

PILOT REPORT

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Pilot report of PBN

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Executive Summary/Management Summary

The main goal of PBN's pilot action was to identify resilient companies from a national dataset containing financial information of the firms at hand. The definition of resilience is quite complicated since there are many things that can cause a crisis in the life of a business. 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.

There are comprehensive economic crises, such as the global financial and economic crisis of 2008-09, which affected all aspects of life and business. There are crises that do not affect all sectors equally (such as COVID-19: although it has an impact on tourism and the food industry, the effects are not comparable). Radical sectoral regulation, product fee changes or an increase in the minimum wage for skilled workers may also pose a crisis situation for certain sectors.

However, crises can be completely unique and company specific. The withdrawal of the largest customer, the termination of the most important supplier, or the loss of important key people from the organization can also lead to an unexpected shock situation for a company when it comes to creatively solving the problem and finding a way out, moving forward.

Resilience works in economic life in the same way as it does in the human body. One can be so resilient (so-called proactive resilience) that the crisis does not spectacularly tear up (although it may be, that its peers, competitors in the sector or region are falling back), it is also resilient to those who feel the crisis but shake themselves in a short time, adapt quickly (adaptive resilience), and are also considered resilient who can find a way out of the downturn and recover from losses (reactive resilience).

Since resilient attributes, reaction to economic crises and the simple identification of those subjects that had and survived such a negative scenario is gaining more and more attention, and it is deliberately desired to develop a technique for the fulfilment of this task. Scientific literature besides macroeconomic resilience (economic resilience of regions and countries in a broader sense) tends to expand towards microeconomic fields indeed that involves small- and medium sized enterprises and other company structures as well. Such companies are of great interest, since the present Covid-19 pandemic situation already brought negative economic impacts both on global- and local scale and presumably further, even greater negative impacts and turbulences are imminent that can easily have a perceivable effect on the individuals' level unlike any other economic downturn in the past few decades. Therefore, to protect companies and keep as many workplaces as possible is essential and tools are sought to promote decision- and policy makers to promote them in this.

One possibility to achieve this is to find those companies and participants that already have experience in economic recession periods, are familiar with the signs, actions to take and consequences. Best practices could be collected from various walks of life how to survive and even come out prosperous from such scenarios by further increasing competitive advantages compared to others.



1. Introduction (incl. business needs and requirements)

Companies that already survived turbulent periods might survive the following ones, but it cannot be stated for sure. It is even possible that resilient companies cannot contribute to the macroeconomic progress of nations, only in the short-run, resilient attribute can prevent bigger collapses on regional and national level and prevent larger economic crises that could drag other sectors with them via the subtle and complicated economic connections.

In order to have an objective and tangible result on which aspect resilient companies could contribute or utilized by economic experts from the relevant factors, was one of the main focuses of the pilot work for which the procurement of a database containing financial balance sheets and income statements were used.

Our main aim in the pilot action was to analyse- with using advanced data analytics methods- national companies how they reacted to crises based on a national database. In the first part of our pilot action- namely D.T.3.7.1- a quantitative analysis was carried out and based on that finally four groups (segments) have been classified how companies were exposed to economic shocks. -level of their resilience-. In the second phase of the pilot activity, based on the conclusions of the quantitative research as well as data from public balance sheets and profit and loss accounts, we filtered out businesses that showed signs of resilience following a business downturn in a given year. In this upcoming phase, we built on interviews, surveys and publicly available data (from company websites, media) to take one step ahead of understanding factors of resilience.

2. Applied methodologies

This session shall summarise the main methodologies as well as the lessons learnt in connection with the company data analysis in a quantitative (D.T3.7.1.) and qualitative way (D.T3.7.2)

2.1. Main characteristics of the national company database

The procured database contained financial balance sheets and income statements on little bit more than 26 000 Hungarian companies- including also the companies which had undergone the analysis in the first half of the project in WPT1- and 73 variables were involved in the dataset. The investigated time period covers 2002-2019 and mainly companies from processing sector have been involved, since these partakers contribute the most to the Hungarian economy according to the Hungarian Central Statistical Agency. With the financial information other meta-data, like company addresses, industrial branch information, numbers of employees in each year, predecessor-successor information and



historical remarks on negative- and positive events that had an impact or influence on the active operation of the companies at hand were obtained.

During the exploratory data analysis several problematic anomalies were detected and had to be handled in order to be able to extract sensible input for the applied mathematical and further statistical processes. (These problematic anomalies are detailed in the D.T3.7.1 analysis) Within the framework of the investigation, these anomalies and defects were handled in a robust way or were eliminated, however it has to be highlighted that number of variables offer a possibility for much wider economic-mathematical investigation that was obviously beyond the scope of the analysis and therefore other abnormalities are to be expected that have to be handled case specifically if further approaches and methods shall be applied. Thus, the data preparatory phase shall be handled as a still open task that will inevitably be part of future data science or statistic related investigations.

Besides data handling that eliminated or reduced the undesirable effects of the missing values and other defects it had to be taken into consideration that the investigated data encompassed almost two decades during which several legal- and economic conditions changed. The most important transformations on the data that aimed to bring information from the given time-span to a common root were the following:

- The NACE numbering of the companies that coded the industrial branch information were synchronised and updated backward in time.
- The predecessor-successor information was utilized to unite companies that were technically the same organization just changed tax numbering due to some reason.
- Annual revenue has been selected for further investigations (in accordance with other relevant literature suggestions) since this variable had the least missing value among the financial variables.
- Financial statements where ambiguous information were given to a specific year have been corrected and unified.
- Financial information that were not given in HUF were discarded, since unrealistically large values were provided thus making such data unreliable (most probably the values were given in HUF but the currency was indicated in some other currency).
- Company NACE information were simplified to main NACE categories and companies were grouped accordingly into these main categories.
- Employee numbers were transformed to categories for every year in order to make data uniformized.

However, the applied transformations could lead to partial information loss they were inevitable for enabling the comprehensive and uniform handling of the companies without biasing the expected results.



2.1.1. Main results of the quantitative analysis carried out in D.T3.7.1

As the analysis in D.T3.7.1 reflects, based on the selected financial metric the impacts of the macroeconomic crisis of 2008 affected the most companies within the processing industry in Hungary a year later, so in 2009. The same holds regarding number of employees affected at those companies that were exposed to economic shock at a certain level, thus not just small companies with relatively small number of employees have been affected than this crisis truly hit a broad segment of society. Consequently, in 2010 a relatively comprehensive decrease in employee number was observed that was also presented in the analysis.

It is important to note that resilience is a time dependent and volatile attribute of the companies, which means that being resilient at a certain level (corresponding to the shock level survived) does not necessarily indicate that the company remains resilient in the long-run and retain this characteristic for the whole of its operation. Therefore, resilience in our understanding is a temporal feature, a given company can be resilient only in case of facing an economic downturn and during its lifetime the company can be resilient several times at different “resilience-levels” when being exposed to various types of disturbances.

In our examination we focused on companies that were exposed to an economic shock in a given year and right after the year of shock they managed to compensate and gain momentum to reach the economic status (or even overshoot it) as the year prior to the shock. Based on literature definition, we could denote these companies as “one-year-reactive-resilient” companies Those companies which managed to steer back to the state prior to the economic shock only years later (more than one) are not considered as resilient in the present investigation due to their slower reaction, they could be denoted as “multiannual-reactive-resilient” companies.

According to literature with respect to level of the economic indicator in the comeback year compared to the level of the year of the distress and prior to it the companies can be regarded as fragile, robust, resilient or antifragile. The companies in case they experienced crisis- including the ones already involved in WP T1- belonged to these groups, but it has to be highlighted that one company can belong to different segments depending on the examined year.

The resilience related history of the WPT1 firms based on the present concept could be analysed in case of 39 companies where all the necessary data were available.

The corresponding results are listed in *4STEPS D.T3.7.1_resilience history of WPT1 companies.xlsx*.

A control group was also identified in the framework of this analysis, and those companies belonged to the control group who did not go through a crisis period according to the analysis.



The year of economic disturbance was indicated as year_i, while the previous one with year_{i-1} and the year of comeback with year_{i+1}. The exact definition of the 4 groups (segments):

- **Fragile:** Annual revenue(year_{i+1}) < Annual revenue(year_i) or (Shock level)% > Sales Growth(year_{i-1} -> year_{i+1}) > -100%
- **Robust:** Annual revenue(year_i) < Annual revenue(year_{i+1}) < Annual revenue(year_{i-1}) or 0% > Sales Growth(year_{i-1} -> year_{i+1}) > (Shock level)%
- **Resilient:** Annual revenue(year_{i-1}) < Annual revenue(year_{i+1}) < 2*Annual revenue(year_{i-1}) or 100% > Sales Growth(year_{i-1} -> year_{i+1}) > 0%
- **Antifragile:** 2*Annual revenue(year_i) < Annual revenue(year_{i+1}) or Sales Growth(year_{i-1} -> year_{i+1}) > 100%

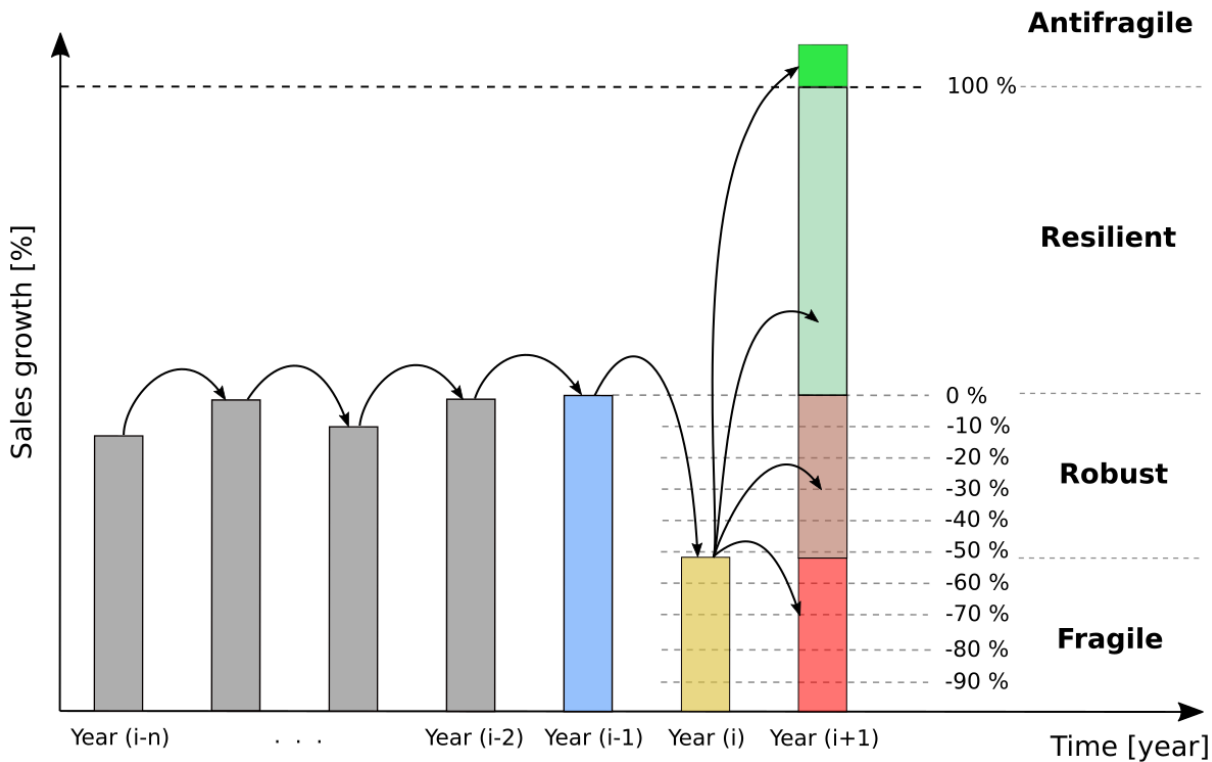


Figure 1: Basic concept for the classification of companies that were exposed to economic shocks.



2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	class
189.0	198.0	188.0	145.0	382.0	687.0	845.0	533.0	579.0	630.0	506.0	506.0	607.0	534.0	475.0	492.0	684.0	Fragile
50.0	53.0	70.0	39.0	108.0	74.0	217.0	168.0	139.0	216.0	184.0	172.0	167.0	206.0	182.0	156.0	147.0	Robust
90.0	71.0	160.0	80.0	171.0	113.0	359.0	321.0	212.0	356.0	401.0	255.0	270.0	321.0	307.0	257.0	205.0	Resilient
5.0	2.0	5.0	6.0	9.0	16.0	19.0	35.0	15.0	24.0	29.0	21.0	17.0	27.0	28.0	21.0	9.0	Antifragile

Figure 2: Number of companies ordered into resilience-related classes in each year at 10% shock level they were exposed to.

2.1.2. Main results of the qualitative analysis carried out in D.T3.7.2.

In the qualitative phase of this research, we looked for the secrets, causes and tools of perseverance and resilience in businesses. We intended to know how a company recovers from a crisis, what external and internal resources it relies on in this process, and what solutions can serve as an example for other businesses.

We endeavoured to assess what external and internal tools a company can use to recover from a difficult situation after an economic downturn. Based on data from public balance sheets and profit and loss accounts, we filtered out businesses that showed signs of resilience following a business downturn in a given year. We built on interviews, surveys and publicly available data (from company websites, media) to take one step ahead of understanding factors of resilience.

Since not only crises/shocks, but “resilience” patterns can also be very different, a systemic approach was designed that watched out for internal as well as external factors that can lead to resilience. As a hypothesis, the following tools/means have been identified for a company to react in times of crisis. (Here the main tools are listed, the detailed description can be found in the D.T3.7.2 analysis):

- Financial positive
- Financial negative
- Labour force and organizational structure
- Products/Services
- Technological
- R&D
- Clients
- Suppliers
- Packaging, marketing, sales
- Trainings
- Professional assistance at the top level

In the framework of the analysis, we presented 12 different case studies on companies, identified with various resilience trends, based on the groups defined in the D.T3.7.1 quantitative analysis. The fragile companies were not analysed in this part of our work, only the robust, the resilient and the antifragile. More precisely, 3 companies (including one WPT1 company) per group, plus 3 companies from the control group (all of them had been involved in WP T1), so all in all 12 companies were examined in the D.T3.7.2 qualitative analysis.

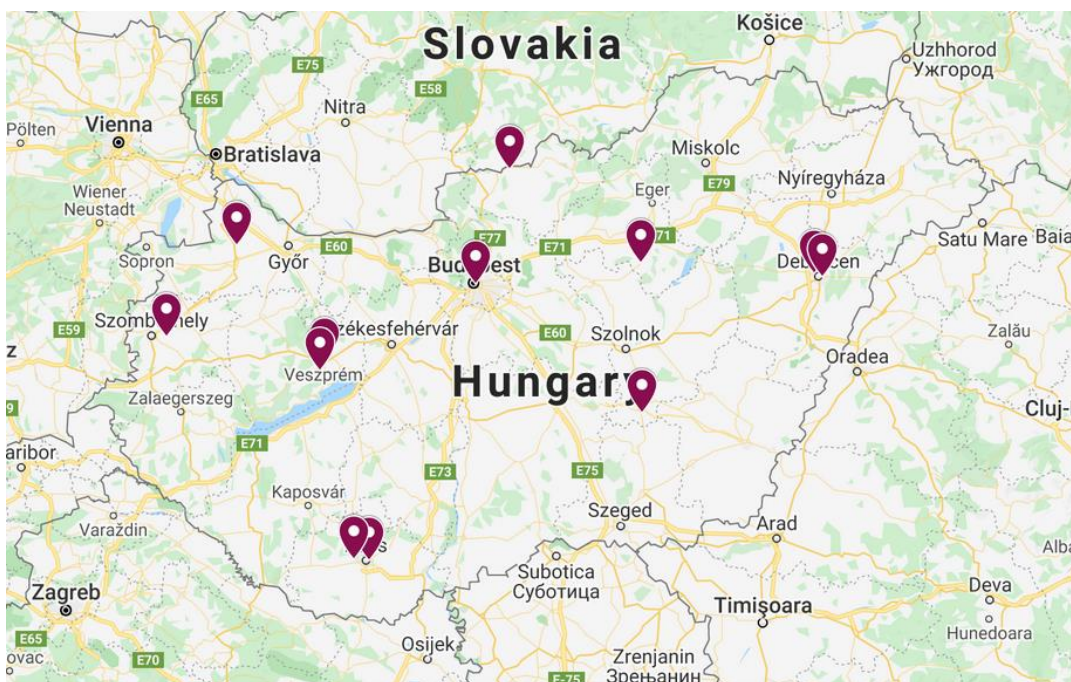


Figure 3: Map of Hungary with the location of the headquarters of the companies presented in the case studies in D.T3.7.2

A common feature of all the examined companies is that they were founded in the 90s or early 2000s, none of them was established later. These companies have by now a lot of institutional experiences and tacit knowledge, very likely to push them towards the more resilient character.

This selection is biased due to the fact that the initial picking scheme for the companies took into account their economic performance over the years and the longer the timeframe for evaluation, the more data the analysis had to be taken into account.

Taking a good look at the analysis, we can see that the potential traits of resilience are definitively identified in many of these companies. Interestingly - and also partly due to a selection bias - these companies are more of the “oak” types, the old, traditional ones, who have been through a lot and gained a lot of expertise during the decades.



The following factors can be considered behind success:

- Successful management of generational change if necessary
- Investing into R&D and innovation, developing their own products portfolio
- Investing into Industry 4.0 technologies (which, on the one hand, offer speed and preciseness in production but also force companies to standardise the production process, making it less prone to human error and less dependent on individual tacit knowledge)
- Investing into staff: organising trainings, watching out for employee needs
- Being embedded into local networking, let those be professional or civil society

In addition to these above, we have found that more than one of the companies operate in a special niches segment with a high share of public institutional buyers. These segments are: the military and the public transport.

Interestingly, we could not confirm the different patterns in case of the control group. What we can suppose at the moment is that individual luck still plays a role in certain companies being resilient or not, as all factors cannot be controlled by all means.

3. (Expected) Impacts for your tackled business/industry, region, country & Interreg

In the framework of our pilot action, we carried out a comprehensive analysis, both quantitative and qualitative way, in terms of how Hungarian companies reacted to crisis which corresponds with their resilience level.

Since resilience and being resilient are currently playing an important role in the most recent European strategies and initiatives, our advanced work carried out in the 4STEPS project can be considered a base which might be further exploited in the upcoming years. In our analyses we examined numerous kinds of data of a certain company and based on these, we managed to categorise them into the identified categories. The research also reflected that data is also a significant factor, since the more data is available the more precise picture we can present of a company and their reaction towards crisis. Since the dataset included some companies who did not experience shock in their lifetime, their experience and good practices might be also transferred to other companies in order to decrease the crisis amongst the firms.

After having identified crisis phenomena in the operation of Hungarian processing industry companies a definition of reactive resilient companies has been given, which companies have actually gone through economic turbulences and survived them. Based on the reaction to the crisis, a classification of the companies has been recommended and the number of companies has been counted in each year to the formed groups.



In our research- both quantitative and qualitative- we concluded that crisis can be diverse and might be completely unique and company-specific as well which will be also beneficial in later studies.

Based on the scientific literature review, we also managed to identify four different groups (segments) in connection with the different level of resilience and how companies reacted to crisis. Further analysis in the topic might be carried out based on this segmentation.

Going through the 12 case studies, (detailed in the D.T3.7.2 qualitative analysis) we aimed to identify the most relevant potential factors behind resilience. We have found different patterns (detailed in the summary of D.T3.7.2) in connection with robust, resilient and antifragile behaviour as well as we also could identify some common characteristics of the defined control group companies. These features should be highlighted in order to make a company as resilient as possible.

Nevertheless, statistical evidence has been found that reactive resilience as a temporal characteristic of individual companies has no positive influence on long-term performance and survival rate and therefore shall be considered as a short-term positive attribute that helps alleviating larger macroeconomic crises or at least suppresses and prolongs the magnitude of such turbulences by keeping unemployment rate at a lower level etc. In the long-run once reactive-resilient companies on a statistical level shall be considered as wounded economic characters that might need to be identified and helped to bring them to the same level as the appropriate control groups.

In a future work other aspects of resilience beside reactive-resilience should be elaborated and models shall be worked out in order to numerically characterize companies and collect best-practices for preparing and avoiding negative impacts during operation. Further hypothesis tests could be figured out and performed and geographic data could be incorporated to the investigation. As a more advanced outlook from the present study, bankruptcy prediction models could be used to have a deeper understanding on economic resilience and form other (most probably still just a subset of) resilient groups and their features.

The development of both the quantitative and the qualitative methodology for analysis, sampling and questioning (setting up a more detailed interview structure) will help to better identify the nuances making the difference for resilience.

It is advised for the further steps of analysis and research into resilience to work on the enhancement of the quantitative selection procedure as well as to elaborate a detailed methodology, interview panel and questionnaire for qualitative analysis of various resilient form behaviours.