AGENT-BASED SIMULATION OF DEVELOPMENT STAGES OF FAMILY BUSINESSES

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Pavla Odehnalová, Kamila Olševičová

Introduction

In 2007, Masaryk University has carried out empirical research of the competitiveness of enterprises in the Czech Republic. A substantial part of responding enterprises were family businesses. Therefore family businesses were analyzed as a separate category from a sample of 432 companies on the basis of appropriately selected criteria. The family business was considered to be such a company in which members of one family hold at least two strategic management functions. By the strategic management function was understood the property of shares in the company. Based on this criterion there were selected 91 firms, which have been recognized as family businesses. Information on the nature of business was obtained from publicly available databases and websites of individual companies.

Within the observed group of 432 companies there were found the differences between family and non-family businesses. The main differences were HR investments [16], relationship to employees [20], relationship to customers [15], risk tendency [3], [12], profit tendency [3], [20] amount of loans [10], increasing number of employees [4], capital intensity [12], professional management [8], strategic planning [10], [19], local market orientation [5], centralization to the family [9], innovation [16], quality [21], tradition [3], maintenance tendency [3], [20]. Recognized differences within family and non-family businesses correspond with the findings presented by the research concerning the family business.

1. General Characteristics of Observed Group of Companies

Most family businesses were from South Moravia and the Zlín Region. The fewest family businesses were from the Karlovy Vary Region. Family businesses dominated also in the Olomouc and Hradec Králové Regions. Conversely non-family businesses dominated over the family businesses in the Moravian-Silesian, Vysočina, and Středočeský Regions. There were found no differences in the legal status between family and non-family firms. For both types of enterprises there was the predominance with 56% of the legal form of a limited company. The largest representation of companies was in the category of NACE 45 – the construction industry. Industries, which were typical for family businesses were NACE 29 – Manufacture of machinery and equipment, and NACE 28 – manufacture of metal structures. Industries with the predominance of family businesses over the non-family businesses were NACE 17 – manufacture of textiles and textile products, NACE 25 – manufacture of rubber and plastic products NACE 36 – manufacture of furniture. The above-mentioned findings corresponded with the numbers provided by the Czech Statistical Office. According to statistics, the most representative sector of family businesses is the construction industry with 182,000 of companies. The results also showed that family businesses fall into groups with fewer employees in comparison with non-family businesses [14].

2. Used Methodology

There were used questionnaire surveys in order to obtain detailed data from individual firms. Data were then transferred to the SPSS program, subjected to the primary analysis [1] and correlation analysis. The results of the questionnaires' evaluation were supplemented by the necessary information from the web site of businesses and from publicly available databases Albertina – Company Monitor and justice.cz website.

Different characteristics of family and non-family businesses were simulated by means of the method of agent-based simulation in NetLogo, version 4.0.4. The objective of simulation experiments was to show differences in the development of the examined group of family and non-family businesses. The development of enterprises has been modelled according to Greiner´s theory of firm growth [7].

The Greiner´s theory describes the evolution of the company depending on its size and age. According to Greiner, the organization develops in time through the phases, which differ in their nature. Greiner divides phases into two groups labelled as „Evolution" and „Revolution". Evoluti-on is a prolonged period of growth, which do not appear bigger shocks in the practical activities. Revolution is a period in which significant chan-ges take place in the life institution [7], see Fig.1.

Each of the five stages of the evolution is chara-cterized by the management style. Revolution sta-ges are characterized by crises, which must be resolved to enable further development. The size of the enterprise is used as the dependent vari-able and is described by the number of employe-es, amount of assets and amount of sales. The behaviour of family and non-family business was examined more closely, in particular in the first three stages of Greiner´s model: phase of crea-tivity, leadership crisis, and phase of professional management. The length of each phase was set at 6 years of development (i.e. 72 months). The total duration of the simulation is 20 simulated years, i.e. 240 months. This period corresponds to the longest available period of existence of private businesses in the Czech Republic (since 1989), so the evolution of family and non-family businesses is studied in the longest possible time of their lives.

Empirical research of Masaryk University contained a total of about 250 questions. There were also included questions, which describe the development of companies as defined in Greiner´s theory [6]. The answers to these questions were analyzed statistically through primary analysis to the distribution of the family and non-family businesses. The primary analysis was focused on frequency of responses in each division of the family and non-family businesses and the average response, again in the division of the family and non-family businesses. Results of primary analysis division of the family and non--family companies help to define the differences between family and non-family businesses under a sample of companies that enter as the essential characteristics of agent-based simulation. The co-rrelation analysis was used to describe the inten-sity dependence between two different variables (Tab.1, Tab.2). In the analysis, Pearson correlation coefficient r was used, which can be applied on interval and ratio variables, and requires the condition of linearity and normality distribution of variables [2]. Correlation analysis was used to identify associations between dependent and independent variables examined in the context of

Fig. 1: Organizational development model
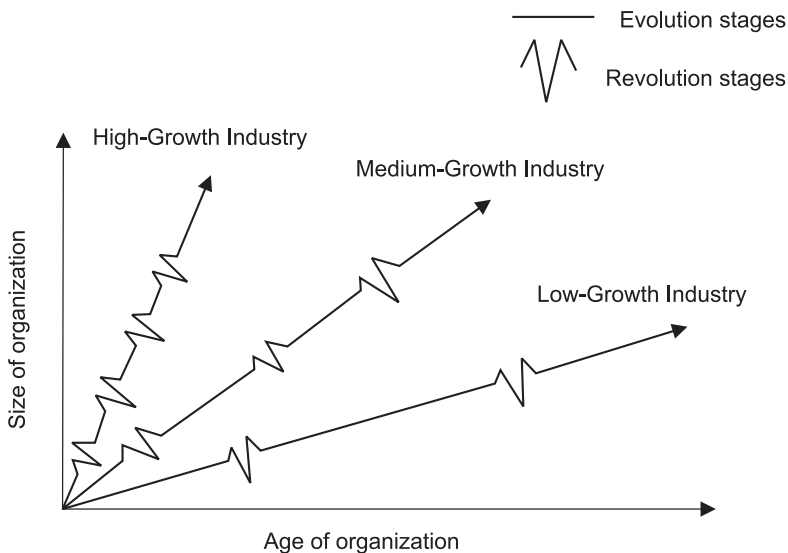
Source: [6]

family and non-family businesses. The intensity and direction of the relationship under Pearson coefficient of correlation are also weight, which shows the real relationship between the dependent and independent variables, and thus enters into agent-based simulation.

3. Different Characteristics of Family and Non-Family Businesses

For the transfer of the results from the primary analysis to the simulation there was used the average distribution of responses to family and non-family businesses. The resulting average value, expressed as a percentage was used as a weight, representing the diversity of characteristics of family and non-family businesses. Relationship between dependent variables and independent variables has been identified within the Pearson correlation coefficient r. Negative correlation coefficient means the negative association and the positive correlation coefficient means positive association. The strength of the relationship gives the absolute value of the coefficient. [11]

4. Agent-Based Simulation

The simulation model of the development of family and non-family businesses was implemented in NetLogo 4.0.4, which is a multi-agent programmable modelling system. In general, agent-based models are composed of agents that live and interact in certain environment. Agents in NetLogo are usually understood as movable entities, while the environment is defined as the grid of stable patches. Agents can react to states of the environment; they can change the environment, communicate with other agents or respond to actions of other agents indirectly. Agent-based models can be applied in numerous domains, typically in computer science, biology, chemistry, medicine etc. In case of economy, agent metaphor can be used for modelling companies, decision makers, employees, customers etc. acting in the market. Agent-based models either can be based on empirical data (then each agent corresponds to a real entity), or models are more abstract and agents are completely virtual entities. For more information about agent-based approach, see e.g. [6], [22], and for overview of variability and wide applicability of NetLogo models see NetLogo models library [13].

Our agent-based model allows us to observe developmental stages of two abstract companies: family business (FB) and non-family business (non-FB). The simulation enables experimenting with different settings of parameters (independent variables) that describe companies. Independent variables determine

Tab.1: Family business – association between dependent and independent variables

	Family business	Number of employees *Pearson´s r*	Amount of assets *Pearson´s r*	Amount of sales *Pearson´s r*
Innovation	70,44 %	-0,025	0,009	-0,062
Quality	73,55 %	-0,004	0,067	0,100
Consumers' care	72,95 %	0,011	0,062	0,064
Employees' care	82,64 %	0,014	0,074	-0,057
Autonomy	37,4 %	-0,023	0,084	-0,017
Capital intensity	70,11 %	0,059	0,077	0,082
HR investment	5,53 %	-0,067	-0,062	-0,012
Average number of employees	247	1	**0,742**	0,021
Average number of top managers	3,26 %	0,466	**0,416**	0,042
Local market orientation	28,55 %	-0,242	-0,158	0,024

Source: [15]

Tab. 2: Non-family business – association between dependent and independent variables

	Non-family business	Number of employees *Pearson´s r*	Amount of assets *Pearson´s r*	Amount of sales *Pearson´s r*
Innovation	66,66 %	**0,111**	0,097	0,118
Quality	75,01 %	-0,049	-0,042	-0,026
Consumers' care	71,58 %	0,005	-0,047	-0,095
Employees' care	79,94 %	0,047	0,049	0,069
Autonomy	46,6 %	**0,245**	**0,770**	**0,786**
Capital intensity	71,07 %	**0,158**	**0,181**	**0,174**
HR investment	5,56 %	-0,045	0,012	-0,032
Average number of employees	294	1	**0,679**	**0,546**
Average number of top managers	3,31 %	**0,558**	**0,475**	**0,457**
Local market orientation	28,04 %	-0,093	-0,102	-0,140

Source: [15]

the behaviour of the company in stage of its development. Independent variables used in our model are:
- Initial number of employees,
- Initial amount of assets,
- Initial amount of sales,
- HR investments,
- Relationship to employees,
- Relationship to customers,
- Risk tendency,
- Profit tendency,
- Amount of loans,
- Increasing number of employees,
- Capital intensity,
- Professional management,
- Strategic planning,
- Local market orientation,
- Centralization to the family,
- Innovation,
- Quality,
- Tradition,
- Maintenance tendency.

It is possible to explore the impact of different settings of the model to the dependent variables. According to [6], the dependent variables in our simulation model are:
- number of employees,
- amount of sales,
- amount of assets.

The simulation experiments run for predefined number of iterations. There were defined 240 month-cycles, i.e. as if both types of companies evolved for 20 years. The outputs of the simulation are visualized in line charts.
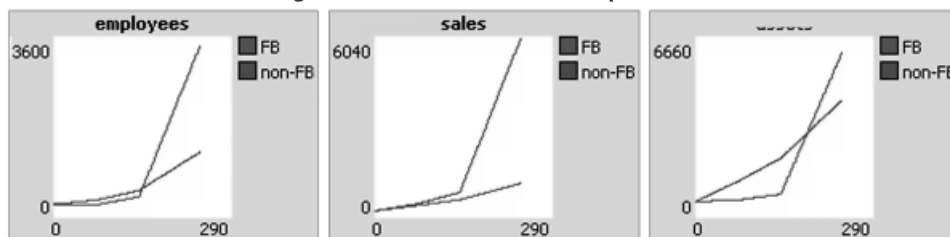
5. Results of Simulation

For the first simulation experiment results of family business (FB) and non-family business (non-

Fig. 2: Line charts from the 1st experiment
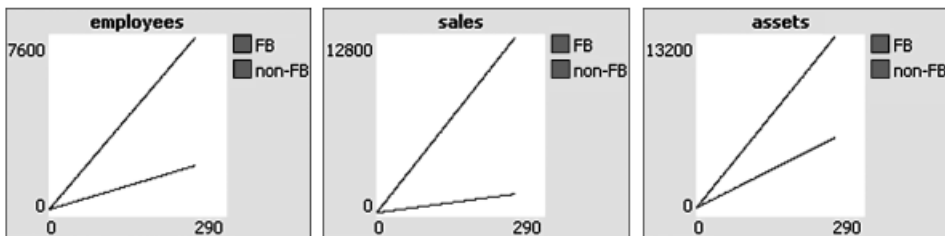
Source: own.

Fig. 3: Line charts from the 2nd experiment

Source: own.

-FB), see three line charts (Fig. 2). Development stages of companies were not taken into account. In all charts, horizontal axes represent the number of iterations (cycles) of the simulation. Vertical axes present the level of the dependent variables, which were number of employees, amount of sales and amount of assets.

In the second simulation experiment, development phases of the company were taken into account. The simulation results for the 20-year--long period are presented in Fig. 3. As well as in the previous chart, horizontal axes represent the number of iterations and vertical axes correspond to the level of the dependent variables, which were number of employees, amount of sales and amount of assets.

Discussion

The agent-based simulation results show that family businesses in the first phase of their development grow in terms of amounts of asset and sales. This growth is faster than the growth of non--family businesses. The break occurs at the stage of leadership crisis, where family businesses are starting to lag in size behind the non-family businesses. This corresponds with [18], and also with the conclusions of [3]. These researches indicated an aversion to the employment of non-family members on the position of professional managers in family businesses and preferring family members on these positions. This conservative approach is related to the orientation on undertaking domestic markets and efforts to maintain the size of the enterprise to the extent that the family will be able to control itself. With the aversion to non-family employees is closely related nepotism and paternalism, expressed by the management of the company [8]. The above simulation shows the case where the management of the company accepts the professional management. However,

if the family business may not accept professional managers all it can leads to the "freezing" of company in the developmental stage, company's return to the previous phase of creative management. The worst scenario is the bankruptcy of a family company. The above simulation shows the case when the family business accept a professional manager, however limited in comparison with non-family business [18]. Non-family business is at the stage of crisis management looking for professional managers immediately. There is a gradual delegation of tasks and partial decentralization of the management to newly arrived managers. Linked with this is the new division of labour and the need to hire new employees [7]. Enterprise slowly moves to the next stage of professional management. With new employees also the assets and sales grow. In the stage of leadership crisis, the management of family businesses may appear in fear of the delegation of tasks to new employees. Owners want to keep the firm in the hands of the family [9] and therefore they prefer to delegate the functions needed for the further development of the enterprise rather to family members than to the „foreign" professional managers. Entrepreneurs are probably aware of the risk that they borne [17] in comparison with managers - employees. Trust in non-family managers is less than it is in the managers from the family. This is probably the reason for a smaller increase of professional managers from outside the family and thus smaller growth of companies in terms of assets and sales.

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Ing. Pavla Odehnalová
Masarykova univerzita
Ekonomicko-správní fakulta
Katedra podnikového hospodářství
63229@mail.muni.cz

RNDr. Kamila Olševičová, PhD.
Univerzita Hradec Králové
Fakulta informatiky a managementu
Katedra informačních technologií
kamila.olsevicova@uhk.cz

ABSTRACT

AGENT-BASED SIMULATION OF DEVELOPMENT STAGES OF FAMILY BUSINESSES

Pavla Odehnalová, Kamila Olševičová

This article builds on results of the empirical research "The competitiveness of companies" done by Masaryk University in 2007. Within the group of 432 observed companies there were found interesting characteristics of family businesses (91 companies). The family business was considered to be such a company in which members of one family hold at least two strategic management functions. There were used questionnaire surveys in order to obtain detailed data from individual firms. Data were then transferred to the SPSS program, subjected to the primary analysis and correlation analysis. Characteristics of family businesses were used as inputs for the NetLogo agent-based simulation. Agent-based models can be applied in numerous problem domains, typically in computer science, biology or medicine. In case of economy, agent metaphor can be used for modelling companies, decision makers, employees, customers etc. acting in the market. Our agent-based model allowed us to observe developmental stages of two abstract companies: family business and non-family business. The simulation enables experimenting with different settings of parameters (independent variables) that describe companies. The objective of the simulation was to identify the differences between the family and non-family businesses in sense of the Greiner´s theory of the organization growth. The agent-based simulation results showed that family businesses in the first phase of their development grow in terms of amounts of asset and sales. This grow is faster than grow of non-family businesses. The break occurs at the stage of leadership crisis, where family businesses are starting to lag in size behind the non-family businesses. Our findings of the simulation experiments correspond with the findings in the area of family businesses research made in other European countries and in the USA.

Key Words: *Family business, Greiner´s theory, Agent-based simulation.*

JEL Classification: *C63, L21, D21.*