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FORECAST OF THE PROFITABILITY OF A COMPANY IN THE MEDICAL ADHESIVES MARKET

Dissertação no âmbito do Mestrado em Métodos Quantitativos em Finanças, orientada pelos Professores Doutor Pedro Bação e Doutor Joshua Duarte e apresentada ao Departamento de Matemática da Faculdade de Ciências e Tecnologia e à Faculdade de Economia.

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Resumo

Esta tese visa prever o desempenho financeiro das empresas que operam no mercado dos adesivos médicos entre 2022 e 2031. Para tal, começa por determinar quais os factores macro e microeconómicos que tiveram impacto na rentabilidade das empresas, usando um modelo de efeitos fixos. Adicionalmente, foi usado um modelo ARIMA para prever a evolução das variáveis explicativas presentes no modelo de efeitos fixos seleccionado. A rentabilidade de cada empresa foi então prevista através da conjugação do modelo de efeitos fixos com as previsões obtidas através dos modelos ARIMA. Finalmente foi feita uma análise de cenários para determinar como a rentabilidade de cada empresa responderia a cenários optimistas e pessimistas.

Palavras-chave: adesivos médicos, rendibilidade, previsão, análise de cenários

Abstract

This thesis aims to predict the financial performance of companies operating in the medical adhesives market between 2022 and 2031. To this end, it starts by determining which macro and microeconomic factors had an impact on companies' profitability, using a fixed effects model. Additionally, an ARIMA model was used to predict the evolution of the explanatory variables included in the selected fixed effects model. The profitability of each company was then predicted by combining the fixed effects model with the forecasts obtained from the ARIMA models. Finally, a scenario analysis was performed to determine how each company's profitability would respond to optimistic and pessimistic scenarios.

Keywords: medical adhesives, profitability, forecasting, scenario analysis

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Chapter 1

Introduction

The topic of this thesis was suggested by an internship carried out at besthealth4u (BH4U). BH4U creates medical adhesives that prevent skin injuries, accelerate healing and improve the overall ostomate patients health. Their solutions are petroleum-free, CO2 free and zero-waste. BH4U has been developing innovative products such as Bio2Skin, a state-of-the-art glue-less adhesive that adheres tightly to the skin and peels off without causing pain or irritation. BH4U is a relatively recent player in the market for medical adhesives, where it competes with well-known firms such as Beiersdorf and Johnson & Johnson. To succeed, BH4U must make the best use of its resources. Thus, planning plays an important role in BH4U, and planning requires forecasts.

In this thesis I develop a model to forecast the profitability of companies in the medical adhesives market. I proceed in three steps. First, using data from five other companies — Baxter Int. (1), Beiersdorf (2), Cryolife (3), Coloplast (4) and Johnson & Johnson (5) — that sell similar products to BH4U, I estimate the relationship between profitability and a set of company and macroeconomic variables Second, I construct forecasts of the macroeconomic framework. Finally, using the macroeconomic forecasts, I make a forecast of the companies' profitability. A 22-year database (2000-2021) was used and the forecasts concern the profitability of each company.

The following questions are the focus of this study:

- What macroeconomic variables matter for companies' profitability?
- What microeconomic variables are useful for forecasting companies' profitability?
- What is the likely evolution in the next decade of the profitability of the companies in the sample?

The fixed effects model was employed to model the link between business profitability and macro and microeconomic variables, with profitability measured by the return on assets (ROA). Numerous studies, identified in the literature review, have already been conducted on this subject of the determinants of companies' profitability. However, the majority of them seem to be devoted to the banking sector. Models with some similarity to the model used in this thesis have also been used to model the profitability of investments in the stock market. In general, the results in that literature indicate that the growth rate of the gross domestic product (GDP), the interest rate, the inflation rate, the exchange rate, the level of industrial production, and oil prices appear to have some impact on companies' profitability. On the side of microeconomic factors, firm size, firm growth, and leverage seem to be the most useful for forecasting profitability. Furthermore, according to those studies, ROA is negatively impacted by factors like leverage, interest rates, exchange rates, oil prices, and inflation. In contrast, firm size, firm growth, and the growth rate of GDP appear to have a favorable effect on profitability. However, several studies report results that are somewhat unexpected. For instance, oil prices have been found to impact companies profits positively. The same happens in this thesis.

Besides the fixed effects model, this thesis also uses the Autoregressive Integrated Moving Average (ARIMA) model. The ARIMA model was used to produce forecasts of the macroeconomic variables that were found to be relevant for the profitability of medical adhesives companies.

The next chapters are organized as follows. Chapter 2 presents the historical background of BH4U and describes the market where it operates. Chapter 3 presents a literature review. Note that the studies reviewed concern the determinants of profits of companies in markets other than the market where BH4U competes — studies concerning this market do not seem to exist. Chapter 4 explains the rationale behind the selection of the dependent and independent variables. The fixed effects and ARIMA models are described in Chapter 5. The results of these models are presented in chapter 6. Chapter 7 concludes.

Chapter 2

Historical context

A surgery that involves the formation of an ostomy can be performed for a variety of reasons, incluing cancer, trauma, inflammatory bowel disease and obstruction. An ostomy is a surgical procedure done on a portion of the gastrointestinal or urinary systems that allows feces and urine to exit the body's natural excretory channels [1]. This surgical surgery may be a temporary or a permanent solution, and complications may arise that have an impact on a person's quality of life on the physical, psychological, social and spiritual levels. There was clearly a need for an adhesive that would aid ostomy patients. An adhesive is a product that can be used to bind two surfaces such that they remain in close contact. Two factors work together to create adhesion: the size of the area in physical contact between the two surfaces and the degree of chemical attractiveness between the two surfaces. Adhesives play an important role by supporting the ostomy bag and protecting the peristomal skin from being exposed to stoma effluent.

Dental, internal medical devices and equipment, and external medical applications are all part of the medical adhesives industry. The medical adhesives market is antecipated to reach USD 15.15 billion by 2028, at a compound annual growth rate (GAGR) of 7.5% between 2022 and 2028, according to the most recent industry research analysis released by SNS Insider in June 2022 [43]. According to an article published by the World Health Organization in 2019 [50], there has been a substancial increase in the number of persons with cardiovascular diseases. At the same time, the number of elderly people is predicted to double by 2050, compared to 2017, and reach 2.1 billion, according to the United Nations projections [11]. These two developments, together with the incidence of Alzheimer's disease, hypertension, type 2 diabetes, osteoporosis arthritis, colorectal cancer, cardiovascular disease and atherosclerosis, are significant reasons to expect the expansion of the medical adhesives industry. According to Grand View Research [38], internal medical applications dominated the global market for medical adhesives in 2019. It is predicted that this segment will experience the fastest revenue growth from 2020 to 2025, with a CAGR of 8.6%. The medical devices and equipment market, which accounts for 13% of BH4U's total available market (TAM), has a serviceable available market (SAM) of 1573 million USD.[1] These medical device adhesives are utilized in a variety of applications, including pacemakers, catheters, tube sets, masks, needles and syringes, and polycarbonate devices. The demand for the adhesive used in these devices is anticipated to increase. External medical

[1] TAM is the total potential revenue for a good or service, taking into account potential future growth Team [47]. SAM describes the market a company can reach at the moment, including the limitations of its location and business model.

applications, which is the SOM (Serviceable Obtainable Market[2]), worth 847 million USD, of BH4U and represents 7% of the TAM, include wound dressing, skin tissue adhesives, transdermal patches, bandages, surgical drapes, electrodes and ostomy care. In external medical applications, adhesives are replacing traditional closure methods such as wires, sutures and staples, owing to several limitations of these techniques. Since the Bio2Skin adhesive produced by BH4U is a biomaterial, ostomy, wearable, and wound dressings are the initial target use cases.

Due to the enormous demand, robust purchasing power and opportunities for innovation in the healthcare industry, the North American region has the biggest market share. In 2020, the U.S. accounted for over 33.7% of global market size according to Global New Wire [51]. The medical adhesives market in North America is expanding as a result of the government covering 60-65 percent of all healthcare expenditures and services.

The Asia-Pacific region is expected to generate the fastest growth in the coming years because of the rising population, the urgent demand for better medical facilities, numerous government initiatives, the presence of high-tech medical product manufacturing facilities, rise in presence of prominent players, increasing R&D activities and the region's quickly rising healthcare spending [51]. China is forecast to grow at a 9.3% CAGR for the period of 2020-2027 and is expected to reach an estimated market size of $1.4 billion in 2027 [51]. Japan and Canada are forecast to grow at 5.5% and 6.1%, respectively, over the 2020-2027 period [51].

Within Europe, Germany is expected to grow at 6.1% CAGR in the same period, while the rest of the European market will reach $1.4 billion in 2027 [51]. The European market for medical adhesives is experiencing considerable growth, due to the rising elderly population. According to the European Cardiovascular Disease Statistics [17], cardiovascular disease accounts for 45% of all deaths in Europe, which is a significant factor in driving demand and consumption of medical adhesive products. Europe has also witnessed an increase in per capita healthcare spending, driving additional market growth. This region has the most technologically advanced healthcare industry in the world after the USA and accounted for the second largest revenue sector in 2018 [51].

The Latin America, Middle East and Africa markets registered moderate growth rate over the 2020-2027 period [51]. These regions are projected to register a significant growth in the coming years because of the high burden of cancers, rising geriatric population and increased government funding.

The global medical adhesives market is characterized by the presence of several big and small players. Some of the important companies in this market are 3M (USA), Baxter International Inc. (USA), Strzker (USA), Dentsply (USA), Bostik (USA), Henkel (Germany), H.B. Fuller (USA), and Beiersdorf (Germany). According to Beiersdorf's annual report for 2021 [2], the company has a higher percentage of sales in Europe (48.2%), followed by Africa, Asia and Australia (31.8%) and Americas (20%). Since 1998, based on the information contained in the annual reports, the continent where Beiersdorf has the largest percentage of sales is Europe. The Baxter International company, according to its 2020 annual report [20], has the highest net sales in the Americas (6069 million USD), followed by EMEA (Europe, Middle East and Africa - 3129 million USD) and APAC (Asia Pacific region - 2475 million USD). The Americas is the region where Baxter International has the highest

[2] SOM is the revenue a company expects to capture within a specific product segmentation; in other words, SOM provides an estimate of how muh a firm may earn given the demand for its products, consumer interest and competition.

percentage of sales, since 1998, according to its annual reports. Johnson & Johnson evidenced in 2021, as mentioned in its annual report [24], in sales, $47.2 billion in the United States (U.S.), $23.6 billion in Europe, $17.3 billion in Asia-Pacific, Africa and $5.7 billlions in the Western Hemisphere. Since 1998, Johnson & Johnson has a higher percentage of sales in U.S. According to Coloplast's Annual Report [8], in 2021 the revenue of Coloplast in European markets (Wester, Northern and Southern Europe) was 11.3 billion DKK in other developed markets (USA, Canada, Jpan, Australia and New Zealand) was 4.8 billion DK and in emerging markets (all other markets) was 3.4 billion DKK. Cryolife has the highest percentage of sales in the United States, with revenues of 79.4 million dollars in 2021, according to the company's annual report [9].

One of the weaknesses of this thesis is the fact that it only includes five companies in the dataset. The five companies are Baxter International, Beiersdorf (which also partners with BH4U: they are in trials of the adhesives produced by BH4U), Cryolife; Johnson & Johnson and Coloplast. It was necessary to define a small sample size in terms of companies in order to be able to collect data for a longer period — the resulting database spans 22 years. For other companies in the same market it was not possible to collect a sufficiently long times series without significant gaps. Nevertheless, the fact that the five companies included in the dataset the ones that control the medical adhesives market, according to data from the Markets and Markets [28], provides some confort and a justification for the choice made regarding the composition of the sample.

Chapter 3

Literature review

Previous studies on the relationship between macroeconomic variables and firm profitability/returns mostly concern the banking industry and the stock exchange market. The majority of the studies have not included macroeconomic variables as possible influences on company's profitability. In addition, there are few or no studies available on profitability forecasting for companies in the medical adhesives market.

Pasiouras and Kosmidou [37] studied 584 European banks between 1995 and 2001 and showed that inflation had a small positive influence on profitability of domestic banks and a negative impact on foreign banks. Serrasqueiro et al. [41] looked into the relationship between the microeconomic factors and profitability of 162 Portuguese companies between 1999 and 2003. According to the study's findings, size and expansion had a positive and statistically significant impact on the dependent variable, whereas debt had a negative and significant effect on profitability.

Lee and Lee [27], argued that firm size, financial leverage, reinsurance, underwriting risks, liquidity ratio and return on investment had a significant impact on firm performance.

Boldeanu and Pugna [5], conducted research on the pharmaceutical industry in the EU. The paper's major goal was to analyze the financial performance of the EU pharmaceutical industry and pinpoint its advantages and disadvantages. The research also examined the primary elements influencing the financial performance (return on equity, ROE) of businesses in that industry. According to the analysis, the variables that have the biggest effects on ROE are related to liquidity, risk, and growth dynamics. The ratio of R&D costs to total costs, administrative costs, and the price to book ratio were other significant variables. Lee [26], studied the impact of firm specific factors and macroeconomic variables on profitability of property liability insurance industry in Taiwan between 1999 and 2009. Underwriting risk, reinsurance, input cost, firm size, firm growth, diversification, inflation rates, economic growth and financial holdings group were significantly and positively correlated with the operating ratio (pretax operating income from underwriting and investment activities). Return on investment (ROI) and market share had a significant and negative influence on the operating ratio. Financial leverage was significantly and negatively correlated with ROA, while underwriting risk, reinsurance, input cost, financial holdings group and ROI had the same impact as on the operating ratio. Firm size, market share were positively related to ROA and firm growth. Diversification, economic growth ratio and inflation rates had a negative influence on ROA, but were not significantly different from zero.

Chowdhury [7] study Islamic banks and argue that inflation had a positive significant influence on their ROA.

Issah and Antwi [23] used Principal Component Analysis (PCA) and Multiple Regression Analysis to analyse the relationship between the performance of UK's public listed companies and 59 macroeconomic variables compiled by Stock and Watson [45]. The authors concluded that real GDP, the adjusted unemployment rate and the exchange rate (value of foreign currency relative to US dollar) had a significant positive impact on firm performance.

Martinho et al. [29], from Banco de Portugal, studied the relation between bank profitability and macroeconomic factors. The authors' aim was to understand how bank profitability is impacted by macroeconomic and bank-specific factors. They came to the conclusion that macroeconomic factors account for a large share of variations in EU banks' ROA. Pacini et al. [35], studied how firms perform during the business cycle and the macroeconomic factors that most influence industrial firms' performance. The authors used estimation method proposed by Shintani and Guo [42] and found that the rate of domestic debt interest payments to the net borrowing, the rate of domestic debt interest payments to total income tax, GDP and inflation rate were significantly and positively related to profitability. However, the rate of short term foreign debts to central bank international reserves, exchange rate, and interest rate were significantly and negatively related to profitability.

Obeng-Krampah [32], examined the relationship between macroeconomic factors and the performance of firms listed on the Ghana Stock Exchange (GSE), using partial regression and panel data from 2007 to 2015. The study found that size, inflation and interest rate significantly and negatively affect ROA and ROE, respectively. Dividend-pay-out and company growth improved firm profitability. Leverage negatively affected ROE and positively affected ROA, with a statistical significance of 5 percent. Egbunike and Okerekeoti [13], explored the interrelationship between macroeconomic factors, firm characteristics and financial performance of quoted manufacturing firms in Nigeria. The results were that the interest rate and exchange rate had a negative but non-significant effect, while the inflation rate was significantly and negatively related to dependent variable. GDP had a positive and significant effect on ROA. Firm size, leverage and liquidity were also significantly and positively related to the dependent variable.

A study conducted by Ismail et al. [22] concluded that GDP and the interest rate have a significant effect on firm performance, while the Consumer Price Index had a smaller impact on it. Heidari et al. [18] examined the effect of macroeconomic variables on the pharmaceutical industry in Iran using VAR models, with monthly data from 2005:1 until 2016:3. The results were that the effects of the money growth shocks and shocks to the inflation rate of healthcare had enormous effects on the pharmaceutical industry's returns and volatility, respectively. Islam et al. [21], examined the factors that affect profitability of the pharmaceutical industry in Bangladesh using the random effects model and data on 20 listed pharmaceutical companies in Bangladesh. The panel dataset covers the period between 2007 and 2016. The findings showed that operating income, ROE and firm size had a positive impact on proftability of the pharmaceutical firms. However, operation costs and the liabilities of the firm affected negatively the profitability.

Kulustayeva et al. [25] used a panel dataset, from 2012 to 2018, of insurance companies in the Republic of Kazakhstan, in order to assess the determinants of profitability. The authors found that leverage had the largest and negative influence on profitability. Growth and earnings had a negative influence on profitability, while size, liquidity and age had a positive impact. De Leon [10] studied the effect of credit risk and macroeconomic factors on the profitability of 20 ASEAN banks, from Indonesia, Malaysia, Thailand and Philippines, covering the period of 2012 to 2017. The author used a fixed effects model and a random effects model followed by simple ordinary least squares (OLS) regression. The conclusions were that credit risk and GDP growth had a negative influence on ROE at the 5% level of significance. The inflation rate had a positive (the highest) impact on ROE, followed by GDP growth and credit risk. The same results were obtained when ROA was the dependent variable.

The majority of the literature have little to do with the market for medical adhesives. The previous research that uses ROA or ROE as a measure of firm profitability and incorporates macro and microeconomic factors relates to markets other than the one this thesis focuses on. Yet, I think they constituted a important foundation for the approach used in this thesis.

Chapter 4

Variables

This section discusses the variables chosen for inclusion in the empirical model. The definitions and sources are presented in Table 4.1.

4.1 Profitability

The profitability of organizations is the first thing that investors want to verify. It is a measurement that can be use to describe a business's long-term success. In other words, it is an organization's ability to generate income by using resources that it has available, such as time, people and equipment. When someone wants to create a company, his/her main goal has to be profitability since it is the money that business ventures generate through their activities that will enable the firm to pay for the resources it uses and stay in the market. It also enables those ventures to grow, develop new products or enter new markets. Profitability indicators are used to measure a company's overall financial health over a given period of time, and also to compare similar firms across the same industry or to compare industries or sectors. It is measured mostly by financial ratios, such as the Return on Assets (ROA), the Return on Capital (ROC), and the Return on Equity (ROE), according to Venkatraman and Ramanujam [49].

Entrepreneurs can do many things to increase profits and help their company achieve their primary goal. The factors that may impact a business venture's profitability are: demand, competition, size, productivity, direct expenses, overhead and advertising [48]. Demand refers to the number of products or services that consumers are willing to purchase. Companies have to create products that meet client requirements and needs, if they want to increase their revenue and increase the chances of accomplishing profitability. Competition can be divided into direct, indirect, potential, replacement and future competition, according to Rodrigues [39]. When a company faces higher competition than others, it may find it harder to be profitable because it competes with many similar companies that offer similar, or even the same, products. To raise sales, the company has to lower prices to make its product more attractive to its customers. Alternatively, if a company is developing a new business concept, like BH4U, the best choice is to find a market niche or a product which there is a high demand but where not many companies sell. The size refers to the benefit of expanding the production process when the company has successfully established a production line that makes a profit and increasing output would not exceed the customer demand. Some companies have to increase productivity to accomplish profitability, that is, it may be necessary to be able to increase output without spending more on production. In this case, a step towards higher profits may be to upgrade their equipment or set higher sales commissions. The direct expenses are one of the main factors that companies need to be careful about if they want to be profitable. The rule is, if a company is producing more this means that it purchases more raw materials, which may be risky if the company miscalculates the demand because it may end up with a lot of products that customers are not willing to buy. So, to avoid this, it is important to conduct consumer research; this research will help business development and product teams to better estimate that demand. Overhead refers to the ongoing expense of running a business. One example of overhead is the cost of top-level management. If a business decides to hire a more qualified management team that uses their experience and expertise to develop higher quality products, this increase in overhead may allow the company to make more money. Finally, advertising increases a company's expenses but obviously it may increase sales. Small and mid-sized companies usually hire external advertising agencies to develop and run ad campaigns for them.

As mentioned above, profitability can be measured by different indicators. In this thesis, the profitability indicator is the Return On Assets (ROA). ROA is, according to Birken and Curry [4], a ratio that compares the value of a business's assets with the profits it produces over a certain period of time. This measure, of how much profit a company can generate from its assets, is a tool used by managers and financial analysts to determine how efficiently a company is using its resources to make a profit. To obtain ROA simply divide net profit by total assets, which are available on the company's income statement and balance sheet, respectively. If a firm's ROA rises over a certain period of time, it indicates that the firm is getting more profits out of each dollar it owns in assets. In this thesis we used ROA because the companies included in the sample are from the same industry and thus ROA should be determined in a similar way at all of those companies. ROA reflects the influence of the assets' management and it is acknowledged as a key indicator of companies' performance. It is also a key indicator of their economic growth potential as mentioned in Helfert [19].

4.2 Firm performance

Firm performance and firm profitability are two concepts that are strongly connected. If a company has good performance, it has the ability to maintain long-term profits. This ability has two viewpoints: general and intrinsic dimensions. The general dimension refers to auxiliary components that characterize the environment in which a company operates, and includes the administrative system of a given nation and the level of global trade. This dimension also includes industry-related factors and the influence of macroeconomic dimensions (inflation rate, interest rate, exchange rate, GDP and among others). The intrinsic dimension alludes to individual firm practices which allow it to maintain their performance in the long-term: governance (practices, procedures and structures that guarantee the successful administering of the firm), organizational (practices and procedures which include well-working of the administration of a company), functional (operational procedures, such as promoting techniques and advancement), sustainability (talent advancement and digital factors concerns forms that empower companies to guarantee the viability of its governance, organizational and functional factors), talent development and digital factors, as mentioned by Seashore and Yuchtman [40].

4.3 Macroeconomic variables and profitability

Macroeconomic stability is important for achieving economic growth, and this will correspond to the growth of companies. Over the years, many studies, concerning a large sample of countries, have suggested that growth, investment and productivity are positively correlated with macroeconomic stability Easterly and Kraay [12]. If macroeconomic stability is low, domestic and foreign investors will stay away and resources will be diverted elsewhere.

In this thesis, the macroeconomic factors that were studied as possible influences on profitability were the OECD Gross Domestic Product (GDP) growth rate, the interest rate, the exchange rate, the inflation rate, industrial production, the OECD unemployment rate and oil prices. The macroeconomic factors may have a positive or a negative effect on the economy. Factors with a positive effect stimulate economic growth by encouraging industries to expand and increasing the spending power of the population. Factors with a negative effect refer to unforeseen events or policies that make economic expansion difficult. High unemployment and rising inflation are examples of macroeconomic variables that are likely to have a negative influence on the sales and profits of many firms.

4.3.1 GDP growth rate

GDP is the total market value of final goods and services that are produced by a country's economy during a given period of time. As mentioned by Mwangi [30], GDP is the main macroeconomic indicator that is used to measure total economic activity within an economy and its growth rate reflects the state of the economic cycle.

GDP growth implies increased economic activity in a country, leading to higher industry profitability. An economy with stable economic growth is more likely to be associated with predictable demand and higher firm profitability. In general, an increase in GDP means people spend more, more jobs are created, more taxes are paid and workers get pay rises. In other words, a higher GDP means that companies will hire new employees, pay higher salaries, open new departments and promote more products. But, if GDP declines, businesses would need to make savings, which will require layoffs and cost-cutting measures. For these reasons, GDP is often used by businesses to predict whether their industry will grow or fall. Investors, on the other hand, may also consider GDP while determining whether or not to invest in companies in a certain country. It may be challenging for businesses to find investors ready to invest in them while the GDP is dropping.

Since the companies in the sample used in this thesis sell products worldwide, it was considered more appropriate to include the OECD's GDP, more precisely, the real growth rate of OECD' GDP.

4.3.2 Interest rate

The interest rate is the amount a lender charges a borrower, that is, it is the cost of borrowing money or the reward of saving it. In this thesis real interest rates were used. Absent taxes and other elements, these reflect the true cost of funds to the borrower and the real yield to the lender/investor. It tells how much purchasing power an investor, or saver, or lender, earns from that interest. According to Group [16], the "real interest rate is defined as the lending interest rate adjusted for inflation as measured by the GDP deflator". The lending rate is the bank rate that usually meets the short and medium-term financing needs of the private sector [16]. The real interest rate is used in many economic theories to explain phenomena like capital flight, business cycles and economic bubbles. In situations where the real interest rate is high (demand for credit is high), the money will move from consumption to savings, *ceteris paribus*. In contrast, if the real interest rate is low, demand will move from savings to investment and consumption.

When inflation is too high, the Central Bank increases interest rates. Higher interest rates affect personal life because they increase the cost of borrowing; they increase the return of savers; they lead to higher mortgage interest payments; they increase the cost of bank loans; and may reduce the confidence of borrowers. An increase in interest rates will influence economy because the currency will appreciate (exports will be less competitive and imports cheaper); inflation will tend to be lower; economic growth will be slower; unemployment may increase and the government will see a rise in borrowing costs. Fluctuations in the interest rate exposes the firm's financial position to a risk situation. Thus, real interest rates are expected to be one of the factors in the determination of profitability.

4.3.3 Inflation rate

Inflation is a sustained increase in the general level of prices for goods and services. Inflation occurs when the demand for goods and services produced in a country exceeds production. The inflation rate can be measured by indexes such as the Consumer Price Index (CPI), the Producer Price Index (PPI), and national accounts deflators. In this document, the inflation rate was measured as the percent change in the CPI.

The inflation rate determines the purchasing power of money: if prices rise then one unit of money buys fewer goods and services. However, this increase in the general level of prices not only affects the purchasing power of money but all the economy, from business investment and employment rates to government programs, tax policies and interest rates. As Fama [14] argued, inflation is negatively correlated with profitability.

4.3.4 Exchange Rate

The exchange rate is determined by the economic activity and market interest rates in each of the countries. It affects the price of exports when converted into a foreign currency and the price of imports when expressed in domestic currency. Thus, the exchange rate influences the whole economy, so it is a major economic factor for growth, stability and economic development. Fluctuations in exchange rates affect firm's export opportunities which may be an negative influence in profitability.

In this work was used multilateral exchange rates, which is the value of a currency against a set of other currencies. This rate is a nominal effective exchange rate adjusted for relative movements in the national price deflator or cost indicators [16].

The exchange rates and volatility are two concepts that are associated. Volatility represents the degree to which a variable changes over time and can be used to describe the degree of risk implied by that variable. Exchange rate volatility is an important factor that agents take into consideration when making investment and transaction decisions abroad. Excessive exchange rate volatility creates uncertainty in the economy, which negatively affects economic growth by affecting investment and investor confidence, productivity, consumption and international trade and capital flows, according to

Oaikhenan and Aigheyisi [31]. In this thesis, the absolute value of the exchange rate variation rate is used as the measure of volatility in each period.

4.3.5 Industrial Production

According to the OECD [33], the industrial production index (IPI) measures the output of industrial establishments, i.e., sectors such as mining, manufacturing, electricity, gas and steam and air-conditioning. The data from industry production is a very important source of information on current economic conditions for managers and investors. The composite index is also a crucial macroeconomic indicator for economists and investors, that is, fluctuations in the industrial sector are related to overall economic growth.

4.3.6 Unemployment rate

The OECD unemplyoment rate was used in this thesis, again because the companies included in the sample sell to the whole whorld. As stated by [34], the unemployed refers to people of working age who do not have work, are available for work and have taken specific steps to find work. The unemployment rate is the percentage of unemployed in the labor force. The unemploymente rate is a lagging indicator, that is, change in the unemployment rate tend to track with a delay changes in economic activity.

Unemployment affects everybody, from an individual to a big company. When people are unemployed, they lose income and the nation, as a whole, loses their contribution to the economy in terms of goods and services that could have been produced. Unemployment ups and downs have a direct impact on business ups and downs. In what concerns companies in the medical adhesives market, such as BH4U, when the unemployment rate increases, demand for their output is likely to be significantly negatively affected, because it will lower people's income. In other words, if people have a lower purchasing power, they will be not able to access the healthcare they need, which will greatly decrease the profitability of the companies.

4.3.7 Oil prices

Oil plays a critical role in the global economy, despite the necessity to reduce its use and to find alternative green energy sources. Oil is a high-demand global commodity, which means that major fluctuations in price can have a significant economic impact. The price of oil is affected by current supply (total world output of oil), future supply (depends on oil reserves) and expected global demand. One of the most recent examples was the Covid-19 pandemic, which led many governments to restrict travel and close businesses to contain this pandemic, which resulted in a drop in demand for oil, reducing oil prices. However, the war between Russia and Ukraine worsened the situation, dramatically increasing oil prices.

Most industrial glues are petroleum-based, which means that changes in oil prices might affect the profitability of those industries. As it was mentioned before, many companies in the market produce medical adhesives which work with acrylate, silicone and hydrocolloids. Acrylate, for example, is a product derived from petroleum. Part of the material of hydrocolloids is also petroleum-based and synthetic. Rising input prices for companies associated with an increase in oil prices will reduce profit margins. In addition, when we are in a period of high oil prices, investors become more uncertain about the outlook for corporate earnings, which may lead to higher equity risk premiums.

4.4 Microeconomic variables

In this thesis we selected three "microeconomic variables" for inclusion in the ROA model, i.e., characteristics of the firm that may help predict profitability: firm size, firm growth and leverage. Firm size refers to the amount of resources available to the firm and is measured by total assets. Total assets refers to the total amount of assets owned by an entity or person. The values used were total assets deflated, in dollars, using the GDP deflator (2010=100). The natural logarithm of total assets was used to stabilise the variance of the measure. Firm size is related to a firm's performance. As mentioned by Stierwald [44], bigger firms are more productive than smaller firms. Thus a bigger firm is likely to have easier access to funding. Firm growth occurs when firms increase their size, which can involve replication or diversification into new markets, and may be measured in terms of revenues. Revenue is the money generated from normal business operation and is obtained by calculating the average sales prices times the number of units sold. We initially put all revenues in dollars and then we applied the GDP deflator to obtain deflated revenues of each company. We expect to observe a positive impact of firm size and firm growth on companies' profitability.

Leverage refers to using debt in order to finance an investment or project. Companies use debt financing to invest in business operations in an attempt to increase shareholder value. To evaluate a company's financial leverage we can use many ratios, such as debt-to-equity (D/E) ratio, which is calculated by dividing a firm's total liabilities by its shareholder equity. This metric is very important in corporate finance, since it measures the degree to which a company is financing its operations with debt rather than its own resources. In other words, the D/E ratio tells how much debt a company has taken on relative to the value of its assets net of liabilities. A higher D/E ratio indicates a leveraged company, which may be good when a firm is growing or stable and generating significant cash-flows, but not when a company is in decline. Earnings of firms that are highly leveraged are riskier and volatile. For all these reasons, I expected an inverse relationship between firm profitability and leverage.

Table 4.1 Data definitions and sources

Variable	Meaning	Source
	Dependent variable	
ROA_{it}	Return on Assets for firm i in period t	Annual report of each firm
	Macroeconomic variables	
$GDPGR_{it}$	OECD GDP growth rate for firm i in period t	OECD
IR_{it}	Interest rate for firm i in period t	The World Bank
IF_{it}	Inflation rate for firm i in period t	The World Bank
IP_{it}	Industrial production for firm i in period t	FRED
ER_{it}	Exchange rate, absolute value of the rate of change of the exchange rate, for firm in in period t	The World Bank
UR_{it}	OECD unemployment rate for firm in period t	OECD
OP_{it}	Oil prices, average annual WTI crude oil prices, for firm i in period t -	Statista and FRED
	Control variables	
FS_{it}	Firm size, natural logarithm of total assets, for firm i in period t	Annual report of each firm
FG_{it}	Firm growth, in sales, for firm i in peirod t	Annual report of each firm
LEV_{it}	Leverage, debt-to-equity ratio, for firm i in period t	Annual report of each firm

Chapter 5

Fixed effects and ARIMA models

5.1 The fixed effects model

We used the fixed effects model to estimate the parameters that relate the dependent variable to the explanatory variables. This model assumes that the independent variables have a constant relationship with the dependent variable across all observations. Additionally, the model assumes that error term is given by $\alpha_i + \varepsilon_{it}$, where α_i is a unit-specific and time-invariant component (the fixed), and ε_{it} is an observation-specific error, uncorrelated with the explanatory variables and with its past values. The fixed effects model is given by (e.g. Greene [15]):

$$Y_{it} = X_{it}\beta + \alpha_i + \varepsilon_{it} \tag{5.1}$$

The matrix form of the T observations for the i-th individual is:

$$\begin{bmatrix} y_{i1} \\ y_{i2} \\ \dots \\ y_{iT} \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ \dots \\ 1 \end{bmatrix} \alpha_i + \begin{bmatrix} x_{1i1} & x_{2i1} & \dots & x_{Ki1} \\ x_{1i2} & x_{2i2} & \dots & x_{Ki2} \\ \dots & \dots & \dots & \dots \\ x_{1iT} & x_{2iT} & \dots & x_{KiT} \end{bmatrix} \begin{bmatrix} \beta_1 \\ \beta_2 \\ \dots \\ \beta_K \end{bmatrix} + \begin{bmatrix} \varepsilon_{i1} \\ \varepsilon_{i2} \\ \dots \\ \varepsilon_{iT} \end{bmatrix} \tag{5.2}$$

It is possible to use a dummy variable for each cross-sectional unit to estimate the fixed-effects parameters, besides the β's (this approach is usually known as the Least Squares Dummy Variables — LSDV — estimator):

$$y_{it} = \beta_1 x_{1it} + \dots + \beta_K x_{Kit} + \lambda_1 D1_i + \dots + \lambda_n Dn_i + \varepsilon_{it} \tag{5.3}$$

where Dj_i, $j = 1, \dots, n$, are dummy variables corresponding to each individual, i.e. their value is 1 when $j = i$ and zero otherwise. The above equation can estimated using ordinary least squares, which, under the assumptions given, will provive estimates that are unbiased and consistent.

An alternative estimation approach employes the within estimator. In this case, instead of estimating the model with the individual dummy variables, one estimates the model in deviations-from-the-mean form, i.e., after subtracting the individual mean from each variable:

$$\tilde{y}_{it} = \beta_1 \tilde{x}_{1it} + \dots + \beta_K \tilde{x}_{Kit} + \tilde{\varepsilon}_{it} \tag{5.4}$$

where

$$\tilde{y}_{it} = y_{it} - \bar{y}_i \tag{5.5}$$

with the "group mean", $\bar{y}_i$, defined as

$$\bar{y}_i = \frac{1}{T}\sum_{t=1}^{T} y_{it} \tag{5.6}$$

Given parameter estimates ($\hat{\beta}$) obtained from the data, it is possible to retrieve estimates of the α_is from the following formula:

$$\hat{\alpha}_i = \bar{y}_{it} - (\hat{\beta}_1\bar{x}_{1it} + ... + \hat{\beta}_K\bar{x}_{Kit}) \tag{5.7}$$

The LSDV and the within-groups estimator provide the same estimates of the model's parameters.

The first-difference (FD) estimator can also be used to estimate the fixed effects model. In fact, if the FD estimator is used, the individual effect α_i can be assumed to be correlated with the explanatory variables ($COV(\alpha_i, X_{it})) \neq 0$) because that will not affect the consistency of the estimator. The FD estimator estimates an equation obtained by subtracting equation (5.3) lagged one period from that same equation (5.3), losing the first observation in the process. The lagged equation is

$$y_{it-1} = \beta_1 x_{1it-1} + ... + \beta_K x_{Kit-1} + \lambda_1 D1_i + ... + \lambda_n Dn_i + \varepsilon_{it-1} \tag{5.8}$$

After subtracting this equation from equation (5.3), we obtain a model in first differences that can be estimated by OLS:

$$\Delta y_{it} = \beta_1 \Delta x_{1it} + ... + \beta_K \Delta x_{Kit} + \Delta\varepsilon_{it} \tag{5.9}$$

However, this method has autocorrelated errors because $\Delta\varepsilon_{it} = \varepsilon_{it} - \varepsilon_{it-1}$ and $\Delta\varepsilon_{it-1} = \varepsilon_{it-1} - \varepsilon_{it-2}$, i.e., the ε_{it-1} is a common element of the two error terms.

In the model estimated in this thesis, the lag of the dependent variable was included as an explanatory variable:

$$y_{it} = \rho y_{it-1} + \beta_1 x_{1it} + ... + \beta_K x_{Kit} + u_{it} \tag{5.10}$$

This lag of the dependent variable can be problematic because if the error u_{it} includes an individual effect (α_i) then the y_{it-1} is correlated with the error term, because the value of α_i affects y_{is} in every period s. This problem is overcome by the LSDV/within estimator when the number of observations T is large.

Since the α_i component is connected with the explanatory factors over all time periods, the fixed effects model was chosen as the best alternative to represent panel data. Yet, since α_i is considered a fixed effect, it is preferable to adopt the fixed effects model since the observations come from the entire population, whereas what we want to do is draw conclusions for the people for whom we have data.

An alternative to the fixed effects model is the random effects model, which assumes that the unobserved individual effect is uncorrelated with the explanatory variables. That would lead to using the random effects estimator (e.g. Greene [15]). However, consistency of the random effects estimator requires a large number of individuals in the sample. In this thesis, the data used comes from just five companies. Thus, an estimator with properties that do not depend on having a large number of companies in the firm, such as the LSDV/within estimator, is preferable to the random effects estimator. Therefore, the fixed effects model, which is more general (i.e., incorporates less restrictive assumptions) than the random effects model, provides a more apropriate framework for this case study.

5.2 Time Series

Despite the fact that the main model in this thesis uses with panel data, it will also be necessary to employ time series models to reach the objectives of the thesis. The reason is that some of the explanatory variables are macroeconomic indicators rather than company-level variables. Those macroeconomic indicators are time series for which forecasts will be necessary. A time series is a set of ordered observations over time concerning a characteristic of a single individual (in our case, region), whereas a panel dataset observes multiple individuals at multiple times. Thus, a time series can be defined as sequence of data points that are observed in successive order over a certain period of time (see, e.g., Pascoal [36], on which the rest of this chapter is based):

Definition 6.1. A time series is a set of observations (x_t) measured sequentially through time:

$$T = (t_1, ..., t_n), t_i \in \mathbb{R} \tag{5.11}$$

A time series is discrete when observations are taken only at a specific times, equally spaced, even if the measured variable is a continuous variable. A time series is deterministic if it can be predicted exactly. Alternatively, the time series is stochastic when the future is just partly determined by past values, so that predictions will with positive probability be wrong. In addition, time series can be univariate (composed of a single variable), bivariate (composed of two variables), or multivariate (composed of several variables). For the usual statistical inferences to be valid, the time series must be stationary.

Definition 6.2. A discrete time process (time series) $y_t = ..., y_{t-1}, y_t, y_{t+1}, ..$ is (weakly) stationary if the following assumptions are verified:

- Its mean and variance do not change systematically over time;
- For all t and j, its means and the covariance between y_t and y_{t-j} are independent from t:

$$E(y_t) = \mu \tag{5.12}$$

$$cov(y_t, y_{t-j}) = E[(y_t - \mu)(y_{t-j} - \mu)] = \gamma_j \tag{5.13}$$

  where γ_j is the j-th autocovariance;

- The covariance between the time series in two periods depends only on the lag between the two periods and not on any of the two periods.

A stationary time series is one for which the joint probability distribution does not change over time. As a result the time series is identically distributed at all points in time. A time series is strictly stationary if all the moments, not just the mean and variance, of the probability distribution remain invariant over time. Thus, ascending or descending trends in time series data indicate that the time series are not stationary.

5.3 Forecasting time series

There are several models that can be used for forecasting time series. In this thesis, the model that will be used is the Autoregressive Integrated Moving Average (ARIMA) model. This model is an important forecasting tool, commonly used by forecasters, namely in the field of economics.

The ARIMA or Box-Jenkins model, introduced by Box and Jenkins in 1970, is a generalization of the ARMA model (a combination of the autoregressive and moving average models in which the dependent variable is a linear function of past values of both the response variable and the disturbance term). The ARIMA model is defined as a regression model in which the response variable is a linear function of past values of both the dependent variable and the disturbance term, where the time series has been differenced d times. The ARIMA(p,d,q) model can be divided into three parts: the number of autoregressive lags (p), which corresponds to a weighted moving average over past observations; the integration order (d), which is related to the existence of linear or polynomial trends in the time series, and the number of moving average lags (q), corresponds to a weighted moving average over past disturbances.

5.4 Autoregression (AR)

An autoregressive model of order p, AR(p), can be expressed as:

$$y_t = c + \phi_1 y_{t-1} + ... + \phi_p y_{t-p} + \varepsilon_t, \quad \phi_p \neq 0 \tag{5.14}$$

where ε_t is a white noise ($\varepsilon_t, t \in \mathbb{N}$), with variance σ^2 ($\forall t, Var(\varepsilon_t) = \sigma^2, \sigma^2 > 0$), mean zero ($\forall t, E(\varepsilon_t) = 0$), no autocorrelation ($E(\varepsilon_t \varepsilon_{t-k}), \forall t, \forall k$) and independently and identically distributed (i.i.d.). In this model, observations of the dependent variable in the previous time periods are the predictors and the errors have the usual assumptions as in the usual linear regression model. The longest lag of the dependent variable included in the model is the order p of the AR model.

5.5 Moving Average (MA) Process

A moving average model of order q, MA(q), is a time series model that uses past disturbances in a regression-like model:

$$y_t = \mu + \varepsilon_t + \theta_1 \varepsilon_{t-1} + ... + \theta_q \varepsilon_{t-q}, \quad \theta_q \neq 0 \tag{5.15}$$

where ε_t is a white noise process, with the same characteristics mentioned above for the AR model. The MA(q) model is expressed in terms of past disturbances. The issue is estimating the coefficients

$\theta_i, i = 1,...,q$ and use it for forecasting. Disturbances far in the past do not affect y_t, however disturbances up to q periods before will affect the current level of y_t, which implies that it is a short memory model.

5.6 Autoregressive Moving Average Model (ARMA)

The ARMA model combines the AR and MA models. Thus, in an ARMA model both the lags of the dependent variable and the disturbances are used for forecasting the future values of the time series. This model can be written as:

$$y_t = c + \phi_1 y_{t-1} + ... + \phi_p y_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + ... + \theta_q \varepsilon_{t-q} \tag{5.16}$$

where $\phi_p \neq 0$, $\theta_q \neq 0$, and ε_t is a white noise with the same characteristics mentioned before.

5.7 Autoregressive Integrated Moving Average Model (ARIMA)

An ARIMA model may be written as:

$$\Phi(L)(1-L)^d y_t = c + \Theta(L)\varepsilon_t \tag{5.17}$$

where c is a constant, ε_t is a white noise, with non-zero variance and the characteristics mentioned before for the AR, MA and ARMA cases, $\Phi(L) = 1 - \phi_1 L - ... - \phi_p L^p$, $\phi_p \neq 0$, $\Theta(L) = 1 + \theta_1 L_1 ... + \theta_q L^q$, $\theta_q \neq 0$ are polynomials whose roots are of modulo greater than 1, ϕ_i and θ_i are the coefficients of the i-th AR and MA components, respectively, and $d \in \mathbb{N}$.

Identification, estimation, diagnostics, and forecasting are the four steps of using an ARIMA model for forecasting. To begin it is necessary to collect data and examine its characteristics. Then, a test such as the Augmented Dickey-Fuller (ADF) test may be used to assess whether the series are stationary. This test was developed with the purpose of generalizing the Dickey-Fuller (DF) test. While DF tests assume an AR(1), ADF tests allow the variable under test to follow an autoregressive process of order greater than 1. The ADF test is founded on the following regression:

$$y_t = \beta' D_t + \phi y_{t-1} + \sum_{j=1}^{\mathrm{p}} \psi_j \Delta y_{t-1} + \varepsilon_t \tag{5.18}$$

where D_t is a vector of deterministic terms that can include a constant, a trend, and other elements, to ensure that the ε_t terms are uncorrelated. The hypothesis tested by the ADF test is the following:

H_0: The process has a unit root ($\phi = 1$) vs H_1: The process is stationary

5.8 Estimation of ARIMA model

The parameters of the ARIMA(p,d,q) model can be estimated consistently using maximum likelihood estimation (MLE). MLE returns estimates which, given the assumed model, maximise the probability of observing the sample that is being used in the estimation. Conditional on initial values for $x_t = \Delta^d y_t$ and ε_t, the likelihood function for the ARIMA(p,d,q) is:

$$L(\delta_0) = -\frac{T}{2}\log(2\pi) - \frac{T}{2}\log(\sigma^2) - \sum_{t=1}^{T}\frac{\varepsilon_t^2}{2\sigma^2} \tag{5.19}$$

where δ_0 is the set of parameters to be estimated, T is the number of observations (after the initial p observations on which the estimation is conditional), σ^2 is the variance of ε_t, and ε_t is given by

$$\varepsilon_t = x_t - c - \phi_1 x_{t-1} - \ldots - \phi_p x_{t-p} - \theta_1 \varepsilon_{t-1} - \ldots \theta_q \varepsilon_{t-q} \tag{5.20}$$

The maximum likelihood estimator of δ_0 is assymptotically unbiased, efficient and normally distributed:

$$\sqrt{T}(\hat{\delta}_0 - \delta_0) \xrightarrow{l} \mathbb{N}(0_{K\times 1}, {I_F}^{-1}) \tag{5.21}$$

where I_F is the Fisher information matrix and K is the number of parameters in δ_0.

After the coefficients being determined and find out the likely model using Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), is necessary to validate the model using diagnostics tests, and simple statistics and confidence intervals to determine the validity of the forecast and monitor model performance.

5.9 Diagnostic checking

It is important to ckeck the model for adequacy before using it for forecasting. When assessing adequacy of the model, the behaviour of the residuals is the main issue: the estimates of the ε should simply be white noise. However, it has become usual to select the ARIMA model on the basis of an information criterion rather than on the inspection of the behaviour of the residuals. In this thesis, the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) were used to select the best ARIMA models. These are the most commonly used criteria for model selection (e.g. Chakrabarti and Ghosh [6]). AIC is computed as

$$AIC = -2\log L + 2K \tag{5.22}$$

where L is the likelihood, which is a measure of the fit of the model (the higher the likelihood, the better the fit) and K is the number of parameters estimated in the model. Given this definition of the AIC, the best model is the one which minimizes the AIC.

BIC is an alternative to AIC and is given by:

$$BIC = -2\log L + K\log T \tag{5.23}$$

where T is the number of observations.

The difference between the AIC and the BIC is in the penalty for the introduction of additional parameters. AIC penalizes additional parameters less than BIC. Therefore, AIC will tend to select models with more parameters than BIC.

Chapter 6

Results from fixed effects and ARIMA models

This chapter reports the estimations of the fixed effects and ARIMA models. All the computations were performed using the econometrics software Gretl.

6.1 Fixed effects model

Many fixed effects models were estimated in order to determine the most suitable model. The set of estimated fixed effects models included models with dummy variables (for events such as the global financial crisis and the Covid-19 pandemic), one lag of all the microeconomic factors and one lag of all the macroeconomic variables. The model with the lowest AIC and BIC values was selected for the analysis.

As discussed in Chapter 4, in the fixed effects models the dependent variable is firm's profitability, while the explanatory variables included the OECD GDP growth rate, the interest rate, the inflation rate, industrial production, the exchange rate, the unemployment rate, oil prices, firm size, firm growth and debt-to-equity ratio. Table 6.1 presents a description of the selected variables and the expected sign of their coefficients. 105 observations were included in the sample, 21 for each company (the first observation was lost due to the use of the lagged dependent variable in the models). Table 6.2 reports descriptive statistics for the variables in the dataset. The correlation matrix is in Table 6.3. The correlation matrix gives some information about the possibility of multicollinearity problems, which is important to be aware of before estimating the model. The results in Table 6.3 indicate that the correlation between the independent variables is small. The same is true for the correlations with the dependent variable, which indicates that, individually, the explanatory variables would not be enough to produce accurate forecasts of the dependent variable.

Table 6.1 Description of the variables and expected signs

Variable	Meaning	Expected sign
	Dependent variable	
ROA_{it}	Return on Assets for firm i in period t	
	Macroeconomic variables	
$GDPGR_{it}$	OECD GDP growth rate for firm i in period t	+
IR_{it}	Interest rate for firm i in period t	-
IF_{it}	Inflation rate for firm i in period t	-
IP_{it}	Industrial production for firm i in period t	+
ER_{it}	Exchange rate, absolute value of the rate of change of the exchange rate, for firm i in in period t	+/-
UR_{it}	OECD unemployment rate for firm i in period t	-
OP_{it}	Oil prices, average annual WTI crude oil prices, for firm i in period t	+/-
	Control variables	
FS_{it}	Firm size, natural logarithm of total assets, for firm i in period t	+
FG_{it}	Firm growth, in sales, for firm i in period t	+
LEV_{it}	Leverage, debt-to-equity ratio, for firm i in period t	-
ε	Error term	

Table 6.2 Descriptive statistics

Variable	Mean	Median	Standard Deviation	Minimum	Maximum	Skewness	Kurtosis
ROA	0.096445	0.09270	0.1083	-0.4300	0.32700	-1.4187	6.4185
FS	22.252	22.32	2.1873	18.343	25.878	-0.11639	-0.98050
DE	1.0727	0.8798	0.67476	0.11701	3.2286	1.2643	1.6445
GDPGR	0.017987	0.02084	0.020687	-0.044617	0.052183	-1.6802	3.0910
IF	0.019789	0.01838	0.013906	-0.00047304	0.076044	1.7545	5.15211
IP	-0.060698	-0.01250	0.38712	-1.3913	0.87500	-0.90761	3.3065
IR	0.026505	0.02500	0.020425	-0.0090000	0.10130	0.78631	1.3352
OP	60.975	59.36	23.858	25.900	99.060	0.18594	-1.1576
UR	0.068578	0.06830	0.0089265	0.054200	0.085300	0.32101	-0.88666
FG	0.04212	0.03637	0.1184	-0.3651	0.3855	-0,30697	3,4898
ER	0.027783	0.02069	0.022970	0.00015977	0.10910	1.2414	1.9236

Table 6.3 Correlation matrix

	ROA	FS	DE	GDPGR	IF	IP	IR	OP	UR	FG	ER
ROA	1	0.26	0.08	−0.05	−0.18	0.05	−0.11	0.15	−0.04	0.23	−0.13
FS	0.26	1	0.32	−0.02	0.04	−0.04	−0.00	−0.00	−0.05	−0.12	0.03
DE	0.08	0.32	1	0.04	0.21	−0.15	0.09	−0.19	−0.10	−0.01	−0.09
GDPGR	−0.05	−0.02	0.04	1	0.38	−0.05	0.09	0.03	−0.33	0.13	0.09
IF	−0.18	0.04	0.21	0.38	1	−0.45	−0.04	−0.01	−0.14	−0.04	−0.08
IP	0.05	−0.04	−0.15	−0.05	−0.45	1	0.09	0.09	−0.01	0.05	−0.04
IR	−0.11	−0.00	0.09	0.09	−0.04	0.09	1	−0.35	−0.22	0.26	0.10
OP	0.15	−0.00	−0.19	0.03	−0.01	0.09	−0.35	1	0.35	−0.11	−0.18
UR	−0.04	−0.05	−0.10	−0.33	−0.14	−0.01	−0.22	0.35	1	−0.19	0.15
FG	0.04	0.05	0.15	0.02	−0.01	0.01	−0.02	0.12	0.05	1	−0.08
ER	−0.13	0.03	−0.09	0.09	−0.08	−0.04	0.10	−0.18	0.15	−0.04	1

6.2 Estimates of the fixed effects model

The basic regression model is given by:

$$ROA_{it} = \beta_0 + \beta_1 ROA_{t-1} + \beta_2 GDPGR_{it} + \beta_3 IR_{it} + \beta_4 IF_{it} + \beta_5 IP_{it} + \\ + \beta_6 ER_{it} + \beta_7 UR_{it} + \beta_8 OP_{it} + \beta_9 FS_{it} + \beta_{10} FG_{it} + \beta_{11} LEV_{it} + \varepsilon_{it} \quad (6.1)$$

Not all variables were statistically significant. However, some variables may become significant in the absence of other variables. The problem is which variables should be deleted and which initially non-significant variables will then become significant and should be kept in the model. An ad-hoc process was applied to perform this selection of the variables. After estimating the model, the next variable to be omitted was the statistically insignificant variable that had the largest p-value. The model was then re-estimated without that variable and the same procedure was applied. This process ended when all the variables still present in the model were statistically significant. A final step was the application of an F-test to test the joint significance of the variables that were omitted in the final model.

In the final model, showed in Table 6.4, oil prices, firm growth and lagged ROA were the only variables that showed statistical significance at least at the 10% significance level. The estimated coefficients are positive. The value of the firm growth (FG) coefficient was expected and agrees with past studies. The positive coefficient for the WTI oil prices (OP) is somewhat unexpected. Perhaps oil price are correlated in this sample with the level of global economic activity (rising when activity, and thus demand for oil, increases), and therefore provides a better indicator of demand conditions than the GDP growth rate. Additionally, even though the literature does not consider the positive sign for the coefficient of oil prices to be expected, a positive coefficient for oil prices has been reported before in a study done by Benaković and Posedel [3].

The final regression model is thus:

$$ROA_{it} = \beta_0 + \beta_1 ROA_{it-1} + \beta_8 OP_{it} + \beta_{10} FG_{it} + \varepsilon_{it} \quad (6.2)$$

Table 6.4 Final model: coefficients

	Coefficient	Standard error	t	p-value	
const	-0.00922330	0.0198807	-0.4639	0.6437	
ROA_1	0.569749	0.0773343	7.367	5.78e-11	***
OP	0.000707168	0.000282080	2.648	0.0094	**
FG	0.15702	0.0595534	2.648	0.0094	***

Table 6.5 shows some statistics concerning the fit of the model.

Table 6.5 Final model: statistics

LSDV R-squared	Adjusted R-squared	Std. error of the estimate
0.655943	0.431825	0.110511

6.3 F-test

As mentioned above, to test the overall significance of the omitted independent variables, the F-test was used. This test indicates whether the restricted model ("r": without the omitted variables) is better than the unrestricted model ("ur": with all variables). The hypothesis under test in the case of the final model is therefore

$$H_0 : \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_9 = \beta_{11} = 0$$

$$vs$$

$$H_1 : \beta_2 \neq 0 \vee \beta_3 \neq 0 \vee \beta_4 \neq 0 \vee \beta_5 \neq 0 \vee \beta_6 \neq 0 \vee \beta_7 \neq 0 \vee \beta_9 \neq 0 \vee \beta_{11} \neq 0$$

The statistic and its distribution are:

$$F = \frac{R^2_{ur} - R^2_r}{1 - R^2_{ur}} \frac{T - K}{q} \quad (6.3)$$

where q is the number of omitted variables, R^2_{ur} is the R-Squared of the unrestricted model, R^2_r is the R-Squared of the restricted model, T is the number of observations in the sample and K is the number of explanatory variables (i.e., coefficients estimated). If the p-value is greater than the significance level chosen, we accept the null hypothesis, which means the best model is the restricted model. The test statistic was $F(8,89) = 0,587224$, with $p - value = 0.785979$. Therefore, we do not reject the null hypothesis, which states that the restricted model is superior to the unrestricted model.

6.4 ARIMA model results

The final fixed effects model includes one macroeconomic variable (oil prices) and one company variable (firm growth). To forecast firm profitability it is therefore necessary to forecast these variables also. As explained above, these forecasts will be obtained by means of ARIMA models.

The variable oil prices is not stationary according to the ADF test (the p-value was greater than five percent). Thus it was first-differenced and the ADF test was again used to test stationarity. When seven lags or fewer were used in the ADF test, the first difference of OP was found to be stationary. Given the relatively low number of observations, it is not advisable to use more than seven lags. Then the AIC and BIC were used to select the best model for oil prices, using the first difference of this variable ($d = 1$ in the ARIMA models). The best model according to these criteria is the ARIMA(1,1,1). The estimates are in Table A.1 in the Appendix, and the corresponding model may be written as:

$$y_t = 1.51463 + 0,753256\phi_{t-1} + \varepsilon_t - \theta_1 \varepsilon_{t-1} \quad (6.4)$$

As for firm growth, when the full sample was used, the forecasts appeared implausibly high for Beiersdorf, Coloplast, and Johnson & Johnson. This was found to be the result of very high values in the beginning of the sample. In fact, these companies saw revenue peaks between 2001 and 2003 as a result of the avian flu epidemic that occurred during that time. Thus, it was necessary to limit the sample used in the estimation of the ARIMA models for Beiersdorf, Coloplast, and Johnson & Johnson. For Beiersdorf, Coloplast, and Johnson & Johnson, the revised time periods were 2002–2021, 2003–2021, and 2002–2021, respectively. Although Baxter International and Cryolife experienced these oscillations as well, it was found that imposing time restrictions actually made the firm's growth forecasts less plausible, in contrast with the case for the other firms.

The FG variable was stationary, which suggests, for the situation of enterprises that altered throughout the course of the period.

Firm growth of Baxter International became stationary after first-differencing. In the case of Cryolife, the second difference was necessary to achieve stationarity. For the other companies, it was not necessary to difference firm growth. Table A.2 in the Appendix shows all the ARIMA models for firm growth that were estimated. The ARIMA models selected according to the AIC and BIC criteria for Baxter International, Beiersdorf, Coloplast, Cryolife, and Johnson & Johnson, were ARIMA (0,1,1), ARIMA(1,0,0), ARIMA(1,0,1), ARIMA(0,2,2), and ARIMA(1,0,0), respectively. The estimates of these models can be seen in Tables A.3 to A.7 in the Appendix. Table 6.6 below summarizes those tables. Table 6.7 reports the standard errors of each ARIMA model.

Table 6.6 ARIMA models for firm growth

Firm	ARIMA model	constant	ϕ_{t-1}	θ_{t-1}	θ_{t-2}
Baxter Int.	ARIMA(0,1,1)	0.00116413	0	-1	0
Beiersdorf	ARIMA(1,0,0)	0.00466165	-0.379922	0	0
Coloplast	ARIMA(1,0,1)	0.0680621	-0.534766	1	0
Cryolife	ARIMA(0,2,2)	-0.000176439	0	-1.98124	0.999999
Johnson & Johnson	ARIMA(1,0,0)	0.0326512	0.434222	0	0

Table 6.7 Standard error of each ARIMA model

Firm	Variable	ARIMA model	Standard error of the estimate
Baxter Int.	FG	ARIMA(0,1,1)	0.175258
Beiersdorf	FG	ARIMA(1,0,0)	0.154740
Coloplast	FG	ARIMA(1,0,1)	0.058525
Cryolife	FG	ARIMA(0,2,2)	0.271801
Johnson & Johnson	FG	ARIMA(1,0,0)	0.033109
All companies	OP	ARIMA(1,1,1)	18.19502

Chapter 7

Forecasting the profitability of medical adhesive companies

We selected and estimated a fixed effects model for the profitability of medical adhesive companies, in which the explanatory variables, apart from the lagged dependent variable, were oil prices and firm growth. We then selected and estimated ARIMA models for oil prices (the same for all firms, since the time series is always that for WTI oil prices) and firm growth (one ARIMA model for the time series of each company). An ARIMA(1,1,1) was selected for oil prices. The ARIMA models for firm growth are ARIMA(0,1,1) for Baxter Int, ARIMA(1,0,0) for Beiersdorf, ARIMA(1,0,1) for Coloplast, ARIMA(0,2,2) for Cryolife, and ARIMA(1,0,0) for Johnson & Johnson. These models were then used to forecast profitability for the years 2022 through 2031; this chapter reports the results.

Table B.1 in the Appendix presents the forecasts of oil prices and firm growth for each of the five companies in the sample. According to the forecasts reported for the oil prices, oil prices are predicted to climb between 2022 and 2031, reaching USD 87.75 in 2031. As for firm growth, the behaviour of the forecasts varies across firms. For Baxter International, the forecast is that firm growth will rise between 2022 (1.2%) and 2031, reaching 2.25%. For Beiersdorf, the forecast is that there will be an increase in firm growth between 2022 and 2023, a decrease in 2024, again an increase in 2025, and then firm growth will be decreasing continuously from 2026 until 2031. Nevertheless, the lowest rate of firm growth is projected to occur in 2022 (-0.09%) and the highest immediately after, in 2023 (0.06%), which means that the growth rates for Beiersdorf are expected to be both very stable and very low.

As for Cryolife, firm growth forecasts oscillate between 2022 and 2031, with the highest value occurring in 2022 (7.54%), and the lowest value in 2023 (6.41%). These rates of firm growth are about ten times those expected for Beiersdorf. In the case of Coloplast, according to the forecasts, firm growth will experience a significant decline throughout the years 2022–2031, starting at 10.7% in 2022 and ending at 0.98% in 2031. Last but not least, it is anticipated that Johnson & Johnson will also see a decline in the rate of firm growth, from 4.51% in 2022, before stabilizing at 3.27% in the final years of the forecast period.

These forecasts for oil prices and firm growth were used to recursively produce forecasts for the ROA of each company between 2022 and 2031,[1] To compute the forecasts of ROA for each firm it was necessary to make use not just of the coefficients estimated for oil prices, firm growth and the lagged dependent variable, but also of the coefficients estimated for the fixed effect of each of the firms. Table B.2 in the Appendix presents the forecasts obtained using this procedure.

For Baxter International, it is predicted that ROA will decline between 2022 and 2023, but afterwards it will increase. In the forecast period, the forecast for 2022 is the highest (7.90%), while the forecast for 2023 is the lowest (4.90%). Beiersdorf's forecasts for ROA behave in a similar way. The years 2022 and 2023 are projected to correspond to the highest (7.82%) and lowest (4.64%) ROA values, respectively. In the case of Cryolife, it is anticipated that ROA will rise between 2023 and 2031. However, the highest ROA occurs in 2022 (26.57%), whereas the lowest is 8.97% in 2023. The ROA forecasts for Coloplast fluctuate over the years 2022 to 2031, with the lowest ROA occurring in 2022 (-0.76%) and the highest ROA occurring in 2023 (0.34%). Finally, concerning Johnson & Johnson's ROA, it is predicted that it will fall between 2022 and 2023, before rising all the way until 2031. The highest forecast is for year 2022 (12.46%), and the lowest is for year 2023 (5.85%).

Thus, with the exception of the Coloplast company, for which negative profitability is projected to occur in 2031, and ignoring the year 2022 (which appears to be a special year: it is when forecasted profitability is higher, with the exception already noted of Coloplast), the base forecasts indicate that the profitability of the companies in the sample will increase over the next ten years.

To complement the predictions regarding the profitability of each company, a scenario analysis was performed. Scenario analysis is the process of looking at and analyzing potential future occurrences (scenarios) in order to forecast the widest range of outcomes. In the case of this thesis, scenario analysis is utilized to calculate forecasts for the companies' profitability while taking into account prospective occurrences that could have a positive or an unfavorable effect on profitability. The method of scenario analysis was used because it gives investors insight into the returns and risks associated with future investments. By using this method, the companies can avoid or significantly reduce losses by adopting strategies that mitigate the impact of the factors associated with the worst case. Three cases make up the scenario analysis: the base case (the profitability forecasts computed using the ARIMA forecasts discussed above), the best case, and the worst case.

The worst and best cases are defined with respect to the paths assumed for oil prices and for firm growth. The worst and best scenario paths assumed for oil prices are paths are that the oil price in 2022-2023 is always equals to the lowest (worst case) or to the highest (best case) value observed for oil prices between 2000 and 2021, i.e., in the sample. Note that oil prices have a positive coefficient in the final fixed effects model. This is the reason why the best (worst) case scenario corresponds to a high (low) price of oil. As for firm growth, first, the average of the rate of firm growth between 2000 and 2021 was computed for each company. Then the minimum and the maximum of those averages were computed. Finally, the worst (best) case scenario path for firm growth (equal for all firms) was defined as the path where firm growth is always equal to that minimum (maximum) of the average rates of firm growth. In addition, two other "best/worst" case scenarios were computed. In one only the oil prices go through their best/worst case paths, in the other only the rate of firm growth goes through its best/worst case paths.

[1] The computations were performed using Microsoft Excel.

The best and worst case scenarios for oil prices and firm growth are in Table B.3 in the Appendix. The outcomes of each scenario analysis are presented in Tables B.4 to B.18 in the Appendix. A graphical representation of the scenarios considering both the oil prices and firm growth is provided in Figures B.1 to B.5 in the Appendix. Figures B.6 to B.10 and B.11 to B.15 in the Appendix depict the best/worst cases considering only either firm growth or oil prices, respectively.

With the exception of Coloplast, all companies will experience a positive ROA in the period 2022-2031 according to the best/worst cases presented. The scenarios indicate that oil prices are the major determinant of uncertainty concerning future profitability. In fact, when only firm growth is considered in the computation of the best/worst cases, the difference between the best and worst cases is considerably smaller than when only oil prices are considered.

Chapter 8

Conclusion

The goal of the current dissertation was to discuss and propose a framework for forecasting the profitability of medical adhesives companies. This analysis may be helpful for supporting future research and investment decision-making. Several macro and microeconomic factors were used in the empirical analysis. In the end, the procedure employed led to the conclusion that the profitability of medical adhesives companies appears to be determined by oil prices and firm growth. The coefficients estimated for both the oil prices and firm growth were positive. The positive coefficient for oil prices was unexpected, although other studies have reported the same finding. One possible explanation is that oil prices may be acting as an indicator of the level of global economic activity, with oil prices rising when global economic activity increases.

ARIMA models were used to predict the evolution of oil prices and firm growth in the period 2022-2031. The forecasts of the ROA for each firm were then calculated. Finally, a scenario analysis was performed in order to assess the uncertainty concerning profitability in the next years, as well as the factors that are more important in creating uncertainty.

This framework seems like an interesting starting point for developing procedures that may be helpful for planning activities in companies such as BH4U, the company that inspired this thesis. Obviously, several aspects of the work carried out in this thesis may be improved upon. Namely, a larger sample of firms would provide a more representative set of results. Additionally, further investigation into the set of variables that may be useful for forecasting profitability is important. In particular, it would be interesting to understand why oil prices appear to have a positive impact on profitability. Furthermore, alternative procedures for constructing the best/worst case scenarios may be used.

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Appendix A

ARIMA models

In the following table is the only ARIMA model obtained for the variable OP, since all the other attempts did not allow us to reach final models consisting only of significant variables.

Table A.1 ARIMA(1,1,1) for oil prices

Variable	Coefficient	Standard error	z	p-value	
const	1.51463	1.57557	0.9613	0.3364	
ϕ_1	0.753256	0.167758	4.490	7.12e-06	***
θ_1	-1,00000	0.133101	-7.513	577e-14	***

Table A.2 Firm growth: models and information criteria

ARIMA	Firm	AIC	BIC
ARIMA(1,1,0)	Baxter Int.	-15.46527	-12.33171
ARIMA(0,1,1)	Baxter Int.	-23.79564	-20.66207
ARIMA(1,1,2)	Baxter Int.	-23.41273	-18.19012
ARIMA(2,1,0)	Baxter Int.	-16.50991	-12.33182
ARIMA(2,1,3)	Baxter Int.	-17.35100	-10.03935
ARIMA(1,0,0)	Beiersdorf	-16.19885	-13.21165
ARIMA(2,0,2)	Beiersdorf	-13.83454	-7.860149
ARIMA(1,0,1)	Coloplast	-50,56304	-46.78529
ARIMA(2,0,1)	Coloplast	-49.95180	-45.22960
ARIMA(1,2,0)	Cryolife	2.943407	5.930604
ARIMA(0,2,1)	Cryolife	-5.940740	-2.953543
ARIMA(0,2,2)	Cryolife	-7.297048	-3.314119
ARIMA(2,2,0)	Cryolife	-2.498048	1.484881
ARIMA(0,0,1)	Johnson & Johnson	-77.03608	-74.04888
ARIMA(1,0,0)	Johnson & Johnson	-77.87486	-74.88767

Table A.3 ARIMA(0,1,1) for firm growth of Baxter International

Variable	Coefficient	Standard error	z	p-value	
const	0.00116413	0.00371628	0.31338	0.7541	
θ_1	-1,00000	0.1177717	-7.826	5.02e-15	***

Table A.4 ARIMA(1,0,0) for firm growth of Beiersdorf

Variable	Coefficient	Standard error	z	p-value	
const	0.00466165	0.00227376	0.2050	0.8376	
ϕ_1	-0.379922	0.198970	-1.909	0.0562	*

Table A.5 ARIMA(1,0,1) for firm growth of Coloplast

Variable	Coefficient	Standard error	z	p-value	
const	0.0680621	0.0146149	4.657	3.21e-06	***
ϕ_1	-0.534766	0.209209	-2.556	0.0106	**
θ_1	1.00000	0.430711	2.322	0.0202	**

Table A.6 ARIMA(0,2,2) for firm growth of Cryolife

Variable	Coefficient	Standard error	z	p-value	
const	-0.000176439	0.00134019	-0.1317	0.8953	
θ_1	-1,981240	0.298625	-6.635	3.25e-11	***
θ_2	0.999999	0.298507	3.350	0.0008	***

Table A.7 ARIMA(1,0,0) for firm growth of Johnson & Johnson

Variable	Coefficient	Standard error	z	p-value	
const	0.0326512	0.0116206	2.810	0.0050	***
ϕ_1	0.434222	0.225406	1.926	0.0541	*

Appendix B

Forecasting medical adhesives companies profitability

B.1 Forecasts

Table B.1 Forecasts of oil prices and firm growth

Year	OP	FG(1)	FG(2)	FG(3)	FG(4)	FG(5)
2022	70,71	0.011980	-0.0008980	0.075400	0.1069610	0.0451660
2023	73,14	0.0131400	0.0067740	0.0641000	0.0968720	0.0380860
2024	75,34	0.0143080	0.0038590	0.0702000	0.0866060	0.0350110
2025	77,37	0,0154720	0.0049670	0.0669000	0.0761640	0.0336760
2026	79,28	0,0166360	0.0045460	0.0687000	0.0655460	0.0330960
2027	81,09	0,0178000	0.0047060	0.0677000	0.0547510	0.0328440
2028	82,82	0,0189640	0.0046450	0.0682000	0.0437790	0.0327350
2029	84,50	0,0201280	0.0046680	0.068000	0.0325310	0.0326880
2030	86,14	0,0212930	0.0046590	0.0681000	0.0213070	0.0326580
2031	87,75	0,0224570	0.0046300	0.068000	0.0098060	0.0326580

(1): Baxter Int.; (2): Beiersdorf; (3): Cryolife; (4): Coloplast; (5): Johnson & Johnson

Table B.2 Forecasts of ROA for each firm

Year	ROA (1)	ROA (2)	ROA(3)	ROA(4)	ROA(5)
2022	0,07897631	0,07824335	0,2656833	-0,007577518	0,12459081
2023	0,04897172	0,04641697	0,08973127	0,003375076	0,058532061
2024	0,050711687	0,047513039	0,092249018	0,003311877	0,059602897
2025	0,052330804	0,049123324	0,093164152	0,003100703	0,060827916
2026	0,05386506	0,050407622	0,094798706	0,002776914	0,062087139
2027	0,055328599	0,051712829	0,095920979	0,002354495	0,063327373
2028	0,056735564	0,05292661	0,09722323	0,00184759	0,064533584
2029	0,058107172	0,054118279	0,098379732	0,00127757	0,065714214
2030	0,05945065	0,055276615	0,099555258	0,000651508	0,066870658
2031	0,060772756	0,056410582	0,100678028	-0,00002368	0,068007779

(1): Baxter Int.; (2): Beiersdorf; (3): Cryolife; (4): Coloplast; (5): Johnson & Johnson

B.2 Scenarios for 2022-2031

Table B.3 Best and worst case scenarios of FG and OP variables

	Best case scenario		**Worst case scenario**	
	FG	**OP**	**FG**	**OP**
2022	0,090	99,06	-0,0010	25,9
2023	0,090	99,06	-0,0010	25,9
2024	0,090	99,06	-0,0010	25,9
2025	0,090	99,06	-0,0010	25,9
2026	0,090	99,06	-0,0010	25,9
2027	0,090	99,06	-0,0010	25,9
2028	0,090	99,06	-0,0010	25,9
2029	0,090	99,06	-0,0010	25,9
2030	0,090	99,06	-0,0010	25,9
2031	0,090	99,06	-0,0010	25,9

Table B.4 Forecast of Baxter Int. profitability between 2022-2031 taking into account the best and worst case scenarios of the OP and FG variables

Year	ROA best case scenario	ROA worst case scenario
2022	0,111328436	0,045241143
2023	0,079422492	0,013335199
2024	0,079422492	0,013335199
2025	0,079422492	0,013335199
2026	0,079422492	0,013335199
2027	0,079422492	0,013335199
2028	0,079422492	0,013335199
2029	0,079422492	0,013335199
2030	0,079422492	0,013335199
2031	0,079422492	0,013335199

Table B.5 Forecast of Beiersdorf profitability between 2022-2031 taking into account the best and worst case scenarios of the OP and FG variables

Year	ROA best case scenario	ROA worst case scenario
2022	0,112626361	0,046539058
2023	0,077871672	0,011784379
2024	0,077871672	0,011784379
2025	0,077871672	0,011784379
2026	0,077871672	0,011784379
2027	0,077871672	0,011784379
2028	0,077871672	0,011784379
2029	0,077871672	0,011784379
2030	0,077871672	0,011784379
2031	0,077871672	0,011784379

Table B.6 Forecast of Cryolife profitability between 2022-2031 taking into account the best and worst case scenarios of the OP and FG variables

Year	ROA best case scenario	ROA worst case scenario
2022	0,285918987	0,219831694
2023	0,112145542	0,046058249
2024	0,112145542	0,046058249
2025	0,112145542	0,046058249
2026	0,112145542	0,046058249
2027	0,112145542	0,046058249
2028	0,112145542	0,046058249
2029	0,112145542	0,046058249
2030	0,112145542	0,046058249
2031	0,112145542	0,046058249

Table B.7 Forecast of Coloplast profitability between 2022-2031 taking into account the best and worst case scenarios of the OP and FG variables

Year	ROA best case scenario	ROA worst case scenario
2022	0,009795911	-0,056291382
2023	0,020621142	-0,045466151
2024	0,020621142	-0,045466151
2025	0,020621142	-0,045466151
2026	0,020621142	-0,045466151
2027	0,020621142	-0,045466151
2028	0,020621142	-0,045466151
2029	0,020621142	-0,045466151
2030	0,020621142	-0,045466151
2031	0,020621142	-0,045466151

Table B.8 Forecast of Johnson & Johnson profitability between 2022-2031 taking into account the best and worst case scenarios of the OP and FG variables

Year	ROA best case scenario	ROA worst case scenario
2022	0,15170943	0,085622137
2023	0,085048797	0,018961504
2024	0,085048797	0,018961504
2025	0,085048797	0,018961504
2026	0,085048797	0,018961504
2027	0,085048797	0,018961504
2028	0,085048797	0,018961504
2029	0,085048797	0,018961504
2030	0,085048797	0,018961504
2031	0,085048797	0,018961504

Table B.9 Forecast of Baxter Int. profitability between 2022-2031 taking into account the best and worst case scenarios of the OP variable

Year	ROA best case scenario	ROA worst case scenario
2022	0,099024526	0,047288115
2023	0,067301516	0,015565105
2024	0,067485712	0,015749301
2025	0,067669277	0,015932867
2026	0,067852843	0,016116432
2027	0,0668036408	0,016299997
2028	0,068219973	0,016483562
2029	0,0668403538	0,016483562
2030	0,0668587261	0,01685085
2031	0,068770826	0,017034415

Table B.10 Forecast of Beiersdorf profitability between 2022-2031 taking into account the best and worst case scenarios of the OP variable

Year	ROA best case scenario	ROA worst case scenario
2022	0,098291565	0,046555154
2023	0,064746765	0,013010355
2024	0,064287064	0,012725387
2025	0,064461798	0,01725387
2026	0,064395405	0,012658994
2027	0,064420638	0,0112684227
2028	0,064411018	0,012674607
2029	0,064414645	0,012678234
2030	0,064413226	0,02676815
2031	0,070980095	0,019243684

Table B.11 Forecast of Cryolife profitability between 2022-2031 taking into account the best and worst case scenarios of the OP variable

Year	ROA best case scenario	ROA worst case scenario
2022	0,283616538	0,231880127
2023	0,10806106	0,056324649
2024	0,109023042	0,057286632
2025	0,108502626	0,056766215
2026	0,108786489	0,057050079
2027	0,108628787	0,056892377
2028	0,108707638	0,056971228
2029	0,108676098	0,056939687
2030	0,108691868	0,056955457
2031	0,108676098	0,056939687

Table B.12 Forecast of Coloplast profitability between 2022-2031 taking into account the best and worst case scenarios of the OP variable

Year	ROA best case scenario	ROA worst case scenario
2022	0,012570695	-0,039265716
2023	0,02170487	-0,030031541
2024	0,020086901	-0,031650509
2025	0,018439177	-0,0332971714
2026	0,016764697	-0,03497174
2027	0,015062304	-0,036674107
2028	0,013331998	-0,038404413
2029	0,011573936	-0,040162475
2030	0,009788119	-0,041958292
2031	0,007974388	-0,043762023

Table B.13 Forecast of Johnson & Johnson profitability between 2022-2031 taking into account the best and worst case scenarios of the OP variable

Year	ROA best case scenario	ROA worst case scenario
2022	0,144639019	0,092902608
2023	0,076861855	0,025125445
2024	0,076376922	0,024640511
2025	0,07616639	0,024429979
2026	0,076074922	0,024338512
2027	0,076035182	0,024298771
2028	0,076017992	0,024281581
2029	0,07601058	0,024274169
2030	0,076007268	0,024270857
2031	0,076005849	0,024269438

Table B.14 Forecast of Baxter Int. profitability between 2022-2031 taking into account the best and worst case scenarios of the FG variable

Year	ROA best case scenario	ROA worst case scenario
2022	0,091280223	0,076020341
2023	0,061092698	0,04674816
2024	0,062648467	0,048297585
2025	0,064084018	0,049733136
2026	0,065434709	0,051083827
2027	0,066714683	0,052363801
2028	0,067938084	0,053587202
2029	0,069126126	0,054775244
2030	0,070285882	0,055935
2031	0,071424422	0,05707354

Table B.15 Forecast of Beiersdorf profitability between 2022-2031 taking into account the best and worst case scenarios of the FG variable

Year	ROA best case scenario	ROA worst case scenario
2022	0,092578148	0,087227266
2023	0,059541878	0,045190996
2024	0,061097647	0,046746765
2025	0,062533198	0,048182316
2026	0,063883889	0,049533007
2027	0,065163863	0,050812981
2028	0,066387264	0,052036382
2029	0,067575306	0,053224424
2030	0,068735062	0,05438418
2031	0,069873602	0,05552272

Table B.16 Forecast of Cryolife profitability between 2022-2031 taking into account the best and worst case scenarios of the FG variable

Year	ROA best case scenario	ROA worst case scenario
2022	0,265870774	0,251529892
2023	0,093815748	0,079464866
2024	0,095371517	0,081020635
2025	0,096807068	0,082456186
2026	0,098157759	0,083806877
2027	0,099437733	0,085086851
2028	0,100661134	0,086310252
2029	0,101849176	0,087498294
2030	0,103008932	0,08865805
2031	0,104147472	0,08979659

Table B.17 Forecast of Coloplast profitability between 2022-2031 taking into account the best and worst case scenarios of the FG variable

Year	ROA best case scenario	ROA worst case scenario
2022	-0,010252302	-0,024603184
2023	0,002291348	-0,12059534
2024	0,003847117	-0,010503765
2025	0,005282668	-0,009068214
2026	0,006633359	-0,007717523
2027	0,007913333	-0,006437549
2028	0,009136734	-0,005214148
2029	0,010324776	-0,004026106
2030	0,011484532	-0,00286635
2031	0,012623072	-0,00172781

Table B.18 Forecast of Johnson & Johnson profitability between 2022-2031 taking into account the best and worst case scenarios of the FG variable

Year	ROA best case scenario	ROA worst case scenario
2022	0,131661217	0,117310335
2023	0,066719003	0,052368121
2024	0,068274772	0,05392389
2025	0,069710323	0,055359441
2026	0,071061014	0,056710132
2027	0,072340988	0,057990106
2028	0,073564389	0,059213507
2029	0,074752431	0,060401549
2030	0,075912187	0,061561305
2031	0,077050727	0,062699845

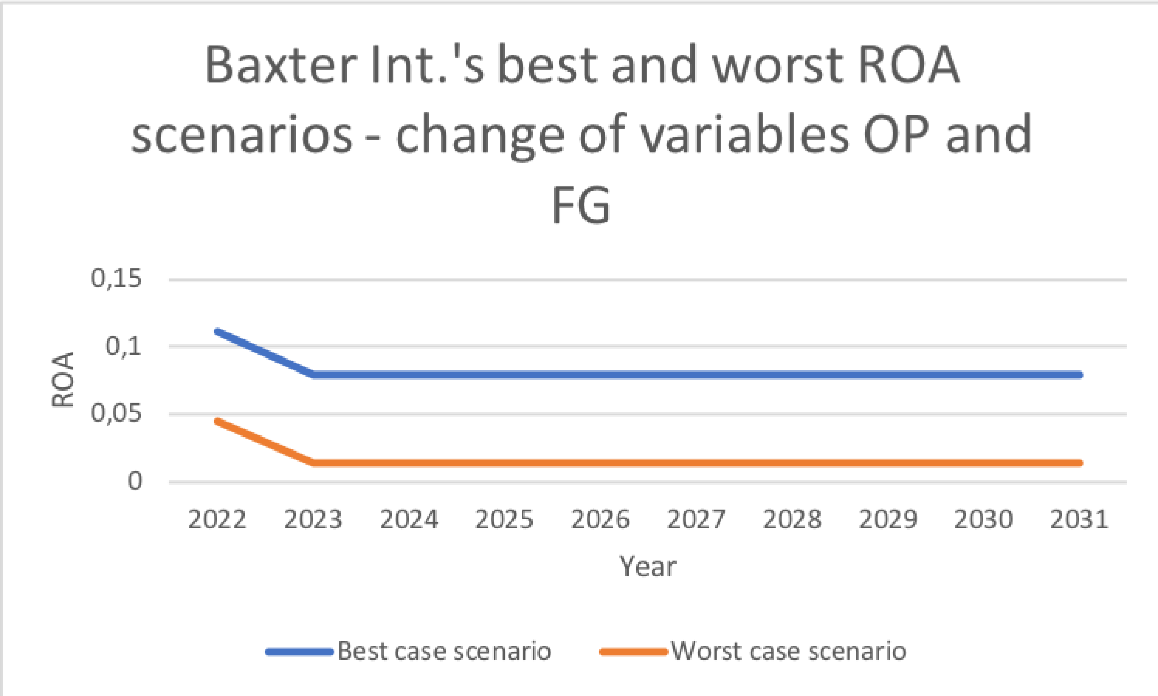

Figure B.1 Baxter Int.’s best and worst ROA scenarios - change of variables OP and FG

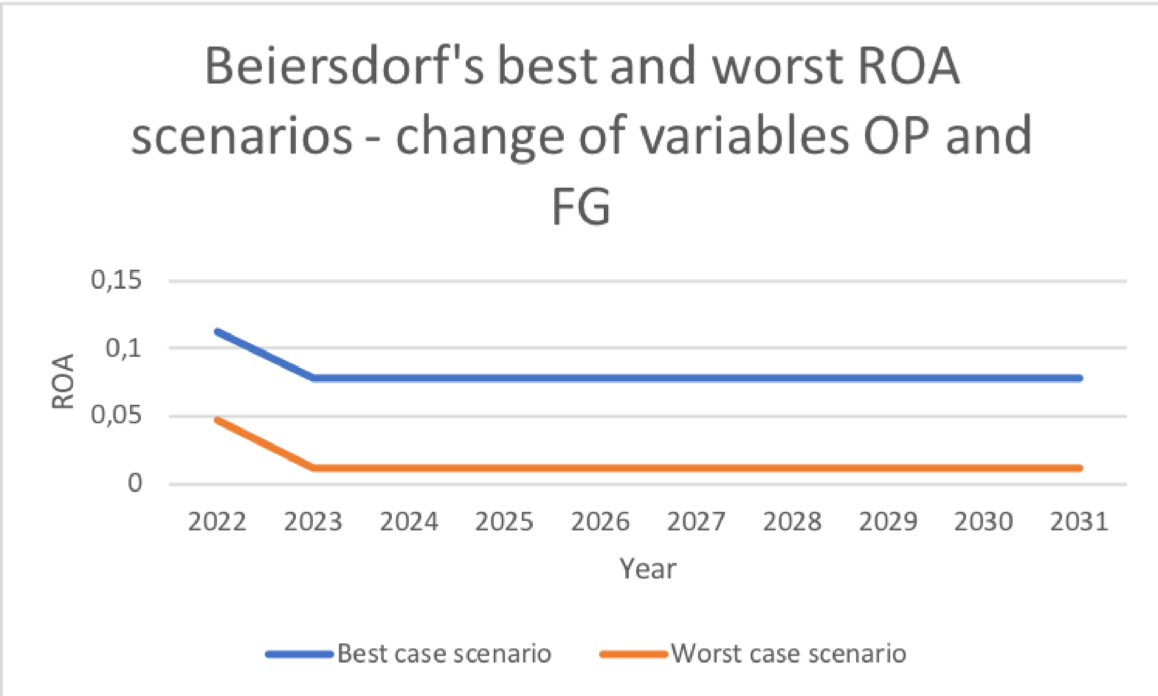

Figure B.2 Beiersdorf’s best and worst ROA scenarios - change of variables OP and FG

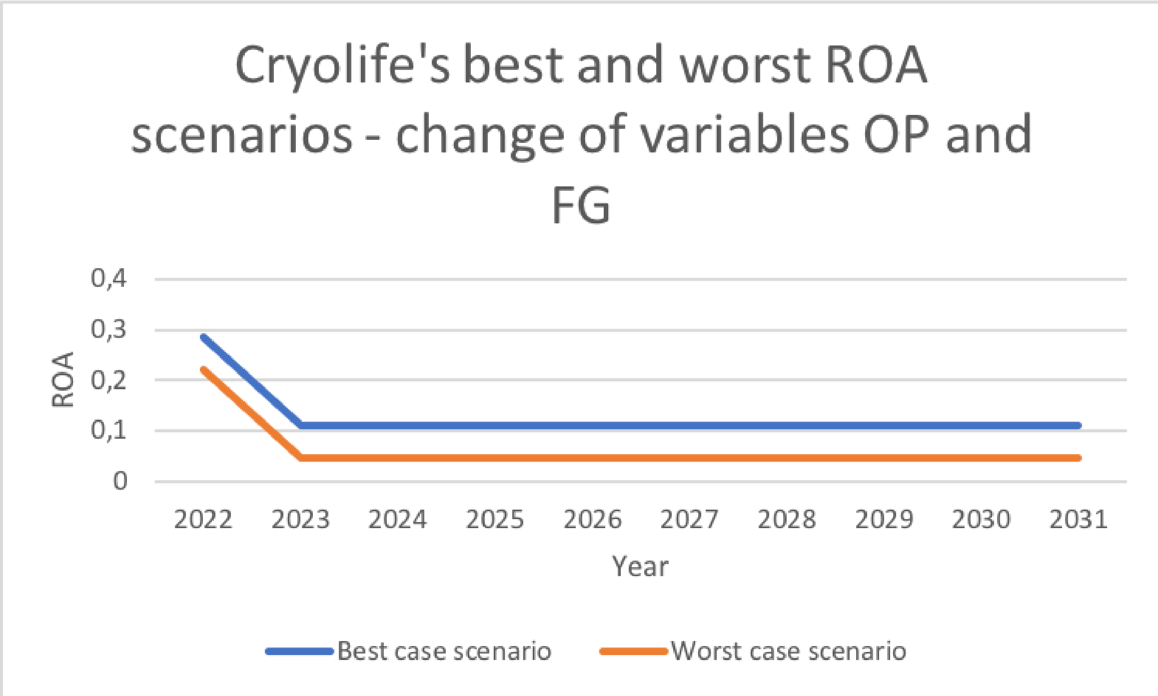

Figure B.3 Coloplast's best and worst ROA scenarios - change of variables OP and FG

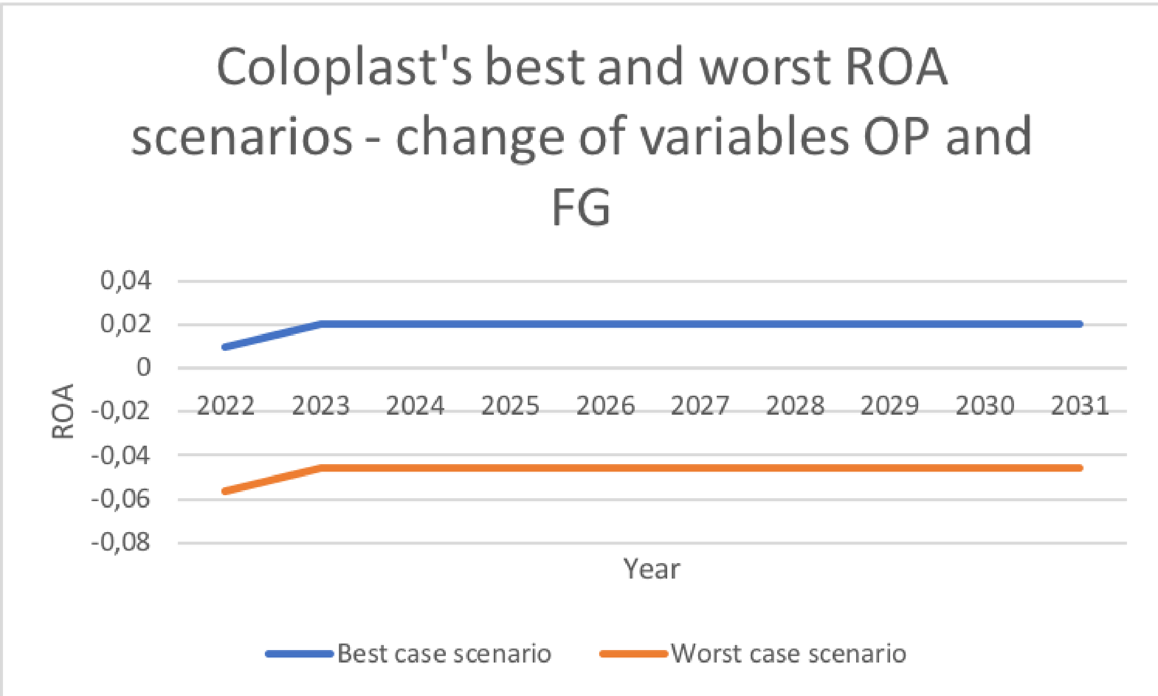

Figure B.4 Cryolife's best and worst ROA scenarios - change of variables OP and FG

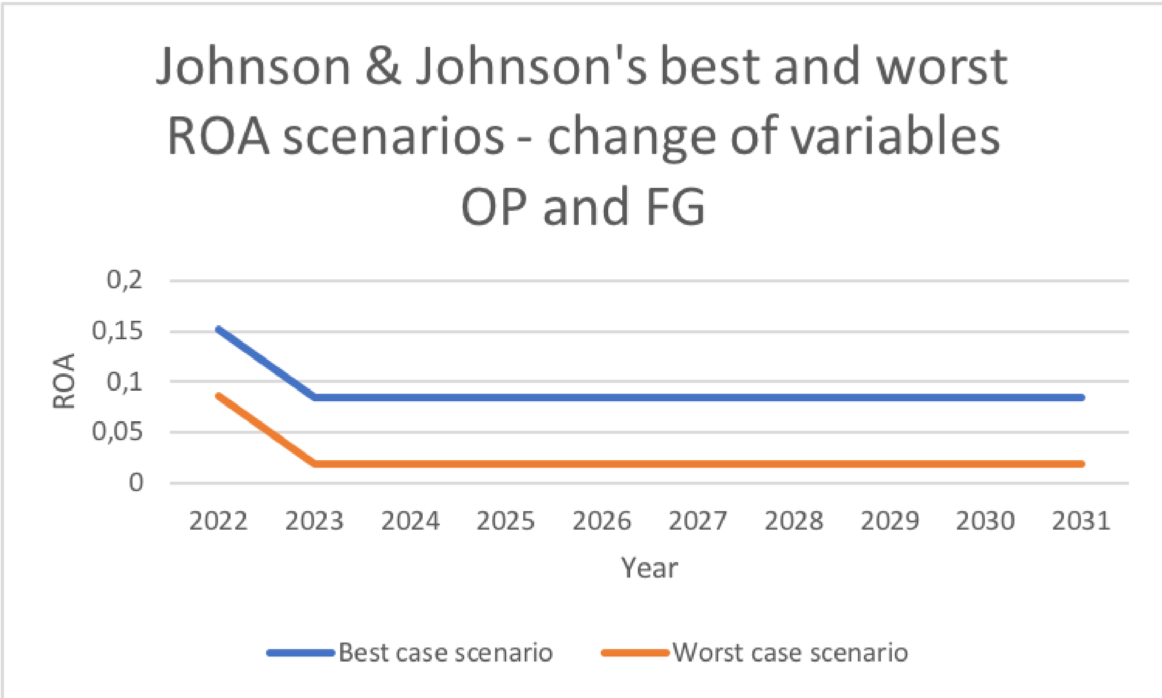

Figure B.5 Johnson & Johnson’s best and worst ROA scenarios - change of variables OP and FG

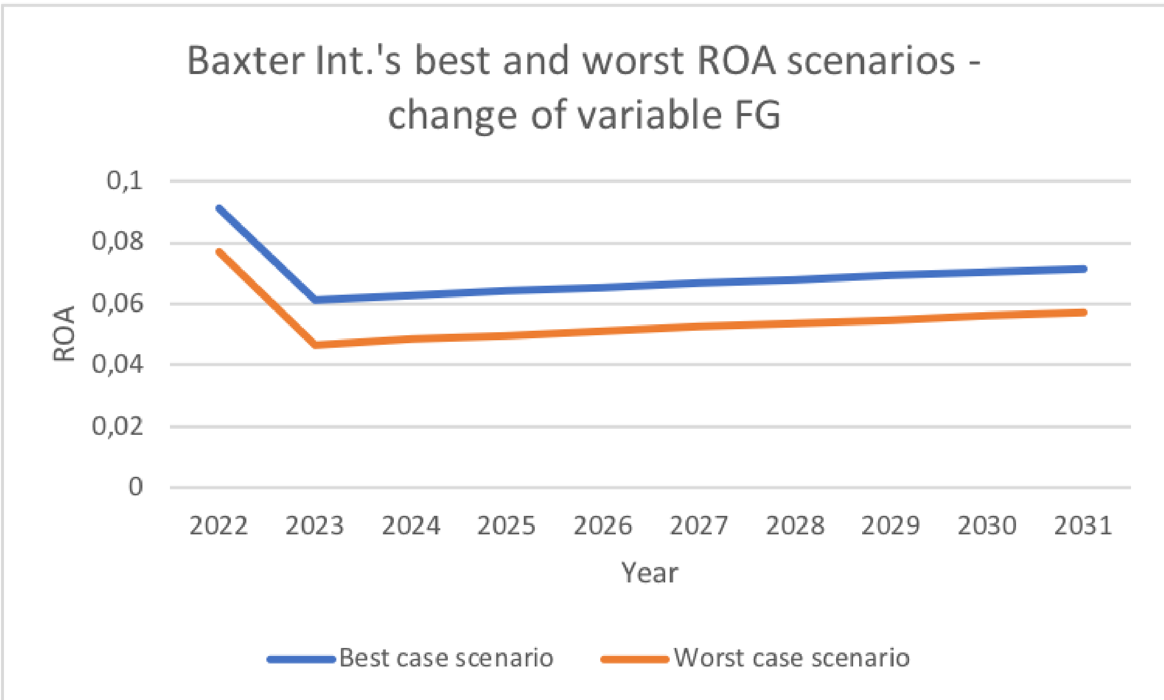

Figure B.6 Baxter Int.’s best and worst ROA scenarios - change of variables FG

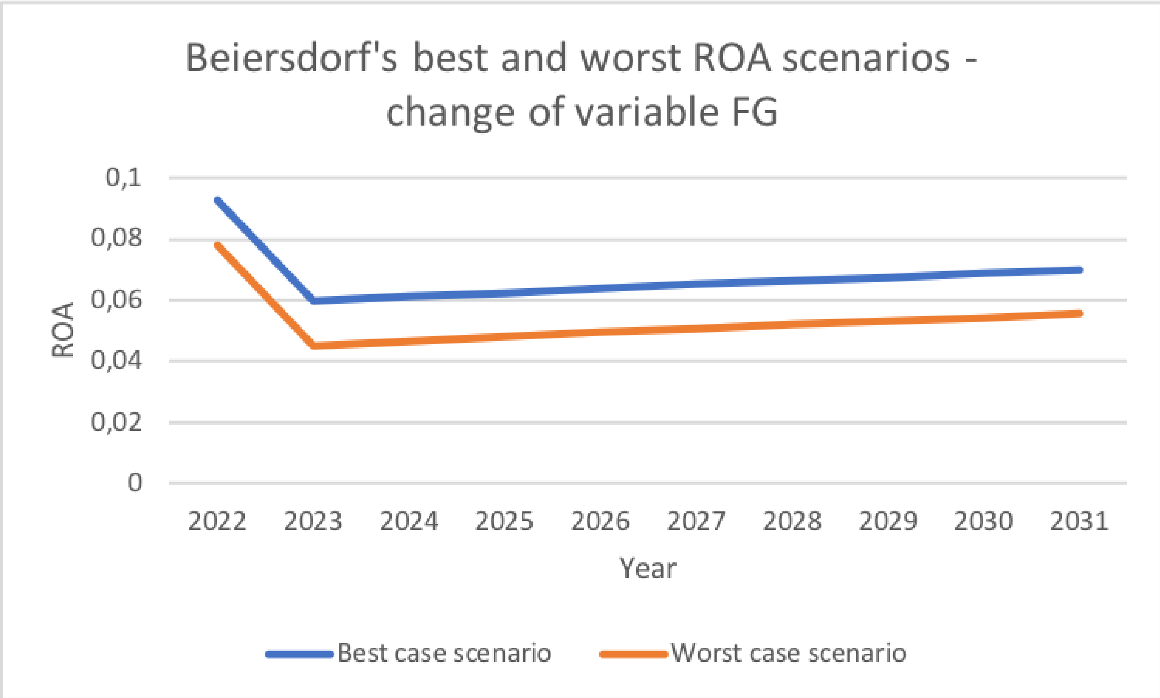

Figure B.7 Beiersdorf’s best and worst ROA scenarios - change of variables FG

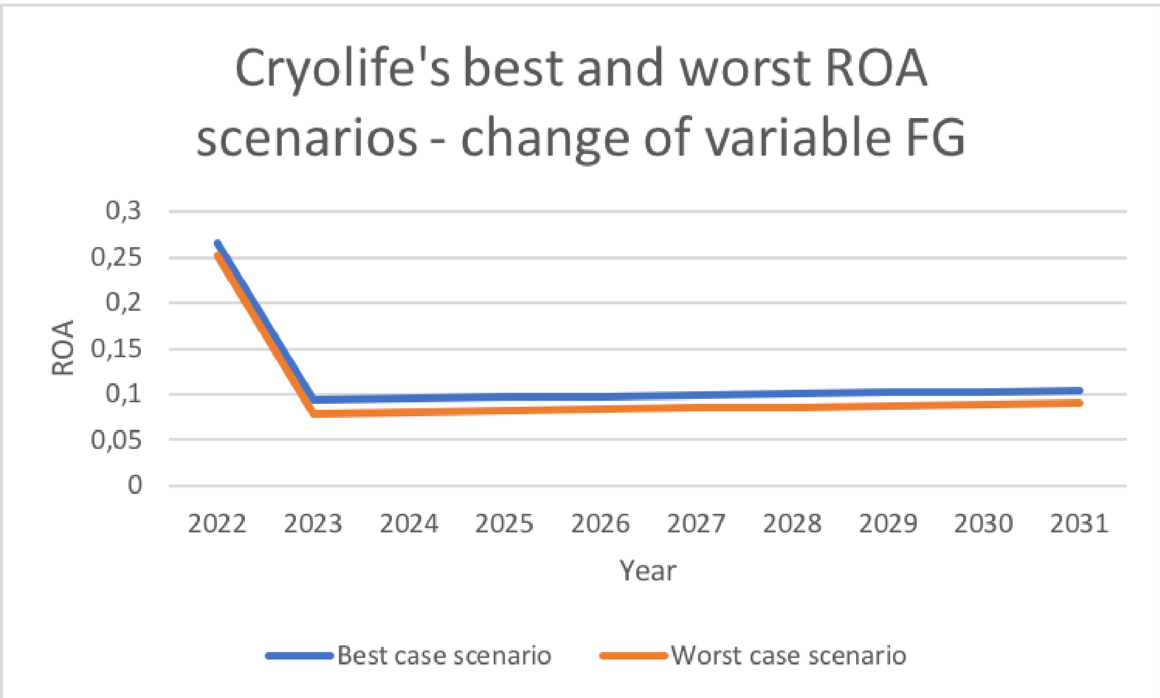

Figure B.8 Coloplast’s best and worst ROA scenarios - change of variables FG

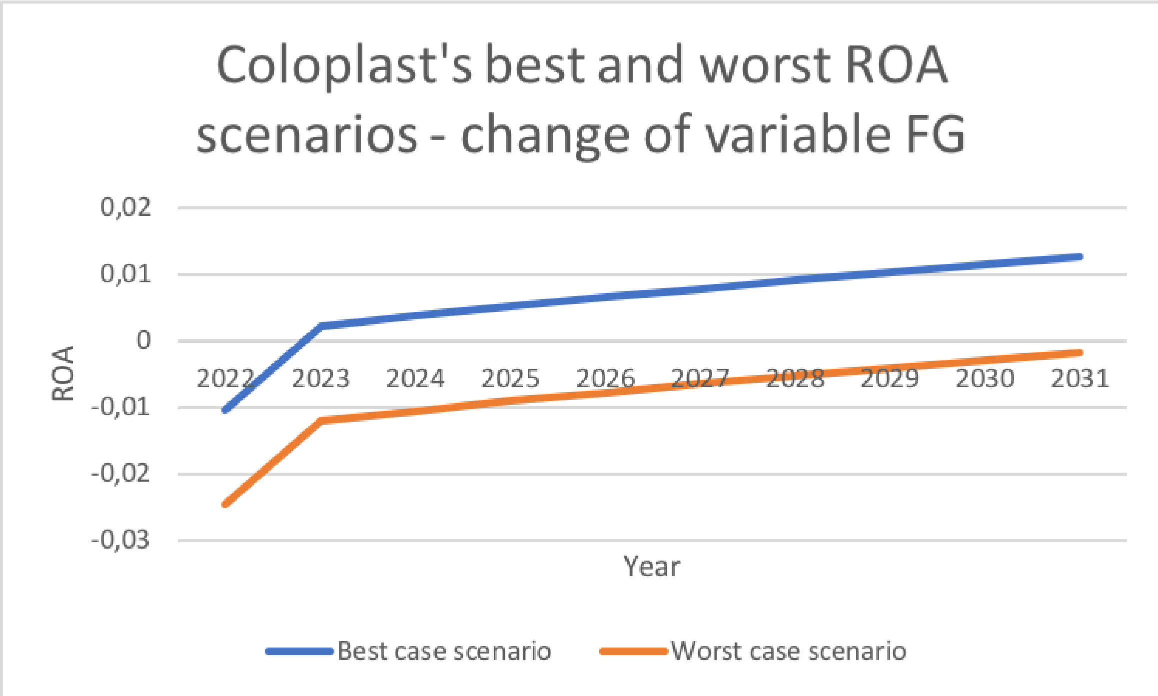

Figure B.9 Cryolife's best and worst ROA scenarios - change of variables FG

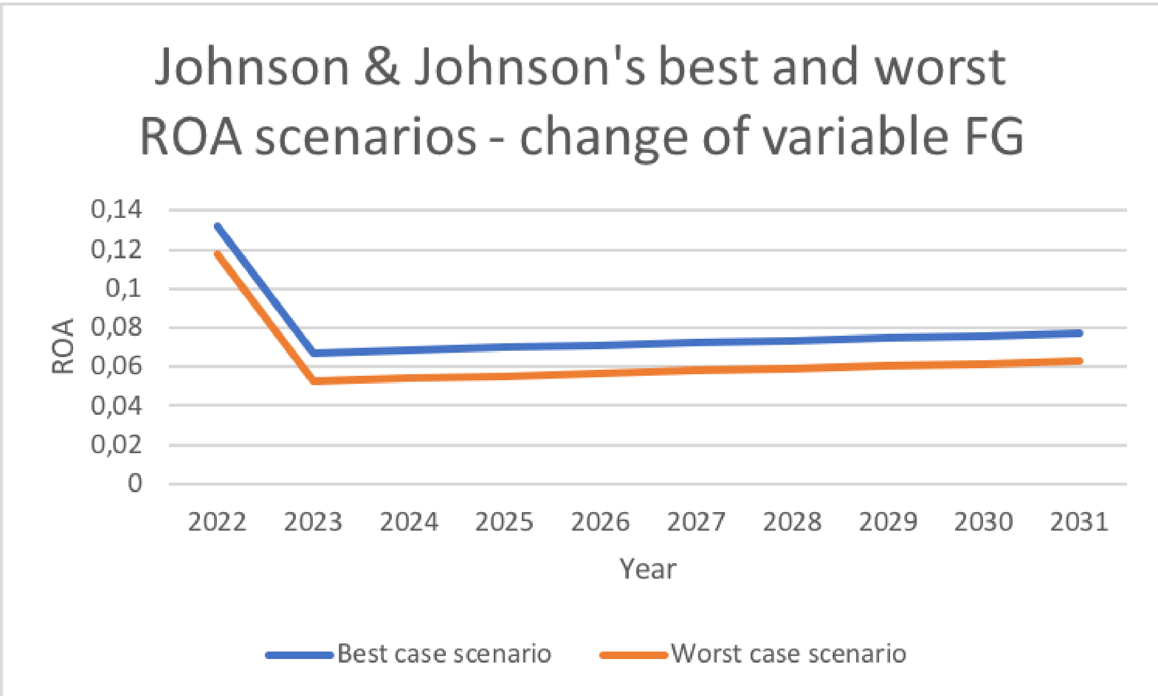

Figure B.10 Johnson & Johnson's best and worst ROA scenarios - change of variables FG

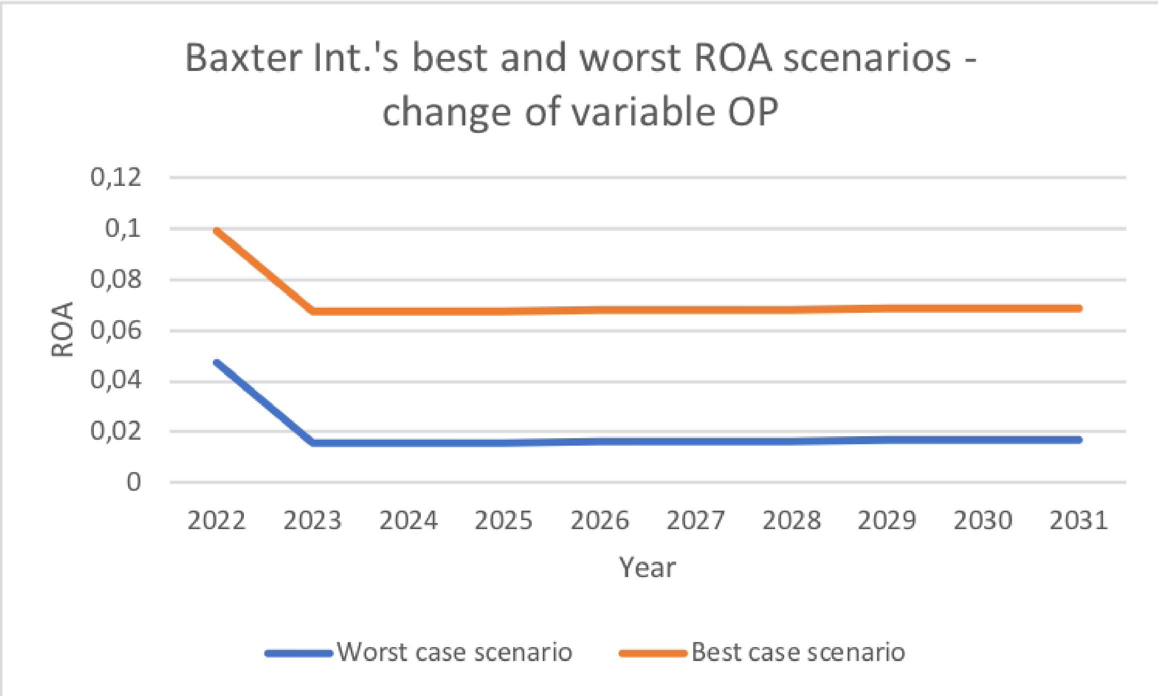

Figure B.11 Baxter Int.'s best and worst ROA scenarios - change of variables OP

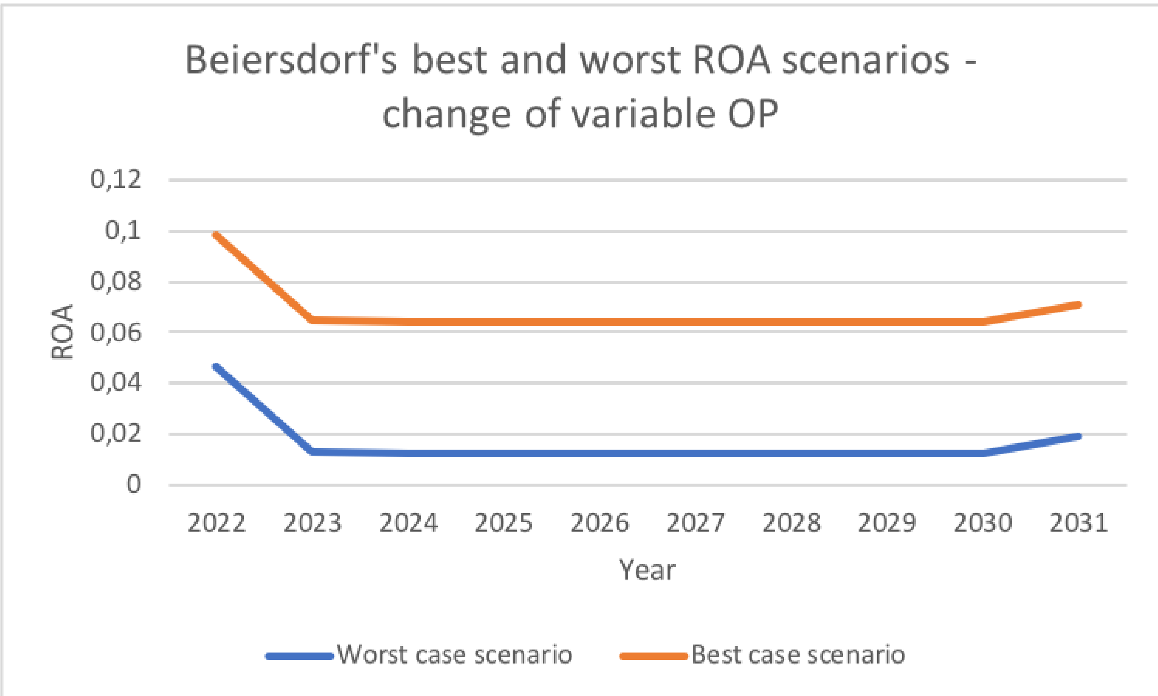

Figure B.12 Beiersdorf's best and worst ROA scenarios - change of variables OP

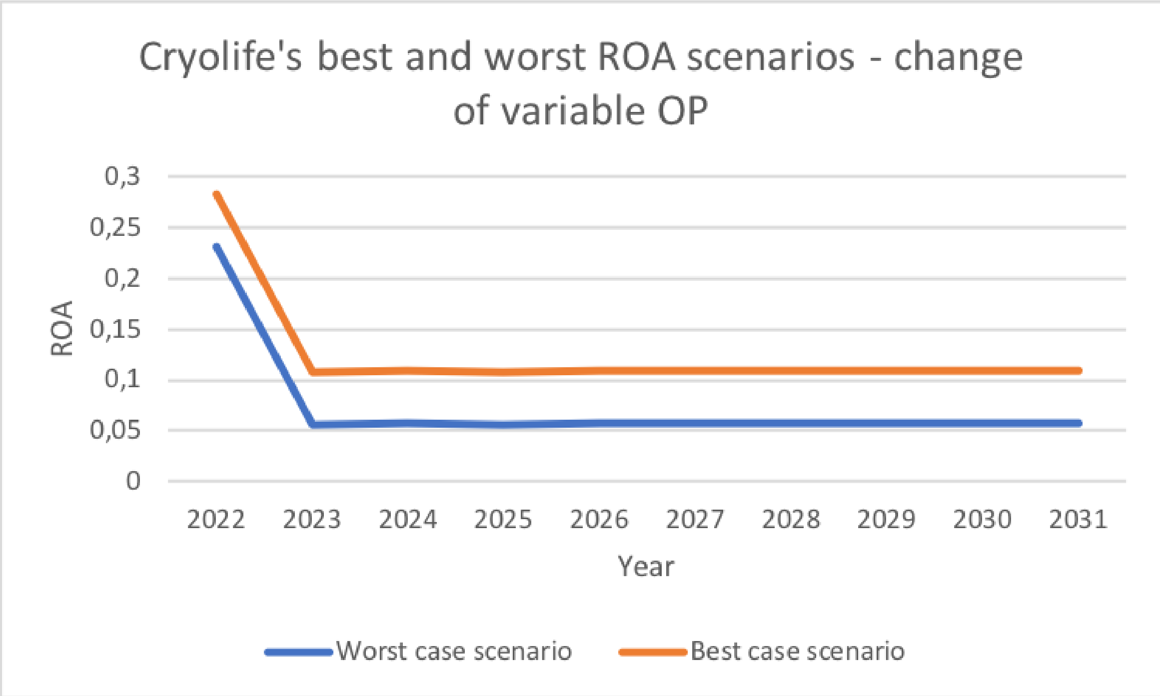

Figure B.13 Coloplast’s best and worst ROA scenarios - change of variables OP

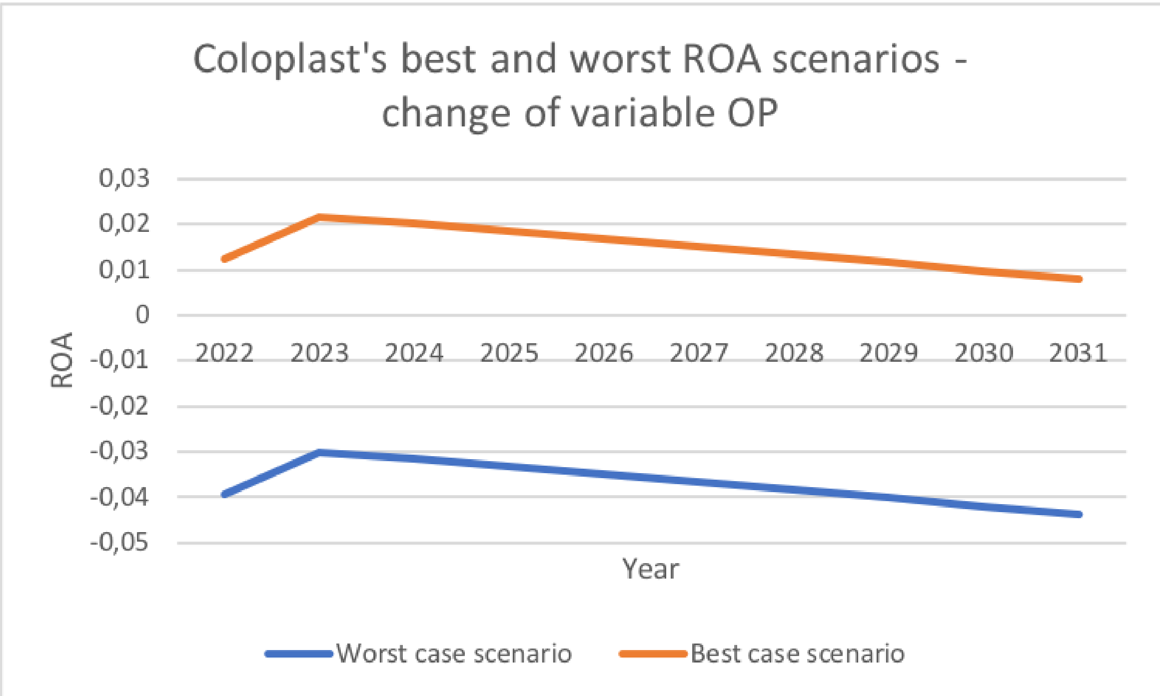

Figure B.14 Cryolife’s best and worst ROA scenarios - change of variables OP

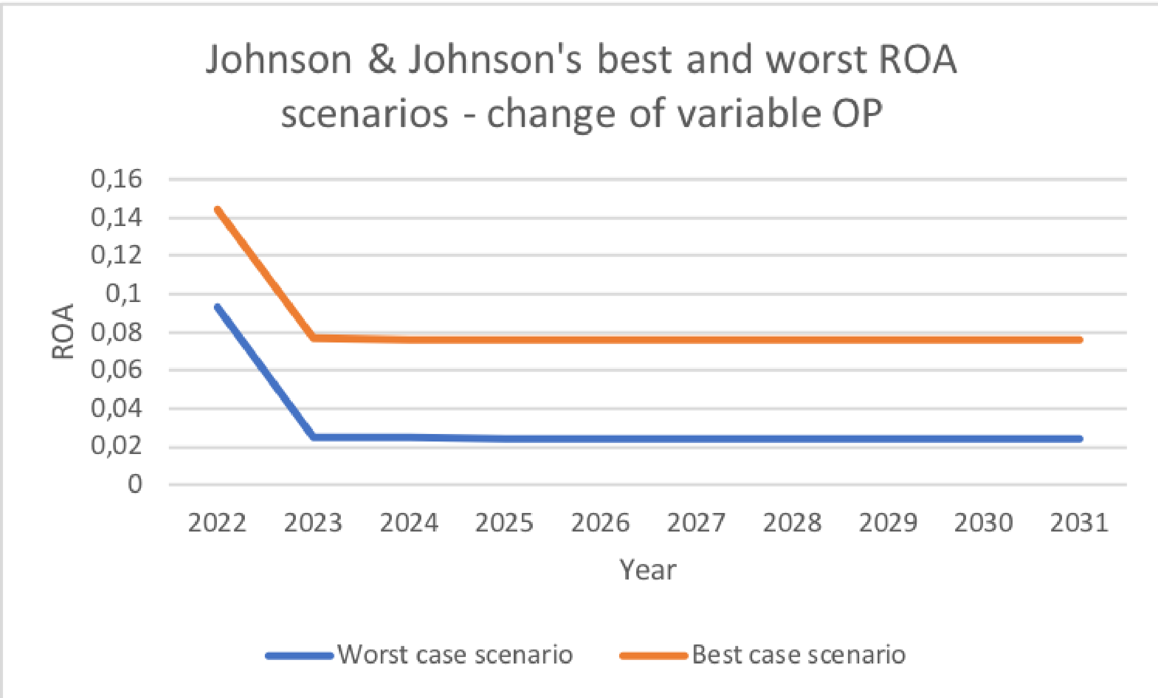

Figure B.15 Johnson & Johnson’s best and worst ROA scenarios - change of variables OP