CHAIN REACTIONS

INNOVATION BRIEF 10

Measuring Business Resilience

ABOUT INNOVATION BRIEFS

CHAIN REACTIONS addresses the challenge for industrial regions to increase regional capacity to absorb new knowledge and turn it into competitiveness edge and business value. There is a strong need to help SMEs to overcome capacity shortages for innovation and integration into transnational value chains. The project aims at empowering regional ecosystems with the knowledge and tools to help businesses overcome those barriers and generate sustained growth through value chain innovation.

CHAIN REACTIONS regularly publishes INNOVATION BRIEFS presenting the rationale behind specific innovation drivers and illustrate them with practical examples. The present Innovation brief addresses the use of digital tools for a better company organization. CHAIN REACTIOSN thanks hereby the author, Mr. Thomas Wolter-Roessler, for this contribution to the project's objectives.

Measuring Business Resilience: An analysis of Financial Indicators for Quantifying Resilience on the Micro Level

Abstract

Resilience is a complex topic that has gained the interest of more and more researchers in the area of economics. In the current study a literature review of previous research is performed in order to understand the concept through the following topics: definition of resilience, crisis; economic levels of resilience; temporality and components of resilience. From these it became clear that the topic lacks empirical research, and tools for quantitative analysis on the micro level. The aim of this research is to establish the financial components of resilience based on a dataset of 26,000 companies with twenty years of financial data. This study introduces the research with its initial steps, the methodologies used and the results from them. As according to previous research, being resilient has different types of components. As in the first part financial indicators were examined, the second part will be dealing with the qualitative, managerial aspects of the question.

Introduction

The concept of resilience has been becoming more and more attractive for researchers especially nowadays, since we are currently facing a global crisis and it is crucial to understand how to react properly, to avoid bankruptcy, or even to enhance performance. This article concerns itself with introducing the concept and the initial steps of a research that will result in creating a composite resilience index that is to be used for measuring resilience on business level, and by that serve as a tool to determine whether a firm has a strong base to be able to react to a shock properly.

Methodology

The research has two main phases:

1)   Analysis of the financial data to distinguish resilient

companies

2)   Interviewing resilient companies for understanding the non-financial attributes of being resilient

In the first phase a methodology suitable for finding in- dividual crises of the examined companies was established. However, even before that a deep literature review was made to clarify our interpretations on the used concepts, like resilience or crisis. These can be found in Section III. For creating the composite index, the following steps were taken:

1)   Familiarizing with the dataset

2)   Creating derivative indicators

3)   Filter the companies by a system of criteria to create a test dataset

4)   Categorize the components of the test dataset to four groups: resilient, non-resilient, dynamically growing, none of the above

5)   Examine the resilient ones with logistic regression

In the second phase the results of the first phase will be used: the resilient companies. The goal is to understand the non-financial aspects of resilience. By interviewing the management of resilient companies, insight will be gained on the conscious decisions and actions that made their company survive the crisis.

As a result of the research, a supportive service for compa- nies is planned to be provided, to help them understand their current state from the aspect of resilience and give assistance about what would be the right direction to move forward in order to strengthen their operations.

Exploring resilience – a literature review

a.   Definition

There is no universally accepted definition for resilience. The first use of the word emerged in ecological research for distinguishing between the state of equilibrium within a system from the same system while being stressed [1]. Several interpretations emerged ever since from diverse contextual backgrounds including from organizational or socio-ecological aspects [2]. To highlight one that concludes the most important features: the qualities that enable an individual, community or organization to cope with, adapt to and recover from a disaster event [1].

b.   What is crisis?

On the micro level the term refers to an unexpected negative event, or series of events that result in affecting the operations of a business in a negative way. In the current analysis financial aspects are considered, so mainly financial disruptions are taken into account. Financial crises can come from diverse sources and can grow into global recession or depression. These events can exist on different levels of the economy, in fact, in many cases, crises spread through sectors and economies, causing graver and graver problems. The most expanded one is the global crisis, like the one caused by the

current pandemic. Crisis can happen on the level of certain industries for example as the result of scarcity in the needed factors of production. National or regional crises are on the territorial level and can impact the companies operating in the certain territory. And last, but not least, individual crises are on the level of companies. These happen as a result of an operational failure that can have several causes, especially in the case of SMEs. In the research, all types of crises were planned to be included, so the companies were examined individually. With this approach crises with any kind of source are shown in the data and taken into account.

c.   Economic levels

The concept of being resilient has emerged on diverse levels of the economy. Microeconomic resilience refers to the ability of an organization to react to a shock either coming from a negative externality or caused internally. On the mesoeco- nomic level the definition is extended to the crises that are present within a given industrial sector, that influences the operation of companies either active in that certain sector or are in contact with representatives of such sector through their operations connected to procurement or distribution. Macroeconomic or regional resilience takes all the markets present within the territory under examination with special focus on the interactions between the actors [3]. In the present research the focus is on microeconomic resilience.

d.   Temporality

Resilience also has a time dimension. Diverse interpretations exist regarding the period of time where resilience can be determined. Proactive resilience refers to a prepared and alerted state even before the shock. Attributive/ absorptive resilience is in relation with the ability to adapt and sustain the activities at the time of the crisis. Reactive resilience means the ability to return to the initial state or have even higher results. Dynamic resilience, which is aimed to be understood in the current research, considers the above listed features all- together [4]. Other previous research also gives insight on the timely evolution of resilience, and on how the process can be interpreted on a timeline as it is shown on Figure 1. [5] and Figure2. [6].
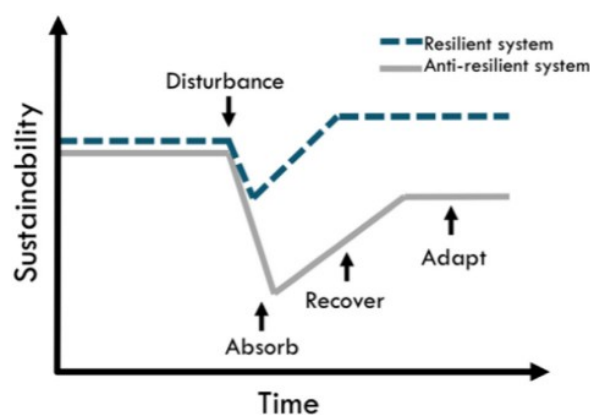
Figure 1: Differences in the reaction of a resilient and a

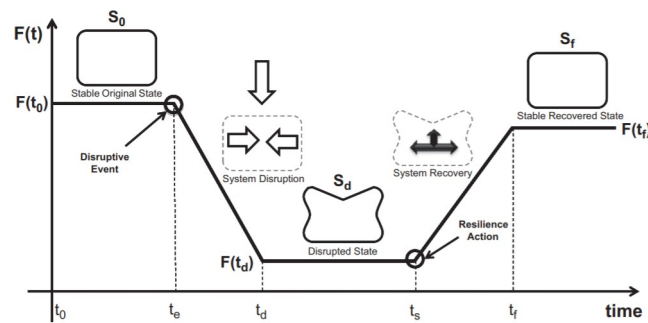**non- resilient system for a disturbance [5]**

Fig. 2. Delivery function transition in resilience.

Figure 2: The stages of the process of resilience [6]

e. Components of resilience

Understanding the components of resilience is crucial for creating a methodology that can distinguish the resilient com- panies from others. According to previous research, resilience is not only reliant on financial features, but has managerial aspects, as well [7] . From one point of view, the determining factors can be classified into three groups: The internal fac- tors (organizational behaviour, managerial characteristics and quality), the external factors (globalization) and the enabling factors (use of technology, generation of capital, supply chain integration) [8]. Another research suggests that the core of resilient performance consists of four basic abilities: the ability to respond, the ability to monitor, the ability to learn and the ability to anticipate [9]. Others suggest that resilience relies on a system of organizational qualities and pillar features. Figure 1. presents a systematic view on resilience.

Dataset

For creating the resilience index, a sample of approximately 26,000 companies with financial data from 2002 to 2019 was acquired for examination, including data from the income statement and the balance sheet. The sample mostly consists of SMEs, however, all the companies that provided data were required to meet the following two criteria: having 10 employees and income of 100,000,000 HUF (~280.000 EUR) in at least one of the examined years.

Empirical research – The process

A. Familiarizing with the dataset

The first step was understanding the sample and its char- acteristics. Python was used through the whole process. The sample can be considered hectic, since there is a lot of missing data and the definition of certain values differ in numerous cases, and always the same type of income statement was used among companies. Also, taking a look at the financial indicators, it seems obvious that non-normal distributions are to be dealt with. As the first task, the dataset was cleared out, so the irrelevant companies were not taken into consideration later. Companies were excluded if their time of operation was 10 years or less, if they stated negative equity for two following years, or if they performed negative net sales. Unfortunately, the companies that used foreign currency for certain years were also excluded, since the exchanges between currencies were not in consistency with the exchange rates used in the given years, leading to the assumption that the data provided is invalid. In some cases, certain elements of the financial
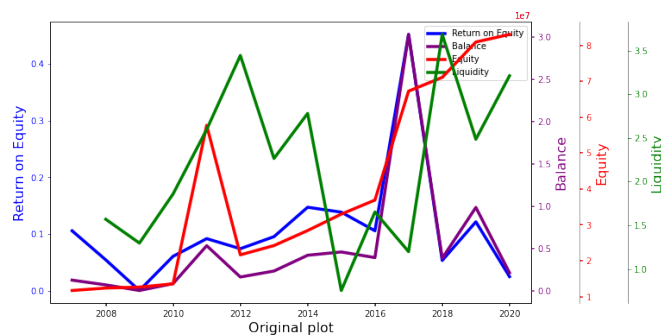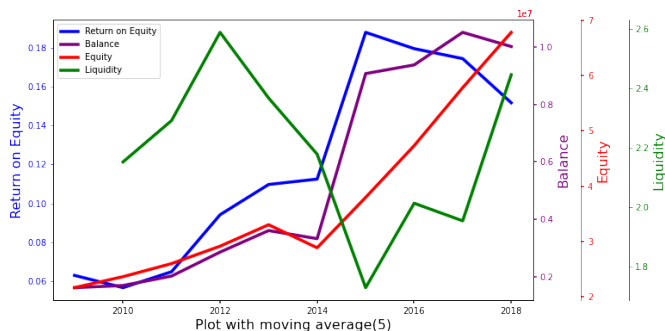
statements did not add up as determined by the rules of such statements. These companies were excluded, as well. In the case of employees and industrial categories the data was given according to different classification methods. In case of the number of employees, standardized categories were created, that will serve as standard in the research from now on. The problem with the industrial segmentation was that since almost twenty years are covered in the dataset, the categorization system (TEÁOR1) changed two times. The most up to date categorization was used, the categories of the older systems were translated.
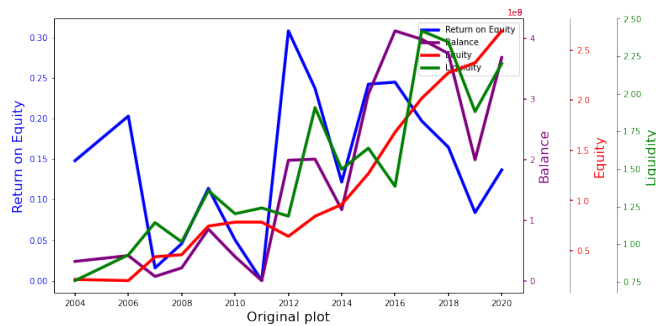
B.   Creating derivative indicators

The next step was to create the derivative indicators such as Return on Equity (ROE2) and Liquidity rate that can be calculated from the given data, since these will be useful in the further research. Based on the complexity of the research questions, ROE was chosen initially for examination, as it is expressive not only to the profitability of the company, but to its capital management, as well. ROE is also an indicator that is company-based not market-based, which means that it is more descriptive on the operations of the company [7], [11]. Both of which are important from our aspect under examination. Liquidity is also taken into account, since it is determining the firms' ability to pay its short-term liabilities. Then the timely distribution of these, together with the basic financial indicators (balance, shareholders' equity) were examined. In a lot of cases the fluctuation of the indicators was disturbingly high, so the smoothing technique of the moving average was used, to make the graphs easier to understand. The following figures (Fig. 3., 4., 5., 6.) illustrate the results of the process so far.
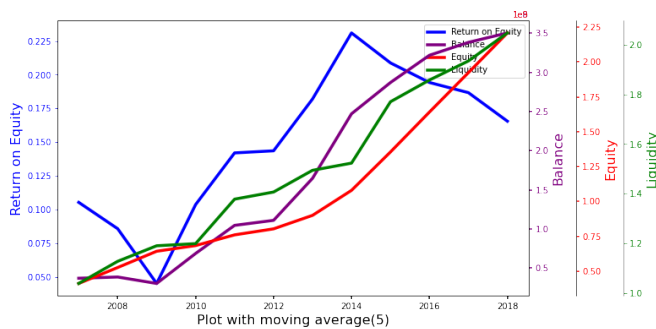

Figure 3: Company no.1 – original plot

Figure 4: Company no.1 – plot with moving average

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Figure 5: Company no.2 – original plot

Figure 6: Company no.2 – plot with moving average

C.   Filter the companies by a system of criteria to create a test dataset

The next step was to decrease the number of companies by excluding the ones that cannot fulfil the following established criteria regarding the balance, equity, number of workers and ROE:

- shareholders' equity exceeds 500.000 HUF in all the examined years

- data of the company is provided for at least 10 years (regarding the period of 2011-2020)

- balance of the last year is higher than the balance of the first year (corrected with inflation)

- the sum of the balance of the last five years is higher than the sum of the previous five years (corrected with inflation)

- shareholders' equity of the last year is higher than of the first year (corrected with inflation)

- the sum of the shareholders' equity of the last five years is higher than the sum of the previous five years (corrected with inflation)

- ROE is negative maximum two times (the company closes with a net loss in maximum two years)

D.   Categorize the components of the test dataset

All companies were classified into four groups: resilient, non-resilient, dynamically growing, none of the above. This process was done manually, the experts examined all compa- nies individually in order to create the categories. The dynami- cally growing companies were distinguished from the resilient ones, because these will be analysed differently. In case of these it cannot be determined from the available data that these are consciously operating companies that strategically plan to avoid crises, or fortunate

companies that did not have to face any negative event.

E.   Examine the resilient ones with a decision tree and logistic regression

In order to validate these groups, and to explore which vari- ables influence the outcome of our target variable, resilience most significantly, we carried out computations using two classification methods.

Firstly, a logistic regression was ran including only five variables (Liabilities, Balance, Shareholder's Equity, Return on Equity, Number of Employees). The dataset was split and filtered into 80% training and 20% test data and was tried to be computed including data from different years. Number of employees proved to be the variable with the highest coefficient, and after evaluating the models with confusion matrices achieved a maximum of 75% accuracy.

For a more straightforward interpretation, a decision tree was created, as well. However, it tended to overfit and created a very complex model lacking explainability. On the other hand, limiting its depth to make the tree sensible left us with some nodes that were pure albeit small in size, and others that were rather impure.

Conclusion

In this article we presented the initial steps of our business resilience analysis. The partial results that we reached are: a deep literature review on the topic, a classification of the companies and propositions of methodologies and ideas that are to be implemented to the further research.

We concluded that in order to achieve the best results with classification methods, we need different variables. We need to transform our data and create dynamic parameters to capture how companies reacted when facing financial crises, and how they adapted their structure and strategy to overcome these issues. Furthermore, we can implement other classification methods such as Naive Bayes classifier and k-nearest neigh- bours in order to cross validate our findings and choose the best fitting model.

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