AN APPROACH TO ANALYSIS OF THE IMPACT OF NATURAL DISASTERS ON THE ECONOMIC EFFICIENCY AND PROFITABILITY OF BUSINESS

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ABSTRACT:

The paper purpose is to propose an approach to the analysis of the impact of various natural disasters (intense rainfall, extreme high or low temperatures, droughts, strong storms, floods, earthquakes and others) on the economic efficiency and profitability of the business. In this study, more specifically, the business companies in the sphere of production, trade and services are considered. These companies generate net income from sales of production, goods and services. In view of the successful development and sustainability of these companies, it is necessary to analyse the variations in specific ratios of two of the main business indicators (economic efficiency and profitability) under the influence of different natural disasters. The ratios related to the indicator of economic efficiency and profitability are calculated as the corresponding net revenues or profits from sales (of production, goods and services) are divided by one of the following variables: sum of the average balance values of current or fixed tangible assets, incurred full costs of the activity or other. Numerical results of several applications of the proposed approach with particular values of the variables that are included in the expressions describing the two business indicators are presented. The results of the analysis of the calculated values of the ratios related to the two business indicators (economic efficiency and profitability) before and after the possible occurrence of a given natural disaster can successfully support decision-making financial managers to take adequate measures to reduce the potential negative consequences, recover the normal operative activity or increasing resilience of companies.

1. INTRODUCTION

Nowadays, due to climate changes, natural disasters have a significant negative impact on the sustainability and development of business (IPCC-Working group II, 2022; UNISDR, 2019). These impacts can be direct or indirect, and can affect companies with different characteristics from all economic sectors (Climate-ADAPT_EEA, 2022; Advisory team-World Bank, 2018). Furthermore, the extent of the impact can vary depending on the type and severity of disaster (intense rainfall, extreme high or low temperatures, droughts, strong storms, floods, earthquakes and others), as well as the geographic location of the company and the economic sector in which it operates (EEA, 2021; Commission Notice-EC, 2021; Dimitrov, Penchev, Bogomilova, 2019).

The size of a business can also affect its ability to adapt to and recover from natural disasters. Larger businesses can have more resources and contingency plans to deal with disturbances of their sustainability, while smaller businesses can be more vulnerable to the negative economic effects of natural disasters.

Some of the ways in which natural disasters can affect business sustainability and development are as follows (Bragg, 2022):

- **Physical damages**: Natural disasters such as floods, hurricanes, earthquakes, and others can cause damages to buildings, equipment, and other physical assets of a business. These damages can result in significant repair or replacement costs, as well as reduce the sustainability of the business.
- **Supply chain disruption**: Natural disasters can disrupt supply chains, which can affect a business's ability to produce and sell its products. For example, if a business relies on a supplier that is located in an area affected by a natural disaster, it may be unable to obtain the necessary raw materials or components to continue production. This can lead to delays, increased costs, and lost revenue.
- **Interruption of Operations**: Natural disasters can cause business operations to be interrupted for a time period due to difficulty in accessing the business location (road closures, difficulties for employees to get to work), power outages, several infrastructure damages or other reasons, which can result in loss of customers, suppliers, and profits.
- **Increase in prices of raw materials**: Natural disasters can cause an increase in the prices of raw materials that are needed to production. For example, a drought can reduce the amount of wheat and both lead to an increase in its price, as well as the prices of flour and bakery products.
- **Higher Costs:** Business can incur higher costs to recover from natural disasters, such as the cost of repairs and replacement of damaged equipment, loss of revenue due to downtime, increased insurance premiums, etc.
- **Need to adapt to changing climate conditions:** Natural disasters can be caused by climate change and this requires businesses to adapt to these new conditions. This can include investing in more sustainable own infrastructure, using environmentally

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friendly technologies, improving energy efficiency and other similar measures.

- **Need to improve the quality of products and services**: Natural disasters can force the businesses to invest in more efficient technologies and innovations to improve the quality of their products and services. This can increase the competitiveness of the business, as well as make it more resistant to future crises.

In this study, more specifically, business companies from sectors dealing with production, trade and services are considered. These companies generate net income from sales of products, goods and services. In view of the successful development and sustainability of these companies under the influence of different natural disasters, it is necessary to analyse the variations of two of the main business indicators (economic efficiency and profitability).

The paper purpose is to propose an approach to analysis of the impact of various natural disasters on the economic efficiency and profitability of the business. The idea is to perform the analysis based on the change in the values of the specific ratios that describe the two business indicators.

2. ESSENCE OF BUSINESS INDICATORS - ECONOMIC EFFICIENCY AND PROFITABILITY

2.1 Essence of Economic Efficiency

The efficiency, in economics and organizational analysis, is defined as a measure of the input a system requires to achieve a specified output. A system that uses few resources to achieve its goals is efficient, in contrast to one that wastes much of its input (Encyclopedia Britannica, 2023).

In general, economic efficiency in an economy indicates that the available resources are being utilised in the best possible way. It is known when an economy is economically efficient, any changes made to assist one entity would harm another. From a microeconomic point of view, business's pursuit of economic efficiency means increasing output and reducing costs.

In the production case, goods are produced at their lowest possible cost, as are the variable inputs of production. For consumers, economic efficiency leads to lower prices for goods and services. For the government, more efficient companies and higher levels of productivity and economic activity increase economic growth (StudySmarter, 2023).

There are various types of economic efficiency: Productive efficiency, Dynamic efficiency, Static efficiency, Social efficiency, Allocational efficiency, Pareto efficiency, etc. (Barnier and Bellucco-Chatham, 2020; Gordon, 2022; StudySmarter, 2023):

- Productive economic efficiency exists when output is fully maximised from the available inputs. In this situation is impossible to produce more of one good without producing less of another. For a company, productive efficiency occurs when the average total cost of production is minimised.
- Dynamic efficiency is explained as the productive efficiency of a company over a long period of time. This can be accomplished if the company reduces its costs by implementing new production processes and innovations. Dynamic efficiency aids in reducing long-run average cost (LRAC).
  Dynamic efficiency is affected by the following factors: Investment - Investing in technology and more capital can lower future costs; Technology - Improved technology in a company can help reduce costs; Finance - Accessibility to finance can help the company invest more capital to improve production, which in turn leads to a reduction in costs; Motivating the workforce - Encouraging and motivating workers and managers can enable a company to reduce costs.
- Static economic efficiency is concerned with the best combination of existing resources at a particular time. It is concerned with producing outputs at a specific time by allocating resources differently.
- Pareto efficiency is when every economic good is optimally allocated across production and consumption so that no change to the arrangement can be made to make anyone better off without making someone else off.

2.2 Essence of Profitability

Profitability is the main goal of any business. Without profitability the business will not survive in the long time. Therefore, measuring current and past profitability and forecasting future profitability is very important (Hofstrand, Johanns, 2021).

Profitability refers to the extent to which a company earns a profit. Also, in many financial analyzes of various businesses, profitability and profit are used interchangeably, but the two terms are not equivalent. Both are accounting metrics that are used to analyze the financial success of a company, but there are distinct differences between the two. Although a company can realize a profit, this does not necessarily mean that the company is profitable. Profitability is a financial metric that companies use to determine how successful they are. This is a relative measure and is usually expressed as ratios. While profit is a specific number and is considered as an absolute measure (Horton, Potters, Munichiello, 2021)

In this regard, the value of a business cannot be estimated only on the basis of its profit. It is necessary to perform a profitability analysis to understand whether the company is using its resources and capital effectively

Profitability can also be defined as a measure of a company's profit relative to its expenses. Businesses that are more efficient can make more profit as a percentage of its expenses than a less-efficient business, which must spend more to generate the same profit (Gartner Inc. 2023).

It is generally accepted that a business achieves profitability if the total amount of its income is greater than the total amount of expenses for the accounting period. However, it is also necessary to consider if a company is recording its business transactions under the accrual basis of accounting, it is quite possible that the profitability condition will not be matched by the cash flows generated by the organization, since some accrual-basis transactions (such as depreciation) do not involve cash flows (Bragg, 2022).

The profitability of a company is predetermined by various factors, such as expenses/costs, demand, productivity, competition, etc. (Horton, Potters, Munichiello, 2021).

Profitability is commonly expressed by various financial ratios, which are created by the income statement. The values of these profitability ratios can be considered tools for making decisions about the financial state of the given business. Also, these ratios can help management, analysts, and investors better understand how the company is able to earn the money necessary to cover its expenses and other company-related costs.

3. DESCRIPTION OF THE APPROACH TO ANALYSIS OF THE IMPACT OF NATURAL DISASTERS ON THE ECONOMIC EFFICIENCY AND PROFITABILITY OF BUSINESS

3.1 Essence of the Approach

The main idea of the proposed approach is that the financial manager needs to be well aware of the impact that a natural disaster can have on the economic and sustainable development of the company in order to be able to make informed and effective decisions to deal with potential financial problems.

In this study, it is assumed that the economic efficiency is measured by comparing the economic effect with the resources or costs invested in its achievement, i.e. the ratio is economic effect/resources and economic effect/costs. The profitability is measured as comparing the financial result with the resources or costs or revenues through which this result is realized, i.e. the ratio is financial result/resources, financial result/costs and financial result/revenues.

The essence of the proposed approach is to calculate and compare various coefficients related to the economic efficiency and profitability of the company, taking into account the impact of natural disasters on the business sustainability. In particular, the coefficients related to these two business indicators (economic efficiency and profitability) can be calculated as the corresponding net revenues/costs or profits from sales (of production, goods and services) are divided by one of the following variables: sum of the average balance values of fixed or current tangible assets, incurred total costs of the activity or other elements.

3.2 Essence of the Proposed Approach

The essence of the proposed approach is to carry out an analysis of the impact of various natural disasters on business based on the variation in the values of several specific ratios determining the levels of economic efficiency and profitability of the monitored company. In particular, the companies from real sectors dealing with production, trade and services are considered. Knowledge of these ratios and the impact of natural disasters on their values is essential for the financial management of companies. It is important for managers to know how a natural disaster can affect the business sustainability so that they can make adequate recommendations to reduce the negative consequences and increase the company resilience.

3.2.1. Ratios of economic efficiency:

Efficiency ratio of fixed tangible assets in production sector =

$$= \frac{\textit{Net income from sales of production}}{\textit{Sum of the average balance sheet values of fixed tangible assets in the production sector}} \quad (1)$$

Efficiency ratio of fixed tangible assets in the trade sector =

$$= \frac{\textit{Net income from sales of goods}}{\textit{Sum of the average balance sheet values of fixed tangible assets in the trade sector}} \quad (2)$$

Efficiency ratio of fixed tangible assets in the service sector =

$$= \frac{\textit{Net income from sales of services}}{\textit{Sum of the average balance sheet values of fixed tangible assets in the service sector}} \quad (3)$$

Efficiency ratio of current tangible assets in production sector=

$$= \frac{\textit{Net income from sales of production}}{\textit{Average balance sheet values of current tangible assets in the production sector}} \quad (4)$$

Efficiency ratio of current tangible assets in the trade sector =

$$= \frac{\textit{Net income from sales of goods}}{\textit{Average balance sheet values of current tangible assets in the trade sector}} \quad (5)$$

Efficiency ratio of current tangible assets in the service sector =

$$= \frac{\textit{Net income from sales of services}}{\textit{Average balance sheet values of current tangible assets in the service sector}} \quad (6)$$

Efficiency ratio of total costs invested in the sold production =

$$= \frac{\textit{Net income from sales of production}}{\textit{Total costs invested in the sold production}} \quad (7)$$

Efficiency ratio of total costs invested in the sold production =

$$= \frac{\textit{Net income from sales of goods}}{\textit{Total costs invested in the sold goods}} \quad (8)$$

Efficiency ratio of total costs invested in the sold production =

$$= \frac{\textit{Net income from sales of services}}{\textit{Total costs invested in the sold services}} \quad (9)$$

3.2.2. Ratios of profitability:

Profitability ratio of fixed tangible assets in production sector =

$$= \frac{\textit{Profit from sales of production}}{\textit{Sum of the average balance sheet values of fixed tangible assets in the production sector}} \quad (10)$$

Profitability ratio of fixed tangible assets in the trade sector =

$$= \frac{\textit{Profit from sales of goods}}{\textit{Sum of the average balance sheet values of fixed tangible assets in the trade sector}} \quad (11)$$

Profitability ratio of fixed tangible assets in the service sector =

$$= \frac{\text{Profit from sales of services}}{\text{Sum of the average balance sheet values of fixed tangible assets in the service sector}} \quad (12)$$

Profitability ratio of current tangible assets in production =

$$= \frac{\text{Profit from sales of production}}{\text{Average balance sheet values of current tangible assets in the production sector}} \quad (13)$$

Profitability ratio of current tangible assets in trade sector =

$$= \frac{\text{Profit from sales of goods}}{\text{Average balance sheet values of current tangible assets in the trade sector}} \quad (14)$$

Profitability ratio of current tangible assets in service sector =

$$= \frac{\text{Profit from sales of services}}{\text{Average balance sheet values of current tangible assets in the service sector}} \quad (15)$$

Profitability ratio of total costs invested in sold production =

$$= \frac{\text{Profit from sales of production}}{\text{Total costs invested in the sold production}} \quad (16)$$

Profitability ratio of total costs invested in sold production =

$$= \frac{\text{Profit from sales of goods}}{\text{Total costs invested in the sold goods}} \quad (17)$$

Profitability ratio of total costs invested in sold production =

$$= \frac{\text{Profit from sales of services}}{\text{Total costs invested in the sold services}} \quad (18)$$

4. APPLICATIONOF THE APPROACH TO ANALYSIS OF THE IMPACT OF NATURAL DISASTERS ON THE ECONOMIC EFFICIENCY AND PROFITABILITY OF BUSINESS

4.1 Applications of the Approach to Analysis of the Impact of Natural Disasters on the Economic Efficiency of Business

If it is assumed that a natural disaster occurred at the end of the previous year, which caused significant damage to the production tangible assets of the company, and then it is logical to assume that in the current year the net sales revenue will be smaller compared to the previous year.

Let's analyze the impact of a natural disaster on the economic efficiency of the business based on variations in the values of the efficiency ratio of the total costs invested in the sold production (7).

One of the main components of total costs is prime cost of sold production. Let's assume that due to a natural disaster production has decreased, and hence the prime cost of sold production also decreases, for example by 15%. Other components of total costs are selling and administrative costs. Let's assume that due to a natural disaster they have decreased, for example by 18% and by 10% respectively. Let's assume that net income from sales of production has also decreased, for example by 20%.

Here, let's denote prime cost of sold production by A, cost of sell by B, administrative cost by C, and Net income from sales of production by V. In this case, the efficiency ratio (7) is presented as follows:

Efficiency ratio of total costs invested in the sold production =

$$= \frac{V}{A + B + C} \quad (19)$$

The efficiency ratio (19) after taking into account the reductions in the variables due to a natural disaster is rewritten as follows:

Efficiency ratio of total costs invested in the sold production =

$$= \frac{(1\text{-}0.20)\,V}{(1\text{-}0.15)A+(1\text{-}0.18)B+(1\text{–}0.1)C} = \frac{0.8V}{0.85A+0.82B+0.9C} \quad (20)$$

If, for example, $V = 200$, $A = 120$, $B = 15$, and $C = 30$, then the efficiency ratio (19) has the following value:

Efficiency ratio of total costs invested in the sold production =

$$= \frac{200}{120 + 15 + 30} = \frac{200}{165} = 1.21 \quad (21)$$

If a natural disaster occurs that damages the production activity of the company, then taking into account the indicated reductions in the values of the considered variables for the efficiency ratio (20), the following value is obtained:

Efficiency ratio of total costs invested in the sold production =

$$= \frac{0.8 \times 200}{0.85\text{x}120+0.82\text{x}15+0.9\text{x}30} = \frac{160}{102+12.3+27} = \frac{160}{141.3} = 1.13 \quad (22)$$

As can be seen as a result of the damage caused by the natural disaster to the business, the value of this ratio decreased from 1.21 to 1.13 for the same duration periods, respectively before and after the disaster.

In the given example, the economic effect decreases by 20%, (from 200 to 160) and the costs invested in its realization decrease by 14%, (from 165 to 141.3) i.e. the rate of reduction of the effect is higher than the rate of reduction of costs, as a result of which the value of the ratio decreases.

It is also possible that after the natural disaster the rate of reduction in the economic effect is equal to the rate of decrease in costs in general. In this case, the value of the economic ratio (7) does not change, i.e. it remains equal to 1.21 (21).

Let's consider the third scenario, in which the rate of reduction of the economic effect is less than the rate of reduction of the costs invested in this effect. Let's take the same sample data again: the net income from sales of production (the economic effect) is 200 and the total costs invested in the sold production are 165.

Let's assume that after a natural disaster, the economic effect decreases by 20% and the total costs by 30%. In this case, the economic coefficient (7) can be expressed numerically as follows:

Efficiency ratio of total costs invested in the sold production =

$$= \frac{(1-0.20) \times 200}{(1-0.30) \times 165} = \frac{0.8 \times 200}{0.7 \times 165} = \frac{160}{115.5} = 1.39 \qquad (23)$$

Here there is a reduction of net income from sales of production (the economic effect) from 200 to 160 and of total costs invested in the sold production from 165 to 115.5 for the corresponding equal periods before and after the disaster. In this case, due to the changes in the variables mentioned above, the efficiency ratio (7) increases from 1.21 to 1.39 for the same size post-disaster period.

The increase, retention and decrease of the value of the efficiency ratio of total costs invested in the sold production is relative to the period before the disaster. The pre-disaster and post-disaster periods are of equal length in all analyses.

4.2 Applications of the Approach to Analysis of the Impact of Natural Disasters on the Profitability of Business

In the denominators of the expressions for the various ratios, for profitability (10)-(18) are included the values of the resources, expense/costs and revenues, through which the financial results (profits) are obtained.

If it is assumed that a natural disaster occurred at the end of the previous year, which caused significant damage to the company's property, then it is logical that in the current year after the natural disaster, the profits for the business will be lower compared to the previous year.

If for the current year after the occurrence of a natural disaster the rates of decrease in profits are greater than the rates of decrease of the variables that are present in the denominators of the expressions, then the values of corresponding ratios are smaller for the current year compared to the previous year. This means that a unit of resource is engaged in realizing less profit from sales in the current year after the occurrence of the natural disaster compared to the previous year.

If the rates of decrease in profits are equal to the rates of decrease in the variables that are present in the denominators, then there will be no change in the the values of corresponding ratios for the current year compared to the previous year. However, this does not mean that the natural disaster did not have an adverse impact on the company, as the profits in the current year are lower compared to the previous year, and this decrease affects the financial result of the business for the current year.

If for the current year the rates of decrease in profits are smaller than the rates of decrease of the variables that are present in the denominators of the expressions, then the corresponding ratios will be greater for the current year after the occurrence of the natural disaster compared to the previous year. This means that a unit of resource is engaged in making more profit in the current year than in the previous year. However, for the current year, the profits are smaller compared to the previous one, and this has an impact in the direction of reducing the financial result of the company.

The three analyzed scenarios for the potential impact of natural disasters on the company's profitability ratios can be successfully verified through different numerical examples.

Let's consider a company that sells production with prime cost $A = 120$, costs of sales are $B = 15$, and administrative expenses are $C = 30$. Let the net income from sales of production is V=200. Then the profit from sales of production, denoted by variable P, is calculated as follows:

$$P = V–(A+B+C) = 200–(120+15+30) = 200–165 = 35 \qquad (24)$$

Let's calculate the value of the *Profitability ratio of total costs invested in sold production* (16) with the above numerical values of the variables as follows:

Profitability ratio of total costs invested in sold production =

$$= \frac{P}{A+B+C} = \frac{35}{120+15+30} = \frac{35}{165} = 0.21 \qquad (25)$$

Let's consider the following scenario: It is assumed that a natural disaster has occurred and caused damage to the company's property. For this reason, prime cost of sold production decreased by 15% from 120 to 102), costs of sales decreased by 18% (from 15 to 12), and administrative expenses decreased by 10% (from 30 to 27). In addition, the net income from sales of production also decreases by 20% (from 200 to 160). Therefore, in this case the profit on sales is calculated as:

$$P = V–(A+B+C) = 160–(102+12+27) = 160–141 = 19 \qquad (26)$$

In this example, after comparing the values of (24) and (26), it can be seen that the *profit from sales of production*, P, is reduced from 35 to 19. This reduction is about 46% and is due to negative impact the natural disaster on the business activity.

In this case, the value of the *Profitability ratio of total costs invested in sold production* (16) is calculated as follows:

Profitability ratio of total costs invested in sold production =

$$= \frac{P}{A+B+C} = \frac{19}{102+12+27} = \frac{19}{141} = 0.13 \qquad (27)$$

It can be seen from (25) and (27) that there is a decrease in the value of this profitability ratio from 0.21 to 0.13. This is due to the impact on business of the natural disaster that occurred, which in this case leads to the fact that the rate of decrease in profit from sales of production is greater than the rate of decrease in the total costs invested in the sold production. In particular, the decrease in profit from sales of production is about 46% (from 35 to 19) and the decrease in total costs invested in the sold production is about 15% (from 165 to 141).

Let's consider a second scenario in which, due to the occurrence of a natural disaster, the rate of decrease in profit from sales of production equals the rate of decrease in total costs invested in the sold production (for example with 30%):

Profitability ratio of total costs invested in sold production =

$$= \frac{(1-0.30) \times 35}{(1-0.30) \times 165} = \frac{0.70 \times 35}{0.70 \times 165} = \frac{24.5}{115.5} = 0.21 \qquad (28)$$

In this case, the value of the profitability ratio (28) does not change, i.e. remains equal to 0.21 (25). However, there is a decrease in profit from sales of production due to the natural disaster that occurred, and this negatively affects the overall financial sustainability of the business.

Let's consider a third scenario and assume that after occurrence of a natural disaster the rate of decrease in profit from sales of production is less (for example with 30%) than the decrease in total costs invested in the sold production (for example with 40%). In this case, the profitability ratio (16) can be expressed numerically as follows:

Profitability ratio of total costs invested in sold production =

$$= \frac{(1-0.30) \times 35}{(1-0.40) \times 165} = \frac{0.70 \times 35}{0.60 \times 165} = \frac{24.5}{99} = 0.25 \quad (29)$$

As can be seen from (25) and (29) , if the rate of decrease in the profit from sales of production is less than the rate of decrease in the full costs invested in the realization of this profit, then the value of the profitability coefficient increases (here from 0.21 to 0.25). However, this in case the profit from sales of production is less (P=24.5) after the impact of the natural disaster compared to the profit from sales of production before the disaster (P=35). However, it should be noted that this circumstance affects the financial sustainability of the business.

It is important to point out that for the sustainability of the business it is good for the experts working in the financial management of the company to know very well the essence of these two business indicators (economic efficiency and profitability). Therefore, after the occurrence of a natural disaster that caused material damage to the company, it is necessary to calculate and analyze these business indicators. Then it is necessary to propose to the management of the company adequate measures aimed both at overcoming the adverse consequences and at restoring the values of these business indicators to pre-disaster levels. Certainly, it is better if these measures lead to an increase in the values of the economic efficiency and profitability of business.

5. CONCLUSIONS

The essence and their respective coefficients of the two business ratios are described. Numerical results of several applications of the proposed approach with particular values of the variables that are included in the expressions describing the two business indicators are presented. The results of the analysis of the calculated values of the relevant ratios related to the two business indicators (economic efficiency and profitability of the business) before and after the possible occurrence of a given natural disaster can successfully support decision-making financial managers to take adequate measures to reduce the potential negative consequences, recover the normal operative activity or increasing resilience of companies.

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