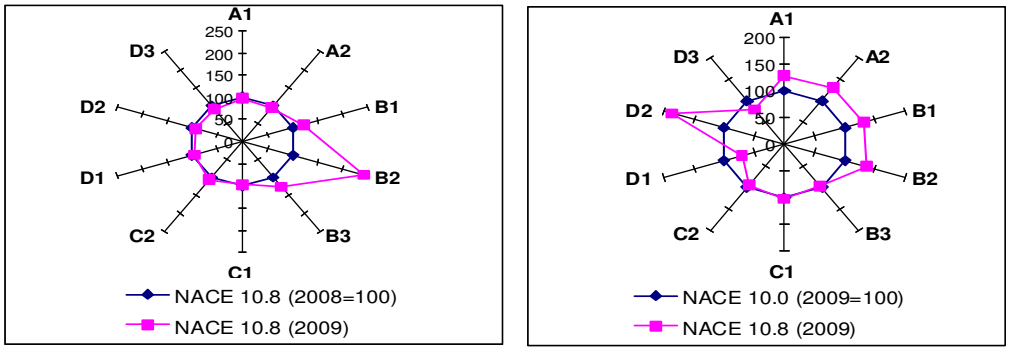

Figure 8: Year-on-year development of financial economic indicators in the branch Manufacture of other food products (CZ-NACE 10.8) in the framework of the Manufacture of Food Products (CZ-NACE 10) in 2008-2009.

Financial economic indicator	2007	2008	2009	Year-on-year difference 2008/2007	Year-on-year difference 2009/2008
Profitability ratios					
A1 – Return on equity (ROE)	5.41	3.51	1.80	-1.90	-1.71
A2 – Return on liabilities	2.58	1.62	0.94	-0.96	-0.68
Liquidity ratios					
B1 – Total liquidity	3.57	3.54	4.01	-0.02	0.47
B2 – Quick ratio	0.20	0.21	0.34	0.01	0.13
B3 – Current ratio	1.88	1.98	2.70	0.10	0.72
Financing structure					
C1 – Share of equity	47.78	46.17	52.19	-1.62	6.03
C2 – Debt-to-equity ratio	109.29	116.61	91.60	7.32	-25.01
Asset structure					
D1 – Ratio of accounts receivable to assets	29.45	30.78	35.96	1.33	5.18
D2 – Inventory turnover (days)	77.29	61.54	47.58	-15.74	-13.97
D3 – Accounts receivable turnover (days)	76.83	69.64	85.24	-7.19	15.60

Source: Czech Statistical Office, own calculations

Table 6: Year-on-year development of financial economic indicators in the branch Manufacture of prepared animal feeds (CZ-NACE 10.9) in 2007-2009 (%, p. b.).

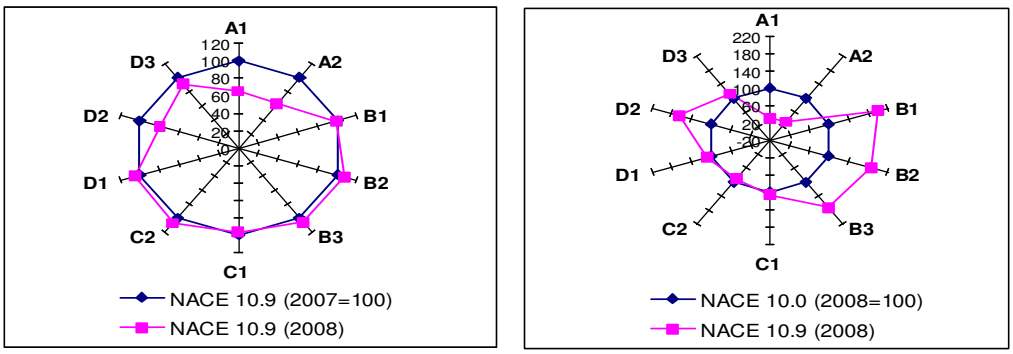

Figure 9: Year-on-year development of financial economic indicators in the branch Manufacture of prepared animal feeds (CZ-NACE 10.9) in the framework of the Manufacture of Food Products (CZ-NACE 10) in 2007-2008.

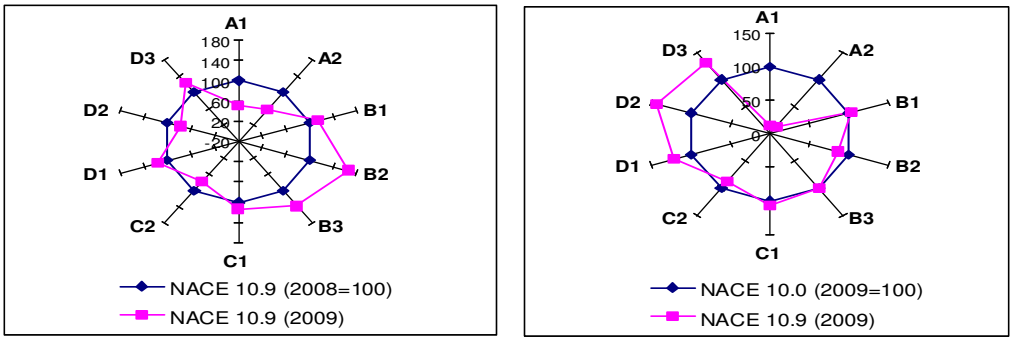

Figure 10: Year-on-year development of financial economic indicators in the branch Manufacture of prepared animal feeds (CZ-NACE 10.9) in the framework of the Manufacture of Food Products (CZ-NACE 10) in 2008-2009.

Manufacture of Food Products (CZ-NACE 10)

After the adoption of the CZ-NACE classification system this branch does not include the manufacture of beverages anymore; it will be analysed as a separate sector. The data shown in Table 7 document an overview of data on the set of enterprises included in financial analysis that was described in the preceding part of this paper. In relation to the selected food branches this manufacture represents a relevant comparative basis.

Table 7 illustrates that profitability of the evaluated manufacture showed an upward trend in the years of evaluation, which was a positive trend. The values of liquidity ratios also rose. In the financing structure the share of equity increased while the debt-to-equity ratio decreased, in a pronounced way in 2009. In the asset structure the ratio of accounts receivable to assets showed a fluctuating development, inventory turnover markedly shortened and accounts receivable turnover fluctuated. In general, taking into account difficult economic conditions such development cannot be evaluated in a negative way, particularly with respect to profitability growth.

Manufacture of Beverages (CZ-NACE 11)

The manufacture of beverages, which includes spirits, wine, beer and malt (beer being dominant in this manufacture), soft drinks and production of mineral waters and other bottled waters, is classified separately in the CZ-NACE system. If this manufacture were classified within the original food sector, it would take up an important position.

Table 8 documents that profitability of this manufacture worsened in 2008 and it did not change very much in 2009. The values of liquidity ratios decreased moderately in 2008 while they increased to some extent in 2009. In the financing structure the share of equity, and similarly the debt-to-equity ratio, fluctuated. In the asset structure the ratio of accounts receivable to assets rose, inventory turnover shortened and in 2008 accounts receivable turnover lengthened markedly, in 2009 it shortened but it did not return to the 2007 level.

Besides the evaluation of development in the studied years it is possible to make a comparison with the Manufacture of Food Products (CZ-NACE 10). The evaluated manufacture shows a higher level of profitability, higher values of liquidity ratios and lower debt-to-equity ratio and the asset structure is also different. Beer output will be a crucial indicator for this group of manufactures that does not show a progressive trend from the aspect of this manufacture, especially due to declining domestic consumption. A chance of maintaining the popularity of Czech beer is to maintain its distinctness. A permanent guarantee of the long-term popularity of Czech beer has been long-term customer satisfaction and that the product meets expectations, is interesting, different from ordinary beers (Tolar 2010). According to Daszynska-_Żygadło,K., Słoński, T., 2010 a data analysis of four beer producers shows also that a general financial policy outline depends on a global financial policy of corporations that own local breweries, with certain adjustments to local market requirements and conditions.

Financial economic indicator	2007	2008	2009	Year-on-year difference 2008/2007	Year-on-year difference 2009/2008
Profitability ratios					
A1 – Return on equity (ROE)	6.91	11.61	14.15	4.70	2.54
A2 – Return on liabilities	2.93	5.05	6.92	2.12	1.87
Liquidity ratios					
B1 – Total liquidity	1.59	1.76	2.21	0.17	0.45
B2 – Quick ratio	0.11	0.11	0.23	0.00	0.12
B3 – Current ratio	1.02	1.14	1.54	0.12	0.40
Financing structure					
C1 – Share of equity	42.42	43.53	48.92	1.11	5.39
C2 – Debt-to-equity ratio	135.73	129.72	104.41	-6.02	-25.31
Asset structure					
D1 – Ratio of accounts receivable to assets	28.57	28.53	29.62	-0.04	1.09
D2 – Inventory turnover (days)	39.60	37.58	33.14	-2.02	-4.44
D3 – Accounts receivable turnover (days)	63.61	62.39	64.97	-1.22	2.58

Source: Czech Statistical Office, own calculations

Table 7: Year-on-year development of financial economic indicators in the branch Manufacture of Food Products (CZ-NACE 10) in 2007-2009 (%, p. b.).

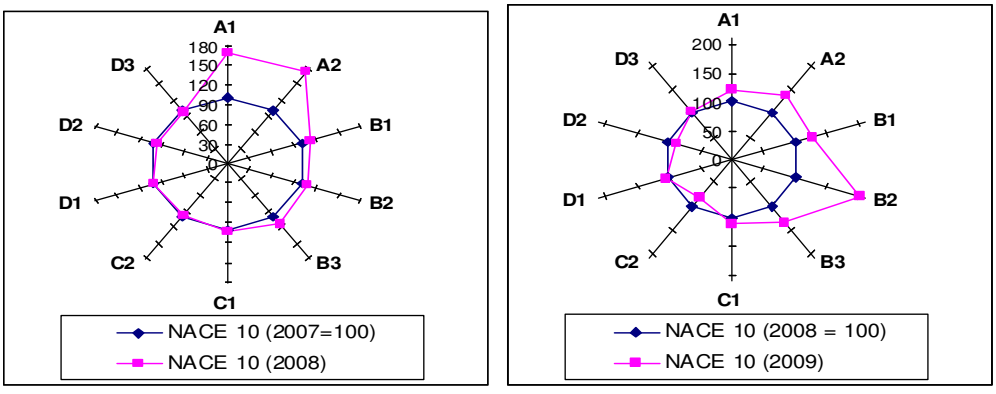

Figure 11: Year-on-year development of financial economic indicators of the Manufacture of Food Products (CZ-NACE 10) in 2007-2008 and 2008-2009.

Financial economic indicator	2007	2008	2009	Year-on-year difference 2008/2007	Year-on-year difference 2009/2008
Profitability ratios					
A1 – Return on equity (ROE)	16.37	14.00	14.18	-2.37	0.18
A2 – Return on liabilities	11.36	9.88	9.80	-1.47	-0.08
Liquidity ratios					
B1 – Total liquidity	2.07	1.98	2.65	-0.09	0.68
B2 – Quick ratio	0.43	0.39	0.87	-0.04	0.48
B3 – Current ratio	1.41	1.40	2.03	-0.01	0.64
Financing structure					
C1 – Share of equity	69.37	70.61	69.11	1.24	-1.50
C2 – Debt-to-equity ratio	44.15	41.61	44.70	-2.54	3.08
Asset structure					
D1 – Ratio of accounts receivable to assets	14.91	16.07	16.14	1.16	0.07
D2 – Inventory turnover (days)	39.70	38.95	35.17	-0.75	-3.78
D3 – Accounts receivable turnover (days)	58.74	68.19	66.28	9.45	-1.91

Source: Czech Statistical Office, own calculations

Table 8: Year-on-year development of financial economic indicators in the branch Manufacture of Beverages (CZ-NACE 11) in 2007-2009 (%, p. b.).

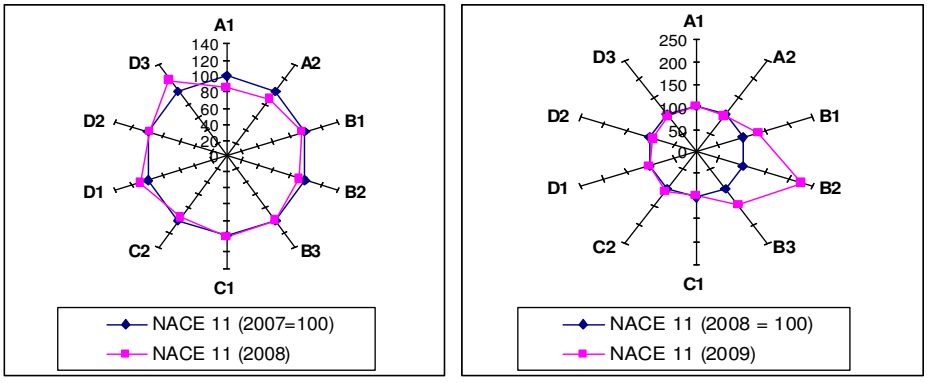

Figure 12 – Year-on-year development of financial economic indicators of the Manufacture of Beverages (CZ-NACE 11) in 2007-2008 and 2008-2009.

Conclusions

The synthesis of results for in view of enterprise collection of financial analysis shows that taking into account inter-branch heterogeneity the total profitability of both manufactures (CZ-NACE 10 and CZ-NACE 11) improved in spite of worsened economic conditions, which was a positive trend. It implies certain adaptability of a significant part of enterprises included in this financial economic analysis and their mutual inter-branch comparison.

Particularly the processing and preserving of meat and production of meat products showed less satisfactory development, mainly of profitability and debt-to-equity ratios; it was mostly caused by the insufficient utilization of processing capacities. A reduction in pig numbers leads to an every-year decrease in the volume of production of feed mixtures, which results in a drop of profitability in the manufacture of prepared animal feeds.

As for the manufacture of dairy products and beverages, the development of debt-to-equity ratio, which showed relatively high values, was less satisfactory in the given period.

In the manufacture of bakery, confectionery and other farinaceous products a negative year-on-year drop of quick ratio was reported in 2009 compared to the sector. But a great year-on-year decrease in debt-to-equity ratio was a very positive trend (56.7 p.p.).

The development of profitability ratios in the manufacture of other food products fluctuated in the given period, an increase in 2008 was followed by a decrease in 2009. In the manufacture of food products as whole positive features were the growth of profitability and liquidity in the studied period, an increase in the share of equity, drop of debt-to-equity ratio and shorter inventory turnover. The manufacture of beverages showed a higher level of profitability, higher values of liquidity and lower debt-to-equity ratio in comparison with the manufacture of food products.

Positive economic development of the food sector based on fair relations among food chain suppliers, emphasis on the regional food trend, consumers' higher awareness of the quality of domestic products, appropriate innovation of products and a possibility of obtaining protected designations such as protected designation of origin (PDO), protected geographical indication (PGI) and traditional speciality guaranteed (TSG) may contribute to higher competitiveness of this chain. In the future the programme of regional foods should be introduced also in the area of gastronomy and in the promotion of tourism while regional foods should be presented on a larger scale e.g. in Austria and Germany, where regional foods are very popular and have a long tradition (Sládek 2010). Plášil, Mezera et al. reported that the most frequent answer to a question in a questionnaire survey of enterprises of the food industry "What do you consider as the main barriers to the competitiveness of your branch of manufacture?" was problems with output (53 % of respondents), macroeconomic environment (37 %) and 10 % of respondents indicated inputs as problematic.

Economic research plays a very important role in this area. It is particularly the monitoring of development by appropriate economic indicators and forecasting of future development and creation of relevant strategies for crucial branches of manufacture in relation to agricultural production and demand on domestic and foreign markets and efforts to reach the highest performance and effectiveness possible.

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A Stochastic Production Investigation of Fish Farms in Ghana

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Abstract

This paper considers the stochastic production frontier approach to analyse the technical efficiency and its determinants of fish farms in Ghana using a cross-section data of 150 farms. It considers the explicit effects of family and hired labour on production by setting the log-value of the zero-observation of these two sources of labour to zero with dummy variables. Results demonstrate that expected elasticities of mean output with respect to all input variables are positive and significant. Findings also show that family and hired labour used for fish farming in Ghana may be equally productive. Fish farms in Ghana are revealed to be characterised by technology with increasing return to scale. The combined effects of operational and farm specific factors are found to influence efficiency. The study further reveals that inclusion of interaction between some exogenous variables in the inefficiency model is significant in explaining the variation in efficiency. Results also suggest that small pond operators are more efficient than farms with large ponds. Mean technical efficiency is estimated to be 78 percent.

Key words

Technical efficiency, stochastic frontier, elasticity, return to scale.

Introduction

The contribution of the fisheries sector to the economic development of Ghana is enormous. The sector provides income, employment and serves as a major supply of protein intake in the country. Consumption of fish ranges from 20 to 30 kg per capita with an average per capita consumption of 27.2 kg per annum, making Ghana one of the highest fish-consuming countries in Africa. The two main sources of fish in the country (traditional marine and inland fisheries) contribute about 435,000MT per annum which is about 400,000MT less of what the country demands (Attah-Mills et al., 2004). It is estimated that Ghana spends about $125 million dollars a year to import fish products to supplement domestic production. This is not only inadequate but also a drain on the nation's scarce foreign exchange.

Due to these problems, the government considers fish farming as a major means of efficiently increasing fish production to bridge the gap between domestic demand and supply and to produce surpluses for export. In view of this point, banks were directed to enhance finance for pond construction at subsidised interest rate in the 1980s. This motivated both male and female individual farmers, farm families and union or cooperative groups to consider fish farming either as a full-time occupation or as a part-time business. This attracted a number of farmers into the industry which resulted in the increase use of agricultural lands for fish farms. Moreover, since the inception of the industry, the fish farming activity has not seen any major technological improvement to boost production due to inadequate resources (MacPherson et al., 1990). Based on these challenges, efficiency study is paramount to raise productivity by improving output without increasing the resource base or developing new technologies.

A variety of frontier techniques have been considered for technical efficiency studies across the globe in many countries. Whilst the two-stage approach (Pitt and Lee, 1981) outperforms the earlier approaches of Aigner et al. (1977), Kumbhakar et al. (1991); Huang and Liu (1994); and Battese and Coelli (1995) criticise this technique on the ground that the specification of the

second-stage model violates the assumption of the identically distributed technical inefficiency effects in the stochastic frontier and propose a single-stage modelling method in which parameters in the frontier and inefficiency models are estimated simultaneously. Application of this methodology in the fisheries and fish farming sector is outlined by Kirkley et al. (1995); Iinuma et al. (1999); Dey et al. (2000); and Chiang et al. (2004).

However, most of these studies fail to account for interactive effects of the exogenous variables on efficiency. Moreover, in order to avoid the problem of zero observation in the estimation of frontier production function, majority of the technical efficiency studies implicitly assume equal productivity and aggregate family and hired labour to assess their effect on production. Although some studies separately consider family and hired labour variables in the frontier model (Heshmati and Mulugeta, 1996), their study is confined to farmers who use positive values of these two sources of labour and discard cases with zero observations. Discarding parts of the observations appears to be unappealing since the available data do not seems to be fully utilised. Thus, some authors treat the zero-observation case by using values of one or an arbitrarily small number greater than zero for the key input concern. This procedure may result in serious bias estimators of the production function as notes by Battese (1997).

Against this background, the present study applies the single-stage modelling stochastic frontier approach to examine technical efficiency and its determinants of fish farms in Ghana and extends the scope of the analysis to explore the issues of interactive effects of some exogenous variables on efficiency of production using a modified model of Huang and Liu (1994) and Battese and Coelli (1995). In addition, the study adopts a model by Battese and Broca (1997) to examine output elasticity with respect to the various inputs used to assess how changes in such input resources could boost productivity. Further, guided by Battese et al. (1996) and Battese (1997), the study examines explicitly the effect of family and hired labour on production by setting the log-value of the zero-observation of these two sources of labour to be zero with dummy variables. This procedure ensures that efficient estimators are obtained using the full data set without introducing any bias. The rest of the paper is divided into three sections. Section 2 discusses the materials and methods. Results and discussion are presented in section 3, whilst conclusion and policy recommendation are outlined in section 4.

Material and methods

The stochastic frontier technique

The two main methodologies for the estimation of technical efficiency include: the Data Envelopment Analysis (DEA) which involves mathematical programming and the Stochastic Frontier Analysis (SFA) which uses econometric methods. This study adopts the stochastic frontier approach as it is preferred because of the inherent stochasticity involved (Aigner et al., 1977; and Meeusen and Van den Broeck, 1977). The SFA specifies output variability by a non-negative random error term (u) to generate a measure of technical inefficiency as considered also by advocates of the deterministic approach (Afriat, 1972) and a symmetric random error (v) to account for effects of exogenous shocks beyond the control of the analysed units which embodies variation in weather conditions, diseases, poaching etc, measurement errors and any other statistical noise

Assuming a transcendental logarithmic production function, this study specifies the stochastic frontier model as:

$$\mathbf{ln}Y_i = \beta_0 + \psi_1 DFL_i + \psi_2 DHL_i + \sum_{j=1}^{6}\beta_j \mathbf{ln}X_{ji} + 0.5\sum_{j=1}^{6}\sum_{k=1}^{6}\beta_{jk}\mathbf{ln}X_{ji}\mathbf{ln}X_{ki} + (\boldsymbol{v_i} - \boldsymbol{u_i}) \quad (1)$$

where i and *ln* are the *ith* farmer and logarithm to base e, respectively.

(Y) Output, is expressed as quantity of fish harvested in kilograms;

(DFL) is a dummy variable equal to one if the number of family labour used is positive, zero otherwise;

(DHL) is a dummy variable equal to one if the number of hired labour used is positive, zero otherwise (X_1) *FLabour* denotes the number of

family labour used (measured in man-days[19]). *Ln* (X_{1i}) in model (1) is expressed as *Ln* [max($FLabour_i$,1-DFL_i)]

(X_2) *HLabour* represents the number of hired labour used (measured in man-days)

Ln (X_{2i}) in model (1) is expressed as *Ln* [max ($HLabour_i$, 1-DHL_i]

(X_3) Feed, represents cost of feed in Ghana Cedi (GHC);

(X_4) Seed, indicates quantity of fingerlings (fry), measured in kilograms;

(X_5) Land, is the total area of pond(s) operated, measured in hectares;

(X_6) Other cost, denotes cost of intermediate inputs in GHC. It includes: cost of chemicals, fertilizer, fuel, electricity, farm rent, maintenance cost, depreciation cost.

(v) Represents a stochastic error term (e.g. measurement errors, extreme weather, industrial action, poaching and other noise errors such as misspecification problems);

(u) Denotes a non-negative random variable associated with farm-specific factors which contribute to farms not achieving maximum efficiency.

The expressions:

Ln [max($FLabour_i$,1-DFL_i)] and

Ln [max ($HLabour_i$, 1-DHL_i]

account for zero usage of family and hired labour respectively by some farmers, whilst *DFL* and *DHL* account for intercept change. The estimator for the responsiveness of fish farm output to use of hired and family labour could be bias without inclusion of *DFL* and *DHL* (Battese, 1997). This study assumes that the elasticities of output associated with other variables are the same for farmers who did not use either hired or family labour and those who did.

[19] Man-days are computed according to the rule that one adult male, one adult female and one child (< 18 years) working for one day (8 hours) equal 1 man day; 0.75 man days; and 0.50 man days respectively. Battese et al. (1996) and Coelli and Battese (1996) also employ the use of these ratios.

The stochastic error term (v) is commonly assumed to be independently, identically and normally distributed with zero mean and constant variance, $\sigma_v^2, [v_i \sim N(0, \sigma_v^2)]$. Different distributions namely: half-normal, truncated, exponential and gamma distributions have been assumed with varied specifications for the inefficiency error term (u) in the literature. However, this study considers a model by Battese and Coelli (1995) which assumes that u1 is distributed as a truncation of the normal distribution with mean μi and a constant variance20,
$[u_i \sim N(\sigma_u^2)]$ such that the mean is defined as:

$$\mu_i = Z_i \delta \qquad (2)$$

where Z_i is a *(Px1)* vector of explanatory variables associated with the technical inefficiency effects which could include socioeconomic and farm management characteristics. δ is a *(1xP)* vector of unknown parameters to be estimated. Huang and Liu (1994) also purport the non-neutral stochastic frontier model defined as:

$$\mu_i = Z_i \delta + Z_i^* \delta^* \qquad (3)$$

where Z_i^* is a vector of values of interactions between farm specific factors and input variables and δ^* is a vector of unknown parameters. Their model implies that a shift in the frontier for different farms depend on the level of the input variables, whilst elasticities of the mean output for different farms are functions of the particular farm specific variables involved in the vector of explanatory variables. When the coefficients in the vector δ^* are zero, this model reduces to model (2) of Battese and Coelli (1995). However, this study adopts a modification of the models by Huang and Liu (1994) and Battese and Coelli (1995) and specifies μ_i as:

$$\mu_i = \varphi_0 + \sum_{m=1}^{7} \delta_m Z_{mi} + \sum_{n=1}^{3} \omega_n I_{ni} + \pi L_i \qquad (4)$$

where,

[20] Caudill and Ford (1993) parameterise the variance of the pre-truncated distribution of the inefficiency term u_i as a function of exogenous variables in an attempt to address the problem of heteroskedasticity. However, earlier check by the study for heteroskedasticity in the residual using Breusch-Pagan test is revealed to be negative.

(Z_1) Gender dummy; has the value of 1, if farm decision maker is a male or 0, for a female;

(Z_2) Cultural system dummy; has the value of 1, if monoculture is practiced or 0, if poly-culture is the adopted practice;

(Z_3) Age; represents the age of the primary decision maker;

(Z_4) Education; represents the maximum level of formal schooling[21] for a member of the household;

(Z_5) Pond type dummy; has the value of 1, if the farm uses earthen pond or 0, if concrete pond is used

(Z_6) Eastern region dummy; has the value of 1, if farm is located in Eastern region or 0, if otherwise.

(Z_7) Ashanti region dummy; has the value of 1, if farm is located in Ashanti region or 0, if otherwise. Greater Accra region is considered as the base. Region-specific dummy variables are included to capture regional influence on technical efficiency of production.

(l_1) AgeExp; represents the interaction of age and experience of primary decision maker;

(l_2) AgeEv; represents the interaction of age of primary decision maker and extension visit;

(l_3) EduFAE; represents the interaction of maximum level of formal schooling and formal fish farming education for a member of the household;

(L) Land input; is total pond area and it is used as a proxy to capture size effect.

φ_0, δ, s, ω,s and π are unknown parameters to be estimated. μ is the pre-truncated mean of u and it is parameterized as a function of Z in order to relate Z to the distribution of the inefficiency (u).

[21] Ranking of level of formal schooling in Ghana is outlined as: None $\Rightarrow$ 0; Primary level $\Rightarrow$ 1; Junior Secondary/Middle School level $\Rightarrow$ 2; Senior Secondary level $\Rightarrow$ 3; Technical School level $\Rightarrow$ 4; Polytechnic level $\Rightarrow$ 5; University (bachelor) level $\Rightarrow$ 5; and University (graduate or above) level $\Rightarrow$ 7.

Elasticities

The estimated coefficients in the translog stochastic frontier production function (1) do not have straight forward interpretation. Considering this function, the output elasticities with respect to the inputs are functions of the first-order and the second-order coefficients together with the level of inputs. Further, since the input variable land in this study is a factor involved in both the stochastic frontier model (1) and the inefficiency model (4), the output elasticity with respect to this input variable is a function of the value of the input in both the frontier and the inefficiency models. This study follows Battese and Broca (1997) to derive the elasticities of mean output with respect to the different inputs. The sum total of the output elasticities is the estimated scale elasticity (ε). When, $(\varepsilon) > 1 \Rightarrow$ increasing return to scale (IRS), $(\varepsilon) < 1 \Rightarrow$ decreasing return to scale (DRS), and $(\varepsilon) = 1 \Rightarrow$ constant return to scale (CRS).

The maximum likelihood estimates of the parameters involved in the frontier and inefficiency models are obtained using the Ox version 4.10 (windows) (C) J. A. Doornik, specifically, the SFAMB package (Brümmer, 2003). The technical efficiency of the ith farm, denoted by TE_i is defined as the ratio of the mean of production for the ith farmer, given the value of the inputs, X_i, and its technical inefficiency effect, u_i, to the corresponding mean of production if there were no inefficiency of production (Battese and Coelli, 1988). This is expressed as:

$$TE_i = \frac{E(Y_i|X_i,u_i)}{E(Y_i|X_i,u_i=0)} = \exp(-u_i) \qquad (5)$$

The measure of TE_i has a value between one and zero, where one indicates a fully efficient farm and zero implies a fully inefficient farm. The estimation of the parameters are obtained in terms of the parameterisation: $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = {\sigma_u^2}/{\sigma^2} = \sigma_u^2/(\sigma_v^2 + \sigma_u^2)$, where for $0<\gamma<1$, output variability is characterised by the presence of both technical inefficiency and stochastic errors (Battese and Corra, 1977).

Hypotheses test

A number of hypotheses are tested to examine the adequacy of the specified models, presence of

inefficiency and relevance of variables in explaining inefficiency etc. (Table II). These tests are investigated using the generalised likelihood-ratio statistic (LR) which is given by: $LR = -2[ln\{L(H_0)\} - ln\{L(H_1)\}]$, where $L(H_0)$ and $L(H_1)$ are values of likelihood function under the null (H_0) and alternative (H_1) hypotheses, respectively. LR has approximately a Chi-square (or mixed Chi-square) distribution if the given null hypothesis is true with a degree of freedom equal to the number of parameters assumed to be zero in (H_0). Coelli (1995) proposes that all critical values can be obtained from appropriate Chi-square distribution. However, if the test of hypothesis involves γ=0, then the asymptotic distribution necessitates mixed Chi-square distribution (Kodde and Palm, 1986).

Data and sampling technique

The study is conducted in three regions of Ghana namely: Greater Accra, Ashanti and Eastern regions. Consideration of these regions for the study is based on concentration of fish farms. A total of five sub-districts from each region were randomly selected. Consequently, the selected sub-districts represent the average condition of the respective regions fairly well. Ten fish farms from each sub-district were chosen for detailed data collection. The overall sample for analysis is 150 farms from the three regions. During the data collection, a well structured questionnaire designed to obtain relevant socioeconomic characteristics, farming practices, output, inputs and price data is employed. Summary statistics of data collected through the survey are provided in Table I.

Results and discussion

Hypotheses test

The first hypothesis that the coefficients of the second-order variables in the translog model are zero, meaning that the Cobb-Douglas frontier is an adequate representation for the data is strongly rejected (Table II). This indicates that the specification for the translog stochastic frontier production function is more suitable to derive conclusions in the data. Both the test for the absence of inefficiency effects and that inefficiency effects are not stochastic in the second and third hypotheses, respectively are strongly rejected. Hence, the traditional average (OLS) function is not an adequate representation for the data. The fourth hypothesis that the intercept and the coefficients associated with farm-specific variables in the technical inefficiency model are zero (that the technical inefficiency effects have a traditional half-normal distribution with mean zero) is strongly rejected. The fifth hypothesis that all coefficients, except the constant term of the inefficiency model are zero (hence the technical inefficiency effects have the same truncated-normal distribution with mean equal to δ_0) is also rejected. This reveals that the combined effects of factors involved in the technical inefficiency model are important in explaining the variation in production of fish farms in Ghana, although individual effects of some variables may not be significant. Given the specification of model (4), the sixth hypothesis that model (2) is an adequate representation of the data i.e. $\omega_1 = \omega_2 = \omega_3 = \pi = 0$, is rejected. This implies that inclusion of the interactions between age and experience of the primary decision maker; age and extension visit to farms; formal schooling and formal fish farming education for a member of the household; and total pond area in the inefficiency model are significant in explaining variation in efficiency.

Frontier model estimates

This study discusses the parameter estimates of the stochastic production frontier model (1) in terms of output elasticities evaluated at the mean values with respect to the various inputs (Table III). The expected elasticities of mean output with respect to all the input variables are positive and significant. Land is found to have the highest elasticity of 0.42, indicating that a 1% increase of pond size will increase production by 0.42%. This means that family labour, hired labour, land, feed, seed and other cost have reasserting influence on fish farming in Ghana. The computed return to scale is revealed to be 1.12 (0.082) and it is statistically different from 1. The return to scale, defined as the percentage change in output from 1% change of all input factors is more than one implying that fish farms in Ghana are characterised by technology with increasing return to scale. This means that if the industry increases all factor inputs by 1%, fish farm output in the study area would increase by 1.12%. Output elasticities with respect to family and hired labour are both significant but not statistically different from each other ($\alpha = 0.05$).

Variable	Minimum	Mean	Maximum	Standard deviation
Output	138	7929	73446	10666
DFL	0	0.91	1	0.29
DHL	0	0.52	1	0.50
Family labour	0	281.60	960	166.54
Hired labour	0	187.20	1620	249.66
Feed	159.42	3493.10	39554	5267.60
Seed	29	471.51	4356	691.02
Land	0.04	0.75	7	1.10
Other cost	141.98	2277.90	36233	4194
Gender	0	0.91	1	0.29
Cultural system	0	0.08	1	0.27
Age	28	49.84	71	9.32
Pond type	0	0.93	1	0.25
Education	0	4.24	7	1.29
Eastern region	0	0.33	1	0.47
Ashanti region	0	0.33	1	0.47
AgeExp[a]	58	382.92	1475	260.62
AgeEv[b]	0	9.53	60	18.71
EduFAE[c]	0	0.46	7	1.43
Land	0.04	0.75	7	1.10

a ≡ interaction between age and experience of primary decision maker, b ≡ interaction between formal schooling and formal aquaculture education, c ≡ interaction between age of primary decision maker and extension visit.

Table 1: Summary of variables in the frontier and inefficiency models.

Null hypothesis	Test statistics (λ)	Critical value $\left(\lambda^2_{0.001}\right)$	Decision
1. $H_0 : \beta_{ij} = 0$	178.60	46.80	Reject H_0
2. $H_0 : \gamma = \varphi_0 = \delta_i = \omega_i = \pi = 0$	102.68a	33.82	Reject H_0
3. $H_0 : \gamma = 0$	17.06a	9.50	Reject H_0
4. $H_0 : \varphi_0 = \delta_i = \omega_i = \pi = 0$	85.54	32.91	Reject H_0
5. $H_0 : \delta_i = \omega_i = \pi = 0$	68.32	31.26	Reject H_0
6. $H_0 : \omega_1 = \omega_2 = \omega_3 = \pi = 0$	30.42	18.47	Reject H_0
Other hypotheses test			

7.	$H_0 : \psi_1 = \psi_2 = 0$	21.96	13.82	Reject H_0
8.	$H_0 : \pi = 0$	32.85	10.83	Reject H_0
9.	$H_0 : \delta_6 = \delta_7 = 0$	0.28	5.99b	Accept H_0

a ≡ test of one sided error from the Ox output. b ≡ critical value at 0.05 level The correct critical values for the hypotheses involving γ are obtained from Kodde & Palm (1986).

Table 2: Hypothesis test for model specification and statistical assumption.

Elasticities with respect to					
Family labour	Hired labour	Feed	Seed	Landa	Other cost
0.07*	0.09	0.13*	0.17	0.42	0.24
(0.03)	(0.02)	(0.05)	(0.04)	(0.15)	(0.06)

* ≡ statistically significant at level of 0.05, all other estimates are significant at level of 0.01. Values in brackets are standard errors. a ≡ since the coefficient of land in the inefficiency model is positive, there is a negative contribution of the elasticity of technical efficiency in obtaining the elasticity of mean output for land.

Table 3: Elasticities of mean output.

This revelation may indicate that the two types of labour are equally productive. The intercept coefficient for family labour (*DFL*) and hired labour (*DHL*) are both estimated to be significantly negative. This implies that there could be bias estimators of the parameters in the frontier production function without inclusion of these dummies as confirmed by the rejection of the seventh null hypothesis (H_0:$\psi_1 = \psi_2 = 0$).

Inefficiency model estimates

The estimates of the inefficiency model are presented Table IV. The estimated gender dummy coefficient is significantly negative, indicating that farm decision makers who are males operate more efficiently than their female counterparts. Fish farming involves fairly continuous labour input for gruelling work and coupled with division of labour that assigns domestic role to women in Ghana as notes by Assibey-Mensah (1998), which allows little time to be spent on fish farms impedes efficiency of production. The coefficient of the cultural system dummy is revealed to be negative implying that fish farms involved in monoculture tend to be more technically efficient than farms growing several types of fish. However, the relationship is weak.

The coefficient of age is estimated to be positive and significant, indicating that older farmers are technically less efficient than the younger ones who are progressive and willing to implement new production systems. Further analysis reveals that estimated coefficient for older farmers who have greater number of years of experience in fish farming (AgeExp) demonstrate a significant positive effect on technical efficiency of production. Although many years of experience may infer adhering to old methods of production which may be technically less efficient, it is demonstrated by the current studies that the source of technical knowledge gained by the older farmers over the period in the business may be due to years of contacts with advisory services through extension personnel. This revelation is confirmed by the coefficient of the interaction between age and extension visit (AgeEv) which is estimated to be significantly negative. Many studies have shown that contact with advisory service is a positive factor in increasing agricultural productivity.

Battese et al. (1996) report a positive relationship between maximum years of formal schooling for a member of household and technical efficiency. In this study, the coefficient of education is estimated to be positive and significant, indicating that households with high level of formal schooling are less technically efficient. Fish farming requires proper technical know-how for higher productivity (Roy et al., 2002). Thus, when interaction of household with formal schooling and formal aquaculture education (EduFAE) is modelled to assess their effect on efficiency, the study demonstrates a positive impact. This means that formal education which enlightens farmers about the technical aspect of fish farming is more important in Ghana to enhance efficiency in the industry.

The coefficient of pond type dummy is also estimated to be significantly negative, implying that farmers who adopt the use of earthen pond for their operations tend to be less inefficient than concrete

Variables	Parameters	Coefficients	Standard error
Constant	φ_0	-0.542	0.626
Gender	δ_1	-0.321***	0.104
Cultural system	δ_2	-0.063	0.213
Age	δ_3	0.031**	0.013
Education	δ_4	0.097***	0.030
Pond type	δ_5	-0.124***	0.048
Eastern region	δ_6	0.014	0.044
Ashanti region	δ_7	0.018	0.038
AgeExpa	ω_1	-0.014**	0.005
AgeEvb	ω_2	-0.013**	0.006
EduFAEc	ω_3	-0.065**	0.033
Land	π	0.132**	0.053

*, **, *** ≡ statistically significant at levels of 0.10, 0.05, and 0.01, respectively. a ≡ interaction between age and experience of primary decision maker, b ≡ interaction between age of primary decision maker and extension visit, c ≡ interaction between formal schooling and formal aquaculture education.

Table 4: Inefficiency model estimates.

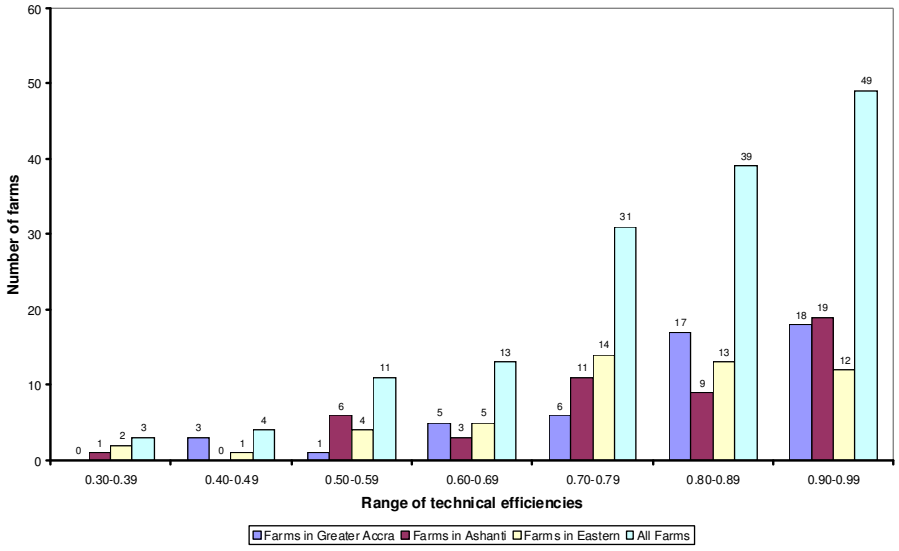

Figure 1: Frequency distribution of technical efficiencies.

pond users. In addition to supplementary feed, fish farmers in Ghana rely on production of fish food through natural process by fertilization. Earthen ponds may provide a good better for growth of live food. Pilley (1990) notes that most live food are rich in essential nutrients needed by fish for growth.

A varied relationship between farm size and technical efficiency in the developing countries using the frontier production function has been established (Lundvall & Battese, 2000). The coefficient of land in this study is estimated to be significantly positive, implying that larger farms suffer from an oversize problem, resulting in larger measures of technical inefficiency (at the mean) than comparably smaller farms. This finding is consistent with Chiang et al. (2004) who observe in Taiwan that smaller farms that produce 20-50 MT per hectare of milkfish operate close to the efficient frontier compared to big producers (> 50 MT per hectare). However, a contrary observation is revealed by Iinuma et al. (1999) in carp pond culture in Peninsula Malaysia, and Dey et al. (2000) in grow-out pond operations in the Philippines.

The coefficients of Eastern region and Ashanti region dummies are both positive but insignificant. This implies that location of farm according to regions may not influence technical efficiency of production in the study area. This is confirmed by the acceptance of the null hypothesis that there is $H_0: \delta_6 = \delta_1 = 0$ no regional effect. This finding may reveal that differences in the quality of inputs used, level of advisory services and support from government aquaculture offices etc. within the respective regions do not influence technical efficiency of production.

Technical efficiency

Figure 1 reports the distribution of the technical efficiencies of farms in the study area. The overall level of efficiency ranges from 34.3% to 98.4%. The frontier is built up by 49 farms (32.7%) found to be operating at efficiency levels of 90% or above. Only 7 farms (4.7%) belong to the least efficient category (30-49%). Majority of the farms (62.7%) operate with technical efficiency index between 0.50 and 0.89. When the study classifies location of farms by regions, no substantial variation in terms of mean technical efficiency is observed as confirmed by the acceptance of the null hypothesis $\delta_6 = \delta_1 = 0$ that there is no regional effect on technical efficiency of production. The predicted overall mean technical efficiency is estimated to be 0.78. This indicates that on the average, fish farms produce 78% of the potential (stochastic) frontier output, given the present state of technology and input level. However, 22% of technical potential output is not realised. Therefore, the possibility of increasing fish farm production in Ghana by an average of 22% can be achieved in the short run by adopting the practices of the best fish farm.

Conclusion and recommendation

This study adopts the single-stage modelling stochastic frontier approach to examine technical efficiency and its determinants of fish farms in Ghana. The study specifically examines the explicit effect of hired and family labour on production by setting the log-value of the zero-observation of these two sources of labour to be zero with dummies. It extends the conventional technical efficiency estimation technique to explore the issues of interactive effects of some farm specific variables on efficiency of production. The study finds that output elasticities with respect to all the inputs (family labour, hired labour, land, feed, seed and other cost) are significant and have the expected positive signs. Results also reveal that although elasticity of output with respect to hired labour is slightly higher than the value obtained for family labour, the two sources of labour used for fish farming in Ghana may be equally productive. The estimate of return to scale is more than one implying that fish farms in Ghana are characterised by technology with increasing return to scale. The combined effects of operational and farm specific factors are found to influence efficiency. Further, the study reveals that inclusion of interaction between some exogenous factors, and input variables in the inefficiency model are significant in explaining the variation in efficiency. Specifically, it is demonstrated that fish farms in the study area suffer from oversize problems whilst extension advice plays a major role in efficiency of production. Mean technical efficiency is estimated to be 78%, indicating that the realised output could be increased by about 22% without any additional resources.

Based on these findings, the study provides evidence to improve fish farm production through increase in technical efficiency. Allocation of resources to improve the level of formal fish education and extension services will play an important role in this respect. Formation of fish farm association should be encouraged to enhance coordination between young and old farmers. It will also be important to advice large farms on how to take advantage of economics of scale to improve efficiency. This study is pertinent since the Ghanaian economy appears to offer several challenges to increasing output directly, thus gains from improving efficient behaviour appear to be a viable option to increase output from the fish farms.

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GIS as spatial decision support system

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Abstract

This paper describes the possibility of the Geographic Information Systems (GIS) as a means to support decision making in solving spatial problems. Spatial problems accompany every human activity, of which agriculture is no exception. The solutions to these problems requires the application of available knowledge in the relevant decision-making processes. GISs integrate hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. Coupled with GISs, geography helps to better understand and apply geographic knowledge to a host of global problems (unemployment, environmental pollution, the loss of arable land, epidemics etc.). The result may be a geographical approach represents a new way of thinking and solutions to existing spatial problems. This approach allows to apply existing knowledge to model and analyze these problems and thus help to solve them.

Key words

Knowledge, semi-structural spatial decision problem, spatial decision support system, Geographic Information System.

Abstrakt

Tento článek popisuje možnosti geografických informačních systémů (GIS) jakožto prostředků pro podporu rozhodování při řešení semi-strukturálních prostorových problémů. Tyto problémy doprovázejí každou lidskou činnost, zemědělství z toho nevyjímaje. Řešení těchto problémů pak vyžaduje použití dostupných znalostí v příslušném rozhodovacím procesu. GISy integrují hardware, software, data a pro pořizování, správu, analýzu a zobrazení všech forem geograficky pojatých informací. Tyto prostředky pak pomáhají lépe pochopit a aplikovat geografické znalosti na celou řadu globálních problémů (nezaměstnanost, znečištění životního prostředí, úbytek orné půdy, epidemie apod.). Výsledkem pak může být geografický přístup představující nový způsob myšlení a řešení stávajících prostorových problémů. Tento přístup umožňuje používat existující znalosti při modelování a analýze těchto problémů, čímž napomáhá k jejich řešení.

Klíčová slova

Znalost, semistrukturální prostorový rozhodovací problém, systém pro podporu rozhodování, geografický informační systém.

Introduction

A number of current global issues (unemployment, environmental pollution, the loss of arable land, epidemics etc.) currently has geographical specificity. Similarly, this will have any problems accompanying agricultural practices. Most of these problems are ill-structured in the sense that the goals and objectives are not completely defined. Such problems require a flexible approach. Issues associated with them must be adequately addressed. A human subject trying to solve them must be provided with a set of relevant knowledge and apply it in the decision making process. Such knowledge must be codified in such a way that could be used effectively in the decision-making processes. One of the possibilities of support in

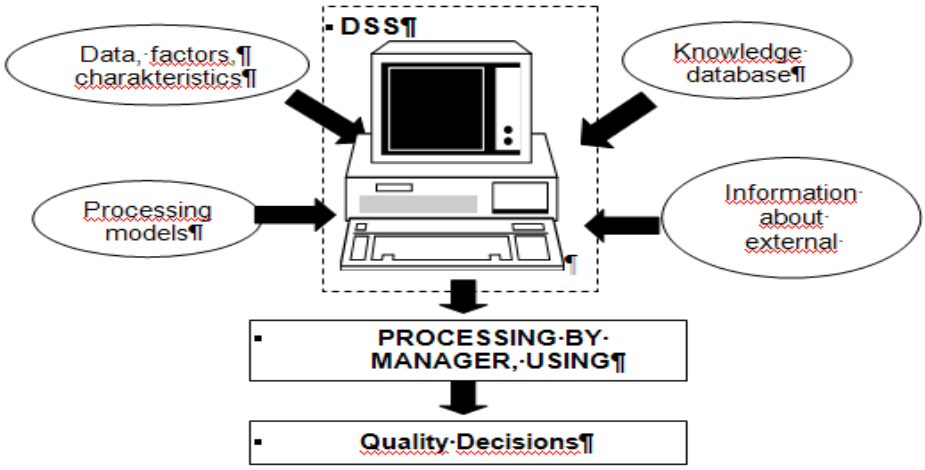
dealing with such problems may represent the tools for supporting decision-making, the so called Decision Support Systems (DSS).

Material and methods

The DSSs are computer-based information systems that support business or organizational decision-making activities. DSSs serve the management, operations, and planning levels of an organization and help to make decisions, which may be rapidly changing and not easily specified in advance (Maxwell, 2008). DSS components may be classified as:

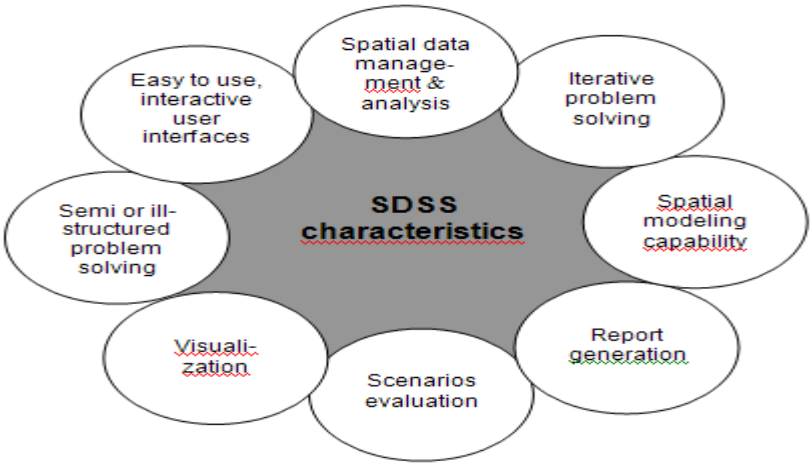
- Inputs: Factors, numbers, characteristics to analyze including user knowledge and expertise.
- Outputs: Transformed data from which DSS "decisions" are generated.
- Decisions: Results generated by the DSS based on user criteria (Amstrong, Densham, 1990).

Another taxonomy for DSSs has been created by Daniel Power. Using the mode of assistance as the criterion, Power differentiates communication-driven DSSs, data-driven DSSs, document-driven DSSs, knowledge-driven DSSs and model-driven DSSs (Power, 2002, 2003). Amstrong and Densham (1990) define the following structure of the DSS:



Source: (Amstrong, Densham, 1990)

Figure 1: General structure of the decision support system.



Source: (Sugumaran, Degroote, 2010.

Figure 2: SDSS characteristics.

Special categories of DSSs are called Spatial Decision Support Systems (SDSS). SDSSs are an interactive, computer-based systems designed to support a user or group of users in achieving a highest effectiveness of decision making while solving a semi-structured spatial decision problems (Sugumaran, Degroote, 2010).

The main characteristics of spatial decision problems include:

- a large number of decision alternatives,
- the consequences of the decision alternatives are spatially variable,
- each alternative is evaluated on the basis of multiple criteria,
- some of the criteria may be qualitative while others may be quantitative,
- there are typically more than one decision maker (or interest group) involved in the decision-making process,
- the decision makers have different preferences with respect to the relative importance of the evaluation criteria and decision consequences,
- the decisions are often surrounded by uncertainity (Malczewski, 1999).

Typical SDSS provides a framework for integrating:

1. analytical modelling capabilities,
2. Database management systems,
3. graphical display capabilities,
4. tabular reporting capabilities,
5. the decision-maker's expert knowledge (Binda, Sharma, 2008, p.198).

Many spatial problems are complex and require detailed analysis. The such problems are very frequently semi-structured or ill-defined because all of their aspects cannot be measured or modelled. Decision support in solving spatial decision problems can be the great opportunity for the geoinformation technology. This information technology in data processing and spatial analysis, together with modern decision analysis techniques promote new styles of knowledge communication and utilization. This technology is closely linked with GIS technology. The corresponding Geographic Information Systems (GIS) can play the significant role in SDSS. The capabilities of these devices in similar matters sets out a number of authors (Johnson, 2005, Pandey, Harbor, Engel 2001, Wilson, Mitasova, Wright 2000, Xu, Ito, Schultz, Li, 2001). Some authors, however, in this context, conclude that GISs normally provide the above paragraph 1, 2,3 and 4, but not the 5 (eg. the decision-maker's expert knowledge) (eg Kurland, 2009), just this role of knowledge in solving spatial problems is crucial. However, this view can be debatable. Therefore, in next will demonstrated that the matter of point 5 is the means of GIS.

Results and discussion

The above stated implies that the fundamental feature of such applications will be possible to make use of corresponding knowledge in decision-making processes. The crucial role of knowledge in decision making and sensemaking is highlighted (Burstein, Holsapple, 2008, p. Preface XV.). The problems of storing and making use of knowledge in GISs involves the following matters.

Tabular representation of the knowledge may be an option for these purposes. This representation was already in the past by a number of authors published and verified (Vanthienen, 1995, Wets 1998, Ziarko, 2005, Vostrovský, 2008). Such a mode of representation of knowledge (ie. the relevant knowledge rules) is acceptable GISs themselves as being in accordance with its database component (for example. in ArcView GIS ESRI, the so-called QUERY BUILDER). In the framework of this component GISs offer for this purposes the SQL tool. Its commands as SELECT a CREATE TABLE provide enough options for in these matters. The syntax of these commands is as follows:

SELECT [DISTINCT] {* |< list column > FROM < name of the table > [, < name of the table >] ...[WHERE < selection condition >] [GROUP BY < list column > [HAVING < selection condition >]] [ORDER BY < column name > [ASC | DESC] [,< column name > [ASC | DESC]]]

CREATE TABLE < name of the table > (<column name > < datatype > [NOT NULL] [,< column name > < datatype > [NOT NULL]]...]

In the context of these commands, is then possible to create the corresponding knowledge databases

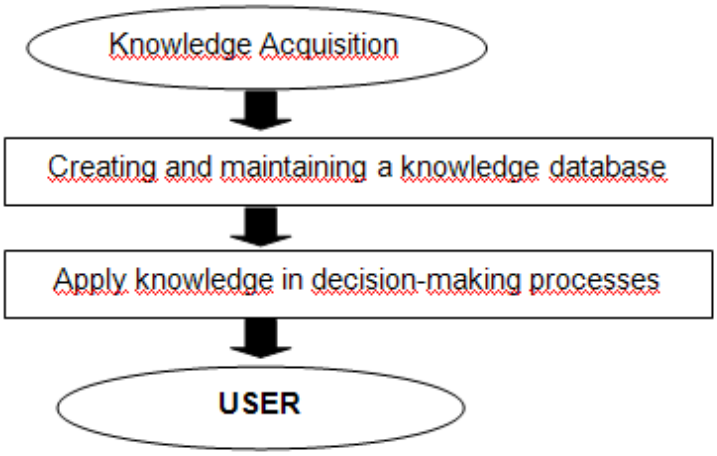


Figure 3: Typical system architecture of the knowledge-driven DSSs.

PROPOSITIONS

PropositionNo	PropositionText
1	xxxxxxxxxxxxxxxxxxxxxxxxxxxx
2	xxxxxxxxxxxxxxxxxxxxxxxxxxxx
3	xxxxxxxxxxxxxxxxxxxxxxxxxxxx
4	xxxxxxxxxxxxxxxxxxxxxxxxxxxx
5	xxxxxxxxxxxxxxxxxxxxxxxxxxxx
Etc.	xxxxxxxxxxxxxxxxxxxxxxxxxxxx

Rules

RulesNo	PropositionNo	Value
1	1	Y
1	2	Y
1	6	xxxx
2	3	Y
2	5	N
2	7	Y
2	9	yyyy
3	3	N
3	4	Y
3	5	N
3	8	zzzz
Etc.	Etc.	Etc.

Figure 4: Possible logical data scheme of the acceptable knowledge database.

and thus retained the knowledge, if necessary, recall, and apply them in solving problems. Such an approach allows the recording knowledge required in the form of rules of type of type IF A THEN H. IF (features, conditions) THEN (consequential identification, methods, techniques)] with the analysis of type WHAT IF, accounting all advantages of spatial data analysis. The final outcome of these applications is usually a map depicting areas simultaneously fulfilling all requested conditions and evaluated in context of related information layers.

In this scheme can be derived knowledge (knowledge rules) of the following structures:

RULE1: IF proposition1= YES AND proposition2 = YES THEN proposition6 (conclusion6) = xxxx

RULE2: IF proposition2= YES AND proposition5 = NO AND proposition7= YES THEN proposition9 (conclusion9) = yyyy

RULE3: IF proposition3= NO AND proposition4= YES AND proposition5=NO AND

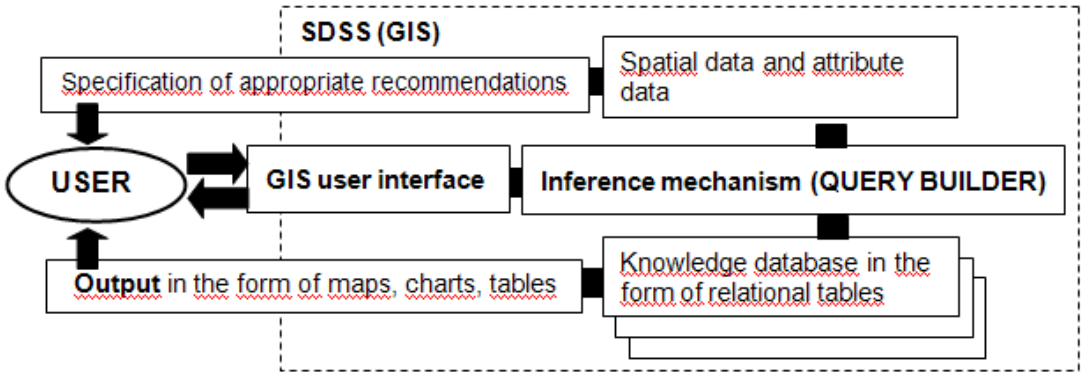


Figure 5: General structure of the proposed solution.

proposition8=YES THEN proposition9 (conclusion9) = zzzz etc .:

The resulting proposed application of GIS tools, as the SDSS will have the following form Own use of GISs in supporting solutions to semi-structured spatial problems should implement the following procedure:

1. identification and localization of the solved spatial problem,
2. specification of its attributes,
3. analysis of the current state by means of the layers,
4. output in the form of maps, charts and graphs,
5. prognosis of future state,
6. specification of the appropriate recommendations.

Conclusions

This article discussed the issue of utilization of GISs as a means to support decision making in solving spatial problems. The above stated implies that the fundamental feature of such applications will be possible to make use of corresponding knowledge in decision-making processes. From the above, it is possible for GIS to store not only knowledge but also in decision-making processes apply. If this knowledge to solve the semi-structured spatial decision problems so utilized, can reasonably expect that the final decision will be of higher quality. The rapid development of information technology, image processing techniques and database knowledge is conceived of such a guarantee of much wider use of GISs as a means to support decision making in solving spatial problems. Our decisions are increasingly dependent on understanding the complex relationships and events surrounding the world of GIS technology is able to include the new requirements.

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Data, Information and Knowledge in Agricultural Decision-Making

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Abstract

It is very important to work with data, information and knowledge correctly, when a decision model is used as a support for managerial decision-making. Unfortunately, these terms are understood differently in various branches; particularly, the definitions of knowledge are very different. It causes problems in praxis; it is not clear, in which case data processing, information or knowledge/expert systems are appropriate to use.

In this paper we introduce modern approaches to indentifying these terms. The objective of the paper is to identify data, information and knowledge in decision-making process, particularly in multiple-criteria decision-making model, to help users of such models to better understand it. To reach this objective, we need to provide appropriate definitions of data, information and knowledge as well as the specific algorithms of decision-making models used in the following sections. Then we go through the decision-making process and analyze the needs of data, information and knowledge in its individual phases. We demonstrate our approach on grains dryer selection problem under conditions of a specific agriculture company.

Key words

Data, Information, Knowledge, Multiple-Criteria Decision-Making Model, Grain Dryers.

Anotace

V rozhodovacích modelech je správná práce s daty, informacemi a znalostmi velmi důležitá. V různých oborech jsou však tyto termíny chápány odlišným způsobem a zejména definice termínu znalost jsou velice různé. V praxi to může působit problémy, neboť nemusí být zřejmé, kdy je vhodné použít systémy pro zpracování dat, v jakých případech informační systémy a kdy znalostní/expertní systémy.

Článek představuje moderní přístupy k identifikaci těchto pojmů. Jeho cílem je identifikovat data, informace a znalosti v rozhodovacím procesu, konkrétně v modelu vícekriteriálního rozhodování, což pomůže uživatelům ke správné konstrukci těchto modelů. Pro dosažení tohoto cíle nejprve uvádíme vhodné definice těchto pojmů a konkrétní algoritmy vícekriteriálního rozhodování, se kterými budeme dále pracovat. Potom projdeme standardní rozhodovací proces a analyzujeme potřebu dat, informací a znalostí v jeho jednotlivých fázích. Náš přístup demonstrujeme na problému o výběru sušičky zrnin, který je řešen v podmínkách konkrétního zemědělského podniku.

Klíčová slova

Data, informace, znalosti, vícekriteriální rozhodování, sušičky zrnin.

Introduction

Terms “data”, “information” and “knowledge” are frequently used, but with different meaning in different theories. It is hard for scientists or any other experts from different fields to communicate with each other, when they understand these basic terms differently. Communication barrier can happen not because of special terms in communication, but because of generally used terms definition. Mathematical models can be very useful for many experts in their work, but they do not use them – they do not understand them well and do not know how to fill them by data and

which information and knowledge they have to use to get some valuable results.

Many authors deal with decision-making support in agriculture regarding to data, information and knowledge available. Šporčič et al. (2010) provides an overview of models which take into consideration simultaneously several criteria, so that they can provide more comprehensive measures of management, and to serve as a background for planning and decision making in agriculture and forestry. They stress that an appropriate method must be chosen in a way in which all the data available with the reasonable amount of effort and dedication could be utilized as fully as possible. They demonstrate that multiple-criteria decision making models in forestry, as in other business systems, can be very strong support to planning and decision making.

Ascough et al. (2009) use decision-making models to solve a tillage system selection problem. They point out that this decision has significant implications for the farm enterprise, both economically and environmentally. Reduced tillage or no-tillage are considered to be conservation tillage practices that assist in maintaining acceptable environmental goals at potentially lower economic costs; however, the decision to invest in conservation tillage systems also involves risk. The authors use the SMART risk analysis framework enriched by other analytical techniques (SERF analysis, the probability of target value or Stop Light approach) to compare individual tillage scenarios and select the best one for specific conditions.

Recio et al. (2003) deal with the complexity of a farm planning process. They mention that traditional approaches to this process have been very simple and unable to manage the complexity of the problem, which involves scheduling of field tasks, investment analysis, machinery selection, cost/benefit analysis, and other aspect of the agricultural production process. The authors stress the necessity to work with available information and knowledge in appropriate way and for this purpose they develop a new approach to the planning process for medium-large farms and integrated in a more general framework to build decision support systems in agriculture.

The objective of this paper is to identify parts of multiple-criteria decision-making model as data, information and knowledge to help users of such models to better understanding it. To reach this objective, we need to provide appropriate definitions of data, information and knowledge as well as the specific algorithms of decision-making models used in the following sections. Then we go through the decision-making process and analyze the needs of data, information and knowledge in its individual phases.

We demonstrate our approach on one of the most used methodology for problem solving in agriculture: machinery/equipment selection problem solved by multiple-criteria decision-making model (see e.g. Bonneau, M., Dourmadi, Lebret et al. (2008) or Gomez-Limon, Arriaza and Riesgo (2003)). In particular we solve grains dryer selection problem under conditions of a specific agriculture company.

Material and methods

Data, information and knowledge

Interesting characterization of data (and information) provide Havlíček and Pelikán (2007). In their work, data is characterized as a set of facts, measures and statistics about real entities that are possible to be named. If data is expressed by selected one-dimensional measure that describes or identifies quantitative characteristic of the object, it is represented by a scalar number. In case of two or more objects the vector of numbers is used.

Firstly, they formalize assignment the name to an object by measure of the zero order as follows

$d0(x) = name,$

where

x is an entity and

name is a language element.

Then, one-dimensional measure determines assessment of some object's property and can be interpreted as a distance of the property rate from the beginning of measuring scale.

Formally,

$d1(x, p) = k,$

where

x is assessed property of object

p is the beginning of measurement and

k is real constant, language term or other assessment kind that express object's property evaluation.

The above given relationship can be read as follows:

"Functional value d of the one-dimensional measure of the selected property of the object x related to the beginning of measure scale p is equal to k."

Information is represented by data and their meaning. It depends on aggregation of data into context. According to Choo (2001), the observer makes sense of noticed data through a process of cognitive structuring which assigns meaning and significance to perceived facts and messages. What meanings are constructed depends on the schemas and mental models of the actor. Schemas mediate between sensory experience and intellectual though: "Schema refers to an active organization of past reactions, or past experience, which must be always supposed to be operating in any well-adapted organic response."

Information is ordered or processed data that – given into connections and context – decrease the entropy of a system. It is of no use to repeat here the theory of information, Shannon's concept of entropy and related things. The most important aspect that allows us to measure and work with information is that information has its standard and respected unit: a bit.

One bit volume information is included in a statement that leads to uncertainty decreasing. The statement is referring to a specific event with probability of occurrence p = 0.5.

From the viewpoint of measures (Havlíček, Pelikán, 2007), information is described by two-dimensional measure. The measure expresses relationships between two objects, elements, entities. It could be formalized as follows:

$d2(x_i , x_j) = f(k_i , k_j) = d_{ij}$,

where

x_i a x_j are compared properties of objects,

k_i a k_j are their values and

d_{ij} is result of their comparison expressed as a decision "yes" (true, valid, …) or "no" (false, invalid, …). The result can be expressed by such language term or by Boolean number.

Information is typically represented by table, by graph or by single variable function. In such case we suppose that all connections between data are valid if it is not explicitly said vice-versa. The above given relationship can be read as follows:

"Relationship between two object's properties xi and xj respectively between values of these properties ki and kj is equal to Boolean value that determines validity of the assignment."

There are many definitions of knowledge based on various approaches. It has been a central matter of human studies especially in philosophy. The knowledge, the process of cognition, the question of know ability of world, has been an object of investigation from time out of mind. The crucial change came when the knowledge became an important economical power and source of economical advance and competitiveness.

Nonaka and Takeuchi (1995), defined knowledge as "a dynamic human process of justifying personal belief in face of factual reality" and described three main observations on knowledge:

- Knowledge, unlike information, is about beliefs and commitments. Knowledge is a function of a particular stance, perspective or intention.
- Knowledge, unlike information, is about action.
- Knowledge, like information, is about meaning.

The problem oriented definition of knowledge was formulated by Havlíček (2006): "Knowledge is information which is used to solve successfully a problem and can be shared with others to solve or facilitate the solution of similar problems."

Such a definition tends to distinguish knowledge according to its owner. This outlines the issue of private versus public knowledge. The defenders of private ownership of knowledge affirm that knowledge represents the main source of competition advantage of the companies. New knowledge should be protected otherwise there will be no motivation for investments into research. Other opinions state that knowledge is not a degradable resource but it increases in repeated applications (Wierbicki, Nakamori, 2007).

The prevailing attitude towards the ownership of knowledge is that knowledge must be a (global) public asset. From the economical point of view this means that knowledge should lack the characteristics otherwise typical for economic assets, namely rivalry and excludability. That some forms of knowledge are public goods is least likely the case for additional, that is, new knowledge. And it is additional knowledge that turns to profit (Stehr, 2007).

Knowledge is defined as an ordered set of information in space and time about important notions, data, facts, axioms, laws, and inference rules related to a specified field of human experience, embedded in a given thought-framework (Roska, 2003). It follows that information without a thought-framework will not be qualified as knowledge.

Atomic (elementary) piece of knowledge is sometimes called "knowledge unit". Similarly to the term "knowledge" it also has a lot of characteristics and more or less an exact definition. For example, Zack (1999) says that "a knowledge unit is an atomic packet of knowledge content that can be labeled, indexed, stored, retrieved and manipulated". There are many such clear definitions in specialized literature.

That is why in the following text the term of "elementary knowledge" will be used equivalently for expressing and representing knowledge units based on systems approach. In their work, Dömeová, Houška and Houšková Beránková (2008) discussed the term "elementary" as more suitable for this purpose. It includes and summarizes three important characteristics and approaches to knowledge unit – the knowledge unit is atomic, it is an element of some system, and it is the knowledge of users.

Knowledge unit may be expressed as a whole in natural language. There is no exclusivity; each part of knowledge unit has several facultative ways of expression and almost all of their combinations are feasible.

The basic form of elementary knowledge expression derived by systems approach is defined as follows: "If you want to solve the elementary problem Y in the problem situation X to reach the objective Z, then apply the solution Q".

Multiple-Criteria Decision Model

Multiple-criteria decision-making (MCDM) model consist of several parts.

- decision alternatives,
- criteria,
- criteria matrix and
- criteria weights.

Decision alternatives are given by a finite set of feasible solutions that includes m alternatives. Such alternatives are evaluated by criteria; the model includes n criteria in general. Usual objective of the MCDM model is to find the alternative with best overall evaluation subject to all criteria (optimum, or rather compromise alternative). Alternate objectives could be to obtain complete order of alternatives or to split the set of alternatives to "efficient" and "inefficient" alternatives. As soon as the evaluation of alternatives subject to all criteria is known, criteria matrix can be constructed. Criteria matrix is formalized as

$Y = (y_{ij})$,

where

i is the index of the alternative,

j is the index of the criteria and

y_{ij} is evaluation of the i-th alternative subject to the j-th criterion.

Not only quantitative evaluation is required in the criteria matrix. For more general case of the criteria matrix, the term of "matrix of alternative attributes" could be equivalently used. Its general matrix form is as follows:

$$\mathbf{Y} = \begin{array}{c} \\ a_1 \\ a_2 \\ \vdots \\ a_m \end{array} \begin{array}{c} \begin{array}{cccc} f_1 & f_2 & \cdots & f_n \end{array} \\ \begin{pmatrix} y_{11} & y_{12} & \cdots & y_{1n} \\ y_{21} & y_{12} & \cdots & y_{1n} \\ \cdots & \cdots & \cdots & \cdots \\ y_{m1} & y_{m2} & \cdots & y_{mn} \end{pmatrix} \end{array}$$

In our case study, we use two specific MCDM methods: the Saaty's method for criteria weights assessment and the Weighted Sum Approach to select the compromise alternative.

Saaty's method is a way to formalize experts' judgments on the importance of compared objects (Saaty, 1980). It is based on pairwise comparison,

i.e. each element is compared with all others. Technically, the comparison is being done in Saaty's matrix that is squared and reciprocal. The following standard scale is used for preference evaluation:

1 - the importance of the i-th and j-th elements is equal;

3 - the i-th element is weakly preferred against the j-th;

5 - the i-th element is strongly preferred against the j-th;

7 - the i-th element is very strongly preferred against the j-th;

9 - the i-th element is absolutely preferred against the j-th.

The final importance of each element is then calculated as normalized geometric mean of the row of the Saaty's matrix.

Weighted Sum Approach is the most frequently used method based on the utility function principle (Hwang and Yoon, 1981). In this method, the decision matrix is normalized by a linear utility function; a normalized criteria matrix R = (r_{ij}) is calculated as

$$r_{ij} = \frac{a_{ij} - D_j}{H_j - D_j},$$

where Dj is the negative-ideal value of the criterion j and Hj is the ideal value of the criterion j. Then, a total utility provided by the i-th alternative is calculated as

$$u_i = \sum_{j=1}^{n} r_{ij} v_j,$$

where v is the vector of normalized weights. Complete order of alternatives is determined by descending values of the total utility function.

Results and Discussion

Let us go through the complete multiple-criteria decision-making process in an agricultural company to identify how data, information and knowledge are supporting it.

Step 1: Objective setting

The process cannot start without a precise determination of the decision-making objective. It should stem from the description of the problem situation and make a base for the selection of criteria. In this phase, all data, information and knowledge are necessary to be used. The decision-maker needs data about the current situation in the company, information about the purpose of the decision-making, and, of course, deep professional knowledge of the substance of the decision-making object. No wonder that Simon (1960) calls this phase Intelligence and sees it as the most important as well as the most complicated and most creative part of the decision-making process.

Step 2: Criteria selection

In concordance with a typical hierarchical structure of the MCDM problems (Saaty, 1980), criteria should be derived from the decision-making objective and on the same base, they should be evaluated by weights. In this phase, in which the model is designed, the decision-maker works with data (names of the criteria) and information (criteria weights). For instance, we can have criterion f1 or f2 (data) and say that criterion f1 has the weight value v1 = 0.11 or the criterion f2 has the weight value 0.42 (information). There is no professional knowledge, only the algorithmical one to use a method for the estimation of the complete weight vector.

Step 3: Evaluation of alternatives subject to the criteria

This is the most illustrative example how to distinguish data and information in decision-making model. Remember the matrix form of the MCDM model from Material and Methods. While headers of the rows and columns of the model (alternative and criteria names/acronyms/symbols) are one-dimensional and so they have the quality of data, interior elements in the criteria matrix are double-indexed. They naturally express the relationship between two objects (evaluate each individual alternative subject to each individual criterion) and so they have quality of information. No professional knowledge is required except expert evaluation of qualitative criteria.

Step 4: Selection of the compromise alternative

This is usual mechanical task for a specific algorithm of the MCDM models. The role of the decision-maker is usually passive; his work is

finished by a precise configuration of the model. We can only discuss about the quality of results. Formally, it is information to say e.g. "Alternative 1 has total utility equal to 0.77" or "The rank of the alternative 2 is 3". In fact, it could also have the quality of knowledge, because the final evaluation of alternatives concentrates all objective of the problem, specific configuration of the model (criteria selection and their weights) as well as the evaluation of alternatives subject to the criteria and the algorithm for the selection of the compromise alternative. Pragmatically, as the result of the decision-making process, we can formulate a knowledge unit as follows:

When we solve the particular MCDM problem in the specific situation of the company to select the best alternative, we should select the compromise one.

This statement has surely the quality of knowledge.

Example

Now we demonstrate our approach on a real decision-making problem in Unesovsky statek, a.s. An analyst should recommend to the management one of four variants of a new grain conditioner to replace the old and inappropriate one.

For our purposes, we follow the process of the analysis and identify necessary data, information and knowledge in each step. Background story and all data are taken from the study Stupka (2011), all calculations are own.

It is crucial to pay attention to post-harvesting treatment of grains, because it directly influences their quality. After harvested, the grains should be dried immediately, because it improves measurable biochemical characteristics, which have positive impact on total financial profit from the grains. Usual capacity of dryers is between 6 and 75 tons of dried grains per hour; for the purposes of the company, the appropriate capacity is about 20-40 tons/hour.

So, the objective of the decision-making task is to select the best continuous grain conditioner. First we should identify individual components of the decision-making model and the MCDM model, respectively.

List of alternatives:

a1 - Matthews Company MC-975 Grain Dryer;

a2 - Continuous Grain Dryer S 420 E;

a3 - Alvan Blanch DF 30000;

a4 - Continuous Grain Dryer NDT 7-1.

The variants are compared subject to the following criteria:

f1 - Performance of drying from 19 to 15% of humidity ($t.h^{-1}$);

f2 - Fuel consumption ($m^3.t^{-1}$);

f3 - Air recirculation (%);

f4 - Total costs (EUR);

f5 - Availability of service (hours).

Now we can construct the criteria matrix for this problem:

We can analyze the contents of the criteria matrix from the viewpoint of the occurrence of data, information and knowledge. We can identify data; they are in headers of rows and columns, e.g. "alternative a3" or "criterion f1". Information is inside the criteria matrix, in each individual cell of the matrix. For instance, the value y11 = 21.8 can be read as "alternative a1 is evaluated by the criterion f1 with value 21.8" or in particular "the

	f1	f2	f3	f4	f5
a1	21.8	1	30	92 530	48
a2	40.3	1.81	15	104 440	24
a3	33	1.1	15	140 000	48
a4	20	1.1	0	100 000	48
Criteria type	max	min	max	min	min

Table 1: Criteria matrix for grain dryer selection problem (Stupka, 2011).

grain dryer Matthews Company MC-975 decreases the humidity of 21.8 tons of grains from 19 to 15% in one hour". Criteria type row is also typical instance of information. We can say "the criterion f1 is maximizing" or "the criterion f4 is minimizing". In this phase of decision-making, there is no knowledge.

We continue with the assessment of criteria weights. Using the Saaty's methods (see Saaty, 1980), the criteria weights are calculated as follows:

	f1	f2	f3	f4	f5	R_i	v_i
f1	1	1/2	3	1/5	5	1.08	0.14
f2	2	1	4	1/3	6	1.74	0.23
f3	1/3	1/4	1	1/7	3	0.51	0.07
f4	5	3	7	1	9	3.94	0.52
f5	1/5	1/6	1/3	1/9	1	0.26	0.04

Table 2: Saaty's matrix with weights calculated.

Obviously, we are still working with information. The values in the Saaty's matrix can be interpreted in identical way as in the criteria matrix in the previous case. The final values have also the quality of information; we can say "the weight of the criterion f1 is 0.14".

On the other hand, some knowledge is also required for this phase of decision-making. We need knowledge how to determine exact weights of criteria. Even though the final weights have quality of information, their determination is equal to providing information about such information. As we mentioned in Material and Methods, information about information (meta-information) is one of the specific forms of knowledge.

Finally, we can determine the compromise alternative. For this purpose, one of the most common methods – Weighed Sum Approach – is used. Considering the criteria weights from table 2, the results are as follows:

	Partial utility functions					Total utility	Rank
	f1	f2	f3	f4	f5		
a1	0,09	1,00	1,00	1,00	0,00	0,83	1
a2	1,00	0,00	0,50	0,75	1,00	0,60	3
a3	0,64	0,88	0,50	0,00	0,00	0,33	4
a4	0,00	0,88	0,00	0,84	0,00	0,64	2

Table 3: Final comparison of alternatives.

This phase is fully aimed at working with knowledge. Several kinds of knowledge are necessary for achieving the objectives of model solving:

1. Knowledge of specific MCDM method on the level of algorithm. Simply said how to obtain reliable results from input information.

2. Knowledge of results interpretation. Apparently, the results also have the quality of information, because they provide relationships between individual variants and their utilities. But, alternatives utilities are depended on determined criteria weights and valid for their specified values only. As it was mentioned above, criteria weights are set in concordance with objective of problem solving in some more or less unique problem situation. Using systems approach to knowledge unit definition (Dömeová, Houška a Houšková Beránková, 2008), it is possible to write generally:

When it is necessary to determine the best of individual alternative in the MCDM model solution to make the final decision subject to specific weights values, compare total weighted utility of individual alternatives.

3. Knowledge of sensitivity analysis. Independently on used MCDM method, stability of found solution subject to possible changes in weight vector should be analyzed.

Conclusion

As we showed the role of all data, information and knowledge in agricultural decision making is unsubstitutable. But if we distinguish professional and algorithmical domains, we will see that data and information are included rather in the professional domain than in the algorithmical one; on the other hand, we need professional and algorithmical knowledge approximately in the same ratio to make the decision correctly.

We also showed interesting relativity of data, information and knowledge. Not in an initial phase but in the final one, the same value can be understood in all three ways. For instance, we can understand the maximum value of the total utility function ui as data. Of course, it is a part of one-dimensional measure (a vector) with one index. Or, we can say total utility of the i-th alternative is ui; that statement has surely the quality of information, because it defines the relationship between two

objects (alternative and total utility function). Finally, the statement - if you want to choose the compromise alternative, then select the one with the maximum value of the total utility function ui - has the quality of knowledge.

For further research, we see the following perspective way to continue. It is connected with subjective perceiving of these terms in agriculture praxis and its influence on the quality of decision-making. We have already consulted several decision-making processes ex-post, when the decision-making procedure failed. The mathematical model was correct, but the decision-makers undermined the key role of data and information in the intelligence phase and so they omitted one or more important aspects of the task. This cannot repair even the best mathematical model.

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Complex assessment of poverty using composite indicator

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Abstract

The article deals with measuring poverty whereas poverty is considered to be a multidimensional phenomenon and is represented by various dimensions. It aims to propose a methodical instrument for complex evaluation of poverty and the differences in poverty among the EU Member States. This instrument is also appropriate for regional comparison among the regions of Czech Republic. Methodical instrument on the basis of composite indicator has been suggested and it has been verified on selected poverty indicators. Using the composite indicator the development of the EU countries in the period 2004 – 2009 is described. While Denmark, Netherlands and Luxembourg made a huge improvement between the two years, the smallest progress was accomplished in Latvia, Hungary and Bulgaria.

Key words

Poverty, material deprivation, multivariate methods, composite indicator.

Anotace

Příspěvek se zabývá různými přístupy k hodnocení životní úrovně, přičemž se zaměřuje na měření chudoby jako vícedimensionálního jevu. Cílem příspěvku je konstrukce souhrnného indikátoru pro hodnocení chudoby a rozdílů v životní úrovni v členských státech EU, který je využitelný také pro hodnocení regionálních diferencí v rámci České republiky. Pomocí sestrojeného souhrnného indikátoru je posouzena nejen aktuální pozice jednotlivých států, ale také jejich vývoj v letech 2004 – 2009. Zatímco Dánsko, Nizozemsko a Lucembursko lze označit za nejsilnější státy s ohledem na největší zlepšení ve sledovaném období, nejnižší pokrok byl zaznamenán u Lotyšska, Maďarska a Bulharska.

Klíčová slova

Chudoba, materiální deprivace, vícerozměrné metody, souhrnný indicator.

Introduction

Fighting against poverty is one of the priorities of the European Union. Social equalityand reduction of poverty are both presented as one of the aims of Lisbon strategy (2000 – 2010) and strategy Europe 2020 – A European strategy for smart, sustainable and inclusive growth (2010 – 2020).

Among the scientists there is large agreement that poverty is a multidimensional phenomenon [3], [1], [16]. In the scientific works of this topic (social inclusion, poverty, living standard) one-dimensional approach is more and more substituted by the multidimensional approach. Bossert [5] presents three arguments for the multidimensional approach for measuring poverty. Firstly he speaks of important studies arguing that well-being has to be understood as an issue that is affected by many factors such as housing, income or health. Many authors measure poverty based on the set of indicators both for measuring inequality among states, e. g. [15], [10] or within states [14]. Second reason for not considering one dimension only is connected with income distribution. The author argues that poverty rate as an indicator based on income it is not always a good measure since it neglects command over resources out of wealth, non-cash transfers from the government and support from family and friends. The third reason reflects the methodology of the European Union. Activities leading to first set of indicators for

measuring well-being were initiated already in 2000 at the Lisbon European Council. The EU Member States agreed to adopt the Open Method of Coordination (OMC). OMC is used by the Member States to support definition, implementation and evaluation of their social policies based on common objectives and indicators (see e. g. [7]).

Together with enlargement of the European Union the inequality between old and new Member States increased. This pointed out to the lack of measures that do not reflect the national income level - measures beyond the poverty rate [5], [4]. The indicators should be both of monetary and nonmonetary character [6], [3].

The aim of the article is the construction of composite indicator for measuring poverty and differences in poverty among the EU Member States. Using the composite indicator not only the present position of the states is to be evaluated but also the development in the period 2004 – 2009.

Material and methods

Composite indicator

Anderson [2] speaks of two basic empirical approaches to making univariate welfare comparisons: through comparing indices and comparing distributions through stochastic dominance tests. The first approach was used in this paper. The selection of appropriate method of calculation was based on four requirements which are discussed in the paper [13]. These are as follows:

Simplicity

The criterion of simplicity reflects the evaluation of severity of the composite indicator's calculation. To meet the requirements without reserve, the user without knowledge of statistics should be able to calculate the result. That means only with the knowledge of calculation of mean. The ranking and the ratio method fulfill that. The range method can be accepted with the reservation. This method works with variation range, which is not a well known concept for a common user. Standardization method contains the variance in its result. It is possible to calculate the variances in MS Excel, but its interpretation and understanding can cause difficulties for the common user. That is why the standardization method is not in this evaluation considered as easy and understandable.

Interpretation

Sufficient interpretation of resulted value of composite indicator is an important aspect. This aspect is different in particular method. The ratio method is considered to be the most appropriate. We can easily comment which results are higher than average (which is higher than 1) and which results are below the average. We can even say by how many percent or how many times is the result of a certain region higher or lower than the average. Standardization and range methods are acceptable with the reservations. Utilization of standardization method is limited when the mean value is zero. When using range method, we do not calculate with the mean. Further, it is not possible to deduce which regions are higher than average and which are below the average. It is hard to relate results of other regions to the zero mean when using standardization method, especially when calculating the proportion. The interpretation of ranking method is not complicated; however there is information about primary values lost.

Differences reflection

When calculation the regional differences it is important to intercept and qualify these differences as well as it is possible. The results of ranking method depict the differences in results out of the focus. That is why we consider this method not suitable. All other methods are suitable with reservations. Each of them in a certain way lowers the degree of disparity and the influence of the distant values. The result of the ratio method depends on the distant indicator's values. They distort the height of the mean and also the value of the composite indicator. The standardization method is a bit more resistant against extreme values than the ratio method. The range method is even less sensitive to those values than the standardization method.

Applicability

All compared approaches were found to be applicable to the data in the regional development. All methods enable to summarize the data in different units and to create the final aggregate indicator. When calculating the ratio method there cannot be zero in the denominator which may be limitative.

According to adjusted requirements for the aggregate indicator, the ratio method based on

the median was chosen (see [13]). The resulted formula for computation is than written as follows:

$$CI_i = \frac{\sum_{j=1}^{m} y_{ij}}{m}, \text{ where } y_{ij} = \frac{x_{ij}}{\tilde{x}_{.j}}, \quad \textbf{(1)}$$

where index i represents the region; i = 1, …., 27 and index j variable; j = 1, …, m; where m is number of variables; xij is original variable; $\tilde{x}_{.j}$ is the median of the variable.

Indicators of poverty and social inclusion

There are various activities leading to set of indicators of poverty and living conditions. For example Gönner et al. [11] introduced a multidimensional model of poverty – Nested Spheres of Poverty (NESP). The authors defined three categories covering basic needs (such as food, health, housing or education) and individual capabilities (skills and physical condition to get out of poverty)**: health, wealth** and **knowledge**.

The initiatives can be however dated much earlier. In 1990 the well-known measure of well-being Human Development Index (HDI) was introduced. The aim of the initiative was to create a single measure by combining indicators of life expectancy, educational attainment and income. It is an indicator that reflects three dimensions: health, education and living standards. Although this is an indicator that takes into account various dimensions of development, many authors, e. g. [17], [1], argue that it is a limited indicator. Ranis et al. [17] aimed to define categories of human development beyond HDI. They established 11 categories and examined the correlation between HDI and other indicators of human development. They found that HDI is poorly correlated with a range of important dimensions of life: mental well-being, environment, economic stability and others.

While our analysis is focused on the EU Member States it is necessary to introducethe activities in the EU. The discussion about indicators needed to measure well-beingand poverty among EU States resulted in the adoption of set of indicators in 2000. These indicators are known as the Laeken Indicators. It is a core set of indicators of povertyand social exclusion which are regularly produced for every EU country on a comparable basis. It is a set of 18 indicators covering income, work, education and health. The **Laeken indicators** cover wide range of topics including poverty rate, inequality of income distribution, life expectancy long term unemployment and others (for detailed information see e. g. [9]).

The discussion of the dimensions of poverty and indicators used to measure them continued. “The measures of income poverty within the Laeken Indicators are based on member specific poverty lines, that is, for each state the income threshold depends on the income distribution of the specific country and does not take into account inequality between
the Member States. This practice has become more problematic with the enlargement ofthe Union and the wide differences existing between the income distributions of old and new Member Sstates” [5].

Bossert et al. [5] then argues that most of the indicators of human well–being are qualitative and that constitutes a limitation in methodological instruments to be used. In this casea counting approach (see [3]) is a possible solution. A counting measure of individual poverty is the number of dimensions in which a person is poor. This approach is used for assessment of material deprivation. Material deprivation is defined as an enforced lack of a combination of items depicting material living conditions, such as housing conditions, possession of durables, and capacity to afford basic requirements [12].

The European Union defined a set of indicators for the monitoring of the European strategy for social protection and social inclusion. In 2009 portfolio of indicators has been updated. Indicators can be divided into four groups:

- Overarching portfolio (14 indicators)

- Social inclusion portfolio (11 primary, 3 secondary indicators)

- Pensions portfolio (11 primary, 11 secondary indicators)

- Health portfolio (18 primary, 12 secondary indicators)

For the purpose of evaluation of poverty and social inequality the social inclusion indicators are to be used. For the social inclusion strand the aim is to

make a strong impact on the reduction of poverty and social exclusion by ensuring:

- access for all to the resources,

- active social inclusion of all, both by promoting participation in the labour market and by fighting poverty and exclusion,

- that social inclusion policies are well-coordinated and involve all levels of government and relevant actors (including people experiencing poverty) that they are efficienand effective and mainstreamed into all relevant public policies [8].

Indicators to be used for monitoring the social inclusion largely draw from the existing set of Laeken Indicators. As it was already mentioned the subgroup (social inclusion portfolio) consists of 11 primary and 3 secondary indicators. Primary indicators are then considered to be "the leading indicators which cover the broad fields that have been considered the most important elements in leading the social exclusion" [8]. Secondary indicators support these lead indicators by describing the problem more deeply or in other dimension. The European Commission [8] emphasizes that poverty and social exclusion are concept that encompasses **income, access to essential durables, education, health care, adequate housing or distance from the labour market.**

Many authors agreed poverty to be a multidimensional phenomenon. Our analysis is therefore based on a set of indicators following the Open Method of Coordination on Social Inclusion and Social Protection. For the analysis indicators of the social inclusion strand (Social inclusion portfolio) and indicators of the health and long term care strand (Health portfolio) were selected. While the new methodology for evaluation of social inclusion and poverty was introduced in 2009 some of the indicators are not available yet. Our analysis covers 13 indicators. Description of the indicators used is presented in the table No. 1.

Results and discussion

The ratio median method has been chosen as a method of composite indicator. Median is a robust characteristic of central location, its usage in the calculation enables more expressive differentiation of the resulting value of composite indicator. Median of each indicator is not defaced in the calculation by distant observations as much as it is in the case of mean. It enables more outstanding differentiation of composite indicator.

The ratio method can be characterized by the formula (1).

As it is obvious from the table No. 2, Denmark achieved the best results in all tracked years. It is followed by Luxembourg and Netherlands. In 2009 these regions embodied better results in variables such as material deprivation rate; people aged 18 – 59 living in jobless households or healthy life years in absolute value at birth of male and females as well. Their composite indicator was markedly above the value 1 which indicated the median value. The ladder is closed by Bulgaria, Romania and Latvia which showed worse results in mentioned variables. Bulgaria and Romania embodied above-average results in the healthy life years in absolute value at birth. Romania and Bulgaria are mainly focused on agriculture and the engineering and on the production with low value added. According to strategically regional documents for years 2007 – 2013, both countries are supposed to focus on the entrepreneurial activity, the exploitation of brownfields and on the better cooperation of institutions of science and research with firms. Both countries are characterized by high poverty rate and high real poverty gap which has been also caused by worse qualifying structure; the regions have been trying to solve this problem by staff retraining. The biggest progress is perceptible between the years 2004 and 2009 in Netherlands, Luxembourg and Denmark. In terms of the tracked indicators, the smallest progress was accomplished in Latvia, Hungary and Bulgaria.

The position of the countries depicting the combination of the stage in certain year and the change in the certain period (table 2) can be digestedly characterized by so called **Diagram of the regional development** (figure 1). The countries in the quadrants leaders, stagnant and catching up can be considered as those with good developing potential. Dashed line for composite indicator in the year 2009 and also for composite indicator of change between the years 2004 and 2009 represents the mean value from the composite indicators of

Shortcut	Label
POV_RATE	At risk of poverty rate (cut-off point: 60% of median equivalised income after social transfers) - percentage of total population
REL_POV_GAP	Difference between the median equivalised income of persons aged 0+ below the at-risk-of poverty threshold and the threshold itself, expressed as a percentage of the at-risk-of poverty threshold
MAT_DEP	Material deprivation rate - Economic strain and durables dimension, 3 items or more[1] - percentage of total population
EDU_LEAVER	Early leavers from education and training - Percentage of the population aged 18-24 with at most lower secondary education (their highest level of education or training attained is 0, 1 or 2 according to ISCED 97) and have not received education or training in the four weeks preceding the survey
JOBLESS_HOUSE_18MORE	People aged 18-59 living in jobless households: share of persons aged 18-59 who are living in households where no-one works
LONG_UNEMPLOY	Total long-term unemployed population (≥12 months' unemployment, ILO definition) as a proportion of total active population aged 15 years or more
POV_TRESHOLD	At-risk-of-poverty thresholds in PPS, single person
LE_BIRTH_FEM	Life expectancy at birth, females
LE_65_FEM	Life expectancy at 65, females
LE_BIRTH_MALE	Life expectancy at birth, males
LE_65_MALE	Life expectancy at 65, males
HLY_FEM	Healthy life years in absolute value at birth, females
HLY_MALE	Healthy life years in absolute value at birth, males

1Share of population living in households lacking at least 3 items among the following 9 items: The household could not afford: 1) to face unexpected expenses, 2) one week annual holiday away from home, 3) to pay for arrears (mortgage or rent, utility bills or hire purchase installments), 4) a meal with meat, chicken or fish every second day, 5) to keep home adequately warm, or could not afford (even if wanted to): 6) a washing machine, 7) a color TV, 8) a telephone, 9) a personal car.

Table 1: Indicators used for the analysis.

Country	CI 09	Rank	CI 04-09	Rank	Country	CI 09	Rank	CI 04-09	Rank
Denmark	1,587	1	1,025	3	**Malta**	0,995	15	0,987	22
Luxembourg	1,502	2	1,030	2	**Poland**	0,982	16	1,011	9
Netherlands	1,466	3	1,038	1	**Slovakia**	0,973	17	1,001	13
Cyprus	1,399	4	1,007	10	**Italy**	0,951	18	0,994	16
Sweden	1,379	5	1,024	4	**Spain**	0,929	19	0,986	23
Austria	1,301	6	1,014	6	**Greece**	0,914	20	0,989	19
Finland	1,234	7	1,018	5	**Estonia**	0,881	21	1,002	12
Slovenia	1,181	8	1,001	14	**Portugal**	0,881	22	0,981	24
Czech Rep.	1,181	9	1,013	7	**Hungary**	0,862	23	0,969	26
United Kingdom	1,070	10	0,991	17	**Lithuania**	0,860	24	0,989	20
France	1,056	11	1,001	15	**Bulgaria**	0,805	25	0,973	25
Belgium	1,039	12	1,012	8	**Romania**	0,792	26	0,987	21
Germany	1,023	13	1,006	11	**Latvia**	0,758	27	0,964	27
Ireland	1,012	14	0,991	18					

Table 2: Composite indicator – results.

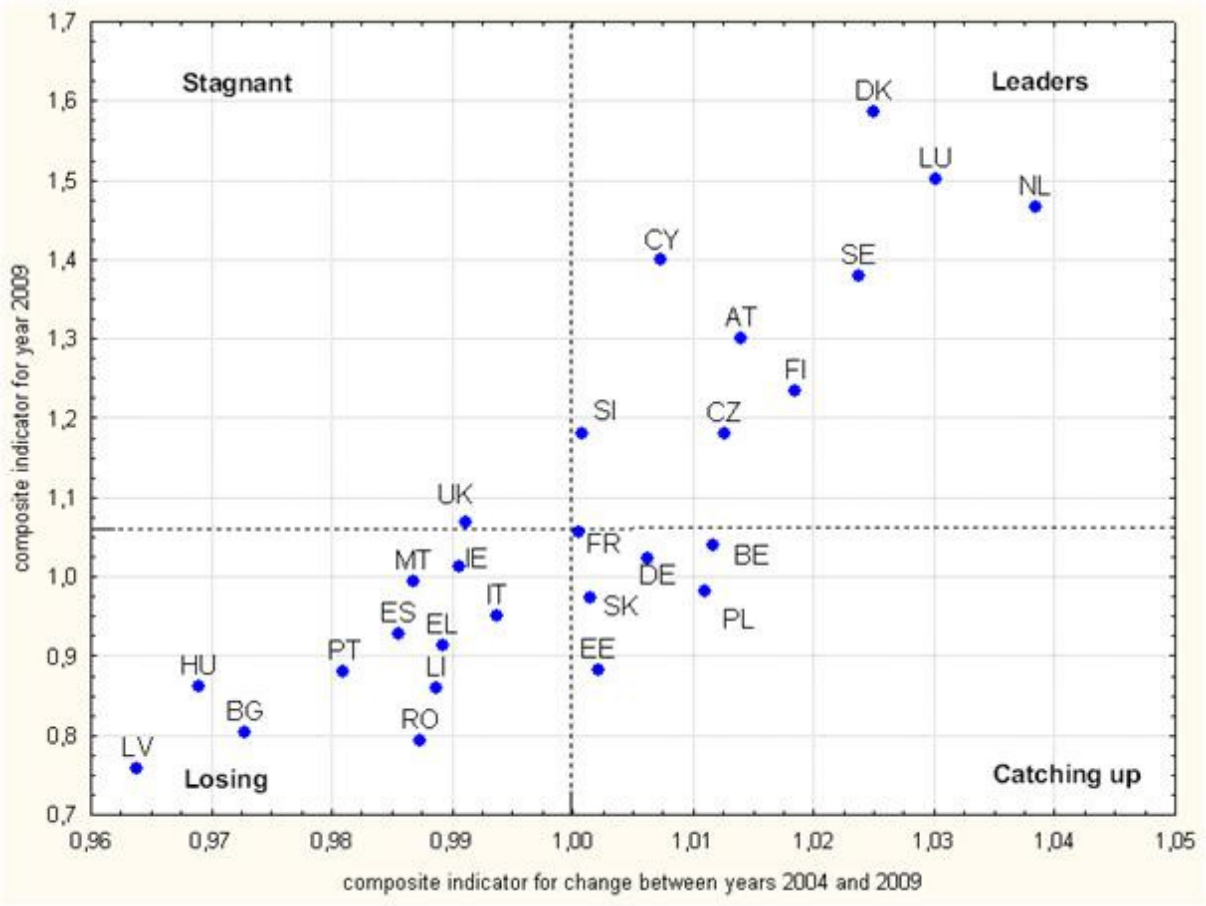

Figure 1: Diagram of the regional development.

observed countries. The best results embody those leaders where there has been the positive development provided in the years 2004-2009 as well as above-average value of composite indicator 2009. These are above all Denmark,Netherlands and Luxembourg. In the light of the change they made huge improvement in the period 2004-2009. The above-average height of composite indicator for the year 2009 and below-average improvement in the period 2004-2009 are characteristic for United Kingdom, the stagnant quadrant. France, Slovakia, Germany, Estonia, Belgium and Poland can be considered as the Catching up. The quadrant Losing contains countries which usually reach below-average values in terms of single years, but even in terms of a change of tracked time series, the countries remain to be under-average.

Conclusion

Methodical instrument for complex evaluation of poverty and the differences in poverty among regions has been suggested in this work. It has been verified on selected poverty indicators. The suitable method for the evaluation of position of the regions has been chosen, the method has been modified by the authors to suit even better the primary requirements. The important base for the determination of the composite indicator is the quantity of data, which is important to gather for all primary indicators. The missing indicators lower the quality of analysis. Using the values of composite indicators for the year 2009 and the change between 2004 and 2009 the diagram of regional development which enabled the categorization of the states was created.

The utilization of the methodological instrument for the complex evaluation of the poverty is universal and is not limited by the type of a country or region. The suggested methodology enabled to carry out a comparison of country collectively, on base of all selected indicators and separately according to topical indicator groups. Differences among particular countries were quantified with the help of composite indicators and based on the results ranking of countries was found.

A situation analysis in selected countries with the help of the composite indicator can be used in creation of development programs aiming to a

stabilization and decrement of poverty. The identification of differences among countries and the determination of the certain rank of countries can be beneficial for the definition of trouble shooting countries and better support aiming.

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