Tobias Hüttche   *Editor*

Finance in Crises

Financial Management Under Uncertainty

Springer

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🐎 Springer

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About This Book

When we started this project, we were all under the impression of a whole series of crises. The climate crisis affecting us all was temporarily eclipsed by Russia's invasion of Ukraine, as well as the resulting energy shortages and the emerging realignment of global power relations. Here in Switzerland, we had our own national near-death experience with the government-imposed bailout of Credit Suisse by UBS.

While we still trust in our own abilities to overcome these crises, many hopes are now also resting on artificial intelligence. Whether this is really a solution or creates new problems, opinions differ.

In any case, with our contributions we hope to provide guidance on how we can use our human intelligence to deal with crises and uncertainties in financial management.

This book is also an expression of an ability that artificial intelligence has not yet demonstrated, namely team spirit, collegiality, and attentiveness. It also takes emotional intelligence on the part of everyone involved to realize such a project in time. I would like to take this opportunity to thank not only the authors, but above all our colleague Prof. Dr. Volker Schulte, who provided us with reliable editorial and emotional support throughout the entire process. We would also like to thank Springer Nature for the opportunity to publish our work in such a prestigious setting.

Contents

Financial Management Under Uncertainty: An Introduction

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Tobias Hüttche

Abstract The financial system is in a polycrisis. Policymakers are therefore faced with two challenges. On the one hand, new instruments and concepts must be developed to find a suitable response to these complex challenges. On the other hand, experience must be gathered on how to react to these crises with due regard to social and societal upheavals. This book attempts to find answers to these questions by means of various case studies and topics. The book is divided into two main parts. Part I "Financial Management Under Uncertainty: Corporates" deals with these aspects at the corporate level. Part II "Financial Management Under Uncertainty: Markets" deals with these aspects at the level of markets as well as government and private households.

Financial management takes place at different levels, with different objectives, and by a whole range of actors. Traditionally, financial management is understood as the financial management of companies and their financial resources. In a broader sense, however, individuals and entire countries also manage their finances.

The fact that things turn out differently than planned is a natural experience that people have probably been making since they consciously began to plan. Financial management has also evolved or had to evolve in the process.

However, we are currently experiencing a polycrisis, or as Kristalina Georgieva from the International Monetary Fund (IMF) recently put it, "we are facing a crisis on top of a crisis".

Financial management is thus faced with two challenges: On the one hand, it is becoming apparent that hitherto valid concepts and instruments are becoming ineffective; on the other hand, there is a lack of experience on how to deal with such a polycrisis.

The book "*Finance in Crises: Financial Management Under Uncertainty*" addresses these issues. Well-known authors from theory and practice deal with

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different aspects, which, however, in essence always reflect risks and uncertainties in financial decisions. We assign the topics to two superordinate parts. Part I "Financial Management Under Uncertainty: Corporates" addresses these aspects at the corporate level. In Part II "Financial Management Under Uncertainty: Markets", we address these issues at the level of markets, government and private households.

At the beginning, Tobias Hüttche and Fabian Schmid cover the subject of uncertainties in business valuation. The value of a company is determined by the financial income that its shareholders will derive from it in the future. In this respect, every company's value is also always a statement about the company's future development and its environment. Traditionally, these statements are influenced by experience. As a result, planning in many cases only extrapolates from the past. The recent past has shown that the assumption that the future could be like the past is wrong. In this respect, the question arises as to how this uncertainty can be dealt with in company valuations. This chapter provides an overview of the ways and uses practical examples to show their possible applications but also their limitations.

Although accounting is notorious as a view in the rear mirror, some accounting principles request a prospective decision. When it comes to the evaluation of the going concern of a company, the above discussed uncertainties must be considered as Brido Schuler shows in his chapter: Even in normal, non-crisis periods, a company's financial reporting is affected by uncertainty. Financial reporting is based on uncertain assumptions and valuations. However, there is no doubt that the going concern principle applies. This means that the continuation of the company is possible and planned for the foreseeable future. Times of crisis are characterized by increased uncertainty. Uncertainty can be so great that the going concern status of the entity is called into question, with implications for the preparation of the financial statements and the reporting. Brido Schuler discusses some of the implications of preparing and reporting on the going concern basis and some of the challenge for those involved, particularly corporate management and the auditors.

When talking about accounting and business valuation, the annual impairment testing is a regular meeting point of these two disciplines. As an example, for an industry, facing manifold challenges and uncertainties, Martin Tettenborn, Marco Canipa-Valdez, and Maya Tettenborn address impairment testing in the automotive industry: Given the recent crises and ongoing structural changes in the automotive industry, future success potentials from formerly acquired investments within the automotive industry should be questioned. In this context, the estimation of future cash inflows and outflows as well as the corresponding discount rate, which is necessary within the International Financial Reporting Standards (IFRS) framework of the impairment test of assets, becomes much more challenging. To shed new light on the impact of these effects on the litmus test, i.e., on the value of goodwill, the authors use the example of the automotive sector in Germany. The possibility of a goodwill bubble in the automotive industry cannot be ruled out, as they suggest.

As the forestanding authors describe with the consequences of uncertainties and crisis for companies, the question arises, if and how forecasting methods can be used to get a more valid understanding of the future developments. Helena Kovacevic

and Silke Waterstraat follow this path and show how predictive analysis may lead to better informed economic decisions.

Predictive analytics is a tool in corporate financial management to gain a better understanding of the future based on forecasting models helping companies to prepare for future uncertainties and crises based on past data. The authors describe a case study on earnings before interest and taxes (EBIT) forecasting model for a global logistics company specializing in the transportation of liquid bulk commodities. The results show the importance of understanding the mechanics of the income statement and the inefficiencies of the processes to generate accurate forecasts. It emphasizes the importance of forecasting models for both prediction and explanation and highlights the need for regular model adjustments to account for changing dynamics. The case study's findings demonstrate the value of financial forecasting for strategic planning and business management.

When talking about tools and techniques, we always must bear in mind, that (yet) humans are using and handling them. So, at the end of the day, the "tone at the top" is determining the risk appetite and the risk resilience of a company. Emilio Sutter and Basil Sommerhalder are covering in their chapter this "tone at the top" embodied in the Internal Control System.

A well-implemented Internal Control System (ICS) helps managing crises and serves to provide adequate assurance regarding the achievement of an organization's goals in relation to its operations, reporting, and compliance. It is mandatory for listed Swiss organizations as well as for Swiss organizations exceeding certain economic key figures. In that case, the existence of the ICS is checked by the external auditor during the so-called ordinary audit. Although it is not mandatory for all other Swiss organizations, they are able to implement an ICS to their own advantage to strengthen their processes regarding the following five components of internal control: control environment, risk assessment, control activities, information/communication, and monitoring activities. The authors give a summary about the theoretical foundations of the ICS with focus on its implementation in Switzerland and how it helps managing crises. Why Swiss organizations can benefit from a mandatory or voluntary implementation of an ICS is shown and explained as well as how a well-implemented ICS serves as an important instrument regarding crises—in a *proactive* manner before and in a *reactive* manner during crises.

Speaking about corporates and corporate governance, the following chapter demonstrates the importance of corporate governance not only for companies, but a whole economy. Clemens Kustner and Silke Waterstraat chose the example Japan as an example, how countries must adapt.

After the bursting of the stock market bubble at the end of the 1980s Japan began to comprehensively reform its corporate governance system. Modernizing Japan's corporate governance system was seen as one of the key levers to making Japanese companies more profitable, faster growing and less risk-prone, with the overarching goal of revitalizing the Japanese economy in the long term. The first phase of the reform lost some of its momentum in the wake of the great financial crisis that broke out in 2008. Prime Minister Abe then pushed the reform process forward again with vehemence from 2012 onwards. Abe's reform efforts encompassed several

elements, such as the reform of company law and the introduction of a corporate governance code and a stewardship code. At the same time, the Tokyo Stock Exchange has influenced the corporate governance of Japanese companies through its listing rules. From a regulatory perspective, the Japanese corporate governance system can be described as modern and efficient. However, corporate practice often lags. The Fujitec case study at the end of this chapter shows two things: first, how lacking the actual practice of corporate governance can be despite good rules. Second, it shows how determined shareholders today have the power to protect their interests and ensure that Japan's modern corporate governance rules are brought to life, to the benefit of employees, shareholders, and the Japanese economy.

Last but not least we are covering an issue, which importance everybody is experiencing right now. Simon Schmied, Ulrich Krings, and Maximilian Koch are focusing on controlling in the circular economy. In times of crisis, environmental protection becomes increasingly important as it plays a crucial role in the long-term sustainability and resilience of our society. The impact of crises, be it a pandemic, natural disasters, or economic turmoil, can put a heavy strain on the environment and lead to further problems. It is therefore of great importance that we increase our efforts to protect our environment to minimize the impact of crises and ensure a sustainable future.

The authors analyze the role of the controlling function in the transformation process from a traditional to a circular business model. Although the task of controlling lies precisely in measuring and managing corporate strategy, controlling has not yet established itself as a strong player when it comes to implementing a sustainable business model. Controlling still plays too passive a role and lacks the necessary expertise. Furthermore, controlling views sustainability more as a marketing or compliance issue than as a fundamental basic understanding of future entrepreneurial action. The chapter describes the linear business model and the need for a shift to a circular model. Based on this, the requirements for sustainability oriented corporate management are outlined and the form in which controlling can support and accompany such sustainability management in a meaningful way and with suitable Key Performance Indicators (KPI).

In Part II we change the perspective—from corporates and economies to markets and households—but stick to the theme, that is uncertainty and crisis.

Markets and market participants are very sensitive when it comes to crisis and uncertainties. Regulators and authorities are responding very authoritative on unwanted market developments. As an example, after the financial crisis of 2008–2009, apprehensions about the financial prospects of many nations, including several in the euro area, escalated among investors. Consequently, sovereign credit spreads for numerous euro area countries witnessed a significant increase. With the increase of sovereign bond yields during the debt crisis, there was a substantial surge in interest in trading credit risk protection on euro sovereign borrowers through credit default swaps (CDS).

Sascha Häusler and Kristyna Ters analyze the dynamics of euro area sovereign credit spreads in CDS and bond markets for the period after the ban on outright short selling of CDS was introduced in March 2012 to contribute to this ongoing research.

The analysis is conducted for the countries that were most affected during the last euro area sovereign debt crisis which is Greece, Ireland, Italy, Portugal, and Spain, hereafter referred to as GIIPS countries, focusing on the price discovery process.

In the following chapter, Loïc Alvarez and Kristyna Ters focus on the examination of sovereign risk associated with Europe's 'Global Systemically Important Banks' (G-SIBs), tracing the trajectory of sovereign risk during and in the aftermath of the euro area sovereign debt crisis. Key to this analysis is the critical evaluation of regulators' role in addressing sovereign risk, with particular emphasis on the approaches of the Basel Committee on Banking Supervision (BCBS) and European authorities. The authors give also insights, whether regulatory measures taken after the last euro area sovereign debt crisis were able to decrease the potential risk of a new sovereign-bank nexus in the euro area.

Not only physical goods are traded on markets, but also intangibles like energy. Especially this segment was hit by the Russian invasion of the Ukraine and the sanctions in its aftermath. In this context, Matthias Härri is following the question, if electricity trading with derivative instruments speculation, hedging, or speculative hedging? Electricity is typically traded 'forward', i.e., future energy volumes and prices are hedged in advance with derivative instruments to minimize price risks. In times of crisis, when energy prices can be highly volatile, such instruments can also be used for speculative purposes. However, hedging and speculative positions can trigger margin calls on derivatives exchanges or increased collateral requirements in the Over The Counter (OTC) market. The causes, interrelationships, and possible consequences of such margin calls on the financial situation of buyers and sellers of electricity (e.g., on balance sheet liquidity) are discussed. As Matthias Härri shows, the use of hedging instruments to protect against price volatility, together with prudential accounting standards, has led paradoxically to financial problems for many electricity producers during the market turmoil of 2022, and to governmental bail outs.

Most of the models used in the chapters, use statistical models, probabilities, and distributions. In risk management, the probability distribution must adequately capture the risks that matter most, namely the outliers. Andreas Blöchlinger estimates the parameters as if the sample were upper censored to put the focus to the most negative observations (non-censored outliers) and then only estimate the probability that he obtains an "ordinary" observation (censored). The left tail is assumed to follow a location-scale Student's t-distribution, yet no distributional assumptions are made outside the tail. Cauchy's and Gauss' distributions are two special cases of Student's t-distribution. For empirical stock index returns, the left tail is neither Gauss nor Cauchy, a Student's t-distribution with around four degrees of freedom offers the best fit. As an empirical application, I compare the pricing of a short-term far out-of-the-money put option on the Dow Jones with a Gauss, a Cauchy and a Student left tail. The Gaussian Black-Scholes model underprices such insurance contracts, Cauchy overprices them, the Student model, however, is a good match.

Keeping stock and saving for bad times seems to be part of the human nature. So in times of economic uncertainty, understanding household saving behavior is

of particular importance to researchers and policymakers alike. Daniel Hoechle and Frank Graef review the recent empirical literature on household saving over the life cycle, cross-sectional determinants of saving rates, and retirement saving, focusing on studies based on high-quality administrative data. They discuss recent evidence on similarities in economic behavior and outcomes across generations. There are some common themes. While less financially savvy and low-income households are particularly at risk of under-saving, the literature also shows surprising differences in savings rates among financially well-off households. Individuals tend to exhibit present bias and inertia in their saving and consumption behavior and are strongly influenced by their upbringing and genetic predisposition.

Tobias Hüttche is Lecturer at the Institute of Finance at the University of Applied Sciences and Arts Northwestern Switzerland, School of Business in Basel. As an expert at the valuation of SMEs, he contributed in various positions to the development of the Swiss standards of valuation.

Tobias Hüttche received his doctorate in Auditing and Accounting at the University in Nuremberg (Germany) in 1995. In addition to his academic work, he worked for international Auditing Firms in Germany and France. Currently, he is off counsel at a medium-sized consulting company.

He has since also held positions as a board member at several companies.

In this book, Tobias Hüttche draws on his extensive knowledge and experience to provide a comprehensive analysis of considering uncertainties in valuation.

Part I
Financial Management Under Uncertainty: Corporates

Consideration of Uncertainties in Business Valuations

Tobias Hüttche and Fabian Schmid

Abstract Valuation seems to be impossible since the future is uncertain. Nevertheless, company values are necessary for many reasons, so the question arises as to how valuations can take these uncertainties into account.

Traditionally, the past is used as a basis for planning, i.e., it is more or less simply extrapolated. Given current experiences (Corona pandemic, Ukraine war, inflation, and energy crisis, to name but a few), the hope remains that these will not be perpetuated. On the other hand, however, we must also expect new and as yet unknown developments, or developments that are not considered likely or unlikely.

To produce reliable valuations as a basis for economic decisions even in times of increased uncertainty, selecting suitable procedures and the appropriate handling of risks is important.

Basically—and recurring to the mathematical model of discounting future cash flow—uncertainties or risks can be taken into account above the line (in the numerator or the cash flows) or below the line (in the denominator or the cost of capital). Double counting must be avoided, meaning that the denominator matches the numerator (equivalence principle) and that the cost of capital adequately reflects the fluctuations in cash flows.

Up to now, most valuations reflect only one path, the future developments may take. In this paper, we want to demonstrate how the traditional valuation approach can be extended by sensitivity analyses, scenario calculations, and simulations to move from pure point estimates to reliable value ranges that may reflect reality more accurately.

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1 Uncertainty in DCF Valuation

1.1 DCF Standard Valuation Model

The discounted cash flow (DCF) method, which is considered best practice (EXPERTsuisse, 2022, N 4), derives the enterprise value from the expected future financial surpluses (free cash flows) discounted to the valuation date. Any non-operating assets, such as surplus liquidity, are considered separately.

Future financial surpluses are derived for the next 3–5 years (detailed planning period) ideally based on an integrated planning—consisting of a forecasted income statement, balance sheet, and cash flow statement. In the subsequent phase of perpetuity (residual value), a sustainable free cash flow is planned once the so-called steady state has been reached and this is extrapolated in perpetuity—with or without growth and taking into account economic equilibrium conditions such as the ratio of depreciation and amortization to capital expenditure.

Integrated planning is rooted in the financial statements of the previous years. Typically, these are the annual financial statements of the last 3–5 years. So, the past and the future are at least linked formally and by formulas. This linkage must not lead to a mere extrapolation of the past, even if that is the way, many plannings are done. The past shows the value drivers and the mechanics of how the company generates cash flows. The circumstances may change and the company may develop more, less, or other abilities—this is the most challenging part of planning.

1.2 Uncertainty and Expected Value

The future development of the company and thus also the financial surpluses are uncertain (Mandl & Rabel, 2019, p. 66). This risk can be taken into account in the company valuation either as a premium to the discount rate (risk premium method) or as a deduction from the expected value of the financial surpluses (security equivalence method) (Mandl & Rabel, 2019, p. 66).

In valuation practice, the risk premium method dominates clearly. Under this method, the numerator of the valuation equation shows the expected values of the financial surpluses, which are discounted using a risk-adjusted discount rate (Ihlau & Duscha, 2019, p. 176). The expected values of the financial surpluses should in particular also reflect the specific risks of the respective company—e.g., dependencies on customers, suppliers, and key persons (IDW, 2016, N 89 f.). As a consequence, the cost of capital should only take into account those risks that affect several companies at the same time, i.e., are systematic (Hüttche & Schmid, 2023, p. 131).

For the valuation of a company, it is necessary to have a plan that is "true" in terms of comprehensive, transparent, and based on expected values. "True" means, that the expected value reflects all possible deviations from the plan in the form of

opportunities and risks with their probabilities of occurrence (Gleissner & Presber, 2010, p. 82 f.). The decisive factors are therefore not the financial surpluses that are expected with the highest probability, but the probable ones weighted with the corresponding probabilities of occurrence (Gleissner, 2008, p. 83).

Nevertheless, the expected value is a statistical metric, which is not likely to be seen: Given a cash flow of 0 with a probability of 50% and a cash flow of 1000 with the same probability, the expected value is 500. Thus, these 500 will never be realized, it is 0 or 1000.

So, valuations and the plans they are based on, are often drawn up using a "base case" (IFBC, 2007, p. 1). This conceals the variations of the cash flows and the respective enterprise value and suggests a supposed certainty of the valuation result.

1.3 Valuation Date Principle

The valuation date is key—not only for the allocation of cash flows to seller and buyer (cut off), but also for the determination of the information that can and has to be considered when setting up the planning and the valuation (Hüttche & Schmid, 2023, p. 49 f.).

Consequently, only information that was available on the valuation date can be considered. However, to be relevant, this information must be not only available but also knowledgeable. It could and should be obtained with due diligence. Problems arise when a light on new issues is shed after the valuation date or it shows that the information gathered at the valuation date was not proper, outdated, or false.

In these cases, the purpose of the valuation is important: If it is a transaction, the valuation is only one step in the process. Any changes between the valuation date and the closing will be considered when drawing up the contract or negotiating the price or terms of payment (i.e., earn out agreements etc.). So, there is no need for any dogmatic discussions.

However, if the valuation is legally or contractually needed—litigation, divorce, etc.—the value is not negotiable. The valuation should reflect the value or the concept of value, that is intended by law or contract, that is in most cases a market value, i.e., the price a willing buyer would pay for the company at the valuation date. Consequently, only information must be considered, which where—as stated above—available and knowledgeable at the valuation date. Developments after the valuation date must be only considered, when their "root" was already laid at the valuation date and were foreseeable with a sufficient high degree of probability (Ihlau & Duscha, 2019, p. 76).

This approach seems sound at first sight but bears some problems. First, it is always a question of cause and consequence: BREXIT would not have happened, without the UK entering the EU, inflation wouldn't have happened without the liberal policy of the central banks, etc. So this is a matter of judgment. Second, when we are talking about expected values, every probability—no matter how small—would have to be considered. But again, this is also a matter of judgment.

2   Cost of Capital

Future free cash flows must be discounted to the valuation date using the risk-adjusted cost of capital. Since the future of a company is uncertain, the financial surpluses are discounted at the risk-free interest rate plus a risk premium. The cost of capital corresponds to the return that an investor in an alternative investment with an identical risk profile, i.e., a comparable company, would expect.

In practice, these (equity) costs of capital are usually estimated using the Capital Asset Pricing Model (CAPM). Here, the expected return corresponds to the sum of the risk-free interest rate and the market risk premium multiplied by a beta factor. For smaller companies, the cost of equity calculated in this way is typically supplemented by a small-cap premium to reflect the additional risk associated with the company's size or the limited tradability of SME shares.

The higher the dependency of sales on market developments (cyclicality), the more fixed the cost structure (operating leverage), and the higher the proportion of debt (financial leverage), the higher the cost of capital should be. These fundamental risk factors are incorporated into the CAPM equation via the beta factor (Hüttche & Schmid, 2023, p. 131).

Even though the individual cost of capital parameters are observable and thus supposedly "true" values, they are subject to considerable uncertainties. Even the risk-free interest rate, which is fundamentally given at the valuation date, is in its future path subject to large fluctuations, not least in the current market environment with inflation and fears of recession. This uncertainty is further accentuated by the estimation of the market risk premium and the beta factor. This is all the truer since the estimated cost of capital should reflect the expectations of the investors and with these, their expectations on future developments such as economy, inflation, interest rates, etc.

As a proxy for the future, actual capital market data—which should reflect the expectations of the market on the valuation date—or time series of the past—which reflect the future expectations of the investors, based on their past returns—are widely used. Again, these costs of capital reflect the situation at the valuation date. Even for the calculation of the terminal value and so the complete life span of the company—the same rate is used. Again, it must be stressed, that risks should preferably be reflected in the plan and so in the future cash flows. And every valuation reflects the expectations of the investor at the valuation date. So, every valuation is as certain or uncertain as the future is. How these uncertainties can be quantified will be shown in the following section.

3   Sensitivity Analysis

Sensitivity analysis is widely used to map the area of uncertainties. As valuations are largely based on assumptions about future developments, sensitivity analyses can clarify the weight of the assumptions made by showing how much the company

value would change if certain key parameters were to turn out somewhat higher or lower (Hüttche & Schmid, 2023, p. 150). Sensitivity analysis shows also the constellation of these parameters—and their effect on the value—under which the decision based on the calculated value would be another (buy/not buy or sell/not sell, etc.).

Sensitivity analysis is therefore a procedure for estimating the risk of a wrong decision by varying one or more input variables. Regarding the parameters, one should be guided by the main value drivers identified during the business analysis or valuation (Ihlau & Duscha, 2019, p. 177). Typically, these are likely to be the cost of capital and the variables—particularly relevant for residual value—margin, return, or growth rate. A sensitivity analysis usually uses a matrix form, showing how the enterprise value changes if one or the other input factor increases or decreases by a certain percentage.

It should be noted that the calculation of sensitivities and the "alternative" company values derived from them are merely a mathematical extension of the basic valuation. They do not represent a fully comprehensive new valuation, but a "ceteris paribus" point of view (Ernst, 2019, p. 253). For example, interdependencies such as the fact that higher growth generally entails additional investments and reduces free cash flows accordingly are not considered. Nevertheless, an analysis of the sensitivity of the enterprise value to changes in the main value drivers allows the universe of possible values to be scaled down to a manageable range.

The following figure illustrates such a sensitivity analysis as it is often seen in practice (app.wevalue.ch) (Fig. 1).

In the middle of the matrix is the expected value of the company, as derived from the base valuation. The other figures provide information on how the value would change if the weighted average cost of capital (WACC) and/or the long-term growth rate were slightly higher or lower. As already pointed out, however, this is purely a "ceteris paribus" consideration, i.e., an alternative valuation assuming that all other factors remain the same.

Equity Value (in KCHF)			
WACC →	8.54%	8.79%	9.04%
growth rate (g) ↓			
g = 0.00%	3'494	3'371	3'254
g = 0.25%	3'587	3'458	3'336
g = 0.50%	3'685	3'550	3'422
g = 0.75%	3'790	3'647	3'513
g = 1.00%	3'902	3'751	3'610

Fig. 1 Sensitivity analysis of net enterprise value to cost of capital and growth rate

4   Scenario Analyses

4.1   Basic Principles

Scenario analyses are sensitivity analyses on a larger scale. Thus, the latter is a "ceteris paribus" calculation, scenarios calculate different values, using a complete set of different input parameters. Usually, the three different scenarios normal ("base case"), optimistic ("best case"), and pessimistic ("worst case") are common. However, scenarios such as "with growth" and "without growth" are also conceivable. Furthermore, economic aspects such as the economy, inflation, exchange rate, etc. can be considered in different scenarios (Lütolf et al., 2018, p. 228 f.).

Scenario analyses are created by varying the key value drivers. However, compared to a sensitivity analysis, this is not limited to one or two parameters. Typically, these are sales, costs, margin, investments, return, financing, and risk. Scenario calculations are used to reflect their various probable future developments (Ihlau & Duscha, 2019, p. 177 f.).

It makes sense to make the main features of the individual scenarios transparent and, for example, to summarize them in a table—as illustrated below (Ihlau & Duscha, 2019, p. 180) (Table 1).

The scenarios should reflect different assumptions about future macroeconomic, industry-related, and company-specific developments. Overall, the scenarios should primarily reflect those conceivable developments that have a certain minimum probability of occurrence and a significant influence on the earnings power of the valuation object.

When creating the scenarios, the assumptions must be critically reviewed, particularly regarding the following issues (Koller et al., 2020, p. 382 f.).

Table 1   Different scenarios with their main distinguishing features

Best case	Base case	Worst case
Very good economic framework conditions	Good economic framework conditions	Poor economic conditions
Increase in sales growth	Stable sales growth due to the replacement of old customers with new ones	Declining sales due to lack of new customers
Increase in gross profit margin	Stable gross profit margin by passing on standard market procurement conditions to customers	Reduction in gross profit margin
Full pass-through of higher energy and labor costs to customers	Partial pass-through of higher energy and labor costs to customers	No possibility of passing on higher energy and labor costs to customers
Replacing existing old loans with more favorable bank loans	Continuation of favorable financing conditions	Deterioration of creditworthiness and financing conditions

- *Overall economic development:* How decisive are market-wide forecasts for results? Some sectors are more dependent on general economic conditions than others. Residential construction, for example, correlates strongly with the general economic situation. Food processing, on the other hand, is less dependent on the economy. Is the planned growth realistic about the expected development of the economy as a whole?
- *Competition in the industry:* A scenario that assumes significant growth in market share is less likely in a competitive and concentrated market than in an industry with fragmented and inefficient competition. Is the planned growth realistic in terms of the industry and competitor companies?
- *Operational capabilities of the company:* Analysis of the capabilities required to achieve the business results forecast in the scenario. Can the company develop its products on time and manufacture them within the expected cost range? Is the projected margin realistic? Are the planned investments sufficient to achieve the sales targets and serve the market?
- *Financial capabilities of the company*: Financing capabilities are often implicit in the valuation. If debt or cash balances are too high relative to enterprise value, how will the company address the imbalance? What is the long-term capital structure? Do the chosen capital costs reflect current market conditions, or are they realistic and risk-adequate return expectations?

Scenario calculations demonstrate the effects of changes in central planning parameters on the forecast financial surpluses and thus the enterprise value. Scenario calculations are particularly essential for high-growth companies, as the plans often include high sales and margin increases, the forecasts for which are subject to considerable uncertainty and fluctuation (Ihlau & Duscha, 2019, p. 178 f.). However, scenario analyses are also useful for established companies, for example when it comes to assessing the impact of a product launch, the possible loss of a key customer, margin pressure, changes in payment deadlines, or a planned major investment.

The scenario technique is a method for obtaining potential, complex images of the future, so-called scenarios. Each scenario describes a possible future development (Foster, 1993, p. 124). Considering the uncertainty that increases with ongoing distance from the valuation date, the scenario technique depicts future developments in the form of a funnel whose diameter or range of variation increases with increasing distance in time. Thus, deviations from the plan are more likely to happen, the more these possible events are in the future. The following figure illustrates this (Hayn, 2019, p. 1089 f.) (Fig. 2).

For reasons of practicality and time, instead of generating all conceivable scenarios, often only a few are created. Thus, in addition to the two extreme scenarios ("best case" and "worst case"), which limit the funnel upwards and downwards, at most a few more scenarios are modeled to obtain a realistic and comprehensive picture of probable future developments.

Free Cash Flow
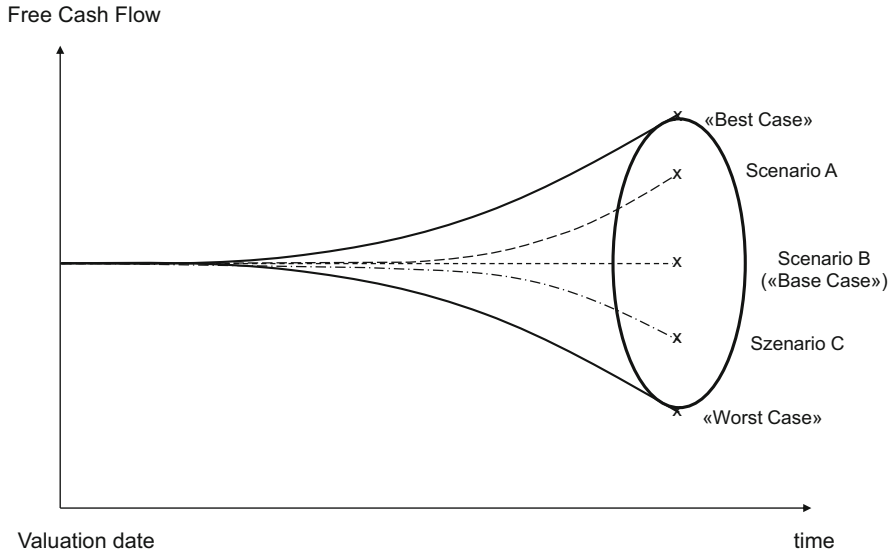
Fig. 2 Scenario technique thought model in the form of a funnel with increasing forecast uncertainty over time

4.2 *Company Valuation using Scenarios*

Once the individual future scenarios have been defined and created, each scenario must be assigned a realistic probability of occurrence. Although it will hardly be possible to quantify the probability of an individual scenario with pinpoint accuracy, in many cases it will be possible to estimate which of the scenarios are more likely than others and what the most probable future development is.

The scenarios assigned the corresponding probabilities can now be considered in the company valuation in two ways. First, a separate enterprise value is calculated for each scenario by discounting the individually forecasted financial surpluses with the risk-adequate cost of capital. The resulting enterprise values are then weighted with the probability of the respective scenario to obtain a single-value enterprise value in the sense of an expected value at the end. The following example is intended to illustrate this approach (Koller et al., 2020, p. 385) (Fig. 3).

Alternatively, the financial surpluses shown in the individual scenarios are weighted with the associated probability and an expected value of the financial surpluses derived. This corresponds to the DCF standard valuation model, in which a single, and expectation-true planning or the expected value of the financial surpluses is ultimately calculated. This expected value of the financial surpluses is then discounted by the expected value of the cost of capital to directly obtain the expected value of the enterprise value. The following figure, which shows both the free cash flow development of the individual scenarios and the expected value derived from
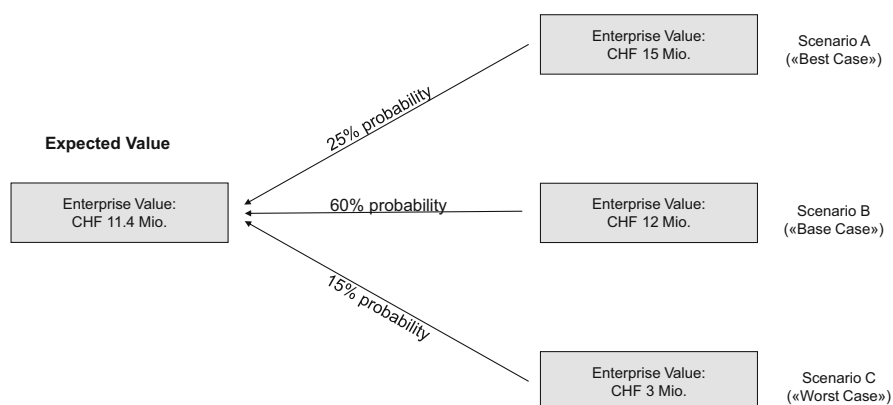
Fig. 3 Derivation of the expected value of the company value from separate company valuations

Free Cashflows (in TCHF)	Probabilty	Plan 2023	Plan 2024	Plan 2025	Plan 2026	Plan 2027	terminal value
Best Case	25%	90	105	120	110	125	120
Base Case	60%	50	60	80	70	50	55
Worst Case	15%	35	25	15	10	5	2
Expected Value		58	66	80	71	62	63
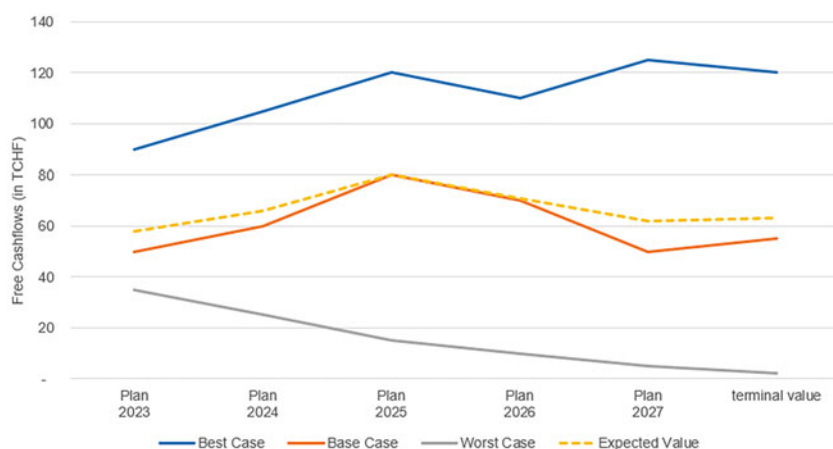
Fig. 4 Financial surpluses of the individual scenarios and the expected value

them, is intended to illustrate this by way of example (Ihlau & Duscha, 2019, p. 182) (Fig. 4).

Basically, both approaches should lead to the same result. However, the separate valuation for each scenario provides valuable additional information in that, in addition to the expected value of the enterprise value (= point estimate), the range of possible enterprise values also becomes apparent. This contrasts with the alternative variant, in which only a company valuation is prepared based on the expected value

of the financial surpluses from the individual scenarios, and the fluctuation risk of the company value thus remains hidden.

5 Simulations

5.1 Basics

In terms of mapping and considering possible future developments, a simulation-based valuation approach goes the furthest. While the scenario calculation described above depicts individual, possibly arbitrarily constructed scenarios, a Monte Carlo approach permits a stochastic (random) and computer-aided simulation of an almost infinite number of possible future scenarios (Gleissner & Wolfram, 2017, 315 f.).

Based on the previously defined probability distributions for the individual parameters, each future scenario shows a possible development of the target variable, e.g., sales, EBIT(DA), margin, capital expenditure, cost of capital, etc. (Ihlau & Duscha, 2019, p. 179). The result is a distribution function for the target variables and the enterprise value, i.e., a value range with a corresponding probability space.

To pursue such a simulation-based approach, in addition to a fully integrated valuation model, software such as Crystal Ball is required, which is available as an Excel add-in. With this software, company valuations can be enriched with probability distributions of the planning assumptions, and countless scenarios can be generated automatically. The result is then a graph showing the distribution or the range of fluctuation of the company value with the corresponding probability.

A simulation-based assessment approach can essentially be divided into three steps (IFBC, 2007, p. 2):

1. Determination of input parameters and creation of the financial and valuation model
2. Determination of the distribution of input factors
3. Simulation and interpretation of the results

These individual steps are briefly presented below. The aim is to show how simulations can be used to determine the risk profile of key parameters and the value of a company, thereby improving the informative value of valuations.

5.2 Determination of Input Parameters and Creation of the Financial and Valuation Model

The starting point for creating a simulation-based valuation model is a financial and valuation model based on planning assumptions. In this context, the budgeted

balance sheet, the budgeted income statement, the budgeted cash flow statement, and the financial surpluses derived from them should be based entirely on a central cockpit with the corresponding planning assumptions. For a good overview, it is advisable to structure the parameters according to the primary value drivers, i.e., sales, costs or margin, investments, and financing.

The individual variables should be planned as far as possible based on the originator, i.e., sales, for example, via a combination of price and quantity, and wage costs via a combination of the number of employees and average wage per employee. The level of detail will depend on the complexity of the business model of the valuation object, the quality of the valuation, and the availability of data on the individual value drivers (IFBC, 2007, p. 2).

5.3 Determination of the Distribution of Input Factors

The next step is the quantitative description of the risk of the planning assumptions through distribution functions. The known statistical methods for calculating volatilities are used to determine these distributions. Ideally, the values can be determined based on historical empirical values of the valuation object, e.g., from the company analysis. Alternatively, the risk distributions of the input factors are to be approximated using competitor, industry, or environmental analyses or estimated by the company itself to the best of its knowledge (Ungemach & Hachmeister, 2019, p. 203).

There are many different distributions. The best known is the normal distribution, which assumes that a value is evenly distributed around its mean value, i.e., symmetrical, and that the probability of occurrence of values decreases the further away they are from the mean value. Such a distribution is likely to be correct in many cases, for example, for certain cost blocks of a company or the margin.

This may be different for events that either occur or do not occur, i.e., are not normally but asymmetrically distributed. Examples could be a loss of a major customer, a bad debt, or a warranty claim, which may or may not occur. In the best case, the negative event does not materialize; in the worst case, the loss significantly exceeds the assumed expected value. In such a case, triangular distributions, or alternative, left- or right-skewed distributions with defined extreme values—which do not have to scatter symmetrically around the assumed expected value—and individually estimated probabilities are probably more accurate.

5.4 Simulation and Interpretation of the Results

Once all input parameters and the associated distributions have been defined, simulation technology can be used to generate many possible future developments and assess their impact on the company's value. As a result of these simulations,

decision-makers have risk information in the form of histograms and cumulative probability distributions (IFBC, 2007, p. 5).

In addition to the risk distribution to the enterprise value and the input parameters, fluctuation ranges can also be generated for selected balance sheets and income statement items. For example, statements can be made about the probability of sales, EBIT(DA), margin, etc. falling within a certain range. This is not only interesting about the plausibility of the planning assumptions but also provides valuable insights into, for example, the sustainability of loans, the required minimum liquidity, or the risk of the company slipping into the loss zone (IFBC, 2007, p. 5 f.).

The explanations given show the advantages of a simulation-based company valuation compared to traditional methods for determining value. In addition to the additional information on the risk profile of the company's value, significant information can be obtained on the dispersion range of the key financial variables. This contrasts with one-dimensional valuation models based on expected values, which do not provide any information on the fluctuation ranges and the probability that the calculated results will occur.

6   Conclusion

In the current practice of business valuation, the financial models reflect often only one—and the most probable—course of events. Even if this development reflects the expected value, such a planning may convey a false sense of security. This is because the many assumptions included in a valuation will never occur in reality but will deviate to a greater or lesser extent from the estimated value. Ideally, the positive and negative deviations roughly compensate each other, so that the financial surpluses and cost of capital correspond to the original expected value.

Increased uncertainties—whether due to war, inflation, energy crises, shortened cycles, etc.—mean that single-value estimates are becoming increasingly difficult. Sensitivity analyses, scenario calculations, or simulation-based approaches are suitable for making this uncertainty or range of variation in key parameters tangible.

Digitization and automation, which are also advancing in business valuation, will help to embody these techniques in the valuation models and process. (Schmid & Hüttche, 2020, p. 85 f.). As a result, the value drivers of a company can be analyzed more quickly and more accurately, the planning assumptions can be estimated using multiple values, and it can be shown transparently how changed input variables affect the company value. The uncertainty in company valuations thus becomes more tangible and is reflected in the fluctuation range of the calculated company values.

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In this book, Fabian Schmid draws on his extensive knowledge and experience to provide a comprehensive analysis of the valuation of firms and specifically the way to deal with uncertainties in such business valuations.

Increased Uncertainty in Times of Crises and Implications for Financial Reporting, Focusing on the Going Concern Principle

Brido Schuler

Abstract Even in normal, non-crisis periods, a company's financial reporting is affected by uncertainty. Financial reporting is based on uncertain assumptions and valuations. However, there is no doubt that the going concern principle applies. This means that the continuation of the company as a whole is possible and planned for the foreseeable future. Times of crisis are characterized by increased uncertainty. Uncertainty can be so great that the going concern status of the entity is called into question, with implications for the preparation of the financial statements and the reporting. This chapter discusses some of the implications of preparing and reporting on the going concern basis and some of the challenge for those involved, particularly corporate management and the auditors.

1 Introduction

Financial accounting is the basis of financial reporting. It records the transactions and facts necessary for the presentation of a company's net assets, financial position, and results of operations (economic position). The purpose of financial reporting is to present and disclose the results of financial accounting. This is done on the basis of assumptions (Swiss Code of Obligations (CO), Art. 957 to 964). A fundamental assumption is the going concern principle.

The going concern principle states that the company will continue as a going concern for the foreseeable future (CO, Art. 958a, Para. 1). The assumptions themselves are subject to uncertainty. In times of crisis, the uncertainties increase and the going concern principle may be threatened, which brings the assessment of the going concern principle into focus. If the going concern principle can no longer be met, the valuation of balance sheet items must be changed from going concern values to realizable values. This change has far-reaching consequences for the

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company, ranging from capital losses and over-indebtedness to liquidation. Before the liquidation of the company measures are usually taken to avoid it. This chapter discusses, various topics, questions and issues relating to the ability to continue as a going concern in times of crisis. These are:

- What is the basis of the going concern principle?
- Which questions help in assessing going concern?
- The impact of events after the balance sheet date (subsequent events).
- Possible retrospective actions in the event of loss of capital and over-indebtedness.
- What are the responsibilities and tasks of the parties involved, particularly the corporate management and the auditor?
- What challenges and areas of tension do management and the auditors face in practice?
- How can these challenges and areas of tension be addressed?

2   Increased Uncertainty Affects the Going Concern Assumption

In principle, an entity's financial statement should be prepared on the assumption that the entity will continue as a going concern. Article 958a paragraph 1 of the Swiss Code of Obligations states: "The financial statements shall be prepared on the assumption that the company will continue as a going concern for the foreseeable future. In paragraph 2 of the same article, the legislator stipulates. If it is intended to discontinue an activity or part of an activity within 12 months of the balance sheet date, or if it not foreseeable, the realizable values of the operation or part of the operation concerned must be used." A provision is also be recognized for the costs associated with the discontinuance. The term "for the foreseeable future" is defined by law as at least 12 months from the balance sheet date.

Swiss Principles of Auditing (ISA-CH) 570, note 19 also defines the foreseeable future as at least, but not limited to, 12 months from the balance sheet date. If the ability to continue as a going concern is foreseeable for at least 12 months, an entity's balance sheet items are carried at going concern values. An assessment of the ability to continue as a going concern may be made without a detailed analysis if the enterprise has a history of profitable operations and has ready access to financial resources (ISA-CH 570, note 6).

Not all companies will be able to meet the twin requirements of a history of profitable operations and rapid access to financial resources. In the event of a multi-year crisis, many companies will experience problems of profitability. Detailed analyses of the ability to continue as a going concern are therefore necessary. If the ability to continue as a going concern cannot be affirmed, the valuation of the balance sheet items must be changed from going concern value to the realizable value. In almost all cases, a change in valuation is accompanied by a reduction

in the value of the enterprise. Only in relatively rare cases where there are forced reserves, e.g., on real estate or securities include in the fixed assets section of the balance sheet, can the realizable values be higher than the going concern values.

2.1 Going Concern Value and Realizable Value

Legislation and regulations define these terms as follows: Going concern value is the value at which assets and liabilities are recognized, measured, and presented. It is based on the assumption that the company will be able to use its assets and settle its liabilities in the normal course of business (ISA-CH 570, note 3).

The valuation concept according to the Swiss Code of Obligations distinguishes between initial valuation and subsequent valuation for the going concern value (CO, article 960a). When an asset is added, i.e., in the initial valuation, it may not be valued higher than its acquisition or production cost. In the subsequent valuation, depreciation must be taken into account for the loss of value due to use or age, while other losses of value must be taken into account through valuation adjustments (Di Nino, 2017).

If the company is unable to use or realize its assets in the normal course of business and is unable to pay its liabilities, the focus of the valuation changes from going concern values to realizable values. Realizable value is understood as the value that could probably be achieved in a sale on the open market (Schneider, 2020, p. 2). Liquidation values are often used for realizable values (Krautter, 2021, p. 4).

In almost all cases, a change from going concern values to disposal values will result in a lower valuation of a company's assets and a higher valuation of its liabilities. This will subsequently reduce the equity and may lead capital losses, to over-indebtedness, or accentuate an over-indebtedness of the company (Zemp & Haas, 2015, p. 870). As a result, the provisions of Article 725 of the Swiss Code of Obligations come into play for the responsible parties.

2.2 Questions for Assessing the Ability to Continue as a Going Concern

For the going concern view to be affirmed, there must be an affirmation of the will and the possibility to continue as a going concern.

The will to continue as a going concern is presumed if the management has no intention of liquidating the entity or is forced to do so. The management does not intend to cease operations or has no realistic alternatives to do so, e.g., by seeking protection from creditors under laws or regulations (ISA-CH 570, note 3). In other

words, the will to continue as a going concern is presumed unless the above reasons exist.

In addition to the will to continue, the possibility to continue must exist: Is the continuation objectively realistic or are there events and conditions that cast significant doubt on the ability to continue as a going concern? (Schneider, 2020, p. 3). If the objective view on the going concern is affirmed and there are no significant doubts about the going concern, the entity can continue as a going concern. Therefore, there is no doubts about the entity to continue as a going concern.

Material Uncertainties About Events and Conditions that Raise Significant Doubt

ISA-CH provides examples of events and conditions that, individually or in the aggregate, may cast significant doubt on the entity's ability to continue as a going concern. The events and conditions are classified as financial, operational and other (ISA-CH 570, note 8):

Financial:

- Net liability or net current liability position.
- Over-indebtedness.
- Approaching maturity of fixed-term liabilities with no realistic prospects of renewal or repayment.
- Signs of withdrawal of financial support, operating cash drain, unfavorable financial ratios.
- Significant operating losses or significant impairment of cash flow generating assets.
- Adverse financial ratios.
- Suspension of dividend payments.
- Inability to pay liabilities as they fall due.
- Inability to comply with the terms of credit agreements.
- Change in payment terms from suppliers.
- Inability to raise funds for major product development or other investments.

Operating:

- Departure of irreplaceable key personnel.
- Loss of key markets and resources.
- Labor difficulties or shortages of key supplies.

Other:

- Litigation.
- Violation of capital adequacy requirements.
- Changes in legislation.
- Loss of confidence in the management.

The significance of any of the above events or conditions may be mitigated by other circumstances. For example, the consequences of the loss of one supplier may

be mitigated or even eliminated by the availability of another supplier (ISA-CH 570, note 8).

If there are material uncertainties about events and conditions that cast significant doubt on the entity's ability to continue as a going concern, the entity shall disclose and explain these uncertainties in the notes to the financial statements (CO, article 958a, paragraph 3).

2.3   Examples that Mitigate Uncertainties About Events and Significant Doubt

If the material uncertainties that give raise to significant doubts about the entity's ability to continue as a going concern can be resolved, the entity may continue to use the going concern basis of accounting. The regulators address such situations in ISA-CH 560, Subsequent Events, and ISA-CH 290, Capital losses and Over-indebtedness.

The Effect of Events After the Balance Sheet Date (Subsequent Events)
The period between the balance sheet date and the date of issue of the financial statements become more important in times of crisis. Events may occur during this period that may affect the going concern status of the entity at the date of the financial statements. ISA-CH 560 deals specifically with such events. Two types of events are distinguished:

1. those that provide evidence of conditions that existed at the date of the financial statement, and
2. those that provide evidence of conditions that have arisen after the date of the financial statements.

ISA 700 precise that the date of the auditor's report informs the reader that the auditor has considered the effects of events and transactions of which the auditor becomes aware and that have occurred up to that date. Therefore, all facts known before the date of the auditor's reports need to be identified and reflected in the financial statements (Fig. 1).

In theory, the work of the auditor reduces the uncertainty of the financial statements.

1. Known events up to the date of the auditor's report must be included in the relevant financial statements and, as said, reduce uncertainty. For example, additional losses incurred after the date of the financial statements and before the date of the auditor's report have resulted in capital losses and over-indebtedness. In such a case, ceteris paribus, the financial statements will have to be restated (financial statements based on liquidation values), which may have an impact on the going concern principle.
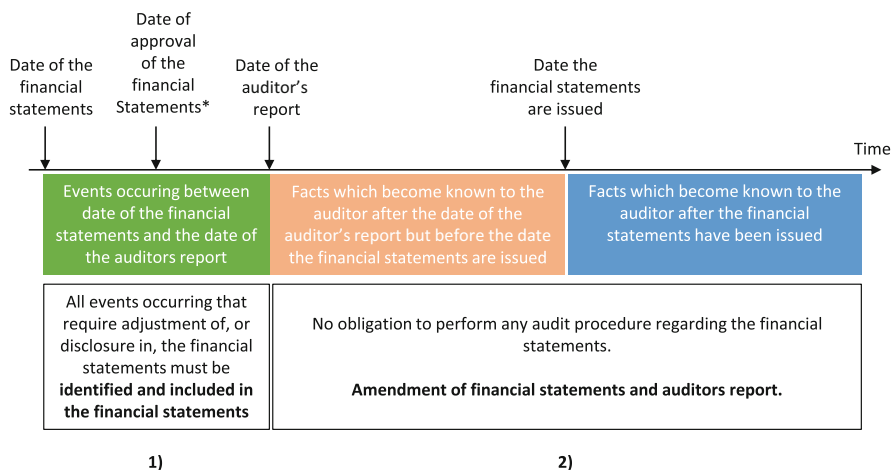
Fig. 1 Timeline of subsequent events. *Note: The date of approval of the financial statements is the date of approval by management, not the date of subsequent approval by shareholders at the general meeting*

2. The auditor is not obliged to perform any audit procedures on the financial statements after the date of the auditor's report. If a fact comes to the auditor's attention after the date of the auditor's report but before the financial statements are issued, the financial statements may need to be amended and the auditor may need to perform audit procedures on the amendment (ISA 560, note 10–13). This may result in the issuance of a new auditor's report on the amended financial statements. If facts become known to the auditor after the financial statements have been issued, the auditor must ensure that the recipients of the previously issued financial statements do not rely on the auditor's report before the new facts are known (ISA 560, notes 14–17).

In summary and in theory, even subsequent events should to be reflected in the financial statements, to the extent that they affect the going concern basis of accounting. In practice, however, management tends not to disclose negative news to the auditors or even to it. Therefore, in some cases, the auditor will not be aware of any. In such a case the financial statements will not reflect the subsequent events appropriately and therefore the inherent uncertainty in the financial statements will not be reduced.

Capital Losses and Over-Indebtedness
In the event of over-indebtedness within the meaning of Art. 725 CO, the balance sheet losses have completely consumed the equity (nominal share capital and legal reserves). In other words, the assets only partially cover the liabilities. Such a situation is often the result of historical and/or current losses. Even before a company becomes over-indebted, in a situation where losses have consumed at least half of the equity capital, the legislator (Art. 725, CO) and the regulator

(ISA-CH 290) require those responsible to take measures to protect creditors. The situation in which losses have consumed at least 50% of the equity is referred in literature as capital losses and can be seen as an early warning of the risk of over-indebtedness and thus the elimination of the going concern assumption, unless retroactive measures are taken.

Retrospective Measures in the Event of Capital Losses and Over-Indebtedness
In the situation of capital losses, the going concern assumption is impaired and may be maintained retrospectively by appropriate measures. Such retrospective measures may include, for example, a debt waivers received by creditors, the subordination of loans received and the release of forced reserves on properties and/or securities. Such measures, or a combination of them, would seldom be good enough, as they would neither provide the company with additional liquidity nor increase the company's profitability.

The above measure would not address the fundamental weakness of the company's low profitability and lack of liquidity.

The new Company Act, which came into force on 1 January 2023, explicitly states that, in addition to the duties relating to capital losses and over-indebtedness, the board of directors must review the liquidity budget for the next 12 months (from the balance sheet date) and ensure that the company can meet its obligations by paying its bills. The review of a liquidity budget is one of the most important tasks of financial management, and therefore it was an important task of the board of directors according to the law (Art. 716a Para. 1 No. 3 CO) even before it was explicitly mentioned in the law (Art. 715 Para. 1 CO). The same view has is held by Glanzmann (2017, p. 403).

3 Responsibilities and Tasks

Answering the questions and performing the tasks outlined above are the responsibility of corporate management and the auditor. The following subsections outline the responsibilities and tasks.

3.1 Corporate Management's Responsibilities and Tasks

The non-transferable duties of the Board of Directors are defined by law (CO, Art. 716a, Para. 1, No. 3 and 6). The Board of Directors is responsible for the organization of the accounting system and the preparation of the annual report. The annual report includes, among others, the financial statements (balance sheet, profit and loss account and the notes to the accounts) (CO, Art. 958, Para. 2). The Board

of Directors is therefore responsible, among other things, for the correct valuation of the financial statements. It must assess the basic assumption of the ability to continue as a going concern (Schneider, 2020, p. 3). The regulations see this in the same way and specify the factors that management must take into account when assessing the ability to continue as a going concern (ISA-CH 570, note 7):

- The degree of uncertainty about the consequences of particular events or conditions increases significantly the further into the future the assessment of those consequences is made.
- Any forward-looking assessment is based on information available at the time of the assessment. Subsequent events may invalidate a previously reasonable assessment.
- The size and complexity of the company, the nature and conditions of its business and the degree to which its exposure to external factors affect the assessment of the consequences of events.

In light of the above, management is responsible for making an assessment of the entity's ability to continue as a going concern. As noted above, management may make this assessment without a detailed analysis if the entity has a history of profitable operations and has ready access to financial resources (ISA-CH 570, note 6).

In the opposite case, management must prepare a detailed analysis of the entity's ability to continue as a going concern (reverse of ISA-CH 570, note 6). Management can do this by performing the following tasks, which it is likely to have already done as part of the context of the financial management of the business in normal times:

- Preparation of liquidity planning for at least the next 12 months, including an assessment of any funding covenants have been breached. Management needs to assess the consequences of such a breach. Often, in such a case, the entire outstanding amount of financing becomes due for repayment.
- Prepare a budget for at least 12 months.

The assumptions underlying the liquidity plan and the budget must be disclosed. This will enable an informed assessment to be made.

If the management denies the ability to continue as a going concern, it must change the accounting and valuation principles to realizable values (Schneider, 2020, p. 3; CO, article 959c paragraph 1, number 1).

As already mentioned, the realizable value is the value that can be probably achieved in a sale on the open market. Liquidation values are often used for realizable values. The determination of the liquidation values can be difficult and costly due to the lack of market prices (Krautter, 2021, p. 4). In the context of a forced sale (e.g., debt enforcement), price concessions may have to be made, which need to be reflected in liquidation values (Krautter, 2021, p. 4).

3.2   Auditor's Responsibilities and Tasks

The auditor's responsibility is to express an opinion on whether the going concern basis of the financial statements is appropriate. This includes assessing whether there are any material uncertainties about the entity's ability to continue as a going concern and, if so, whether these uncertainties have been appropriately disclosed in the financial statements (ISA-CH 570, note 9).

If the auditor has identified events or conditions that cast significant doubt on the going concern basis, the auditor is required to perform the following tasks (ISA-CH 570, note 26):

- Critically review the management's plans for future operations. This includes, but is not limited to, the liquidity planning and the budget prepared by management as part of the going concern assessment.
- Obtain sufficient and appropriate evidence through audit procedures to assess whether or not a material uncertainty exists in relation to these events or conditions.
- Obtain a written explanation from management of its plans for future operations.

The auditor must then perform specific audit procedures in order to form an opinion or to fulfill the three tasks mentioned above.

Further Audit Procedures When Events or Conditions Are Identified
In accordance with the regulations, the following are listed as special audit procedures for arriving at an assessment of the ability to continue as a going concern (ISA-CH 570, Note 28):

- Analysis and discussion of projected cash flows, projected earnings, and other forward-looking information with management.
- Analysis and discussion of the most recent interim financial statements.
- Critically review the terms of financial debt to identify any breaches of covenants.
- Reviewing minutes of management meetings for indications of financial irregularities.
- Interviewing the company's legal advisers regarding litigation to assess the outcome of the litigation and the financial impact on the company.
- Obtain confirmation of the existence, validity and enforceability of agreements with related parties and third parties to provide financial to the company.
- Assess the company's plans to fulfill outstanding customer orders.
- Assessing events after the balance sheet date to identify events that may affect the company's ability to continue as a going concern.

When the analysis of future cash flows is essential to assess the future consequences of events and conditions, the auditor will consider the reliability of the system that generates the cash flow figures and the reasonableness of the assumptions underlying this information (ISA-CH 570, Note 29). It can be assumed that in most cases the analysis of future cash flows is essential for assessing the future consequences of events.

The auditor also compares (ISA-CH 570, Note 29):

- The forward-looking financial information for the current and prior periods with the actual data for those periods.
- The forward-looking financial information for the current period with its actual data.

This enables him to draw conclusion about the quality of the budget.

By questioning management, the auditor aims to obtain sufficient and appropriate audit evidence to assess whether management's plans can be realized and whether the realization will improve the company's situation (ISA-CH 570, Note 28).

3.3 Auditor's Reporting

Depending on the auditor's assessment of the plans to ensure the ability to continue as a going concern—prepared by management—the auditor's reporting will vary. Three options are presented below (ISA-CH 570, Notes 32–40):

Going Concern Assumption Appropriate but a Material Uncertainty Exists
A material uncertainty exists (ISA-CH 570, Note 31) when the potential effect of events or conditions is so great that, in the auditor's opinion, the presentation of the financial statements would be misleading without clear disclosure of the nature and effect of the uncertainty. In this case, the auditor evaluates whether the financial statements (ISA-CH 570, Note 32):

- Adequately describe the principal events or conditions that cast significant doubt about the entity's ability to continue as a going concern and management's plans with respect to them.
- Clearly states that there is a material uncertainty about those events and conditions and therefore the entity may not be able to continue as a going concern.

If the information is adequately disclosed in the financial statements, the auditor issues an unqualified opinion. In addition, the auditor modifies the auditor's report by adding an emphasis of matter and drawing the attention to the note in the financial statements (Jeger & Leuenberger, 2013. p. 314). The note in the financial statements highlights the existence of events and conditions that raise significant doubts about the entity's ability to continue as a going concern. The auditor must explicitly mention that the uncertainty may be material and the doubt may be significant (Jeger & Leuenberger, 2013. p. 314). The emphasis of matter refers to the relevant note in the financial statements.

The purpose of these disclosures is (Grönert & Haag, 2017, p. 2):

- To alert the reader of the report to the existence of a material uncertainty relating to conditions and events that may cast significant doubt about the entity's ability to continue as a going concern.

- The reader of the report should be made aware of the disclosure of these events in a textual paragraph.

An emphasis of matter to highlight a material uncertainty related to the ability to continue as a going concern is likely to be the most common reporting modification in practice (Grönert & Haag, 2017, p. 2). The emphasis of matter paragraph draws the attention to the notes, while in practice the (restructuring-) measures already implemented are noted in relation to events after the balance sheet date (Zemp & Haas, 2015, p. 871).

It is precisely by demonstrating that measures have already been implemented that the confidence of existing and potential investors or financing banks can be regained or built up. This requires, however, that the company's management and the auditor cooperate as promptly as possible in identifying conditions and events that raise significant doubts about the company's ability to continue as a going concern. The board of directors must promptly convene a general meeting of shareholders and propose restructuring measures in the event of a justified concern about over-indebtedness, which will naturally occur sooner rather than later when the company's ability to continue as a going concern is threatened (CO, Art. 725, Para. 2). In practice, any successful implementation of these reorganization measures is of course mentioned in the notes to the financial statements. This can positively influence the confidence of the reader of the report (e.g., financing banks, potential investors). Thus, the "bad news" in the form of the emphasis of matter in the audit report stating that material uncertainties exist due to conditions and events is followed by the "good news" in the notes to the financial statements stating that (restructuring-) measures have already been successfully implemented.

Going Concern Assumption Is Inappropriate
If the going concern assumption is inappropriate, there are two possible outcomes:

1. Abandonment of the ability to continue as a going concern, e.g., due to legal or factual circumstances that prevent the entity from continuing as a going concern, in most cases fundamentally changes the overall picture of the financial statements in most cases (ISA-CH 570, Note 35A). Management then prepares financial statements based on the realizable values. If, based on the special audit procedures performed, the auditor concludes that the financial statements based on realizable values are reasonable and the disclosures in the financial statements are also appropriate, the auditor issues an unqualified opinion. At the same time, the auditor shall add a note (emphasis of matter) drawing the attention of the reader to the different basis of the financial statements (ISA-CH 570, Note 35A).
2. If the auditor concludes that the going concern assumption underlying the financial statements is not reasonable because the entity is unable to continue as a going concern and management does not perform a going concern assessment or does not extend the assessment period at the auditor's request, the auditor expresses an adverse opinion (ISA-CH 570, Note 37).
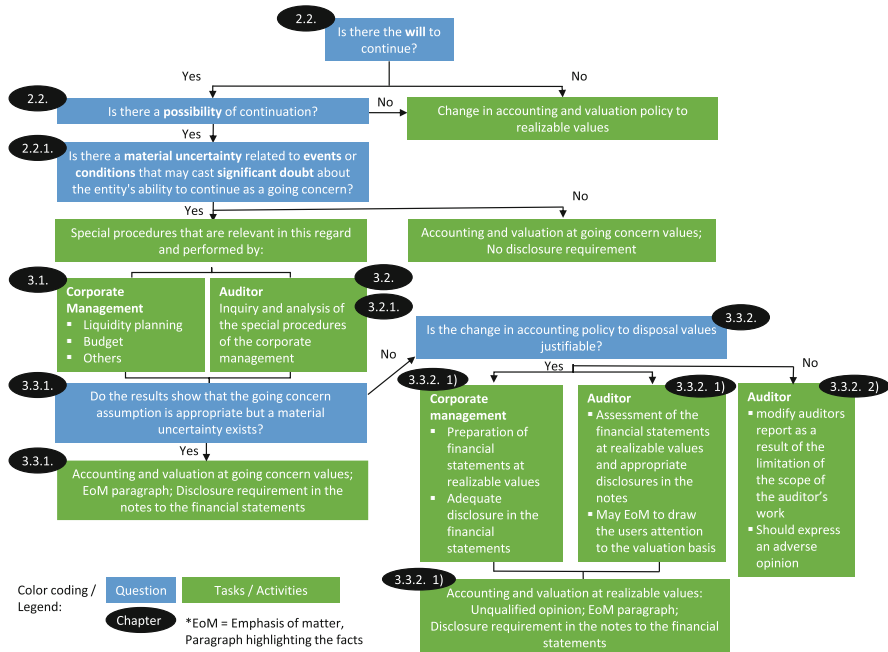
Fig. 2 Summary of questions and tasks for the going concern assessment

4 Summary of Questions and Tasks for the Going Concern Assessment

The above asked questions and the tasks to be taken are summarized in this decision tree. The numbers in the black bubbles refer to the relevant chapters of this document (Fig. 2).

5 Tension and Challenges in Practice

Some areas of tension and challenges in practice are highlighted below and possible solutions are discussed in the concluding Sect. 6.

Room for Interpretation

The terminology used, such as "possibility", "material uncertainty", "significant doubt", "reasonable", leaves room for interpretation. The terminology of the laws and regulations must be interpreted and construed for application to a specific case, which requires a high degree of professional business judgment by the parties' involved (corporate management, auditors). In addition, events or conditions that cast significant doubt on the ability to continue as a going concern may be associated

with effects that are difficult to assess (Schneider, 2020, p. 6). The basis for the assessment of the ability to continue as a going concern are mainly forward-looking instruments such as liquidity planning and budgets. The basic assumptions of these instruments are in turn based on assumptions and estimates. This tends to increase the scope for judgment, as neither management nor auditors have prophetic power. In other words, it will rarely be possible to answer the questions with a "right" or "wrong" answer.

5.1 Different Perspectives and Expectations

In theory, it may be appropriate for listed companies to have different perspectives from management and the auditor. For example, management may be guided by a visionary and risk-taking pioneering-driven entrepreneurship, while the auditor tends to take a more conservative view. This conservative view is further encouraged by the requirements of the Swiss accounting standards with the principle of prudence (Art. 958, Para. 1, No. 5, CO).

Management also has an information advantage over the auditor (asymmetric information), because it is much closer to the day-to-day business than the auditor. In a situation of asymmetric information, the auditor is well advised to be as critical as possible. He should also question management's assumptions in order to get their reaction. From this response, the auditor may be able to draw conclusions about the robustness of the underlying assumptions.

In practice, the perspectives are often not so different. As already mentioned above, the auditor should get involved as early as possible. In this way, time can be gained to "cure" an unavoidable emphasis of matter to the threat to the ability to continue as a going concern with the sufficient disclosure in the notes. The company and the auditor often have a long history together. Therefore, the auditor will only add an emphasis of matter highlighting the threat to the ability to continue as a going concern as a last resort. Otherwise, the auditor will be faced with the legitimate question of why the paragraph was not already applied last year.

5.2 (No) Self-Fulfilling Prophecy

The addressees of the financial statements do not appreciate the emphasis of matter on the threat to the ability to continue as a going concern, because in many cases they do not even know what it is about (Leibfried, 2009, p. 418). This may possibly be the case for large and (listed) companies. In the case of unlisted companies, the possibility of self-fulfilling prophecy can be virtually ruled out. After all, it can be assumed that the addressees, in addition to the owners—who often are identical with the management—the addresses are financing institutions or potential investors who request the financial reports periodically, at least once a year, as part of their credit

assessment. These parties usually have extensive and in-depth analytical knowledge of the financial statements. Therefore, the emphasis of the matter highlighting the threat to the entity's ability to continue as a going concern is merely an expected logical piece of information, since the entity's own analysis of the balance sheet already discloses this.

Thus, the addition of the emphasis of matter highlighting the threat to the ability to continue as a going concern in connection with the disclosure of the facts in the notes is, in the best case a way of regaining trust and signaling the professionalism of the company's management in the case of (restructuring) measures that have already been implemented.

5.3 Suggestions for Resolving the Tensions and Challenges

The following proposals can help to resolve the areas of tension mentioned above:

- Early identification of a possible threat to the ability to continue as a going concern and clear communication in the audit report with an emphasis of matter and in the annual financial statements highlighting the facts (threat to the ability to continue as a going concern) and appropriate disclosure of the facts in the notes. Ideally, this should include a reference to the (restructuring) measures already implemented. This is where the auditor should take action in his own interest and in the interest of the management. At present, this is also due to the possible consequences of the COVID-19 pandemic and possible difficult to fulfill repayment modalities of the companies with regard to possible COVID-19 credits used.
- Credible and clear communication between the parties involved, such as corporate management, the auditor and the users of the financial statements (see previous point).
- A relationship of trust and cooperation between management and the auditor, in compliance with all laws and regulations on independence.

6 Conclusion

In times of crisis (e.g., financial crisis, COVID-19 pandemic, Russian war of aggression against Ukraine), the special tasks and audit procedures related to the ability to continue as a going concern become the focus of attention, as the risk of a company's inability to continue as a going concern increases. The tasks of corporate management are expanded compared to non-crisis periods. It can be assumed that a professional management will prepare a liquidity plan, a budget and other analyses looking into the future, even if the ability to continue as a going concern is not threatened.

In addition, management should consider the strategy in the event that the going concern assumption is not maintained. After all, the strategy has a significant impact on the valuation of balance sheet items at realizable values. Management is then required to prepare a balance sheet at realizable values. When the going concern assumption is in question, the auditor needs to perform special audit procedures in order to make an informed judgment about the detailed analyses that should support the going concern assumption. The special audit procedures may be extensive. The rules and regulations, in particular ISA-CH, provide much useful guidance. However, the auditor's professional judgment is particularly required.

Similarly, a higher degree of professional judgment is required of management. Good professional cooperation between management and the auditor can help to identify a potential threat to the going concern early and to take appropriate action in a timely manner. It goes without saying that the auditor should be as restrictive as possible in adding an emphasis of matter paragraph to highlight the threat to the ability to continue as a going concern, as it is not a trivial matter (Barta & Laverty, 2021, p. 2).

In the context of the COVID-19 pandemic, the legislator has recognized that it is not sufficient to provide companies with the necessary liquidity to ensure their ability to continue as a going concern. It has also adjusted the method of calculating equity for CO Article 725 (capital losses and over-indebtedness). COVID-19 loans are now counted as equity (Ü-ISA-CH, 2022). This minimizes the risk of CO Article 725 coming into play, which benefits the going concern assumption.

However, it will be interesting to see how management and the auditor will assess the company's ability to continue as a going concern in light of the repayment of the COVID-19 loans by 2027. Liquidity planning will continue to be a focus of the going concern assessment.

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In this book, Brido Schuler draws on his extensive knowledge and experience to provide a comprehensive analysis of going concern.

Were the Crises of the Recent Past a Litmus Test for Goodwill in the Automotive Industry?

Marco Canipa-Valdez, Martin Tettenborn, and Maya Tettenborn

Abstract Given the recent crises and ongoing structural changes in the automotive industry, future success potentials from formerly acquired investments within the automotive industry should be questioned. In this context, the estimation of future cash inflows and outflows as well as the corresponding discount rate, which is necessary within the IFRS framework of the impairment test of assets, becomes much more challenging. To shed new light on the impact of these effects on the litmus test, i.e. on the value of goodwill, the chapter is using the example of the automotive sector in Germany. The possibility of a goodwill bubble in the automotive industry cannot be ruled out, as our chapter suggests.

1 Introduction

The current times seem extraordinary for several reasons: Technological change continues to shape industry and society, while the world (economy) seems completely out of sync due to a series of crises (e.g. the COVID-19 pandemic, Ukraine war, energy shortages, inflation, etc.). While these crises affect the economy in general, they have consequences at the company level that are difficult to foresee. On the sales side, lower turnover is to be expected. At the same time, it remains unclear how price-sensitive customers will react to increases in prices. Estimating the availability and procurement prices of raw materials and intermediate products

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has become a formidable task—if possible at all. Moreover, investors are demanding higher risk premiums due to the reduced earning power caused by the crisis, thus increasing the cost of equity financing from company's perspective. Finally, the central banks' turnaround in interest rates triggered by inflation leading to an increase in financing costs. As a result of all of these factors working together, it is likely that the present value of future cash flows will decrease for many companies.

In this context, the estimation of future cash inflows and outflows as well as the corresponding discount rate, which is necessary within the framework of the impairment test of assets, becomes much more challenging. First and foremost, goodwill is to be considered, since it regularly contains a particular risk potential for the realisation of significant unscheduled depreciations, which can consume the equity base of companies. A study analysing the annual reports of companies in the STOXX Europe 600 for the years 2016–2020 showed an increase of nearly 50% in impairments from 2019 to 2020—even before the onset of the recent global crises (Duff & Phelps, 2021, p. 4). Furthermore, the number of impairments in Germany rose steadily from 2018 to 2020 (Duff & Phelps, 2021, p. 14). In the financial statements of DAX companies for the 2021 financial year, goodwill accounted for 35.47% of equity (Zwirner et al., 2022, p. 442). According to a headline in the Handelsblatt business newspaper, "a 352-billion-euro risk is currently slumbering on the balance sheets of the 40 DAX groups," which is "more than twice as much as in 2005," (Sommer, 2023). However, since the introduction of the so-called Impairment Only Approach (IOA) in the IFRS framework, goodwill has proven to be remarkably resilient to crises of all kinds—especially in the financial crisis (Sanchidrian et al., 2021, p. 35). In this context, some stakeholders have pointed out the inherent weakness of the IOA, which results in goodwill impairments being recognised too late, i.e. long after the events that caused these losses (IFRS Foundation, 2020, p. 53). Others (e.g. Reinke, 2021, p. 512) have drawn attention to the short-term nature of external shocks that led to the expectation of overcompensation for losses in subsequent years ("hockey-stick effect"). Still others point out false incentives of the IOA and a deliberate distortion of the asset and financial situation by management (Bonnecke & Brenig, 2022, p. 922; Ballwieser & Weißenberger, 2023, p. 5; Schürmann, 2020, p. 70). Some even speak of a "highly manipulative accounting field" (Hüfner et al., 2022, p. 50). In this context, the IASB itself refers to "management's over-optimism" (IFRS Foundation, 2022, p. 8). However, since it is now foreseeable that the developments many countries are currently experiencing will have a deglobalising effect, and thus a structurally long-lasting effect (OECD, 2022), the aim of this chapter is to shed new light on the impact of these effects on the litmus test, i.e. on the value of goodwill, using the example of the automotive sector in Germany.

First, Sect. 2 shows the challenges in estimating the useful life of goodwill in general. Section 3 then provides an overview of the IOA of the IFRS framework. Section 4 deals with the effect of the current crisis triggers on the recoverability of goodwill in the automotive industry. The chapter is concluded with a summary in Sect. 5.

2   Goodwill and Useful Life

The value of an asset is determined by its useful life. However, the determination of this useful life is problematic in the case of goodwill. As described in detail in the literature, goodwill is a residual arising in the course of capital consolidation (EY, 2020, p. 657; KPMG, 2019, p. 486). As a result, a direct determination of this entity is not possible (IFRS 3.BC328). Goodwill comprises currently unidentifiable intangible resources (Johnson & Petrone, 1998, p. 295; IVSC, 2020a, p. 4) including, for example, the workforce, as well as future success potential (e.g. intangible assets still to be developed in the future). There is a risk that overpayments made for these assets (in some cases as a substantial component of goodwill) may result in an impairment of goodwill due to insufficient future value contributions (Schulze, 2005, p. 282; Schatt et al., 2016, p. 315; Li et al., 2011, p. 773).

Thus, goodwill is not comparable to many other balance sheet items in terms of measurability as it is a conglomerate of resources, and the exact content of this conglomerate may not be known in its entirety by the reporting company in every case. If all components were known, the question would arise in a second step—considering the subsequent measurement—as to how long the components can be utilised. It is possible, for example, that a certain synergy can only be utilised in the following year, and that the workforce must be renewed quickly due to fluctuation. However, it is also feasible that synergies in administration may be leveraged for an indefinite period if a reorganisation by an acquirer will be permanent. Given the recent crises and ongoing structural changes in the automotive industry, future success potentials from formerly acquired investments within the automotive industry, in particular, should be questioned. Overpayments are expected to be more difficult to cover.

As an automotive supplier, Continental has already written off significant parts of its goodwill in recent years, which was foreseeable due to the change from combustion engines to electrified drives. However, the fact that some of the formerly profitable acquisitions from the era of combustion-engine technology no longer pay off today and, therefore, might have to be impaired has not yet been fully accepted in the automotive industry. Instead, the IOA often created the incentive for overpriced company acquisitions in the past, as there was no threat of an amortisation-related burden on earnings and the disclosure of high goodwill was often assumed to suggest that the assets were of value (Bonnecke & Brenig, 2022, p. 922).

Regardless of management behaviour, however, it should be emphasised that the determination of the useful life of any asset represents a somewhat challenging task. This can be explained, for example, by the fact that the useful life depends not only on the future decisions of the respective company, but also on external influences, such as legal regulations. The determination of the useful life of goodwill can be problematic due to its composition and the possibility that its components may have different useful lives. In fact, the IVSC states that goodwill is not a wasting asset at all (IVSC, 2020a, p. 15; Schulze, 2005, p. 282).

3   The Impairment Concept of Goodwill According to IFRS

Irrespective of the problems mentioned above, the accurate reflection of the consumption of value of all assets is indispensable for the presentation of the financial and income situations. Ideally, the useful life of an asset determines its depreciation period. To avoid the question of the appropriate depreciation period, which has been discussed at length in the scientific literature, IFRS accounting does not require scheduled depreciation for certain assets, but for an impairment test to be carried out at least once a year (IOA). The basic premise behind this test is that goodwill cannot generate independent cash flows, but can only do so in combination with other assets. For example, the goodwill components 'synergies in the area of administration,' 'workforce' and 'future success potential' can only be leveraged or used if, for example, there are corresponding buildings, IT equipment, production facilities and sales markets for the products.

According to the IOA, the carrying amounts of the assets of a cash-generating unit are compared with the future earnings value of the cash flows generated by this unit. The future earnings value described in business management literature is the sum of the discounted cash flows. Transferred to IFRS, the concept takes the form of the recoverable amount, which represents the success potential of the cash-generating unit either from an external perspective ("fair value less costs to sell") or from an internal perspective ("value in use"). The higher of the two values is decisive, since a rational management decision would select the better alternative. If the recoverable amount is lower than the carrying amount of the cash-generating unit, the goodwill would first have to be written off (impairment).

The problem of the finite nature of the ability of assets to generate cash flows, and thus the question of useful life, is circumvented in the concept of IOA, as the terminal value is to be determined after a detailed planning phase, for the calculation of which a perpetual annuity of the cash-generating unit, i.e. the investment object, is assumed. The formation of cash-generating units also circumvents the problem that no separate cash flow and, thus, no fair value less costs to sell can be determined for goodwill (EY, 2020, p. 1455; KPMG, 2019, p. 676).

To avoid the risk of a depreciation potential, the impairment test is to be carried out at least once a year. It is reasonable to carry out the test at the end of the year, as the plans approved by the supervisory board are, ideally, available at this time. In addition, however, impairment tests are also to be carried out during the year if there are indicators of impairment (triggered impairment test). IAS 36.12 provides detailed guidance on this. For the impairment test of goodwill, the following indicators are particularly relevant for the year 2022.

3.1 Relevant External Sources of Information

– "Significant changes with an adverse effect on the entity have taken place during the period, or will take place in the near future, in the technological, market, economic or legal environment in which the entity operates or in the market to which an asset is dedicated."

In the course of the last few years, numerous events occurred that could have an impact on the recoverability of a cash-generating unit. For example, the commencement of the war in Ukraine in 2022 led to adverse economic effects in combination with legally regulated sanctions. Companies should therefore observe all cash-generating units whose cash flows are affected by the war in Ukraine.

– "Market interest rates or other market rates of return on investments have increased during the period, and those increases are likely to affect the discount rate used in calculating an asset's value in use and decrease the asset's recoverable amount materially."

The net present value-oriented valuation of the cash-generating unit requires a discount rate. As base interest rates in major economies were significantly increased in 2022 to curb inflation, these measures alone are expected to have a negative impact on valuations. In any case, it must be examined whether a change in the short-term market interest rates also leads to a corresponding change in the long-term market interest rates used for the valuation of the respective cash-generating unit (EY, 2020, p. 1455). The EU securities regulator ESMA assumes that the overall increase in interest rates and uncertainty will have an impact on the discount rates used in the impairment tests. According to IAS 36.12c, among other aspects, increases in the discount rates possibly leading to a significant reduction in the recoverable amount are indications that could be relevant when assessing whether goodwill is impaired. In particular, this occurs if the recoverable amount in 2021 was particularly sensitive to moderate increases in discount rates (ESMA, 2022, p. 6).

– "The carrying amount of the net assets of the entity is more than its market capitalisation."

A declining market capitalisation can be considered a "powerful indicator" because it reflects the market's assessment of "business value" (EY, 2020, p. 1459). For the 2021 financial year of German automotive companies, Zwirner et al. found that the ratio of book value of equity to market value of equity was only 86.39% (2022, p. 442). The stock market year 2022 was then partly characterised by further substantial declines in the market capitalisations of companies in many sectors. Although a listed company can consist of various cash-generating units that are usually not listed themselves, the market capitalisation of the entire company can be affected if the success of individual cash-generating units is not sufficient to compensate for the declines of other units.

3.2 Relevant Internal Sources of Information

– "Evidence is available from internal reporting that indicates that the economic performance of an asset is, or will be, worse than expected."

  The external sources of information described above are expected to have a regular impact on the company's net assets, financial position and results of operations, which are also evident from internal sources of information. Together with the external sources of information that are also apparent to outsiders, it is to be expected that management will decide on adjustment measures that may have an impact on the recoverability of goodwill. If these measures have the potential to influence the price of financial instruments, e.g. the company's shares, they must be communicated immediately by means of an ad hoc announcement (Art. 7 Para. 1 a in conjunction with Art. 17 Para. 1 MAR). According to IAS 36.12 (e) and (f), these additional internal sources of information must be taken into account:

– "Significant changes with an adverse effect on the entity have taken place during the period, or are expected to take place in the near future, in the extent to which, or manner in which, an asset is used or is expected to be used. These changes include the asset becoming idle, plans to discontinue or restructure the operation to which an asset belongs, plans to dispose of an asset before the previously expected date, and reassessing the useful life of an asset as finite rather than indefinite."

  With regard to goodwill, it is conceivable that, due to the distortions that have occurred in recent years, management decides to sell individual business units (Canipa-Valdez et al., 2022, p. 95–101), which may also include cash-generating units that carry goodwill. Likewise, it is conceivable that—due to new legal regulations or market assessments by management, for example—business operations within a cash-generating unit will no longer be maintained indefinitely, but only for a foreseeable period of time. This would have the consequence that fewer cash flows will be discounted and, thus, under otherwise identical circumstances, the value of the cash-generating unit would decrease. This might impact the reported goodwill.

If previous impairment tests show that "the recoverable amount of an asset significantly exceeds its carrying amount, the entity need not reassess the asset's recoverable amount if no events have occurred that would eliminate that difference" (IAS 36.15), which is known as "headroom" (EY, 2020, p. 1459). The existence of impairment indicators, therefore, does not necessarily mean that an impairment test must be carried out (KPMG, 2019, p. 682). However, if entities identify indicators for individual cash-generating units that make impairment probable, an impairment test needs to be performed—regardless of whether an interim report or a quarterly statement has to be prepared soon. Note that different cash-generating units may be tested at different times during a year (PWC, 2018, p. 24030). Even if a test would have to be performed, the recoverability may still be given. The IVSC (2020b, p. 4) explains these reasons:

– Impairment Shielding (internally generated headroom)
– Artificial Headroom (amortisation of acquired intangible assets)
– Impairment Triggers (overly broad and outward-looking)
– Behavioural Considerations (a reluctance for impairment)

Any reverse indicators are irrelevant in relation to goodwill, as they are "likely to be from internally generated goodwill," which may not be recognised (IAS 36.125; PWC, 2018, p. 24039).

In association with the impairment test, extensive disclosures in the notes (BDO, 2020, p. 50) must be considered. In the case of an impairment loss, for example, "events and circumstances that led to the recognition ... of the impairment loss" must be disclosed (IAS 36.130). In this regard, the literature shows a connection between the enforcement quality and the transparency of the disclosures in the notes on the impairment test (Gros & Koch, 2018, p. 160).

In the current period, however, performing a test can be problematic because, as described, projected cash flows are the starting point for determining the recoverable amount. Nevertheless, in the course of 2022, many companies were not even able to forecast the key performance indicators at the end of the year. Therefore, they were permitted to withdraw the forecasts made in the management reports of the previous financial year. At the same time, however, it is important to point out that certain relief—granted by the legislator—require a case-by-case assessment. In particular, the conditions according to GAS 20.133, which allow relief in forecast reporting, must be examined. The minimum requirement in this context is comparative forecasts in the management report that state their respective assumptions (IDW, 2022, p. 9).

With regard to the automotive industry, the far-reaching structural change that began a few years ago has an impact on trigger-related impairment tests as a possible impairment indicator. For example, the auditing firm KPMG had already determined before the pandemic outbreak that negative long-term expectations had materialised in the 2019/2020 analysis period due to structural change as a cause of triggering events (KPMG, 2020, p. 37). The recession in the automotive industry induced by the COVID-19 pandemic and the accompanying accelerated structural change then had a serious impact on production figures and, thus, on the financial performance of the cash-generating units as well. For the year 2020, the Federal Motor Transport Authority reported that the German car market, with 2.92 million new registrations in the pandemic year 2020, fell by 19%. During the pandemic, therefore, it had to be assumed that impairment indicators for goodwill impairment tests were regularly present. In a study on the financial reporting of automotive companies in Germany carried out in Q3/2020, it was found that the pandemic was already classified as an impairment indicator in the first year by all of the companies analysed. Therefore, the litmus test was positive. In 40% of the analysed companies, this even led to a real impairment of goodwill. At that time, turnover forecasts and also, in some cases, forecast profits and cash flows were already corrected downwards and discount rates upwards (Tettenborn et al., 2021, p. 159–166). Due to the abandonment of the expansive monetary policy by central banks in the meantime, share prices may now also be seen as a further indication of a possible impairment (see also external indicators in Sect. 3).

The latest results of a study by KPMG show that a turnaround seems possible, with expected significant increases in turnover and EBIT (KPMG, 2022, p. 15). The Federal Motor Transport Authority offers hope in this regard as well. For example, new registrations in October 2022 increased by 16.8% compared to October 2021—which had shown a decline over the same month in the previous year of −34.9% (Kraftfahrt-Bundesamt, 2021). At the same time, climate change, public pressure and government regulation are accelerating the electrification of automobiles. At the regulatory level, particular reference should be made in this context to the final phase-out of new cars with combustion technology in the EU from 2035. Thus, the share of new registrations with hybrid and electric drives was already 49.9% in October 2022 (same month in 2021: 35.8%). Together with increasing global competitive pressure from the USA and China, supply chains that continue to be interrupted in some cases (Habisch et al., 2022), up to temporary corona-related closures of entire plants in China, or the sharp rise in inflation in 2022 with an impact on procurement prices and a consequent threat of a wage-price spiral, the German automotive industry is in the midst of a transformation process and, thus, continues to face major challenges.

4   Influencing Factors

4.1   Effect of Current Developments on Cash Flow

An impairment of goodwill usually has to be recognised when the "excess returns that were paid for at the time of acquisition" (Schulze, 2005, p. 282) dry up in the future. If the associated decline in cash flows occurs, this should be reflected in the valuation of the cash-generating unit.

Future cash flows are usually forecast in a two-phase model (BDO, 2020, p. 27). In the first phase, the cash flows are planned in detail for the next 3–5 years. Although the planning of these cash flows is already fraught with great uncertainty, this procedure is essential. For the period after the detailed planning phase, the residual value (in the "perpetuity model") is then calculated within the framework of phase 2 (see also Sect. 4.3).

It can be seen that both microeconomic and—recently, in particular—macroeconomic risks have an impact on the determination of cash flows (KPMG, 2022, p. 21). With regard to the first phase, the examples of Rheinmetall AG and Volkswagen AG can be used to show that in a crisis, it is difficult to achieve the previous profits or turnover levels in the detailed planning phase.

In Rheinmetall AG's interim financial statements for 2020, the following was stated with regard to automotive production: "Experts projections suggest that production will not return to pre-crisis levels before 2024" (Rheinmetall AG, 2020, p. 19). This assessment referred to the market environment influenced by the corona crisis. With reference to the additional volatility that occurred in 2022, the following statement was made, which indicates a delayed recovery: "In contrast,

the automotive markets that Rheinmetall supplies continue to face comparatively high volatility. Therefore, in line with expert forecasts, we expect international automotive production to recover slowly as the year goes on—albeit at a much slower rate than expected at the beginning of 2022" (Rheinmetall AG, 2022, p. 14).

Volkswagen AG's interim financial statements for 2022 contain this detailed description of the impact on sales of passenger cars and light commercial vehicles: "Between January and June 2022, the volume of the passenger car market world-wide declined significantly overall year-on-year (−10.1%), impacted primarily by bottlenecks and disruption in the global supply chains as a consequence of the semi-conductor shortage, the coronavirus pandemic and the repercussions of the Russia-Ukraine conflict. The overall market of the Africa region posted an increase; all other sales regions were affected by losses. The Western Europe and North America regions recorded a considerably weaker sales volume. The South America and Asia-Pacific regions saw a below-average decline in new registrations, while the number of new registrations in the Middle East region was at the level of the previous year. Sales volume fell very sharply in Central and Eastern Europe. The global volume of new registrations of light commercial vehicles between January and June 2022 was distinctly lower than the prior-year level" (Volkswagen AG, 2022, p. 9).

Despite this decline in sales volumes, the German premium manufacturers in particular, managed to increase sales and profits in 2022. This was due to changes in the model mix, which meant a focus on high-margin passenger cars. From today's perspective, it is questionable to what extent these effects can be repeated in the future. After all, technological change in the automotive industry is in full swing. Likewise, it is to be expected that the effects of the pandemic as well as the newly emerged crises in 2022 will continue to have an impact in the future. It is therefore unclear whether a stable state can be achieved on a 5-year view, which is commonly the upper limit for the detailed planning period. In any case, the following developments are likely to have an influence on the cash flows to be achieved in the detailed planning period of the coming years:

– Technological change (ban on combustion engines and the increasing focus on car software) and the resulting need to adjust investments in production facilities.
– Opposing trends with regard to deposits (sales problems; possibly higher sales with lower sales volume due to price increases).
– Higher disbursements (supply chain problems; salary increases due to inflation adjustments as well as the shortage of skilled workers; energy costs that are difficult to calculate or a lack of clarity regarding energy availability).

It should also be noted that an increase in interest rates can also have an impact on cash flows (see Sect. 4.2). A higher interest rate level can affect the demand for new vehicles, as it becomes more expensive for potential customers to finance a car. This effect should be considered in sales and revenue planning.

As a result, it becomes clear that companies should view different scenarios in the context of cash flow projections due to the uncertainties mentioned above (BDO, 2022, p. 5). Material assumptions are to be disclosed in the notes according to

IAS 36.134 (f). With regard to risks from energy supply ("gas supply restrictions and potential rationing of energy to certain industries"), the ESMA requires consideration in the sensitivity analyses. Material assumptions would then have to be disclosed accordingly (ESMA, 2022, p. 6).

4.2   Effect of Current Developments on the Interest Rate

The discount rate is the return that market participants would expect for an equivalent investment with the same cash flows (amounts, time periods, risk profile). Since the discount rate is usually not directly observable on the market, it is regularly calculated based on a model (the so-called weighted average cost of capital, or WACC). While the cost of debt is observable (or, at least, readily determinable) on the market, this is not the case with the cost of equity. This is because the return required by equity investors varies between different companies, industries and countries. Therefore, a model must be used to determine the cost of equity capital (for this purpose, the so-called Capital Asset Pricing Model, or CAPM, is regularly used). For the derivation of the WACC, therefore, the equity and debt capital costs are weighted with the corresponding shares of the market values of the equity and debt capital in the total capital (entity value). Compared to the years 2019/2020 and 2020/2021, in which the average WACC in the Germany-Austria-Switzerland (DACH) region was constant at 6.6%, this value most recently increased to 6.8% in 2021/2022 (KPMG, 2022, p. 23). As explained in Sect. 3, an increase in the discount rate can be an indicator of impairment. This is made clear, for example, in the interim financial statements of Volkswagen AG for the financial year 2022: "Due to the increase in the discount rates of the cash-generating units to 0.5–3.5%, unscheduled impairment tests were carried out as of June 30, 2022," (Volkswagen AG, 2022, p. 42).

Broken down to the individual components of the WACC, the following picture emerges for the development of the cost of equity capital in Germany: In 2022, the risk-free interest rate continued to rise significantly. The sole reason for this was that the ECB was phasing out its purchase programmes. In January 2023, the risk-free interest rate was last at 2.25%. In addition, the strong rise in inflation led to an increase in yield expectations in 2022. The initial risk-free interest rate, which remained low, also led to higher market risk premiums (9.25% in July 2022) against the backdrop of increased yield expectations in the first half of 2022. The risk-free interest rate, which then rose in the second half of 2022, finally resulted in lower market risk premiums again (6.4%)—with expected returns at an increased level (8.65% in January 2023). The downward trend in recent years in terms of borrowing costs continued: Such costs were historically low in Germany in 2022.

In summary, it can be stated that the rise in the interest rate level in 2022 was essentially due to the increased level of the risk-free interest rate (Fenebris, 2023) (Fig. 1).
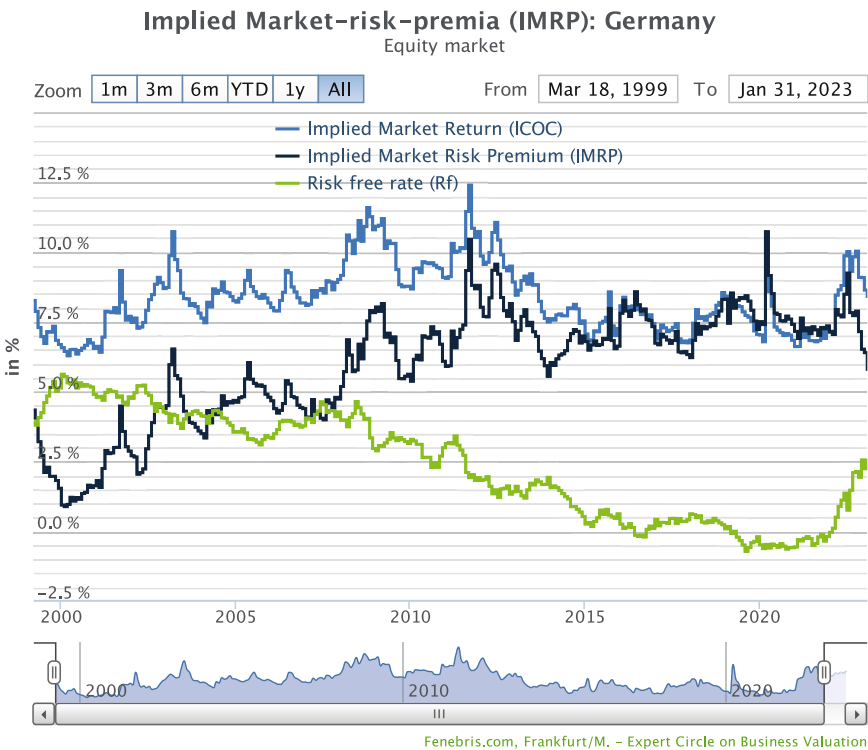
Fig. 1 Market risk premium in Germany (Fenebris, 2023)

For the automotive industry, a study on the financial reporting of automotive companies in Germany carried out in Q3/2020 showed that discount rates for the impairment test were adjusted upwards. However, this only led to an impairment of goodwill in 40% of the companies examined (Tettenborn et al., 2021, p. 159–166). Since then, the interest rate level—also sector-specific in 2022—has risen further. For example, the WACC for the German automotive industry was 8.9% in January 2023 (range: 7.7–9.9%) (PWC, 2023).

The current market environment tends to have a negative impact on both the discount rate and the cash flows relevant for the impairment test. Thus, a goodwill impairment becomes more likely in the result. If risks have already been taken into consideration in the planning of the cash flow, they may not be additionally taken into account in the derivation of the discount rate [IFRS.B14(c)]. In the following section, the effect of current crises on the terminal value will be shown to make an overall assessment of the goodwill litmus test possible.

4.3 Effect of Current Developments on the Lifespan of Companies

The two-phase model known from business valuation provides for the terminal value as the second component (BDO, 2020, p. 27). To simplify, it is assumed that the cash flow generated in the last detailed planning year can be achieved indefinitely. This assumption may be justifiable if the life of the company will not end in the foreseeable future. This is because cash flows generated in the distant future have a low present value due to the discounting effect. As soon as a going concern for the next decades seems implausible, it should be critically examined whether the two-phase model can be applied in its usual form. Presently, there may be various reasons for this. The technological shift away from the combustion engine, for example, can lead to automotive suppliers specialised in the production of parts for combustion engines being disconnected from demand and having to adapt their business models in order to remain profitable (VDA, 2023, p. 126).

The lack of success in this regard is shown by the measures taken by German automotive suppliers in 2022,[1] such as the insolvency applications of Finow Automotive on 11 May, Borscheid + Wenig on 25 July, Dr. Schneider on 8 September, Ibeo Automotive Systems on 2 October, and Borgers on 20 October. The dismissal of 1300 employees of the supplier Schäffler and the production stop at BIA, both in November 2022, exemplify the pressure under which German automotive suppliers are currently operating. Transformation and crises require large investments in the future and, thus, there is a high need for liquidity. Many companies, especially those whose business is linked to the combustion engine, are currently investing more capital in their future than they can generate (VDA, 2023, p. 126), which in turn has a negative impact on the determination of cash flows (Sect. 4.1).

If an adjustment of the business models does not seem possible, the calculation of a terminal value is not appropriate. The assessment of the life of a company must basically be made by management. It is obvious that this matter could be problematic: Management personnel interested in contract extensions will have little interest in communicating that they consider the remaining life of the company to be limited to 10 years, for example. One cause for this is that the management would thereby document its strategic helplessness.

Should management conclude that the company's lifespan is limited and communicate this to the external stakeholders, various stakeholders could lose interest in cooperating with the company concerned. It is conceivable that suppliers would no longer be interested in long-term ties and, accordingly, reconsider investments in plants for the production of preliminary products. Increasing difficulties in recruiting new employees are also conceivable. Unless debt and equity investors themselves

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[1] Three-quarters of the value added to German automobiles is generated by automotive suppliers (VDA, 2023, p. 126).

realise that the lifespan is limited anyway, their interest in providing capital is likely to decline and/or return expectations increase accordingly (Sect. 4.2). Finally, equity investors rely on a return through dividends or, at least, price gains. Debt providers also need returns in the form of interest payments and, in addition, repayment of the capital provided.

For management, there is a risk of a self-fulfilling prophecy, as the change in estimate from an indefinite to a definite useful life would have to be disclosed in the notes. If the consequences described above were to occur, this would lead to a reduction in cash flows. Subsequently, this would lead to a further reduction in the recoverable amount. Given the circumstances, it's conceivable that the crisis could intensify to the point where management must halt business operations and deviate from the going concern assumption (IAS 1.25). Therefore, IOSCO encourages auditors to critically review the assumptions and underlying analyses of the entity regarding the going concern assumption (IOSCO, 2022, p. 5–6).

In order to avoid determining an end of the company due to an increased probability of insolvency, the effect of this could be taken into account in a simplified manner by considering a "surcharge" in the denominator of the terminal value, i.e. in the discount rate (Gleißner, 2017, p. 51).

5   Summary

It becomes clear that macroeconomically induced uncertainties make the credible planning of cash flows impossible in some cases, so that the reliability of impairment tests according to IAS 36 may also be limited. In combination with the ongoing transformational pressure in the automotive industry, the problem is further intensifying. In light of this, there is a risk that the macroeconomic environment will lead to impairment tests in the automotive industry, but that the ongoing uncertainty will cause management to postpone actual impairments. In other words, the litmus test is positive, but is likely to lead to no consequences in the goodwill accounting.

Furthermore, the explanations have shown that the environment of uncertainty affects the determination of cash flows, the development of interest rates and the determination of the remaining useful life (as decisive parameters of the goodwill valuation), and tends to have a negative influence on the recoverability of goodwill. In order to counter arbitrary subjectivity on the part of management (earnings management), it is therefore advisable to move away from one-dimensional estimates of future cash flows—which in the past have certainly been an effective forecasting tool for companies. Instead, the performance and risk factors can only be dealt with systematically and transparently through the use of multidimensional estimates based on scenarios and simulations.

In conclusion, it remains the risk that—in terms of proper financial accounting and reporting—a goodwill bubble will not develop in general, but especially among car manufacturers, which, if it bursts, could lead to massive losses for shareholders and have a negative impact on the German economy. It has been shown all too often in the past that goodwill-related impairments do not correlate well with economic developments.

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Predictive Analytics in Corporate Financial Management: A Case Study on Earnings Forecasting with a Global Logistics Service Provider

Helena Kovacevic and Silke Waterstraat

Abstract Predictive Analytics is a tool in corporate financial management to gain a better understanding of the future based on forecasting models helping companies to prepare for future uncertainties and crises based on past data. This chapter describes a case study on an earnings before interest and taxes (EBIT) forecasting model based on a bachelor thesis for a global logistics company specializing in the transportation of liquid bulk commodities. The company was faced with the challenge of predicting monthly profitability due to the lack of correlation between order volume and financial performance. The objective of the case study was to improve business processes and profitability by developing a forecasting model. The study analyzed 29 months of profit and loss accounts and used a step-wise regression analysis to develop a formula to estimate monthly EBIT. The results show the importance of understanding the mechanics of the income statement and the inefficiencies of the processes to generate accurate forecasts. The chapter recommends further research to optimize the EBIT formula and explore innovative machine learning techniques for forecasting. It emphasizes the importance of forecasting models for both prediction and explanation and highlights the need for regular model adjustments to account for changing dynamics. The case study's findings demonstrate the value of financial forecasting for strategic planning and business management.

1   Introduction

In the face of financial crises and market uncertainties, the potential and importance of technologies such as predictive analytics are becoming increasingly clear. The following analysis looks at the practical application of this indispensable tool and

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shows how companies can better prepare for and manage financial uncertainties. Using the real-life example of a global logistics company, this chapter illustrates how predictive analytics provides a data-driven foundation for companies to navigate the difficult terrain of economic unpredictability. By enabling more accurate profitability forecasts and improving strategic planning, predictive analytics effectively mitigates the impact of market volatility and plays an essential role in crisis management and building resilience. This research fits into the broader academic dialogue on financial uncertainty and highlights the essential role that predictive analytics plays in reducing financial risk, refining strategic planning and fostering resilience in an era of constant economic disruption.

According to McCarthy et al. (2022), not many technologies have the potential to revolutionize how businesses operate. Predictive Analytics is one of them.

Predictive analytics is part of the subject of advanced analytics (Kumar & Garg, 2018). It encompasses three main techniques, e.g., regression analysis, decision trees and neural networks (McCarthy et al., 2022). Kumar and Garg (2018) mention statistics, data mining, machine learning and artificial intelligence as techniques and define three categories of predictive analytics models, e.g., predictive models, descriptive models and decision models.

Application areas of predictive analytics are manifold. Fraud detection (Kumar & Garg, 2018), risk mitigation, identification of new customers, prediction of consumer behaviors as well as the improvement of operations are often mentioned application areas and grounded in the need to benefit from a competitive advantage in a fiercely competitive environment (McCarthy et al., 2022).

Now, predictive analytics has conquered virtually every functional area in every industry (McCarthy et al., 2022). Broby (2022) studied the application of predictive analytics within finance, including earnings prediction from an external perspective. The below case study uses predictive analytics in the case of earnings forecasting from a company's internal perspective with a global logistics service provider.

2   Theoretical Framework

The possibility of generating excess investment returns drives researchers to improve earnings prediction systems for profit-making trading strategies from an outside perspective (Xinyue et al., 2020, p. 543). However, sophisticated profit maximization from an investment perspective necessitates accurate measurement of a company's expense and revenue functions, which is often difficult to achieve for many businesses (Dubas et al., 2011).

Earnings forecasting has as well always been an important subject in accounting study (Beaver, 1968, p. 67). Naturally, cash flow forecasting and earnings forecasting are often intertwined topics. Some of the relevant literature in cash flow forecasting argues that the objective of cash forecasting is to determine financing needs and liquidity utilization and to plan in a way to maximize utilization of the

company's liquid assets (Rajendra, 2013, p. 135). Furthermore, strong forecasts also enable a robust risk management process (Rajendra, 2013, p. 135).

In the context of earnings forecasting, studies on statistical forecasting in general, cash flow forecasting, machine learning trends in forecasting and studies in earnings forecasting, are relevant.

Literature on statistical forecasting has been introducing different methods, with the main focus on regression analysis, which is often cited as the most helpful tool for analyzing dependencies between variables. The literature further elaborated on the importance of time series analysis, e.g., the examination of data for trends and behavioral components as crucial factor to improve models. Furthermore, specific models were introduced which have been used in predicting earnings. The models all share some characteristics, e.g., processes which look for seasonality in the data, perform averaging of past data, and deconstruct the data in trends. Research also analyzes strengths and weaknesses of methods in comparison to each other.

Topics in earnings forecasting ranged from analysis of what is necessary for creating a good forecast to more specific elaborations on how accounting and earnings forecasts are similar. Findings on what is necessary to improve a forecast, include:

- Consistency in forecasting frameworks is essential.
- Data quality and controls need to be undertaken.
- Data should range over several years, ideally up to 10 years.
- Of the data, 80% can be explained by statistical testing and the rest by expert knowledge.
- Accuracy, access, convenience and reliability of data are the key factors to accuracy.
- Information sharing through system interfaces is the key building factor of a model.
- Human inputs are essential to the model.
- Excel is the most popular tool due to its low investment costs and good feature set.

Richardson et al. (2010) noted that accounting attributes are seldom considered in earnings forecasting. Additionally, macroeconomic information is often not included in forecasts. Understanding the volatility of the data can help to improve forecasts. Moreover, it was emphasized that accounting is beneficial to forecasting to assess how income and expense streams will develop in the future.

Cash flow forecasting was also introduced, including its relevance for earnings forecasting. Rajendra (2013) has presented a robust process for building a model by following specific steps. These steps include analyzing the key inputs and influencers of the data, choosing forecasting methods, evaluating, and reporting accuracy, and the associated financial decision-making that results from the forecast (Rajendra, 2013). The steps are highly relevant and valuable in providing structure in preparing a forecast, even if it is an income statement and not a cash flow. Different forecasting methods were also presented.

The approaches described above origin from different industries and disciplines which also reflects the importance of model adaptation due to various factors such as industry, supply chain, cost structure, and internal infrastructures, use of inventory, and IT services.

The following case represents the only publication on short-term forecasting of income statement items in the logistics industry.

3 A Predictive Analytics Case with a Global Logistics Company

Within the scope of a bachelor thesis at FHNW the co-author of this paper developed an earnings before interest and taxes (EBIT) forecasting model for a global logistics service provider, that specializes in bulk liquid transportation, also referred to as case company (CC).

The company's EBIT has been difficult to predict because the number of orders processed does not imply how high the effective monthly profit will be. Consequently, the management of CC could predict profits only based on expert knowledge and personal assumptions. A key objective for management, therefore, was to improve the profitability of the business through internal optimization of processes, e.g., the development of a forecasting model. The monthly earnings before interest and taxes (EBIT) estimates of CC have shown deviations on a month by month basis. This volatility has been difficult to assert to one specific factor. In addition to this, it has been difficult to estimate the EBIT based on order quantities as there is no perfect interdependency between the results and number of orders processed per month. Since the company's strategic goal has been to maximize EBIT without necessarily increasing the number of orders per month, a model which can predict the monthly EBIT estimate has been considered as valuable.

As a result of the thesis, a formula calculating a monthly EBIT estimate was found. By mathematically designing the company's income statement structure, the company management was able to better understand the mechanics of the variables and ultimately implement distinctive operational processes to potentially reduce cost and improve monthly profits without having to increase the existing market share.

3.1 Data Analysis and Method

Data

As a first step, to decompose the relevant studies in a meaningful way and adapt them to the business case, the given data had to be redesigned to fit a model.

Data constituted from the monthly income statements from 2019 to 2020, and from January to May 2021. All values presented are coefficients of the real values, due to confidentiality agreements with CC.

The data was separated into the group's Total Revenue (TR), Total Variable Costs (TVC), Total Fixed Costs (TFX), and Total Costs (TC) and EBIT. Petrov et al. (2015) suggest that the ideal data for a model should range over several years; however, the data to test the model were only available for 2 years and 5 months. This raised some questions relating to data quality and reliability.

Furthermore, information sharing through system interfaces is supposed to be the key building factor of a model (Lu, 2015, p. 134–150). This was another issue for CC because data sharing and access between the departments is currently not possible.

Method

According to Rajendra (2013) the steps to create a cash flow model are to first analyze what the key inputs are and then to detect what influences the data. Once this is done an appropriate forecasting model should be decided upon, followed by evaluating and reporting accuracy. As the dataset is relatively small and the information sharing through systems is difficult, the model relies more on business knowledge and human factors.

The model was created in Excel based on an iterative process, where each step had to be calculated and evaluated by the modelling party before moving on to the next calculations. As a result, the process was developed in three main sections: (1) Descriptive Statistics, (2) Correlation Analysis and (3) Calculation of TR, TVC, TFX, TC and EBIT.

(1) Descriptive Statistics

The first step, descriptive statistics, served to analyze the data further and to recognize the key inputs. Calculations of the descriptive statistics were made in JupyterLab Notebook. The descriptive statistics contains the count, mean, standard deviation (STD), minimum values, maximum values, and the quartile ranges of the dependent and potential independent variables. The applied code to retrieve the values is (*Pandas.DataFrame.Describe — Pandas 1.3.0 Documentation*, n.d.):

```
df.numeric.describe()
```

To analyze the size and power of the various positions, each position was calculated in the proportion of the corresponding category (e.g., *Income Transports* is divided by TR, and the results are used in the analysis). Therefore, all revenue positions are computed as a percentage of TR, variable costs of TVC, and fixed costs of TFX. Moreover, TR, TVC, TFX, and TC are described in real values. Furthermore, EBIT is presented in real values.

(2) Correlation Analysis

After the analysis of the key inputs, the relationship between the variables was examined to detect what influences the data and how the variables might be interlinked. A correlation calculation of all variables was calculated with the support

of JupyterLab Notebook. The codes applied to receive the results in JupyterLab Notebook are (Akisha, 2020):

```
# Create correlation matrix
corr_mat = df.corr(method='pearson')

# Convert correlation matrix to 1-D Series and sort, and print
sorted_mat = corr_mat.unstack().sort_values()

print(sorted_mat)
```

In order to perform step (3) Calculation of TR, TVC, TFX, TC and EBIT. The effective formula for calculating correlations is (Sharpe et al., 2014, p. 130):

$$r = \frac{\Sigma z_x \, z_y}{n - 1},$$

where $z_x = \left(\frac{x - \bar{x}}{sx}\right)$ and $z_y = \left(\frac{y - \bar{y}}{sy}\right)$, which are the standardized results of each variables.

(3) Calculation of TR, TVC, TFX, TC and EBIT

The calculation of the different positions is mainly based on regression calculations performed in Excel by using the Data Analysis Toolpak. In addition to this, the mean and median were also calculated for certain predictions. The respective formulas for the simple regression, multiple regression, mean and median are (Sharpe et al., 2014, pp. 585, 84):

Simple Regression function:

$$\hat{y} = b_0 + b_1 x,$$

where b_0 is the intercept, and $b_1 x$ the estimated coefficient of the predictor variable.

Multiple regression function:

$$\hat{y} = b_0 + b_1 x_1 + b_2 x_2 + \cdots + b_k x_k,$$

where b_0 is the intercept, and each b_k the estimated coefficient of its corresponding predictor variable x_k.

Sample Mean:

$$\bar{x} = \frac{\Sigma x}{n}$$

The median is calculated by arranging the numbers from highest to lowest, afterwards the two middle values are found, added, and divided by two (Sharpe et al., 2014, p. 85).

Instead of calculating EBIT directly, each financial component—Total Revenue (TR), Total Variable Costs (TVC), Total Fixed Costs (TFX), and Total Costs (TC)—was predicted separately. For each regression function created, the predictions were calculated for all 29 months and compared to the actual values of the respective month. The comparison was made by subtracting the predicted variables and the actual variables. Afterwards, the STD was calculated on the calculated deviation of the actual values and predicted results, and the prediction function which showed the lowest standard deviation (STD) was chosen as the formula to calculate the respective category. The STD formula is written as (Sharpe et al., 2014, p. 87):

Standard Deviation:

$$STD = \sqrt{\frac{\Sigma (x - \bar{x})^2}{n - 1}},$$

where x is each value, $\bar{x}$ the sample mean, and n the size of the dataset.

When estimating a regression model, the statistical significance of each explanatory variable must be calculated. Moreover, the t-statistics is a popular tool to calculate this. Nevertheless, it was decided that only the STD will be the decisive factor in the selection of the appropriate function, since the t-statistics in this case did not yield statistical significances, but the results of the calculations were acceptable to the modelling party.

Once the calculation and evaluation process were completed, and the most accurate function, based on the STD, was found, the regression analysis for the next category was made. Ultimately, the EBIT was calculated based on the function EBIT = TR − TC.

To summarize, the process to find the prediction function for each category was to (1) analyze the result of the descriptive statistics, (2) evaluate the results of the correlation analysis, (3) based on steps (1) and (2) decide on the variables for the regression function, (4) calculate the regression functions, (5) predict the results based on the regression functions, (6) calculate the deviation between the predictions and the actual results, (7) calculate the STD of step (6), and ultimately (8) decide which function yields most accurate results. This process was repeated for TR, TVC, TFX and TC.

The final results do not repeat the results from the steps of creating the model but include the results of the best performing prediction function of the corresponding category (TR; TVC; TFX, TC or EBIT). In addition to this, the results section contains an analysis on seasonality and trends, which were ignored in the previous steps of modelling. The deviations between the predictions and actual results were illustrated for each month to see whether there are trends in the data that might improve the accuracy of the model.

3.2   Results

Total Revenue

The first step in the TR calculation was to predict *Income Transport*, which on average makes up 90.77% of TR. Referring to the goal of the research, which aims to show which variables have a significant impact on the results, it was assumed that *Number of Transport Orders* would impact the *Income Transport* results. Additionally, *Number of Working Days* is not a variable which is influenceable; however, the coefficient in the formula for *Number of Working Days* is −1.188; therefore, it is important to understand how much impact one additional working day has on the result. Moreover, the average prices of the past months are difficult to directly control, due to the variety of specific customer quotes based on tender processes and spot rates as well as to the difficulty in exactly predicting order volumes. Nevertheless, optimizations in the use of containers and employees can be made. The formula shows that for each container/box, the result increases by 2.079, and one full-time employee impacts the result by a coefficient of 6.748.

Calculated deviations occurred per month show an overperformance of the model in the late spring and summer months and a tendency to underperform in November and December. As stated by Petrov et al. (2015), 20% of a model should be made based on expert judgment. Therefore, in this case it might be advisable to manually adjust the forecast for future instances. However, it should be noted that there are only 29 data instances which were tested, of which only two full years were examined. It is therefore difficult to make clear assumptions on seasonality if working with a small dataset.

For calculating TR, the applicable equation multiplies income transports by 1.0625 and number of orders by −0.1392. Deviations per month showed that similar trends are apparent for *Income Transports*; however, they seem less significant as some of the previously overperforming results in *Income Transports* are under-performing for TR. Nevertheless, it is advisable to check the deviations of future predictions per month as the trends might become more apparent over a larger dataset.

It was also found that *Other Income* makes up on average 6.81% of TR with a STD of 1.57%. As previously described, *Other Income* consists of a large extent of container rental income. The process of the case companies' additional cost charges is currently not linked to the accounting department. Therefore, additional costs items are invoiced once confirmation from the customer is received and paid within the contractual payment term. The confirmation procedure does have less contractually set agreement times, and therefore it is relatively difficult to predict when an open costs advice is sent to a customer and then accepted. Figure 1 plots the relation between the calculated deviations of TR predictions and the real values of *Other Income*. No concrete statistical relationship can be analyzed, with an *r* of 0.4436. However, there is a negative relationship between the variables. It seems that there is a slight tendency for the model to underperform with higher other income and vice versa. To summarize, predicting *Other Income* is relatively difficult in the
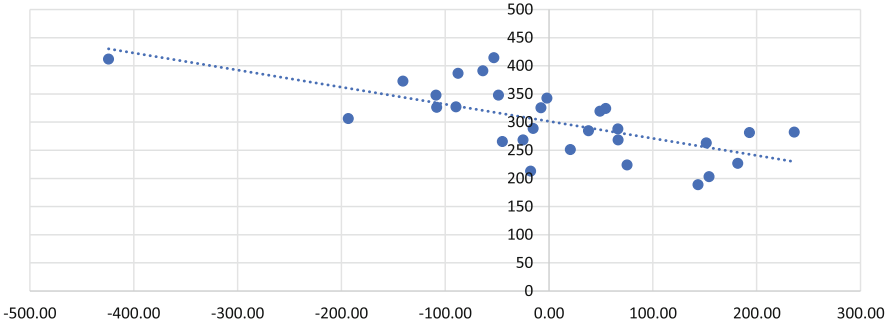
Fig. 1 Other income real values and TR_Pred deviations
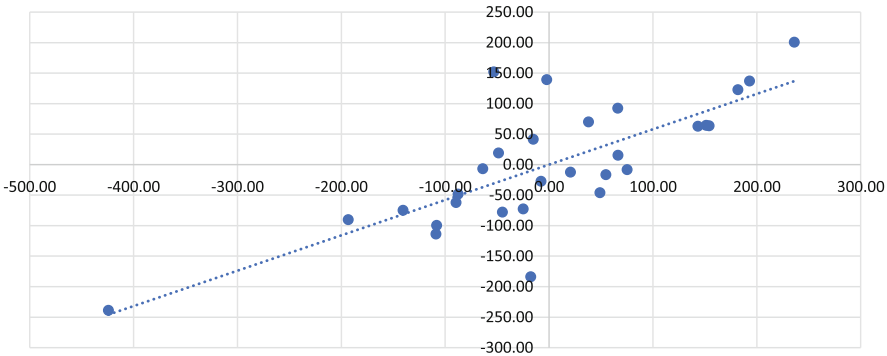
Fig. 2 TR deviations and TVC deviations (from Appendix D)

current data setup and connectivity of the departments. Nevertheless, being able to predict the amount of this position would perhaps improve the predictions for TR.

Total Variable Costs

For calculating TVC, the previous equation of TR is used in addition to the position *Road Freight*. Therefore, it is important to recall that the previous imperfections in the result are further expanded when calculating TVC. In addition, the TVC model is based on a linear model. However, the relationship between the variables cannot be perfectly explained based on a linear model due to the standard errors between the actual values and the regression function. Consistently, this relationship between the TR and TVC deviations can be seen in Fig. 2, which shows that the tendency of overperforming TR results in overperforming TVC.

Seasonal trends in the data are difficult to point out.

In addition, TVC's predictions were improved by adding the values for road freight. The significance to operational processes suggests that minimizing external use of road services does have a positive impact on the result. It was mentioned earlier, however, that it might be difficult to predict this value. However, if management can assume the value based on operational feedback, then the value

can be estimated. The current data situation only allows expert knowledge to be applied in estimating this value. However, linking operational data with accounting data could help to evaluate the data and relationships between the number of orders performed and the change in effective transportation mode. Likewise, if the transport mode information could be retrieved, order information, which is linked to the accounting data, might also help improve predictions of *Income Transport*.

Total Fixed Costs

TFX estimations were difficult to make, as there were no concrete correlations visible which could be used to predict this position. *Personnel Expenses* did show a high correlation of 0.9067 with TFX; however, predicting *Personnel Expenses* might be difficult. Nevertheless, effective higher expenses in the month of December could be explained due to an increase in personnel expenses in December. Nevertheless, the remaining months are not explainable by a specific variable.

Total Costs

TC showed high interdependency with TVC and relatively low relation to TFX; therefore, in order to improve the predictions for TC, it can be recommended that significant focus should be placed on suggested steps in improving the data insights of the TVC.

EBIT

The EBIT results are based entirely on the calculations of TR, TVC and TC, which correspond to the fact that the previous deviations of each subcategory have significant impact on the result of the EBIT. In fact, the correlations of each subcategory were over 0.95, yet the EBIT showed a significant slump in the correlation of 0.8627. Therefore, the linearization of all models and subtraction of TC and TR has significant influence on the results. Accordingly, it can be said that focusing on improving the predictions of TR and TVC, would presumably correspond to improvements of the EBIT forecast.

In addition to this, there is a slight negative relationship between the actual results and the deviations. Figure 3 shows, for instance, that where the actual results of the EBIT were over EUR 300.00, the model underperformed. Due to the small dataset, it is difficult to say whether this is a trend in the model, which should be accounted for, or whether this is a coincidence. Nevertheless, this should be tested for future predictions.

Resulting from a qualitative analysis of forecasting models and their relevance to the business, as well as a quantitative process for running the forecasting model, a final formula was developed:

$$\text{EBIT} = \text{TR} - \left(\left(1.1873 * \left[(TR * 0.567) + \left(\frac{\text{Road freight}}{TR} * 5167.28\right) - 743.329\right)\right]\right)$$
$$+ (-0.2050 * \text{No.of transport orders}) + 1543.3591$$
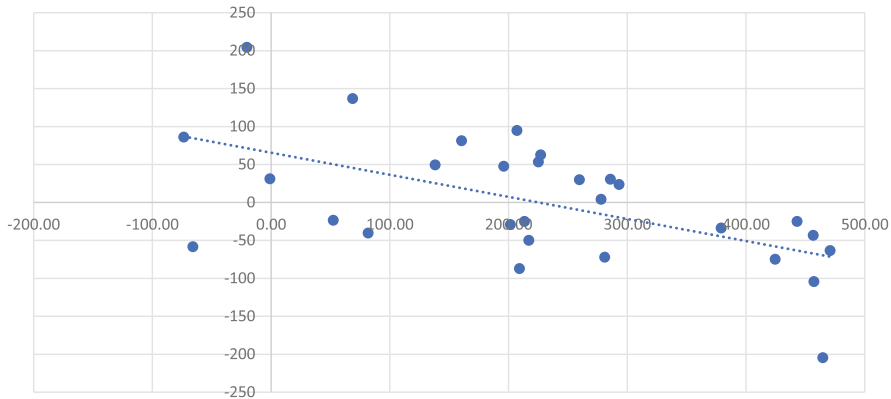
Fig. 3 EBIT_Actual and deviations

whereby,

$$
\begin{aligned}
\text{TR} = \big(1.0625 * \ & [(-1.1886 * \text{No.working days}) \\
& + (2.4488 * \text{No.of transport orders}) \\
& + (2.0798 * \text{Ø No of containers, boxes}) \\
& + (6.7483 * \text{Ø FTE}) + (48.2638 * \text{Ø FTE Operations}) \\
& + (1436.3114 * \text{Ø Price past 4 months}) - 8916.0408]\big) \\
& + (-0.1392 * \text{No.of transport orders}) + 385.6525
\end{aligned}
$$

The formula was tested on all 29 data instances and resulted in correlation of 0.8667. The results demonstrate the importance of understanding the data, as well as the fact that the conventional approach of using regression analysis is a powerful tool for making forecasts based on historical data. However, regressions produce standard deviations in the results that must be accounted for by expert knowledge. Moreover, the data used has limitations due to only evaluating 29 consecutive months of data. Some of the claims in this research therefore may be exaggerations, and the framework should be revised monthly to improve the final outcomes.

The final formula shows that EBIT prediction is based on TR, TVC, and TC calculations, which are essentially linked. From this, several key points emerge:

- The TR forecast, which depends on variables such as the number of working days, transport orders, containers/cartons, average full-time equivalents (FTE), FTE activities and recent price trends, helps management to identify operational aspects for EBIT improvement.
- While the number of orders is significant, it also has a significant impact on the bottom line through operational and commercial aspects.
- Current practices in recognizing revenue streams pose a challenge for accurate TR forecasting. The distribution of additional cost streams across three TR items makes it difficult to understand actual transport revenue.

- The lack of full interconnectivity in the company's information systems hinders simultaneous access to accounting and incremental cost data, making it difficult to predict potential future costs from customers.
- Improving interdepartmental interfaces could increase the transparency and predictability of revenue streams and make them more meaningful.

Better forecasting quality can be achieved by improving the data interface between the operations and accounting departments—specifically for TVC. As an example of this, the formula shows that the influence of the *Road Freight* item in the income statement has a significant impact on the cost structure. This suggests, in principle, that the use of vehicles from third parties considerably ruins profitability. For management, the implication is to focus on optimizing the use of their own fleet; and for the predictability of the model, one consequence is that monitoring of equipment usage can improve the model. The TC formula is based entirely on the outcome of the TVC predictions; therefore, the same conclusions apply. It is also worth noting is that predicting TFX is extremely difficult, even though it is the position least affected by operational changes and number of orders.

These findings highlight the critical role of predictive analytics in optimizing business processes and increasing profitability. By improving data interfaces and fine-tuning cost structures based on predictive models, the CC can not only better predict their financial performance, but also strategically plan for future market uncertainties.

4   Conclusion

Based on the findings of this case study, further research for the CC might include examining the EBIT formula and calculating the optimum levels of the variables that result in the highest EBIT. Furthermore, academic research focuses on cash forecasting or efficient forecasting methods; however, there is limited literature on the topic of monthly EBIT forecasting. Among the reasons could be the highly individualized methods required to develop an income statement forecast, as demonstrated in this research. Future research could focus on analyzing the appropriate measures for income statement forecasting as well as the relationship between income statement mechanics and process inefficiencies.

Overall, the findings of this case study aided in numerically demonstrating the CC's effective income and cost structure and determining which system flaws are impeding correct monthly EBIT estimates. Furthermore, the outcome clearly demonstrates which departments and processes have the opportunity to optimize and boost profitability based on the current business setup, without relying on market expansion.

4.1 Conclusion of the Learnings from the Procedure

An important insight from the process of building the EBIT forecasting model is that the strength of these models lies not only in their predictive power, but also in their descriptive capacity. This case study illustrated that forecasting models not only serve to predict future performance, but also to provide an insightful description of the existing financial structure. By breaking down the elements of profit and loss into quantifiable coefficients, models provide a comprehensive understanding of the financial functioning of the company. In the case of the logistics company, the value of the model was not only in the EBIT forecast, but more importantly in the concrete improvement opportunities it showed to management. Therefore, the use of predictive analytics in companies should be promoted for their descriptive capabilities, in other words, their ability to explain financial mechanisms and highlight opportunities for strategic optimization.

Linear regressions not only provide forecasts with a degree of accuracy, but also offer insights into the dynamics of financial ratios and how they relate to each other. Breaking financial statements down into their component parts allows for a thorough understanding of the factors that influence profitability and thus better decision-making. Although this iterative linear regression model devised in this thesis yielded satisfactory results, the literature review revealed several forecasting techniques in the field of machine learning, that could be employed. These innovative techniques, which align with the applied methodology, suggest a promising avenue for future investigation.

Overall, the thesis highlights the dual capabilities of forecasting models, namely prediction and explanation, as key components of the learning process. This understanding reinforces the need for regular model adjustments to reflect the changing dynamics of the components on which they depend. A constant cycle of monitoring, adjustment and recalibration must be maintained to preserve the accuracy and reliability of the forecasts.

In summary, the objectives of financial forecasting should go beyond future projections and enrich the understanding of financial dynamics. The significance of forecasts is not restricted to numerical projections; hence, whether using traditional statistical approaches or undertaking a machine learning project, it is vital to choose models that offer both accuracy and explanation. In this way, the models not only predict but also improve the comprehension of financial dynamics. Ultimately, it improves business performance by providing a quantitative perspective to compare the effectiveness of different business strategies and practices. As a result, forecasting becomes a critical tool for strategic planning and business management.

The case study highlighted the broader applicability of predictive analytics across different industries. Lessons learned, including the need for integrated data interfaces, the impact of cost structures on profitability and the inherent challenges of forecasting, apply to many industries. In addition, the adaptability of this model offers valuable benefits to other companies. Not only does it improve risk mitigation

and predictability, but it can also reveal hidden inefficiencies and opportunities in a company's internal processes.

In summary, by investing in predictive analytics, companies can improve their resilience, strategic decision-making and preparation for future crises and market volatility by using data-driven insights to develop tailored plans.

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In this book, Helena Kovačević draws on her extensive knowledge and experience to provide a comprehensive analysis of Predictive Analytics in Corporate Financial Management.

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In this book, Silke Waterstraat draws on her knowledge and experience in the areas of international financial management and corporate governance.

Internal Control System (ICS) in Times of Crises: Theoretical and Practical Approaches—The Proactive and Reactive Role of the ICS in Switzerland

Emilio Sutter and Basil Sommerhalder

Abstract Crises can occur at any time with serious consequences for organizations. A well-implemented Internal Control System (ICS) helps managing crises and serves to provide adequate assurance regarding the achievement of an organization's goals in relation to its operations, reporting and compliance. It is mandatory for listed Swiss organizations as well as for Swiss organizations exceeding certain economic key figures. In that case, the existence of the ICS is checked by the external auditor during the so-called ordinary audit. Although it is not mandatory for all other Swiss organizations, they are able to implement an ICS to their own advantage to strengthen their processes regarding the following five components of internal control: control environment, risk assessment, control activities, information/communication and monitoring activities. The authors of this chapter give a brief summary about the theoretical foundations of the ICS with focus on its implementation in Switzerland and how it helps managing crises. Why Swiss organizations are able to benefit from a mandatory or voluntary implementation of an ICS is shown and explained as well as how a well-implemented ICS serves as an important instrument regarding crises—in a *proactive* manner before and in a *reactive* manner during crises.

1   Introduction

Today, organizations face big challenges. The consequences of climate change with long periods of heat, droughts, sudden floods followed by diseases that are often associated with them should be mentioned as well as epidemics like the Covid-19 crisis. Epidemics—beside the danger to health—can also lead to staff shortages in various supply sectors. Additional hacker attacks, terrorism and warlike events such as, e.g., the Russia-Ukraine war may lead to significant supply bottlenecks in

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food and/or energy. The current energy bottlenecks in European countries show that crises can occur at any time with serious consequences for the population and thus also for various organizations.

Usually, well-behaving people who are affected by a crisis often behave differently to when there is no crisis—e.g., fraud can occur. This inevitably has an impact on employees as well as customers and therefore on organizations. Members of supervisory bodies, managers and employees of organizations must adapt their behavior; stronger management is required. The Internal Control System (ICS) is a tool that helps strengthen management in a *proactive* and *reactive* way. The following sections use various illustrations demonstrating what is important for organizations in times of crises.

2   ICS: Basics

This section will first focus on the so-called Fraud Triangle—considered as a possible consequence of crises. Then, the ICS will be defined and the general key points of the COSO framework will be addressed. Afterwards, a brief introduction into the legal regulation and requirements in Switzerland regarding its audit system and the ICS will be provided. At last, the control relationships in Swiss limited companies will be discussed.

2.1   *Implications of Crises: Fraud Triangle*

Before describing and defining the ICS, it is reasonable to have a look at possible forces that may affect members and their actions when their organization finds itself in a crisis. Especially then, internal controls are weakened because of generally scarce resources. As a result, members face uncertainty and doubt, but look for clarity and trust (PwC, n.d., p. 2). Existential fears can then lead to the bypass of already weakened internal controls by members due to crises (KPMG, 2020, p. 1).

Referring to these implications, a useful point of view was provided by Cressey (1950, pp. 738–743) to address fraud (e.g., the bypass of internal controls): There are three components—"opportunity", "pressure" and "justification"—which may explain why members of organizations could commit fraud. Cressey states that the three components must be given simultaneously in order for there to be a potential risk of fraud. Figure 1 shows a useful illustration representing the components mentioned in the "Fraud Triangle".

Although the dimension "justification" is widely known as "rationalization", the authors of this chapter feel that the term "justification" is more appropriate in times of crises. While "pressure" and "justification"—as part of the individual level—can be minimized by following a meaningful and coherent system of values (also known as "Tone at the Top") by the management and/or the board of directors,
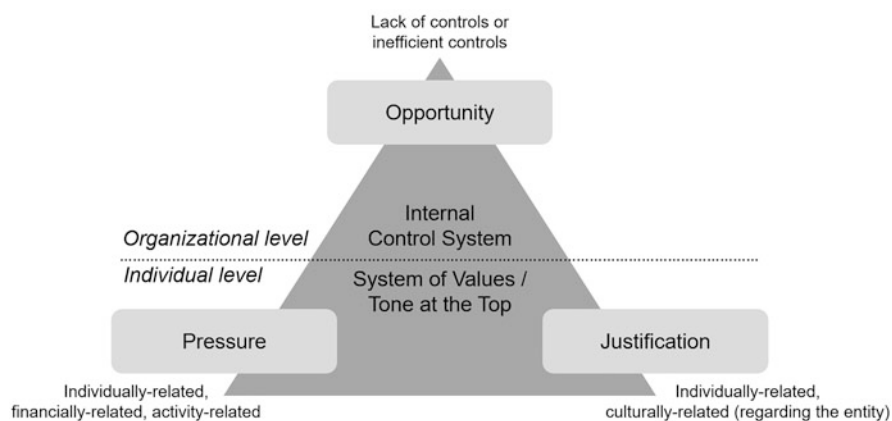
Fig. 1 The fraud triangle (Sutter et al., 2014, p. 35 based on Cressey, 1950, pp. 738–743)

the component "opportunity" on the organizational level can be addressed by an ICS. Developing, implementing and maintaining an appropriate ICS can therefore mitigate the risk of fraud committed by members of the organization and can build and provide trust (PwC, n.d., p. 2). Hence, the goal of ensuring that an organization's ICS also withstands the impact of a crisis and therefore the resulting higher risk of fraud due to the *opportunity* on the organizational level, Sects. 3 and 4 will address theoretical and practical approaches for an appropriate ICS before and during a crisis.

Having now used the term ICS a couple of times the question arises as to what exactly is meant by it. Section 2.2 explains the general definition of the ICS in a quick overview.

2.2   Defining the ICS with Reference to the COSO Framework

Looking at the term ICS, many different interpretations are present. Hence, the existence of a single definition of the ICS is not generally given (Pfaff & Ruud, 2019, p. 25; Sutter et al., 2014, pp. 16–17). Also, the legal situation in Switzerland does not help either as it does not provide a comprehensible definition (translation from the German language): "The Swiss law does not specify the content of the Internal Control System. The audited organization therefore decides for itself which control mechanisms would best suit the specific circumstances" (The Federal Assembly – The Swiss Parliament, 2005). Thus, we need a variety of alternatives.

The COSO framework offers such alternatives. It was published by the "Committee of Sponsoring Organizations of the Treadway Commission" (COSO) in its current state in 2013, is widely accepted and probably the most cited framework for

Fig. 2 The COSO
Cube (COSO, 2013, p. 6)
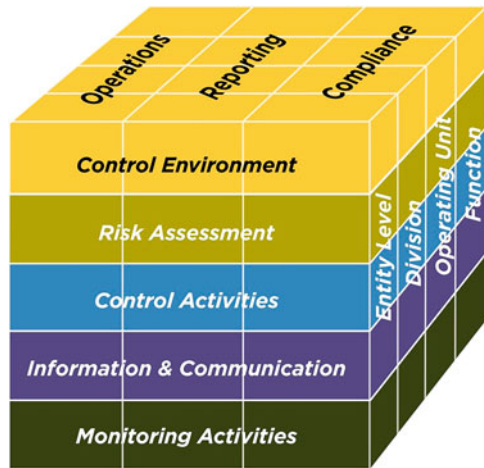
internal control in Switzerland (Ruud et al., 2018, p. 7; Sutter et al., 2014, p. 16).
The COSO framework provides the following ICS definition:

> Internal control is a process, effected by an entity's board of directors, management, and
> other personnel, designed to provide reasonable assurance regarding the achievement of
> objectives relating to operations, reporting and compliance. (COSO, 2013, p. 3)

The main part of this framework is the so-called COSO Cube as shown in Fig.
2—an intuitive overview of what should be captured by internal control.

As outlined in Fig. 2, the COSO Cube consists of three distinctive, inscribed
sides: The three categories of objectives on the top, the five components of internal
control at the front and the entity's organizational structure on the right side of the
cube (COSO, 2013, p. 6). The following sections and chapters will primarily focus
on the most important elements in times of crisis, i.e., the two components "Risk
Assessment" and "Information & Communication". After looking at the general
legal regulation and requirements in Switzerland in Sect. 2.3 and gaining a practical
view on control relationships in Swiss limited companies in Sect. 2.4, Sects. 3
and 4 will then specifically focus on the role of the ICS in times of crises, both
theoretically and practically.

2.3 Legal Regulation and Requirements in Switzerland

Before looking at the legal details of the ICS in Switzerland, it is useful to first
understand the audit requirements according to the Swiss Code of Obligations (CO).
It specifies that Swiss entities can either be subject to an ordinary audit or a limited
audit, or may simply be exempt from all audit requirements, as shown in Fig. 3.
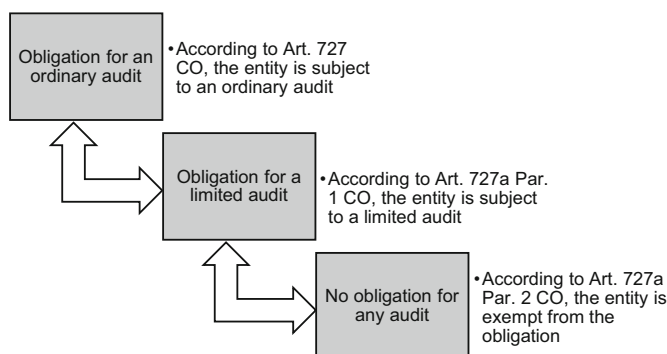
Fig. 3 Summary of the Swiss audit system according to the CO (Sommerhalder, 2020, p. 11)

In accordance with Art. 727 CO, all entities (except associations) meeting or exceeding two of the following three key figures in two successive years are automatically subject to an ordinary audit:

- Total balance sheet of CHF 20 million (associations: CHF 10 million)
- Total revenue of CHF 40 million (associations: CHF 20 million)
- 250 full-time equivalents (FTE) (associations: 50 FTE)

Moreover, an ordinary audit is mandatory for publicly traded companies and organizations which are required to prepare consolidated accounts. Such entities cannot be exempt from that obligation (e.g., make use of an *opting-out/opting-down*). In contrast, entities not subject to the ordinary audit are automatically obliged to perform a limited audit. In this case, however, shareholders can make use of an *opting-up* or an *opting-out/opting-down* as explained in the following (EXPERTsuisse, 2016, p. 24, 2022a, p. 6):

- *Opting-up*: An ordinary audit can be demanded from shareholders holding a minimum of 10% of the share capital (Art. 727 Par. 2 CO). Furthermore, an ordinary audit may also be obligatory on the basis of the articles of association or on a decision made by the general meeting (Art. 727 Par. 3 CO).
- *Opting-out/opting-down*: If the entity does not have more than 10 FTE on annual average, the shareholders as a whole can order to be exempt from all audit requirements (Art. 727a Par. 2 CO).

As the term "limited audit" suggests, the scope and depth of a limited audit is significantly less than that of an ordinary audit (EXPERTsuisse, 2014, p. 58). In both situations, the external auditor examines the annual accounts and the motion made by the board of directors to the general meeting on the allocation of the balance sheet profit. A significant difference in scope between these two types of audits—as well as the most important for this chapter—is the following: The limited audit does not require the external auditor to examine the existence of an ICS (EXPERTsuisse,

2022a, p. 11). Hence, entities subject to a limited audit (or even to *no* audit) do not need to establish an ICS by law—but are free to do so for their own benefit. However—and that is why the Swiss audit system was shown in Fig. 3 briefly: Based on the type of audit alone, it cannot be concluded whether or not an ICS exists in a specific entity (Pfaff & Ruud, 2019, p. 47–48).

2.4 Control Relationships: Using the Example of Swiss Limited Companies

To show the general implications of control relationships in Switzerland, Sect. 2.4 focuses on entities organized as Swiss limited companies. Such a legal structure is being regarded as the most frequently used for capital companies in Switzerland (Federal Department of Economic Affairs, Education and Research EAER, 2023). According to the CO, Swiss limited companies must be composed of the following corporate bodies (also commonly known as "organs"): The general meeting, the board of directors and the external audit (assuming the company has not performed an *opting-out/opting-down*—if so, this corporate body would be unoccupied in line with Art. 727a Par. 5 CO). In the case of Switzerland, the board of directors is characterized as a so-called one-tier system—while being the main supervisory body also the management duties are, if not delegated to others, in its sole responsibility (EAER, 2021; Eling & Pankoke, 2014, p. 140). Figure 4 shows how the two corporate bodies, the board of directors and the external audit, are affected by control mechanisms by Swiss law (highlighted by thick arrows).

Figure 4 assumes that the board of directors delegates the management duties—e.g., to a Chief Executive Officer (CEO). They both are affected by the control mechanism when performing an ordinary or limited audit. The third corporate body
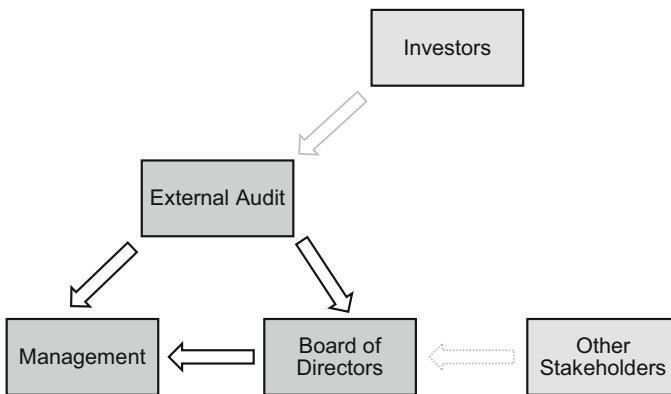
Fig. 4 Overview of control relationships in Swiss limited companies (Sutter et al., 2014, p. 75; based on Jäger, 2007, p. 30)

of a Swiss limited company is not shown in Fig. 4: The general meeting (i.e., the sum of shareholders), can be understood as part of the investors. Clearly such investors as well as other stakeholders (e.g., debt providers like lenders or even creditors) are crucial stakeholders—they are therefore shown separately in order to underline the importance of such other stakeholders.

Focusing on the ICS as such, the board of directors and the external audit are primarily to be taken into consideration when looking at control mechanisms. When performing an ordinary audit, the board of directors is responsible for designing, implementing and maintaining an appropriate ICS according to PS-CH 890 (EXPERTsuisse, 2022b, p. 994). In this regard, various corporate governance frameworks recommend the installation of an audit committee in Swiss limited companies—for example the "Swiss Code of Best Practice for Corporate Governance" (economiesuisse, 2023, pp. 15–16) for listed companies in Switzerland. Also, for non-listed Swiss Small and Medium Enterprises (SME) with 10–500 employees, recommendations are present: According to the "Best Practice im KMU" (Binder et al., 2009, p. 7), SME should appoint individual representatives or committees among others for risk management. Besides that, studies such as "swissVR Monitor II/2021" show that such committees are not uncommon in practice: Out of 175 organizations of all sizes with at least one installed committee, 74% of them had set up an (internal) audit committee in 2021 (swissVR et al., 2021, pp. 16–17). In contrast to these recommendations according to another study, however, in 2022 (internal) audit committees were installed in only around 7% out of a total of 395 medium-sized organizations with 10–249 employees (Sommerhalder, 2023, p. 63).

In turn, the existence of the ICS (as mentioned designed, implemented and maintained by the board of directors, optionally through the form of a committee or individual representative) is being audited in case of an ordinary audit according to Art. 728a Par. 1 CO. Furthermore, the external auditor must take account of the ICS when carrying out the ordinary audit and in determining their extent (Art. 728a Par. 2 CO). As already indicated in Sect. 2.3, the ICS is not required when being audited along the requirements of the limited audit (EXPERTsuisse, 2022a, p. 11).

3   Theoretical ICS Approaches Before and During Crises

In this section, crucial components of the ICS focusing on times before and during crises will be addressed. This is done by taking the COSO Cube into account and by illustrating the *proactive* and the *reactive* role of the ICS.

3.1 Important Elements of the COSO Cube

The two components of internal control, "Risk Assessment" and "Information & Communication", are important elements for organizations in times of crises—the first as a *proactive* element *before* a crisis, the latter as a *reactive* element *during* a crisis. Of course, the other three components of internal control ("Control Environment", "Control Activities" and "Monitoring Activities") are also importantly contributing to a successful ICS. Although they go hand in hand with the components "Risk Assessment" and "Information & Communication", the authors of this chapter emphasize that especially these two components are particularly important when dealing with crises. First, COSO describes the component "Risk Assessment" using the following principles as provided in Table 1.

The authors of this chapter feel, that special emphasis must be made for the Table 1's section highlighted in bold: *"(. . .) how the risks should be managed"* (COSO, 2013, p. 7). It is a direct link to the component "Control Activities", as one component of internal controls. In Sect. 4.1, the authors give a direct suggestion on how to link the two components "Risk Assessment" and "Control Activities" for practical reasons by using the so-called Risk-Control-Matrix as shown in Table 3.

Next, the authors point out the importance of the component "Information & Communication"—especially in a *reactive* manner *during* crises. COSO describes this component as follows (Table 2).

The section highlighted in bold is of particular importance to the authors and will therefore mainly be addressed in Sect. 4.2 for practical implementations.

Table 1 The principles of "Risk Assessment" (COSO, 2013, p. 7)

Risk Assessment
The organization specifies objectives with sufficient clarity to enable the identification and assessment of risks relating to objectives.
The organization identifies risks to the achievement of its objectives across the entity and analyzes risks as a basis for determining **how risk should be managed** [emphasis added].
The organization considers the potential for fraud in assessing risks to the achievement of objectives.
The organization identifies and assesses changes that could significantly impact the system of internal control.

Table 2 The principles of "Information & Communication" (COSO, 2013, p. 7)

Information & communication
The organization obtains or generates and uses relevant, quality information to support the functioning of internal control.
The **organization communicates information, including objectives and responsibilities for internal control, necessary to support the functioning of internal control** [emphasis added].
The organization communicates with external parties regarding matters affecting the functioning of internal control.

In the following section, the *proactive* and *reactive* perspectives will be specified further theoretically.

3.2   Proactive and Reactive Perspectives

First, the authors emphasize the importance for main decision makers to understand potential mitigations of crises before they are even present. The management and the board of directors must be aware of possible threats and their consequences—and also of their effects on the functionality of the ICS. A careful preparation before a crisis can facilitate the dealing with the impact of any crisis. Clearly, crises are coupled with uncertainty—but even the attempt to cover the most likely and reasonable events can lead to important time savings and therefore to a more agile and better management during crises. In a way, the *proactive* preparation enables one to work along a clear action plan which can make *reactive* decisions under pressure less needed and likely.

During a crisis, also ICS processes are under pressure due to a lack of resources (KPMG, 2020, p. 1). Certainly, ad-hoc decision making and communication by leaders (*reactive*) cannot be averted due to uncertainty—but having already established clear communication paths (*proactive*) can support the efficient dealing with crises when resources are missing. Therefore, tasks in the event of a crisis (e.g., to answer the questions such as WHO?, WHEN?, HOW and WHERE?—see also Sect. 4.2) should be planned carefully.

Along the COSO Cube shown in Fig. 2, *proactive* preparations build on an effective control environment. Identifying and assessing possible risks and threats arising therefrom ("Risk Assessment" as a component of internal control) should be coupled with a clear plan on how to communicate when such risks occur—the authors emphasize that defining clear communication paths before risks occur are crucial elements. According to the COSO Cube, the *reactive* element of the ICS can be understood by addressing the component "Information & Communication" as shown in Fig. 2.

4   Practical ICS Approaches Before and During Crises

The front side of the COSO Cube—as explained in Sect. 2.2—shows the five components of internal control (see also Fig. 2). As mentioned in Sect. 3.1, the components "Risk Assessment" and "Information & Communication" are of particular importance in times of crises. Such times are characterized by unpredictability and thus higher risk potential. Organizations have to deal with the unknown and therefore with additional risks—also, existing risks can even increase. Moreover, people—in general and even more in their organizations—have an increased need for clear information and communication. How can these circumstances be

addressed in a risk management as well as an information/communication concept? This question is answered in the following Sects. 4.1 and 4.2 using examples also of non-profit and public sector organizations.

To answer the above question on a risk management and information/communication concept, also a larger organization in the disability sector was deliberately chosen which already has a functioning risk and information/communication concept. The following explanations refer to the risk and information/communication concept of the "Stiftung für selbstbestimmtes und begleitetes Leben SSBL" (translation: Foundation for Self-Determined and Accompanied Living) and give important insights into practice.

4.1   Ideas for a Risk Management Concept

The following explanations focus on the component "Risk Assessment" in connection with the component "Control Activities"—i.e., "to define possible risks and to cover them with internal controls". The authors refer to this as the "*proactive* part" regarding crises and "Risk Management".

How can risks be structured? Hunziker et al. (2015, S. 92) divide risks in relation to an organization's environment: Strategic risks and operational risks. Strategic risks relate to economic, political-legal, socio-cultural, technological and ecological aspects. Operational risks on the other hand can be recorded in a separate risk catalog. Hunziker et al. (2015, p. 200) propose the following five categories as operational risks for Swiss public sector organizations:

- "Personal and organizational risks": In relation to, e.g., customers, clients and employees.
- "Social and political risks": These risks can lead to, e.g., riots, revolts and thus to the "legal risks" listed below.
- "Legal risks": These risks arise when legal bases are not respected.
- "Property, technical and natural hazards": These risks can cause accidents.
- "Financial and economic risks": These risks can lead to financial difficulties or even bankruptcy.

Besides for Swiss public sector organizations, this rough classification can also be helpful for non-profit and for-profit sectors. Communicating is a *"business with and for people"*. For this reason, people-related risks are of high importance. SSBL (2020, p. 3), e.g., lists the following six risk areas in its "Crisis Communication Instruction" for risk analysis from the communication perspective:

- "Risk 1: Care errors with direct consequences for clients (...)"
- "Risk 2: Extraordinary events in everyday work (...) with an impact on clients or the organization" (e.g., pandemic situation)
- "Risk 3: Major incidents and emergency operations: accidents with serious injuries or death"

Table 3 Risk-Control-Matrix (own representation based on Hunziker et al., 2008, p. 11)

Key processes		Key risks		Key controls	
Number	Description	Number	Description	Number	Description
1	. . .	1	. . .	1	. . .
2	. . .	2	. . .	2	. . .
. . .	. . .	. . .	. . .	. . .	. . .

- "Risk 4: Crime-related behavior by employees, clients, relatives/representatives or third parties (...)"—e.g., theft of data, immoral behavior
- "Risk 5: Public criticism of the business (...)"—e.g., damage of reputation, with possible financial difficulties of the organization
- "Risk 6: Total or partial failure of infrastructure"—e.g., energy supply bottlenecks

Such rough classifications, as mentioned above by Hunziker et al. (2015, p. 92) and also by the SSBL (2020, p. 3), may be useful to set a focus on the most important key risks a company is facing. Connecting them with their corresponding key processes and then designing, implementing and maintaining appropriate key controls (i.e., the ICS) helps strengthen the management of crises in a *proactive* way. In order to illustrate this approach clearly, it is helpful to use a so-called Risk-Control-Matrix as shown in Table 3.

Closely related to the above-mentioned key controls is the fact that a clearly defined information/communication concept should be in place when crises occur (*reactive perspective*)—e.g., if negative consequences from foreseen or unforeseen risks arise. Elements of such an information/communication concept will be addressed in Sect. 4.2.

4.2   Ideas for an Information/Communication Concept

Now knowing about the different categories of risks as well as the Risk-Control-Matrix, the following questions arise: *WHEN, WHO* resp. *FROM WHOM TO WHOM, HOW* and *WHERE* is information provided?

WHEN?

The SSBL (2020, p. 7), e.g., recommends to split the information processes in phases 1 and 2: Phase 1 could initially be understood as general initial information, phase 2 in this case would deal with more in-depth information and discussion. Depending on the situation, phase 3 could also be envisaged: It could be described as closure remarks of the case or event. However, it is often difficult to predict when an event must be communicated, i.e., which phase has to be considered.

WHO resp. FROM WHOM TO WHOM?

Every crisis could escalate. For this reason, in phase 1 the press officer (press office/dept. information & communication) would inform the stakeholders. Therefore, it is obviously important that an overview of the related stakeholders exists. They could be listed in a matrix/table (*FROM WHOM TO WHOM*). In general, it is recommended to work with the control relationships as mentioned in Sect. 2.4. The representation of the relationships shown in Fig. 4 can be adjusted in a way to also indicate the so-called inner and outer control triangles as referred by Sutter et al. (2014, pp. 75–77). Assuming the existence of a Swiss limited company with an ordinary audit, the "inner control triangle" then involves the two corporate bodies "board of directors" and "external audit" as well as the management:

- Board of directors: The supreme supervisory and organizational body (EAER, 2021).
- External audit: The responsible auditing and fiduciary companies.
- Management: The management (as individual management, co-management or management committee) including the various management levels (e.g., business unit managers, staff, logistics/service managers etc.).

  The "outer control triangle" includes the investors and also other stakeholders:

- Investors: E.g., shareholders (i.e., the general meeting), suppliers, banks, insurance companies, government etc.
- Other stakeholders: E.g., police department, fire department etc.

HOW and WHERE?

Best would be using communication channels. The SSBL (2020, p. 4), e.g., offers the following linkage and mentions the term "dialogue groups": They are stakeholders, therefore the term "stakeholder" is used below. Also, the SSBL (2020, p. 4) lists stakeholders vertically and the corresponding communication channels horizontally. In connection with the findings of the authors of this chapter, Table 4 shows such a matrix in a simplified form.

Table 4 Matrix on relevant stakeholders and communication channels (own representation based on SSBL, 2020, p. 4)

Stakeholders/communication channels	WhatsApp etc.	Zoom etc.	Intranet	Personal discussions	Meetings	E-mail etc.
Spokesperson						
Board of directors						
External audit						
Management						
Investors						
Other stakeholders						

By using a matrix such as the one shown in Table 4, the relevant stakeholders can be matched to a suitable communication channel—line by line. For the implementation in everyday practice, additional information/communication checklists are useful, as mentioned, e.g., by SSBL (2020, pp. 18ff).

Instead of such checklists, the authors of this chapter use a process-oriented approach. Here, the following three additional processes can be helpful:

- Process 1: Getting and clustering the data/information. Clustering the data/information means: A differentiation must be made. According to SSBL (2020, p. 18) it has to be distinguished whether information can be identified as secured or unsecured (i.e., speculations), and also if the information must not be communicated!
- Process 2: Preparing for the media. According to SSBL (2020, p. 19), the media usually wants the following four questions to be answered:

    "What happened?
    Why did it happen?
    Whose fault is it? Also: Who is liable? Or: Who is responsible?
    What are the consequences?"

- The answers to these questions should match the principles resp. be aligned with the philosophy/culture of the organization.
- Process 3: Preparation of how to inform. The SSBL (2020, p. 19) distinguishes between the following four approaches:

    - *"Monitored (...)"*. Note from the authors of this chapter: The aim should be— if possible—to do it by an initial media orientation, using a corresponding checklist as a recommendation;
    - *"Fast (...)"*. Note from the authors of this chapter: The aim is the prevention of rumors/speculations;
    - *"Timed (...)"*. Note from the authors of this chapter: The media wants to know how and when which information will be published;
    - *"Information on all channels!"*. Note from the authors of this chapter: The possible channels have already been listed above in coordination with the stakeholders.

If the organization has more locations, also the "WHERE-question" has to be answered.

5 Conclusion

To be well prepared for crises, an organization must strengthen its management function. This can be done with practical instruments—such as an ICS—*proactively* and *reactively*. Stakeholders want to be informed in an adequate way. For this reason, "Information & Communication" as part of an ICS becomes more and more

important in a *reactive* way. If you want to inform your stakeholders in an optimal manner, it is necessary to know the involved (negative) risks.

In order to strengthen the sustainability contribution of organizations, ICS findings provide managers and boards of directors of organizations as well as their stakeholders with more certainty. This can also be expressed with the following words: "He who knows the goal can decide, he who decides finds peace, he who finds peace is secure, he who is secure can consider, he who considers can improve" (quote which is said to go back to Confucius) and thus contribute to the sustainability of organizations especially in times of crises.

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Corporate Governance and Corporate Performance: Case Study Japan

Clemens Kustner and Silke Waterstraat

Abstract After the bursting of the stock market bubble at the end of the 1980s Japan began to comprehensively reform its corporate governance system. Modernising Japan's corporate governance system was seen as one of the key levers to making Japanese companies more profitable, faster growing and less risk-prone, with the overarching goal of revitalising the Japanese economy in the long term.

The first phase of the reform lost some of its momentum in the wake of the great financial crisis that broke out in 2008. Prime Minister Abe then pushed the reform process forward again with vehemence from 2012 onwards. Abe's reform efforts encompassed several elements, such as the reform of company law and the introduction of a corporate governance code and a stewardship code. At the same time, the Tokyo Stock Exchange has influenced the corporate governance of Japanese companies through its listing rules.

From a regulatory perspective, the Japanese corporate governance system can be described as modern and efficient. However, corporate practice often lags behind. The Fujitec case study at the end of this chapter shows two things: first, how lacking the actual practice of corporate governance can be despite good rules. Second, it shows how determined shareholders today have the power to protect their interests and ensure that Japan's modern corporate governance rules are brought to life, to the benefit of employees, shareholders and the Japanese economy as a whole.

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1   Japan's Path to a Modern and Efficient System of Corporate Governance

Following the bursting of the stock market bubble at the end of the 1980s and the deep economic crisis of the 1990s, the need to fundamentally change the traditional system of corporate governance, particularly in Japan's larger, predominantly listed companies, became increasingly apparent (Jackson & Miyajima, 2007; Omura, 2020).

Making Japanese companies, and ultimately the Japanese economy as a whole, more profitable, faster growing and less risky was the main motivation for the reform process. In this sense, corporate governance has been seen by successive governments and increasingly by companies as a key management tool for improving performance and managing risks and uncertainty.

The renewal of corporate governance has been challenging for Japan from various perspectives. First of all, a sufficient social and political consensus had to be created again and again for the various reform steps. Matsunaka (2018) impressively illustrates the struggle for a sufficient consensus in the political process for individual reform steps. On the other hand, Western rules could not simply be adopted, but rather they had to be led into a symbiosis with Japan's own cultural conditions (Gilson & Milhaupt, 2005). A major hurdle was and is that good corporate governance rules must not only be on paper, but must also be put into practice (Milhaupt, 2006). And last but not least, the reform process, which has been going on for around 30 years now, shows that perseverance and a willingness to make course corrections were and are required.

Despite some setbacks and ongoing challenges, a number of indicators and multiple case studies suggest that Japan has made great strides in corporate governance over the past 30 years (Milhaupt, 2006, 2017; Benes, 2022). The Fujitec case study presented at the end of this chapter illustrates this development. In the case of Fujitec, in 2022 and 2023, shareholders succeeded in holding an absolutist CEO and biased outside directors accountable and enforcing the protection of shareholder interests. Fujitec shareholders' success is in contrast to a similar case some 15 years ago. At that time, the U.S. investor Steel Partners was booted out by the management of the Japanese company Bull-Dog Sauce through unusual defensive measures and castigated by the Constitutional Court as an abusive shareholder (Kachi & Miyazaki, 2007).

In the next section of this chapter, the traditional Japanese corporate governance system is first described in order to illustrate the major challenges that Japan faced about 30 years ago, at the beginning of the reform process. This is followed by an overview of the reform process that Japan has undergone since the 1990s. The final section uses the Fujitec case study to illustrate how shareholders in Japan can today assert their rights more effectively.

2 Traditional Corporate Governance System in Japan and Its Consequences

The traditional organisational regulations for organising the governing bodies and supervision of a company, which is still found today in a more advanced form, is called Company with Board of Statutory Auditors (or kansa yakkai setchi kaisha) (Spiegel, 2017b).

This governance structure has two bodies, the Board of Directors, which manages the company largely autonomously, and the Board of Statutory Auditors, which is another type of supervisory board (Fig. 1). Both bodies are directly elected by the shareholders (Goto, 2018a). However, the members of the Audit Board are not members of the board of directors and are not entitled to vote on the board of directors. They therefore do not participate in the election of the executive directors of the companies (Goto, 2018a; Learmount, 2002; Matsunami & Tatsumi, 2023; Miyamoto, 2019).

The powers of the board of statutory auditors are thus ultimately limited. Its main task is to audit the company's financial statements and the board's compliance with laws and regulations (Spiegel, 2017b; Miyamoto, 2019).

The board of directors, on the other hand, has a dual function. It can make business decisions autonomously, while at the same time the boards of directors control the decision-makers. The board of directors is therefore self-controlling (Spiegel, 2017a; Miyamoto, 2019). This lack of oversight and supervision was exacerbated by the fact that until the 1990s there was no need for external directors to be represented on the board of directors (Spiegel, 2017b; Waldenberger, 2017; Miyamoto, 2019).
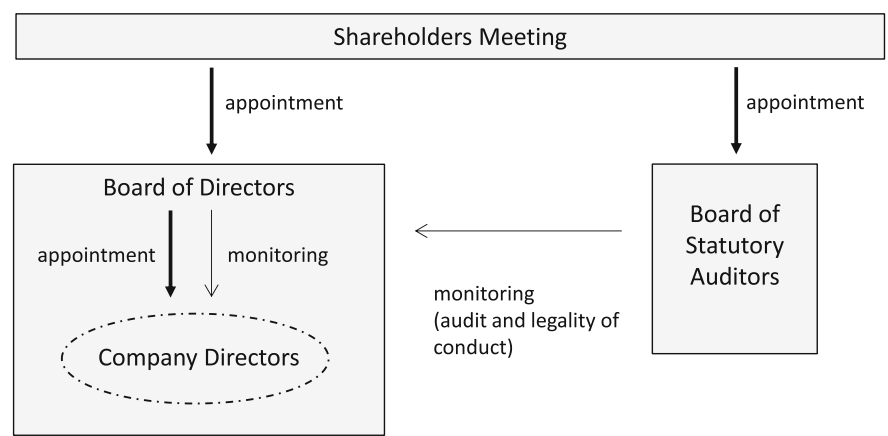
Fig. 1 Organisational regulations of the company with board of statutory auditors (Spiegel, 2017a)

In order to be able to assess the implications and subsequent reform efforts of this organisational model, it must be seen in the context of the Japanese context, with the following four factors being of particular importance (Goto, 2018a):

1. Lifetime employment
2. "Staff Directors"
3. Stable block of friendly shareholders
4. Dominance of bank financing

3   The Life-Long Employment System

The term life-long employment initially meant that large, listed companies hired graduates immediately after their university degree and they then stayed with the company throughout their working life (Kwon, 2006; Shishido, 2000; Miyamoto, 2019). A high-ranking, centralised human resources department takes care of the in-house training, development and promotion of employees and managers (Jacoby, 2005). Salaries and promotions depended heavily on seniority. After retirement, employees with life-long employment usually received a large severance payment (Kwon, 2006; Miyamoto, 2019).

However, the system of life-long employment relationships had a much more far-reaching meaning, e.g. employees with a life-long employment relationship were members of the so-called Company Community, which essentially supported, shaped and developed a company (Shishido, 2000). Promotions and the transfer of managerial responsibilities up to company management, which was elected from among the employees with life-long employment contracts, were based on a consensus of the members of the company community (Waldenberger, 2017; Learmount, 2002; Shishido, 2000). Shishido (2000) even goes so far as to say that the head of the company community also held the CEO role in a quasi-parallel function: "Employees exercise an element of control through membership in the company community. Management is elected based on an informal consensus of the employees. In other words, the top of the Company Community doubles as the CEO of the company" (Shishido, 2000, p. 213).

This system had a massive impact on the corporate governance of Japanese companies. At least in the past, companies and their boards felt a greater loyalty to employees than to shareholders. Shishido (2000) describes the company community of employees with life-long employment, which is characterised by hierarchical subordination and consensus, as quasi-owners of Japanese companies.

In a rapidly growing, dynamic environment, the system of life-long employment relationships may lead to stability and a very high level of commitment of employees to their company (Learmount, 2002). In contrast, conflicts of interest between the interests of the employees and those of the shareholders are obvious, particularly in economically difficult phases (Shishido, 2000). In such an environment, the potentially necessary restructuring of unprofitable business units that would have

led to job losses could hardly be implemented. A feature of the Japanese system of life-long employment was that, as a rule, not qualifications and ability were the decisive factors for promotion, but seniority, length of service and collegiality—with the danger of mediocrity being a logical consequence of this corporate management approach (Lehner, 2016).

Not surprisingly, there was no external market for executives for a long time. With seniority-based pay and promotions and high retirement benefits, tenured workers had a strong incentive to stay with the company. On the other hand, it was very difficult for external managers to gain a foothold in a new company because they were not part of the company community (Waldenberger, 2017).

The result was a self-contained system that was largely isolated from outside influences.

4 Staff Directors

The appointment to the board of directors has long been the culmination of a lifetime achievement for an employee (Hoshi, 1997; Miyamoto, 2019). As already mentioned above, for a long time the board of directors of many companies was only occupied by former employees and thus by insiders. In many cases, the boards of directors were also unusually large, sometimes with up to 40 members. However, the actual decisions were only made by a small group of board members. Decisions taken across the board to meet legal requirements were often a mere formality (Learmount (2002); Gilson & Milhaupt, 2005).

For the company with the board of statutory auditors (as outlined above), this meant that the members of the board of directors actually did not monitor company management in an independent manner as they were developed and promoted by the company community and therefore operated in a tight network of consensus thinking, loyalty and dependency (Miyamoto, 2019; Milhaupt, 2002; Gilson & Milhaupt, 2005; Aoki et al., 1994).

5 Dominance of Bank Financing

Similar to continental Europe, bank loans have played an important role in financing Japanese companies in the past. As a rule, one bank (or a small group of banks) played the role of the main bank. The main bank was usually not only the largest lender, but at the same time held a significant stake in the company's share capital. In many cases, the main bank was also represented on the company's board of directors by its own delegates or employees (Kato et al., 2017; Aoki et al., 1994; Hoshi, 1997).

The main bank was often in a very strong position vis-à-vis the companies. The main bank played a special role in monitoring the management of the company,

which in extreme cases could also mean taking over the actual management of the company in the event of a company crisis (Aoki et al., 1994).

How well the main bank's control of corporate governance worked is disputed. According to Miwa and Ramseyer (2005), there is no evidence to support the thesis that the main banks effectively controlled companies: "If the 'main bank system' ever functioned, the anecdotes [...] suggest it functioned haphazardly at best. Banks missed problems. Firms failed. Banks jettisoned them when they did. Broader empirical evidence, however, suggests the system never functioned at all" (Miwa & Ramseyer, 2005, p. 559).

Regardless of the assessment of the main banking system, it did not solve the issue of management supervision from the shareholders' point of view. Even if the main banks had carried out the monitoring function assigned to them, the interests of the outside shareholders would not have been in the foreground, but rather those of lenders, which the banks were primarily. Conflicts of interest with shareholders were ultimately unavoidable.

The main bank relationship is the aspect of the traditional Japanese corporate governance system that plays only a very minor role today. In particular listed companies have developed alternative sources of financing (Arikawa & Miyajima, 2007). After the bursting of the great Japanese bubble, many banks found themselves in trouble, had to sell their holdings and lost the ability and legitimacy to control other companies (Jackson & Miyajima, 2007; Miyamoto, 2019).

6   Stable Block of Friendly Shareholders

Another relevant aspect when interpreting the traditional Japanese corporate governance system in the 1990s is that in many companies a significant proportion of the shares, in many cases even the majority, were held by a block of friendly shareholders for the long term (Miyamoto, 2019). On the one hand, these were the main banks mentioned above, but on the other hand also business partners, such as suppliers or customers, for whom the often mutual participation in the share capital was a sign of trust and thus an essential basis for a sustainable business relationship.

In this block of friendly shareholders, however, there was usually no dominant shareholder, rather it was made up of a number of smaller holdings (Goto, 2018a; Shishido, 2000). Return considerations played a subordinate role in these investments. Non-financial advantages or the defence against hostile takeovers were in the foreground (Fujita & Yamada, 2022; Miyamoto, 2019; Morck & Nakamaru, 1999; Shishido, 2000).

The fundamentally friendly attitude of this shareholder bloc, characterised by diverse interests, generally precluded critical control of the management. Goto (2018a, p. 36) concludes accordingly: "This ownership structure effectively insulated managers from shareholder pressure, especially from the capital market (. . .)."

7   Concluding Thoughts on the Japanese Governance System in the Early 1990s

Before the beginning of the reform process at the beginning of the 1990s, the employees and not the shareholders were the focus of corporate governance. Management control took place informally through the company community, through the main banks and a network of friendly shareholders (Shishido, 2000, 2001).

The interests and rights of shareholders, especially those who were not part of the Japanese network, played little or no role at best. When they were dissatisfied with management, selling their shares was their only way to exert influence and express their dissatisfaction with management (Shishido, 2001).

In this system, the company management enjoyed a high degree of autonomy and was largely shielded from the demands of outside shareholders. This approach was justified by saying it would allow management to focus on long-term development goals (Johnston & Miyamoto, 2022).

8   Corporate Governance Reforms

After the bursting of the great real estate and capital market bubble in the early 1990s, the economic development in Japan was very weak during the so-called lost decade. Key economic policy makers began to see the corporate governance system outlined above as one of the causes of the ongoing economic malaise (Bandara, 2004; Fukao, 2003; Jackson & Miyajima, 2007).

From today's perspective, it is useful to divide the reform process into two phases: First, the period from the early 1990s to the end of 2011, a point in time that in some ways marks the end of the great financial crisis of 2008/2009, and second, the period from the time the Abe government took office in 2012.

8.1   Reforms Prior to 2012

The first reform phase, which began in the 1990s, focused heavily on modernising the Commercial Code and introduced a number of fundamentally new provisions into Japanese law, as summarised in (Gilson & Milhaupt, 2005; Milhaupt, 2006; Kato et al., 2017):

- Amendments to the Commercial Code in 1994 and 2001 enabled companies to buy back own shares.
- As of 1997, the issuance of stock options to employees became possible.
- As of 1997, the accounting regulations were adapted to international standards; disclosure requirements, which had been limited until then, were significantly improved.

- In 1999, the possibility was created to carry out company takeovers by issuing shares.
- In general, the hurdles for restructuring and reorganisation of a company were significantly lowered.

However, the deeply rooted autonomy of management and the fundamental understanding that important decisions should be developed and made within the system of the company community were not yet changed.

This did not happen until 2002, when a new additional form of organisational structure for companies was introduced, the company with three committees, a remuneration committee, a nomination committee, and an audit committee. Each committee must have at least three members. The majority of the committtee members must be outside directors (Gilson & Milhaupt, 2005; Spiegel, 2017a) (Fig. 2). In this form of organisation, the management was not in the hands of the board of directors, but of subordinate managers who were not members of the board. The dual function of management and supervision that existed in the company with a board of statutory auditors was avoided in this organisational model (Spiegel, 2017a). The adoption of this organisational form was voluntary, as there was no consensus for a binding reform; companies could also opt to retain the traditional organisational form (Gilson & Milhaupt, 2005).

In practice, this organisational model has not been able to gain acceptance for various reasons. The main reason was probably the requirement that the majority of the committees had to be made up of outside members, which meant that in future directors who were not part of the company community would decide on
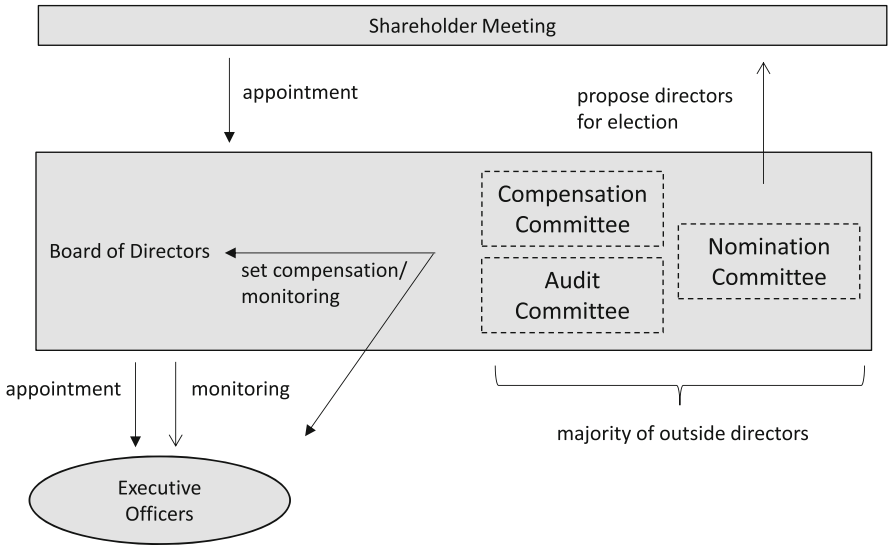
Fig. 2 Structure of a company with three committees (Spiegel, 2017a)

the appointment and remuneration of the management. The ability of outside board members to make good decisions for a company was sometimes doubted due to their great distance from the company (Goto, 2018a; Miyajima, 2022; Nakada & Witty, 2015).

In retrospect, it can be said that in this first phase of reforms, the legally defined regulations made great progress, but the actual implementation in the companies often lagged behind (Milhaupt, 2006). For example, Hamao and Matos (2018, p. 32) concluded from a comparison of the corporate governance rules in force in the US and Japan at the time that "At least on paper, Japan has stronger shareholder rights than the U.S., if shareholders decide to exercise them."

The obstacles for corporate government improvements were manifold:

As already mentioned above, essential new regulations were formulated as "can do" provisions; thus, it was possible to maintain the old status quo in some areas.

Another problem was the passivity of the large Japanese institutional investors. When they exercised their voting rights, they usually voted in favour of the management, even if the track record of the management was weak (Milhaupt, 2006).

Key stakeholders didn't back the reforms. Strong opposition came in particular from the traditional Japanese employers' organisations (Keidanren), which were opposed to restricting the flexibility and autonomy of company management (Buchanan et al., 2014; Gilson & Milhaupt, 2005; Hamao et al., 2011).

Another reason may have been that the decision-makers in Japanese companies were often active and influenced company policy well into old age. A sustainable change in practice was therefore often only possible with a generational change in senior management. For example, the founder of Shin-Etsu Chemicals, one of Japan's leading chemical companies, served as chairman until he was 96 years old. It was only after his passing that the company carried out a stock split, which resulted in the minimum investment required to buy one Shin-Etsu share falling from around US$15,000 to around US$3000 (Seagrim, 2023c).

And the courts also placed major obstacles in the way of shareholders actively claiming their rights (Iida, 2019). The most high-profile battle was that of the US investor Steel Partners against various Japanese companies. Steel Partners was one of the most active activist investors in Japan in the years leading up to 2008, launching a series of takeover bids and pressuring companies for higher payouts through larger stakes (Hamao & Matos, 2018). In May 2007, Steel Partners launched a takeover bid for Bull-Dog Sauce. Bull-Dog Sauce's management responded by launching defensive measures. Bull-Dog Sauce decided to issue three subscription rights per share, which could be exercised by all shareholders except Steel Partners. Steel Partners were to receive a (generous) cash settlement as compensation. As a result, Steel Partners' stake in Bull-Dog was heavily diluted (Kachi & Miyazaki, 2007; Iida, 2019). Steel Partners took legal action against this plan and took the dispute all the way to the Japanese Supreme Court. In a nutshell, the courts clearly sided with management and dismissed Steel Partners' claim, saying that Steel Partners was an abusive acquirer that was only interested in maximising profits (Iida,

2019). The court ruled that the poison pills implemented by Bull-Dog Sauce were permissible (Financial Times, 2010; Hamao & Matos, 2018).

In this context, Hamao et al. (2011) point out that in the first decade after 2000, more than 600 Japanese firms implemented poison pills. In light of this resistance and also as a result of the great financial crisis starting in 2008, activist investors largely withdrew from Japan.

In the decade from the beginning of 2000 to the end of 2009, companies in the Topix index lost an average of 47% in value. Even if a causality between the companies' behaviour and the decline in share prices cannot be proven, the reduced attractiveness of Japanese shares due to a lack of shareholder value orientation was probably a major factor, especially for international investors.

In summary, it can be said that in this first phase of corporate governance reforms, fundamental reforms were formally achieved in some areas, but that the necessary social consensus for far-reaching binding regulations was probably lacking (Gilson & Milhaupt, 2005). In many cases, a real change in the corporate culture had not yet taken place or, at best, had only just begun (Milhaupt, 2006).

Major Reforms Since 2012

Efforts to modernise corporate governance in Japan entered a new phase when Japanese Prime Minister Shinzo Abe took office in 2012. Shinzo Abe pursued a comprehensive renewal of Japan that was based on three arrows to overcome deflation and stagnation and put Japan on a growth path: Expansionary fiscal policy, loose monetary policy with ultra-low interest rates and structural reforms. Further corporate governance reforms formed a central component of the third arrow (Yanagi, 2018; Litt, 2015).

In 2014 and 2015, the following three reform packages then came into force, which are briefly explained below:

- The so-called Stewardship Code (June 2014), which aimed to encourage institutional investors to engage more actively with their portfolio companies (Goto, 2018b; Milhaupt, 2017).
- The so-called Corporate Governance Code (February 2015), which aimed to strengthen the weight and influence of independent directors on boards (Goto et al., 2017).
- And a reform of company law (2015), which, among other things, created a third organisational form for the management and supervisory bodies of companies (Goto et al., 2017).

8.2   *Stewardship Code*

The overarching aim of the new stewardship code was to encourage Japanese institutional investors, who had been mostly passive in the past, to actively engage with their portfolio companies, thereby aligning corporate governance more closely with shareholder interests (Litt, 2015; Goto, 2018b).

Adoption of the Stewardship Code is generally voluntary, but Japanese institutional investors must disclose whether or not they have implemented the Stewardship Code. A so-called comply or explain approach therefore applies (Litt, 2015). According to Milhaupt (2017), however, acceptance was high: by the end of 2016, more than 200 institutional investors, including large state pension funds, had already confirmed their adoption of the Stewardship Code.

If an institutional investor decides to adopt the Stewardship Code, this results in, among other things, the following obligations (Yanagi, 2018; Financial Services Agency, 2014):

- Institutional investors must have clear policies on how they intend to meet their stewardship responsibilities and disclose them.
- Institutional investors are required to monitor their portfolio companies, with a particular focus on the sustainable growth of the portfolio companies.
- Institutional investors must have clear guidelines for the exercise of their voting rights and the disclosure of how the voting rights have been exercised.
- Institutional investors must regularly account to their clients for how they have discharged their stewardship responsibilities, including the exercise of their voting rights.

In practice, these obligations are usually formally fulfilled by an annual summary report on the dialogue with portfolio companies and the exercise of voting rights. Whether the Stewardship Code with its appellative, voluntary character will ultimately lead to a change in behaviour on the part of institutional investors is partly questioned (Milhaupt, 2017).

Published reports on interaction with portfolio companies seem to confirm the scepticism. They show that institutional investors often continue to vote in a very traditional way, which means that company proposals are accepted, while proposals from shareholders are rejected. As an example, one may refer to the report of one of Japan's largest insurance companies, Tokyo Marine & Nichido Fire Insurance Co., Ltd. on voting. In the period from July 2021 to June 2022, Tokio Marine voted in favour of 3704 out of 3707 Company Proposals, and only 3 were rejected. At the same time, Tokio Marine voted against all 174 Shareholder Proposals, which are likely to have been primarily about demands for higher dividends, share buybacks and the disposal of financial interests (Tokio Marine & Nichido Fire Insurance Co., Ltd., 2022).

8.3   Reform of the Company Law

The reform of Japan's Company Law, which came into force in 2015, introduced a third new organisational form for Japanese public companies, the company with an audit-plus committee, since the alternative to the traditional company with a board of statutory auditors, introduced in 2002, had only been taken up by a negligible number of companies (Goto et al., 2017).
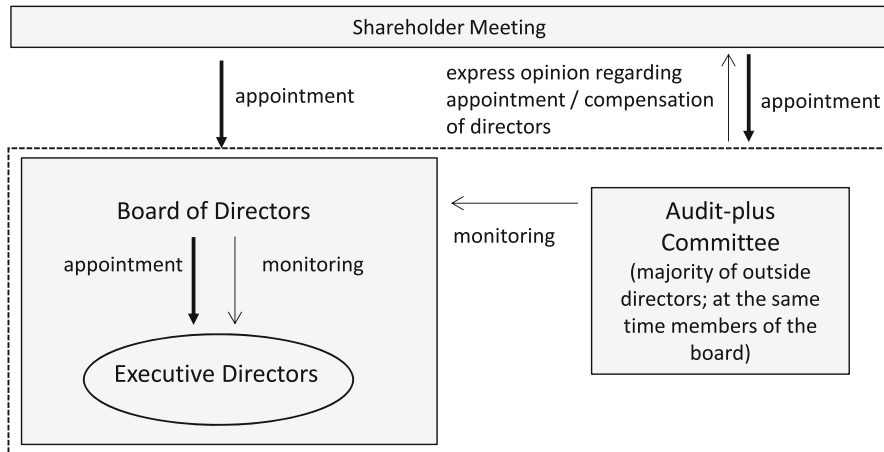
Fig. 3 Basic structure of a company with an audit-plus committee (Spiegel, 2017a, p. 106)

The company with an audit-plus committee is similar to the company with a board of statutory auditors in that there are no managing directors subordinate to the board of directors, but rather management is delegated to executive board members or directors (Spiegel, 2017b). Such delegation allows the board of directors to focus on overseeing the management of the company, which is particularly effective when the majority of the board is made up of external members (Tokutsu, 2019) (Fig. 3).

The most important supervisory body at a company with an audit-plus committee is the audit and control committee (Goto et al., 2017). The committee must consist of at least three board members. The majority of its members must be outside board members. This is to ensure sufficient independence of the committee. The members of this committee, like all board members, are directly elected by the shareholders. They are therefore not appointed by the board of directors, which is intended to further strengthen the independence of the committee (Goto et al., 2017; Nakada & Witty, 2015).

The main task of the committee is to monitor the legality and appropriateness of the directors' performance of their duties and to document the monitoring activities in an audit report (Nakada & Witty, 2015). The company with an audit-plus committee has no remuneration and nomination committees. The audit and control cannot make proposals for the appointment of directors and cannot to determine the remuneration of directors. However, the control committee, which is composed of a majority of outside directors, has the possibility to comment on the election and compensation of directors at the shareholders' meeting (Goto et al., 2017; Spiegel, 2017b).

Since the members of the audit-plus committee are always members of the board of directors and the board of directors elects the executive directors, the assessment of performance and the election of the executive directors are at least partly in one hand, which is considered a prerequisite for an effective exercise of the oversight function (Tokutsu, 2019; Nakada & Witty, 2015).

The other important change in company law was stricter requirements for external board members. In contrast to what was possible until 2014, external directors can no longer be persons who hold management positions at a parent company or who have a close family relationship with a managing director or another person who has a significant influence on the company (Nakada & Witty, 2015). This measure should defuse potential conflicts of interest and increase the independence of the board of directors (Spiegel, 2017b).

9 Corporate Governance Code

The Japanese Corporate Governance Code, introduced in 2015 and modified several times in the following years, is fundamentally based on the OECD Principles of Corporate Governance (Milhaupt, 2017). The Abe government did not delegate the drafting to the Ministry of Economy and Justice, which is close to the business associations (Keidanren), but to the Financial Services Agency, which is close to the shareholders (Litt, 2015).

The Corporate Governance Code not only contains basic regulations such as the equal treatment of shareholders, but also provisions that address Japan-specific challenges and went beyond the rules in force up to that time. One of these is the introduction of a comply or explain provision that a company's board of directors must have at least two outside directors (Litt, 2015; Milhaupt, 2017; Miyajima, 2022). Johnston and Miyamoto (2022) succinctly elaborate in three case studies that this was the first time that supervisory boards had the opportunity to achieve a certain independence from corporate management, which had not been the case in Japan until then.

In 2021, the regulations were further tightened. For companies listed on the Prime Market of the Tokyo Stock Exchange, at least one-third of the directors must be outside directors (or the majority if the company has a majority shareholder). For companies listed in other market segments, at least two directors must be independent (or more than three in the case of a majority shareholder) (Tokyo Stock Exchange, 2021). The requirements of the Corporate Governance Code thus go beyond the statutory regulations and the listing rules of the Tokyo Stock Exchange. According to Spiegel (2017b), the fact that independent directors are commented on in several regulations is due to the Abe government's perceived urgency of the issue.

The second Japan-specific principle is that companies must explain and disclose the reason and objective of shareholdings in other companies (Milhaupt, 2017; Miyajima, 2022). The Corporate Governance Code states in section 1.4:

> When companies hold shares of other listed companies as cross-shareholdings, they should disclose their policy with respect to doing so, including their policies regarding the reduction of cross-shareholdings. In addition, the board should annually assess whether or not to hold each individual cross-shareholding, specifically examining whether the purpose is appropriate and whether the benefits and risks from each holding cover the company's cost of capital. The results of this assessment should be disclosed. (Tokyo Stock Exchange, 2021, Corporate Governance Code, Ziffer 1.4)

A footnote clarifies that "cross-shareholdings" are not only reciprocal but also unilateral holdings (Tokyo Stock Exchange, 2021). The resulting transparency about individual holdings and their purpose enables shareholders to question their relevance.

This regulation is significant for Japan because many companies have large investment portfolios, the value of which alone exceeds the market capitalisation of a number of companies. The requirement to evaluate the benefits, risks and whether the return on investment exceeds the cost of capital ultimately forces companies to prove that large investment portfolios make economic sense. Miyajima (2022) reports that after the introduction of this rule, a gradual reduction of equity portfolios actually began.

Similar to the Stewardship Code, compliance with the Corporate Governance Code is not mandatory, but companies must justify themselves if they decide not to apply the Corporate Governance (Milhaupt, 2017; Johnston & Miyamoto, 2022).

10   Assessment of the Current Corporate Governance System

Japan has made impressive progress in corporate governance over the last 30 years. The persistence and speed with which the Abe government in particular has pushed ahead with reforms in the face of resistance, especially from traditional employers' organisations, is remarkable (Milhaupt, 2017).

With the reforms, Japan was able to eliminate or at least mitigate fundamental weaknesses of the traditional corporate governance system. One weakness of the old system, for example, was that a management elected with the consent of the company community generally found it difficult to take commercially necessary measures that were not in line with the interests of the employees (Tokutsu, 2019). By contrast, the significant strengthening of the position and role of independent directors on the board of directors can effectively counterbalance the interests of the company community.

Although it is not possible to go into detail about the impact of the reforms in this chapter, the underlying fundamentals of the Topix index show that key metrics such as return on assets, profit margins, payout ratio and share buybacks have improved steadily since Abe took office, despite cyclical fluctuations.

A clear indication that corporate governance reforms are beginning to take effect is a renewed interest in Japan on the part of international investors, with individual investors explicitly pointing to corporate governance improvements as one of the arguments for their increased exposure to the Japanese capital market (Ong, 2023; Lewis, 2023).

11 Fujitec Case Study

The following case study uses Fujitec as an example to show how the corporate governance reforms of the last decades are beginning to have an impact. The Fujitec case stands in stark contrast to the outcome of the dispute between Steel Partners and Bull-Dog Sauce. While the shareholders failed at Bull-Dog Sauce, they were able to push through their demands at Fujitec. Developments like those that took place at Fujitec in 2022 and 2023 were not possible 10–15 years ago.

11.1 Background Information

Fujitec is a Japanese manufacturer of lifts and escalators, founded in 1948 by Shotaro Uchiyama. Fujitec has been listed on the Tokyo Stock Exchange since 1974. The Uchiyama family's stake in Fujitec was 6% in 2020 (Fujitec, 2021). Despite this relatively small stake, Fujitec has always been run by members of the Uchiyama family (Oasis, 2022b). At the beginning of the period relevant to the case study, Takakazu Uchiyama was Representative Director, President, and CEO (Fujitec, 2021).

While Fujitec had still developed quite dynamically until around 2015, in the following years the company fell increasingly behind the other internationally active lift and escalator manufacturers in terms of growth, margin and return on investment. On the stock market, Fujitec was valued at a high discount compared to its competitors, despite high levels of cash and cash equivalents (Oasis, 2022a) (Fig. 4).

In purely formal terms, Fujitec met all the requirements of the Corporate Governance Code. Of the nine members of the board of directors, five were classified by the company as external. The board of statutory auditors, whose members were not on the board of directors, consisted of four members, three of whom Fujitec classified as external. In its annual report, Fujitec provided detailed information on the company's corporate governance policy and confirmed compliance with all requirements of the Corporate Governance Code (Fujitec, 2021).

	LFY EV/EBITDA	FY1 EV/EBITDA	P/E Cash Adj.	Operating Margin
Valuation and Capital Efficiency				
FUJITEC	9.8x	9.4x	15.5x	7.4%
OTIS	17.1x	16.5x	30.7x	14.7%
KONE	16.0x	19.2x	24.4x	12.4%
Schindler	12.1x	14.0x	22.0x	10.4%

Fig. 4 Comparison of valuation parameters (Oasis, 2022a)

11.2 *Activist investor Oasis becomes shareholder of Fujitec*

Starting in 2020, the institutional investor Oasis Management Company Ltd (Oasis) began to confront Fujitec with various demands (Oasis, 2022a).

In 2020, Oasis called for Fujitec to cancel its treasury shares, to improve its capital allocation through further share buybacks and to eliminate the existing poison pills designed to prevent a takeover of the company (Oasis, 2022a).

Although Oasis was unsuccessful in its motion that Fujitec should cancel its own shares, it was supported by more than 30% of shareholders at the annual general meeting (Oasis, 2022a). But eventually Fujitec agreed to abandon the poison pills against an unwanted takeover at the end of 2020. On 4 December 2020, the board of directors decided not to renew the defensive measures after they expire in June 2022 (Fujitec, 2020).

During 2021 and 2022, a number of transactions between Fujitec and the Uchiyama family or companies controlled by the Uchiyama family became known. Oasis reported that it discussed these transactions with Fujitec and asked for clarification (Oasis, 2022a). Due to lack of cooperation from the company's management, in May 2022 Oasis intensified its efforts to force Fujitec's management to take a more shareholder-friendly approach.

On 20 May 2022, Oasis published a series of alleged inconsistencies on the specially created webpage "Protect Fujitec" (protectfujitec.com). A 70-page presentation meticulously listed transactions of various kinds between the Uchiyama family and Fujitec, which was intended to show that the boundaries between company assets and thus shareholder assets on the one hand and family assets on the other were fluid. The presentation concluded with a call to all shareholders to vote against President Uchiyama at the next general meeting (Oasis, 2022b).

Fujitec responded with a special investigation, which was completed before the annual general meeting (AGM) in June 2022 and concluded that there was nothing objectionable about these transactions from either a legal or corporate governance perspective:

> We previously received inquiry from Oasis regarding most of the Transactions, in response to which the Company conducted an investigation, and our attorney provided a response to Oasis's attorney confirming that all of the transactions raised were lawful and appropriate, and were taken in accordance with applicable laws and procedures. Further, with respect to one additional transaction from among the Transactions that was raised newly in Oasis's assertion, we have conducted an urgent investigation and confirmed that no such facts exist. (Fujitec, 2022a, S. 1)

11.3 Annual General Meeting 2022 and Resignation of CEO Takakzu Uchiyama

However, many shareholders doubted the results of the investigation, especially because the law firm that Fujitec had hired was not considered independent and unbiased (Oasis, 2022b).

In the days leading up to the AGM on 23 June 2022, it became apparent that Takakazu Uchiyama would not receive the necessary approval for his re-election as President and CEO. According to Oasis (2022b), it was expected at that time that more than 65% of shareholders would vote against Takakazu Uchiyama's re-election.

At short notice, just a few hours before the annual general meeting, Fujitec therefore withdrew the nomination of Takakazu Uchiyama as a candidate for the board position (Fig. 5).

However, in the afternoon of the same day, the board of directors appointed Takakazu Uchiyama as Honorary Chairman of the company without shareholder confirmation (Seagrim, 2022b).

The reaction of various shareholders was devastating (Seagrim, 2022a).

Set Fisher, one of Oasis' lead investment managers, was quoted as saying in the Bloomberg news and information service:

> "This is effectively a coup because he wasn't going to get a mandate from shareholders and so instead he uses a board that is clearly not independent, but beholden to him to a point of junior position," Fischer told Bloomberg on Friday, calling the company's move "outrageous"[. . . .] Fischer said his fund will pursue all options available to hold the board accountable. (Sano & Taniguchi, 2022, S. 1)

AVI, another activist-oriented asset manager, made similar comments:

> Fujitec has defied the voice of shareholders and circumnavigated the AGM voting process to appoint former President Takakazu Uchiyama as Chairman. This flies in the face of the efforts by the TSE, the Government and regulators to enhance corporate governance. [. . .] Outside directors who were party to the decision to withdraw the motion to reappoint Mr Uchiyama just one hour before the AGM and to reappoint him as Chairman should feel ashamed. (Quoted in Seagrim, 2022a, p. 2)

But also more considerate asset managers such as Kempen, which had been a Fujitec shareholder since 2014, voiced their criticism:

> We believe the Outside Directors failed to adequately fulfil their fiduciary duty to protect shareholder rights, reflecting poor corporate governance. (Kempen, 2022, S. 1).

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1. Proposal being Withdrawn

The proposal to nominate Takakazu Uchiyama as a director candidate as part of Proposal 5: "Election of 10 Directors" to be resolved at the Meeting.
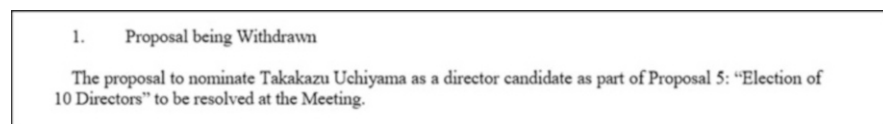
Fig. 5 Withdrawal of nomination of Takakazu Uchiyama (Fujitec, 2022b, p. 1)

As a consequence, we lost trust in the independence of the Outside Directors at Fujitec, who failed to fulfill their fiduciary duty to protect shareholder rights. We also cannot have confidence in the independence of the third-party investigation regarding the related-party transactions, under the current leadership and governance structure. (Kempen, 2022, S. 2)

11.4 New Appointment of Independent Members to the Board of Directors

Following these developments, the reputation and authority of the board of directors, and in particular its external members, were discredited. Shareholders across the board had the impression that Fujitec did not have a functioning corporate governance system, but was being run as the Uchiyama family saw fit (Seagrim, 2022b, p. 2).

The final step then took place on 24 February 2023, when Fujitec held a shareholder-enforced extraordinary general meeting. Oasis pursued the removal of the existing directors and proposed its own candidates (Oasis, 2022b). Oasis succeeded across the board with its proposals. Of Fujitec's original six outside directors, only one ultimately remained on the new board. The others were voted out or resigned. At the same time, four candidates proposed by Oasis were elected to the board, one of whom was elected chairman (Seagrim, 2023a, 2023b).

What is remarkable about the dispute described between Fujitec and its shareholders is that the Uchiyama family received no support from political or public officials and institutions, nor from the press.

But the Uchimaya family has also only partially lost. They can at least be pleased that the value of their 6.4% stake in Fujitec, which was worth around US$60 million at the beginning of 2020, had more than doubled (to around US$130 million) by the end of April 2023. This was at least partly due to the improvement in the company's corporate governance and the resulting reduction in the valuation discount (Fig. 6).

Fig. 6 Development of Fujitec's share price (Bloomberg, 2023)

12 Resume

In the course of a reform process lasting more than 20 years, corporate governance and the possibilities of shareholders to assert their legitimate interests have fundamentally changed. The Fujitec case study outlined above shows two things: on the one hand, that determined shareholders can successfully stand up for their interests, and on the other hand, that companies that trample on shareholder rights have little support in Japan. Compared to the situation at the beginning of the reform process, this is a remarkable change.

On the other hand, this case study also shows that the reform process is not yet complete. Fujitec is probably just one example of a relatively large number of companies where corporate governance is primarily exercised on paper but not yet lived in practice.

It remains to be seen how Fujitec will develop under its new leadership. However, it is undisputed that purposeful, functioning corporate governance is of paramount importance for companies and their market value, but also for the economy as a whole.

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In this book, Silke Waterstraat draws on her knowledge and experience in the areas of international financial management and corporate governance.

Controlling of the Circular Economy

Simon Schmied, Ulrich Krings, and Maximilian Koch

Abstract   This chapter analyzes the role of the controlling function in the transformation process from a traditional to a circular business model. Although the task of controlling lies precisely in measuring and managing corporate strategy, controlling has not yet established itself as a strong player when it comes to implementing a sustainable business model. Controlling still plays too passive a role and lacks the necessary expertise. Furthermore, controlling views sustainability more as a marketing or compliance issue than as a fundamental basic understanding of future entrepreneurial action. The chapter describes the linear business model and the need for a shift to a circular model. Based on this, the requirements for sustainability oriented corporate management are outlined and the form in which controlling can support and accompany such sustainability management in a meaningful way and with suitable key performance indicators (KPIs).

1   Introduction

In times of crisis, environmental protection becomes increasingly important as it plays a crucial role in the long-term sustainability and resilience of our society. The impact of crises, be it a pandemic, natural disasters or economic turmoil, can put a heavy strain on the environment and lead to further problems. It is therefore of great importance that we increase our efforts to protect our environment in order to minimize the impact of crises and ensure a sustainable future.

The industrial revolution ushered in an era of rapidly increasing productivity, to which we owe our current prosperity in no small part. Production is still based on the use of natural—and often non-renewable—resources. Production and consumption

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generate greenhouse gases, and products are disposed of primarily by throwing them away or burning them. Such a linear economic system consumes resources instead of conserving them and is not sustainable in the long run. The aim of this thesis is to show possible controlling approaches which support the due change to a circular economic system. It is time for the controlling function in companies of all sizes to assume responsibility and to actively support the change towards a circular approach and integrate it into the existing controlling systems.

First, in Sect. 2 we show the current situation regarding sustainability in the area of tension between claim and reality. Section 3 then outlays how the advent of the industrial revolution created a linear economic system that transformed society into a throwaway society. Subsequently, in Sect. 4 we will present as a contrast a circular economic system, in which the longevity of the products or their repair and the reuse or the complete recycling and the preservation of resources are in the focus. Finally, we outline in Sect. 5 which tasks can be assigned to controlling in a circular economic system. We conclude with a postulate to legislators and regulators that, despite the urgency and necessity of this change, companies should be given sufficient flexibility to develop individually suitable solutions in a transparent manner.

2   Importance of Sustainability

The definition of sustainability currently most widely used is that of the United Nations (UN) World Commission on Environment and Development, better known as the Brundtland definition. It was published in 1987 and bears the name of the chairperson of this commission, the former Norwegian Prime Minister Gro Harlem Brundtland. It defines sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs and choose their own lifestyles. If one continues to follow the development of sustainability, it only became a relevant topic in western industrial societies at the end of the 1960s and beginning of the 1970s, as air and water pollution became obvious, although without explicit reference to the concept of sustainability. These problems gave rise to the first United Nations Conference on the Human Environment, or World Environment Conference for short, which took place in Stockholm from 5 to 16 June 1972 (Kolk, 2016). The conference, known as the United Nations Conference on the Human Environment, drew up 26 principles, the first of which focused on the responsibility to protect and improve the environment for present and future generation. Many of the 26 principles of this first environmental conference are reflected in the Social Development Goals (SDGs) adopted 43 years later by the United Nations. The task of this resolution, published in September 2015, is no less than the transformation of the world towards sustainable development by the year 2030.

Today the term "sustainability" has arrived in corporate strategies, on the political agenda and among consumers, but is increasingly losing its edge due to inflationary

use (Kropp, 2018; Mayer, 2020). There is also a discrepancy between industry and environmentalists. On the one hand, companies like to present themselves as environmentally aware and responsible institutions in their sustainability reports; on the other hand, environmental activists criticize that far too little is happening in the economic system in general and that large corporations in particular are not taking their responsibilities seriously (Braungart & McDonough, 2021). However, the consequences of climate change are already being felt today. In all likelihood, the 1.5 degree target cannot be achieved by 2030, and thus the net zero target cannot be achieved either (Hildebrandt, 2020; Sihn-Weber & Fischler, 2020). In Europe in particular, climate change is perceived as a serious problem. For this reason, it is to be expected that pressure on companies from consumers, investors and political interest groups will continue to increase in the future (Sihn-Weber & Fischler, 2020).

Against this background, an economy with circular resource flows is considered a possible solution to problems posed by a growing world population on a limited planet. However, a first representative study on the diffusion of circular activities by Swiss companies to implement the circular economy revealed that the potential of a circular economy has not yet been recognized in Switzerland—as one of the most innovative countries (Stucki & Wörter, 2022) and that controlling in particular has not yet been properly involved in setting and/or pursuing sustainability goals (Petersen et al., 2021).

3   Linear Economic System

Society owes a longer life span, a better quality of life and today's prosperity to the industrial revolution. This development was possible because industry, thanks to the division of labor and rational production processes, was able to produce ever greater quantities of goods in ever shorter time. The production in large quantities let the selling price sink, whereby the products became affordable also for consumers with smaller purchasing power. This opened the door to lucrative sales for the industry. Driven by the urge to progress and to increase capital and profits, increasingly powerful machines were developed. Productivity continued to rise. This linear system transformed society into a throwaway society. Today, it is often cheaper to buy a new product model than to repair the old one (Braungart & McDonough, 2021, S. 38–48).

In most countries, raw materials belong to the owners or states on whose land they are found. They are extracted, processed and—when the products are no longer needed—discarded. Such a handling of resources is called a linear economy (Sariatli, 2017). Technological progress has made it possible to extend supply chains across the globe. In the process, the economic opportunity was seized to relocate parts of the value chain to the most favorable regions because of lower labor costs or less stringent environmental regulations. During the first three industrial revolutions, the attitude developed that productive machines guarantee entrepreneurial success. This kind of thinking in linear, simple cause-effect relationships is still widespread

today (Butzer-Strothmann & Ahlers, 2020, S. 198). Even in today's world, only 40% of the resources needed for production are reused in some form (recycled, repaired, composted) (Sariatli, 2017). At the moment, society is in the fourth industrial revolution, which, compared to the previous revolutions, is proceeding faster and more efficiently (Schwab, 2017). In addition to the economic levels, all social levels are also involved, which is why systemic and disruptive thinking is required to achieve economic success in an increasingly complex world (Butzer-Strothmann & Ahlers, 2020).

4   Circular Economic System

4.1   Biosphere and Technosphere

There is neither a uniform definition nor a clear point of origin for the circular economy. This chapter considers nationally and internationally widely accepted explanations of a sustainable circular economy. The Laboratory for Applied Circular Economy (sanu durabilitas, 2020)—an interdisciplinary research project of the Swiss National Research Program for a Sustainable Economy ("LACE")—has developed its own definition: According to LACE, the circular economy is a model that serves society to achieve well-being within planetary boundaries (2020). With a resource-based and systemic view, it considers all planetary laws—such as the interaction of the atmosphere and oceans—to protect humanity's habitat. The goal is to use innovative business models and technologies to create an overall system that produces goods and services as effectively as possible with renewable energy and from materials that orbit in a biosphere or in a technosphere protected from the environment (2020). Production is not optimized in this process, but completely reinvented. For example, it can make sense to include more raw materials in the product design if this means that the materials can flow into new production as high-quality secondary resources at the end of the product's life. This closes the material loops. A recognized method for the material cycles of the biosphere and technosphere is cradle to cradle by the US architect McDonough and the German chemist Braungart (Ahrend, 2022).

The biosphere is an imitation of nature. After a product is consumed, it is returned to the biological cycle as food. Thus, no waste is produced. This cycle assumes that no substances harmful to humans or the environment are used in production and that the product is made entirely of biodegradable materials. For example, the wear and tear of a shoe sole or the use of cleaning agents helps to support the balance of the ecosystem. Further, downcycling is prevented and regulation in manufacturing is unnecessary, as there is no danger to humans or nature (Braungart & McDonough, 2021). The technosphere contains non-regenerable materials or products that have been designed in such a way that they can be returned to the technical cycle. The isolation of technical and biological nutrients allows the

high material quality to continue to circulate within a closed industrial cycle. For example, a robust computer housing could continue to circulate as a robust computer housing (recycling) or be used as a high-quality car part (upcycling) (Braungart & McDonough, 2021). Recycling often involves downcycling, as different materials are mixed together. For example, it is not possible today to separate the paint coating from the metal of used vehicles in order to keep the high-grade steel in a closed loop (Braungart & McDonough, 2021).

4.2 Model of Circular Economy

The leading international proponent of the circular economy is the Ellen MacArthur Foundation, which visually represents the two spheres of the cradle-to-cradle idea in its butterfly model (see Fig. 1). On the left side are the processes for re-producing the biosphere, while on the right side is the technosphere. Since the materials from the technosphere are non-renewable, they are kept in the cycle by means of maintenance (Maintenance/Repair), reuse (Reuse, Redistribute) and remanufacture (Repair, Refurbish, Remanufacture). Only when these activities are no longer possible are the materials recycled. The model makes it clear that the circular economy is to be understood as a holistic system, whereby circularity exists in the entire value chain and the actions of all actors are included.

Building on the cradle-to-cradle principle, three principles of the circular economy can be defined, driven by product and service design (*The Circular Economy in Detail*, n.d.): The elimination of waste and pollution, the circulation of products and materials, and the regeneration of nature. By adhering to these principles, the circular economy achieves a decoupling of economic activity from the consumption of finite resources with the associated greenhouse emissions and further environmental pollution (*The Circular Economy in Detail*, n.d.). Thus, the circular economy offers a possible solution to the described problems of a linear economy.

4.3 Vision and Strategy of a Circular Economy

The vision of the circular economy is that as few resources as possible leave the cycle, which is made possible by changing resource and energy flows with different strategies in three ways (*Was ist Kreislaufwirtschaft | Circular Economy Switzerland*, n.d.). The first strategy relates to the closure through cascade use, reuse, refurbishment and recycling; the second strategy involves a deceleration through longer product lifetimes through durable design, repair and maintenance, and appropriately designed business models. A third strategy pursues the downsizing through increased efficiency and savings, and preferential use of renewable resources. The strategies illustrate the equal cycles of renewable energy sources, as burning fossil fuels is a typical approach of a linear economy (Braungart & McDonough, 2021).
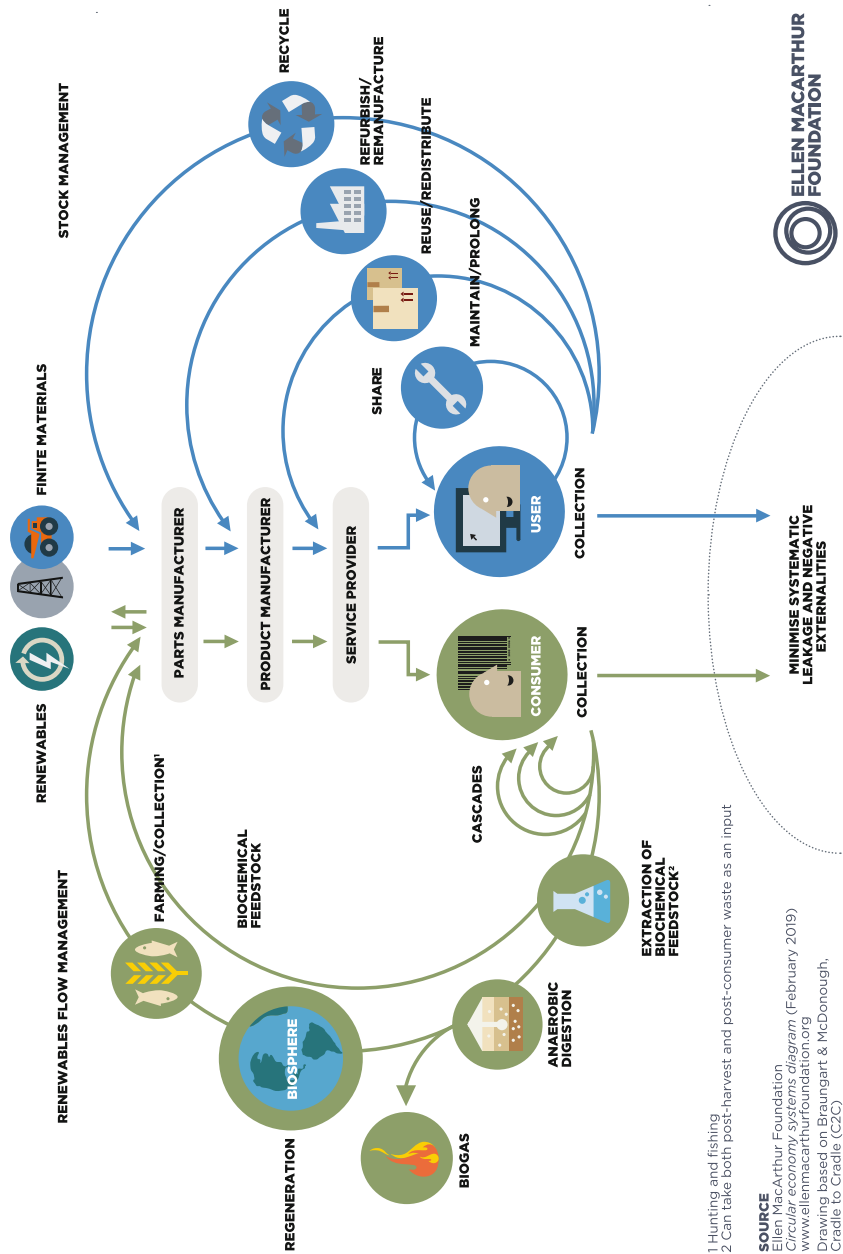
Fig. 1 Butterfly diagram of Ellen MacArthur Foundation (*The Circular Economy in Detail*, n.d.)

5 Sustainability Management and Controlling

In practice, many stakeholders have developed their own understanding of sustainability (Colsman, 2016). The associated sustainability management comprises all activities of a company that serve the goal of achieving sustainable economic development while taking into account the ecological and social requirements of current and future generations (Ernst et al., 2023). In this context, sustainability activities must be pursued in order to safeguard current business models and to achieve short-term success through an improved image. The sustainable corporate goals defined and anchored by management mean that corporate controlling must be adapted accordingly in order to provide a benefit. Thus, sustainability controlling provides sustainability management with information. The resulting transparency supports the decision-makers in their goal-oriented actions. In order to achieve this, sustainability controlling must further develop classic controlling to include the aspects of sustainability, social justice and environmental protection (Ernst et al., 2023; Horváth et al., 2015). In this context, it is important to find answers to the following questions in the context of controlling: "Which sustainability aspects should enjoy management attention only when target achievement or the regulatory standard is in danger of not being met?" and "Which key performance indicators should be the focus of attention on an ongoing basis?" (Schäffer, 2022, p. 7).

5.1 Green Controlling

Green controlling is the simplest form of sustainability controlling. The social dimension of sustainability is not considered here, while the economic perspective is the top priority, as in classic controlling. The goal of green controlling is to identify win-win situations that result in long-term positive economic and ecological contributions. The central factor here is eco-efficiency, which plays an important role in product manufacture and product use. The aim of eco-efficiency is to design processes in such a way that the consumption of resources is reduced while the benefits remain the same (Ahrend, 2022). This not only allows sustainability goals to be achieved, but also saves costs at the same time and may even result in higher margins (Steinke & Internationaler Controller Verein, 2014).

5.2 Life Cycle Assessment

A life cycle assessment (LCA) analyzes material and energy flows for a product, a process or a company. The perspective can be limited to the production process or extend to the entire life cycle of a product, including recycling according to the cradle-to-cradle principle (Ahrend, 2022). For this reason, the LCA can be used

as an analysis tool in the individual value creation phases. The results provide information on whether recycling, for example, makes sense from an ecological point of view. In practice, the CO_2 footprint, also known as the carbon footprint, of the company or of individual products and services has become established as a life cycle assessment. In addition to CO_2, other greenhouse gases such as methane are also included in the calculation. The Greenhouse Gas Protocol Standard (GHG) is an example of this (Ahrend, 2022; Mayer, 2020), which was used by more than 90% of Fortune 500 companies in 2016 to estimate greenhouse gases (Kaplan & Ramanna, 2021). As with all standards, the scope of emissions in the value chain must also be determined for the Greenhouse Gas Protocol. For this purpose, a distinction is made between three different scopes as the cause of emissions in the entire value chain. Scope 1 includes directly caused emissions, i.e., emissions from own fuel combustion or company-owned means of transport. Scope 2 includes energy-linked, indirect emissions, which corresponds to emissions from purchased energy, such as electricity or district heating. Scope 3 includes indirect emissions resulting from services provided by third parties or purchased inputs, as well as subsequent further processing or use (Mayer, 2020). The calculated emissions make it possible to form further relative key figures. For example, the greenhouse gas emissions can be set in relation to sales, allowing companies in similar sectors to be compared with each other.

5.3   *Value Chain-Based Emission Determination*

The approach of value chain-based emission determination is based on the realization that companies operate in complex networks of suppliers, manufacturers and sales partners. In the production of a product or service, several actors are often involved in different phases of the value chain. Each actor contributes to the total emissions of the product. Emissions accounting typically begins with identifying and quantifying a company's direct emissions resulting from the use of fuels and the combustion of materials in operational processes. In addition to these Scope 1 emissions, this method also considers the indirect Scope 3 emissions that occur in a company's supply chains. These include the emissions that arise during the production and transport of intermediate products or raw materials for the company. This can include, for example, the energy required to produce a certain material, or the emissions generated during the disposal of a product. Life cycle analysis is often used as a controlling method in this context. Due to the fact that the data collection effort is very high and the reliability of the data is rather low, blockchain-based controlling solutions are currently being developed (Kaplan & Ramanna, 2021). One reason for choosing this technology is the ability for participants to exercise control over the data, while ensuring transparency and trustworthiness of the data. Inter-company exchange on emissions is still in its infancy, but digitization and blockchain can help make significant progress here (Kaplan & Ramanna, 2021).

5.4 *Sustainability Balanced Scorecard*

Another approach to taking ecological aspects into account in corporate controlling is the extension of the Balanced Scorecard to the "Sustainability Balanced Scorecard" (SBSC). With the help of the SBSC, environmental and social management is aligned with the successful implementation of the strategy, integrated into classic management and potentials between economic, ecological and social goals are exploited (Colsman, 2016). There are several methods for expanding the classic Balanced Scorecard into a sustainable multidimensional system of indicators. On the one hand, ecological and social aspects can be integrated into the existing perspectives. On the other hand, there is the possibility to extend the Balanced Scorecard (BSC) by a fifth perspective—with the ecological and social aspects. Finally, another option is to create a completely independent SBSC that refers exclusively to the aspects that have been missing so far (Heimel & Momberg, 2021). This extension means that greater importance is attached to sustainability in strategy implementation controlling (Ernst et al., 2023). Thus, interdependencies between different performance dimensions become transparent and the sustainability aspect is explicitly considered in the analysis of cause-effect relationships.

6   Summary

The aim of this chapter was to identify controlling concepts that support the transformation to circular business models. A study by the WHU Controller Panel found that in everyday business, controlling still has major weaknesses when it comes to incorporating sustainability issues (Schäffer, 2022). It is confirmed that top managers seldom ask controlling for sustainability related information, which is partly due to the passive attitude of controllers toward the topic. Furthermore, controlling lacks sufficient understanding of sustainability to independently design non-financial key performance indicators (Petersen et al., 2021). It is noted that controlling often defines sustainability more as a compliance and marketing issue.

In addition, it is important to critically question the effects of sustainability controlling on entrepreneurial decision-making. Making something less bad from an ecological and social point of view will not be sufficient in the long run to rethink business concepts in terms of a circular economy. Therefore, in our view, many of the current concepts for sustainability controlling have more of an alibi function rather than supporting a fundamental rethinking. In this case, controlling offers little more than the illusion of a change in ecologically responsible action (Braungart & McDonough, 2021). Many companies use indicators that present them in a good light and are difficult to audit. Many companies are also experiencing a regular inflation in the number of sustainability indicators. As a result, environmental reports are increasingly perceived as greenwashing (Kaplan & Ramanna, 2021). Controlling must be careful not to become a vicarious agent of such dubious

communication strategies and thereby lose respectability in the internal and external perception of the company.

The authors would also like the legislator to limit the quantity to a reasonable extent. It is also true for sustainability controlling that it is not perfect if no further environmental social governance (ESG) key figure can be added, but rather if no ESG key figure can be omitted without reducing the quality of the information.

Although, from a global perspective, society is only in the initial phase of a circular economy, there is already a lot of movement. The initial phase of the circular economy can be compared to the initial phase of the internet. The internet has forged new business models and almost completely changed the behavior of customers. Who could have imagined in the days of the cable telephone that it would be possible in the future to join a meeting from anywhere via video call? Who can imagine holding a product in their hands today that is only used but not owned, that provides information about the sustainable facts of the entire value chain, that consists of 100% secondary materials and that leaves a positive footprint?

It would be desirable for the future of controlling if it accompanied this development and transformation as a reliable support tool.

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Part II
Financial Management Under Uncertainty: Markets

Price Discovery in Euro Area Sovereign Credit Markets: Evidence from the GIIPS Countries 10 Years After the Implementation of the Ban on Naked Short Selling of CDS

Sascha Häusler and Kristyna Ters

Abstract We analyze the price discovery process between credit spreads and credit default swaps (CDS) of sovereign credit risk in GIIPS countries (Greece, Ireland, Italy, Portugal, and Spain) as well as Germany and France after the implementation of the regulatory ban on outright short selling of sovereign CDS, implemented after the euro area sovereign debt crisis. Our findings show evidence, that the CDS market continues to be relevant for price discovery in euro area sovereign credit markets. However, unlike earlier studies with shorter sample periods, the bond market has been observed to incorporate information more rapidly than the CDS market for most countries in the sample. In the case of Ireland and Greece, both markets significantly contribute to the price discovery process, but the bond market in most countries exhibits faster adjustment dynamics. Our findings deviate from previous research with shorter sample periods after the introduction of the ban, which indicated CDS market leadership in price discovery for most markets. However, in our analysis, CDS leadership was observed only in Portugal and Spain, suggesting that further investigation is warranted to comprehend the evolving dynamics of the sovereign credit market.

One intriguing finding concerns the Italian credit market, where the implementation of the unconventional European Central Bank (ECB) monetary policy, specifically the Quantitative Easing (QE) program in January 2015, disrupted market functioning due to excessive liquidity. Consequently, the CDS and bond yield spreads in the Italian market were no longer cointegrated during that period.

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1 Introduction

After the financial crisis of 2008–2009, apprehensions about the financial prospects of many nations, including several in the euro area, escalated among investors. Consequently, sovereign credit spreads for numerous euro area countries witnessed a significant increase. Gyntelberg et al. (2018) find that at the peak of the euro area sovereign debt crisis, yield spreads on sovereign bonds, compared to German bonds, reached several hundred basis points, contrasting from the few basis points average in the years following the euro's inception and before the global financial crisis. With the increase of sovereign bond yields during the debt crisis, there was a substantial surge in interest in trading credit risk protection on euro sovereign borrowers through credit default swaps (CDS).

Gyntelberg et al. (2018) highlight that increased CDS trading stimulated intense interest among policymakers and regulators in the sovereign CDS market. This eventually culminated in the implementation of EU regulation 236/2012, which permanently prohibited the outright short selling of sovereign CDS contracts, otherwise known as 'naked CDS' positions. This regulation was applied uniformly across all European Economic Area (EEA) members in response to concerns that speculative activities in the sovereign CDS market were causing credit spreads in the most distressed nations to skyrocket, leading to high volatilities and a growing disparity in sovereign credit risk pricing in bond and CDS markets (Gyntelberg et al., 2018). Understanding, whether the ban on outright short selling of CDS in euro area sovereign debt was able to decrease pricing mismatches between the bond and the CDS market and therefore also mitigate risk in these markets is the content of our analysis. Normally, credit risk in CDS and bond credit spreads should be priced equally on average based on the no-arbitrage relationship.

Different academic papers analyze the no-arbitrage relationship between CDS and bonds. The predominant finding is, that on average the CDS markets tend to lead credit spreads in the price discovery process after new information enters the market (Zhu, 2006; Palladini & Portes, 2011; Gyntelberg et al., 2018). In their study, Gyntelberg et al. (2018) further emphasize that additional events, next to the introduction of the ban, influence the pricing for credit risk. They highlight the economic adjustment programs for Greece (May 2010 and March 2012) as well as European Central Bank (ECB) Governor Draghi's "whatever it takes" speech on 26 July 2012 at the Global Investment Conference in London (Gyntelberg et al., 2018). Mainly Draghi's "whatever it takes" speech resulted in a notable decline in CDS spreads for several EU sovereigns (Gyntelberg et al., 2018). In contrast, post euro area crisis events, such as the uncertainty among investors about the fiscal implications of a new government in Italy in May 2018 caused Italian government bond yields to increase (Cronin & Dunne, 2019).

Not only concerns about Italy's economic performance, but also the standings of its banks with their high balance sheet exposures towards domestic sovereign debt and the general sovereign debt ratio by the end of 2017 and increasing interest rates after the post-corona period shifted the attention again to sovereign credit

markets. Therefore, it is crucial to understand the pricing process in sovereign risk and whether the ban on short selling has modified its dynamics and was able to mitigate risk stemming from the CDS markets which was the original purpose of this EU Regulation.

In this chapter, we analyze the dynamics of euro area sovereign credit spreads in CDS and bond markets for the period after the ban on outright short selling of CDS was introduced in March 2012 to contribute to this ongoing research. The analysis will be conducted for the countries that were most affected during the last euro area sovereign debt crisis which is Greece, Ireland, Italy, Portugal, and Spain, hereafter referred to as GIIPS countries, focusing on the price discovery process. Like Gyntelberg et al. (2018), we rely on the fact that a credit-risky sovereign bond can be seen as a combination of a risk-free bond and a CDS contract providing credit protection on the risky bond. Holding certain conditions, the yield spread of the risky bond over the risk-free bond should be equal to the premium, usually called "spread", of the CDS contract (Gyntelberg et al., 2018). Duffie (1999) emphasized that under the condition that financial markets are frictionless and complete, CDS and (par floating rate) bonds credit spreads will be equal. Otherwise, investors would be able to make arbitrage profits. In reality, however, such arbitrage trades are difficult and costly to realize due to frictions and imperfections, including limited and time-varying liquidity in some or all market segments, unavailability of instruments with identical maturity and payout structures, and because some arbitrage trades require tying up large amounts of capital for extended periods of time (Gyntelberg et al., 2018). Therefore, it has been found that the difference between credit spreads in the two market segments—often denoted as "basis"—is typically different from zero (Palladini & Portes, 2011; Gyntelberg et al., 2018). However, theory suggests that arbitrage forces emerge if the basis becomes too sizeable, resulting in the basis mean reverting towards zero (Gyntelberg et al., 2018).

To analyze the extent to which spreads adjust in response to a widening of the basis, we apply a vector error correction model (VECM) approach. Additionally, we examine whether the adjustment takes place predominantly in one of the two markets and whether the introduction of the ban on naked CDS short selling, which emerged from policymakers, affects the efficiency of the price discovery process. With the findings of our research, we aim to contribute towards the current research on the dynamics in the euro area sovereign credit risk markets because it has become highly relevant in the outlook of increasing interest rates.

2 Background on Sovereign CDS and Bonds

2.1 Sovereign Credit Default Swaps

Sovereign credit default swaps (CDS) are financial instruments designed to offer safeguards against potential losses from credit incidents linked to a sovereign debtor over a defined duration (Palladini & Portes, 2011). The entity buying the protection is responsible for paying a recurring fee, known as the CDS spread or premium,

which is measured in annual basis points relative to the contract's notional value (Palladini & Portes, 2011). This payment is in return for a singular contingent disbursement if any predefined credit incidents occur (Bomfim, 2016). The CDS can thus be perceived as an insurance contract where the protection buyer pays the seller a premium to secure cover against specific credit events (Bomfim, 2016). Unlike a traditional insurance contract, the protection buyer is not required to incur any real losses to receive payment when a credit incident happens (Bomfim, 2016). Given that CDS are traded over-the-counter (OTC), the conditions of a transaction can theoretically be customized (Bomfim, 2016). However, these transactions have become more standardized over time in real-world scenarios (Bomfim, 2016).

If a credit event triggers the contract, it is settled either via the physical delivery of bonds or via cash settlement (Gyntelberg et al., 2018). In the first case, the buyer of protection may sell any acceptable deliverable obligation to the seller of protection for a price of par (Gyntelberg et al., 2018). In the second case, the protection seller pays an amount corresponding to par minus a pre-specified recovery rate (percentage of notional repaid in the event of a default) to the buyer (Gyntelberg et al., 2018). Cash settlement has gradually replaced physical settlement as the most popular settlement method. In addition, for most sovereign CDS, auction settlement became standard, meaning that following a credit event, there will be an auction to determine the final recovery rate (Gyntelberg et al., 2018). Gyntelberg et al. (2018) stressed that investors who wish to do so could deliver (or receive) underlying debt in the auction. In contrast, investors who do not participate will settle only in cash using the final recovery rate from the auction. Additionally, Gyntelberg et al. (2018) emphasized that sovereign CDS contracts are nowadays typically denominated in a currency different from the main currency of the deliverable obligations. Therefore, CDS on euro area sovereign entities tend to be denominated in US dollars (whereas US sovereign CDS tend to be denominated in euros). The main reason is that faced with a credit event, it is assumed that the local currency will come under considerable pressure (Gyntelberg et al., 2018). Hence, the euro area sovereign CDS market is highly concentrated in the dollar-denominated segment, which is much more liquid than the euro-denominated segment (Gyntelberg et al., 2018).

2.2   *Interconnectedness Between Sovereign CDS and Bonds*

Theory suggests that sovereign bonds with considerable credit risk are valued to reward investors for holding this risk (Palladini & Portes, 2011). Thus, the credit risk element, also referred to as the credit spread, can be deduced by subtracting the yield of a comparable, credit risk-free bond from the yield of the credit risk-inherent bond (Palladini & Portes, 2011). Consequently, the CDS spread, and the bond credit spread, hereafter interchangeably used with bond yield spread (BYS), of the same sovereign entity should be priced equally on average, as both signify credit risk compensation (Blanco et al., 2005).

From a more formal perspective, we can employ no-arbitrage theories to demonstrate that the CDS spread should equal the spread between the payments of a par floating-rate note issued by the reference entity of the CDS and the payments of a floating-rate credit risk-free note (Duffie, 1999). However, for this parity to be upheld, several precise conditions must be satisfied (Gyntelberg et al., 2018). These include perfect and frictionless markets, the possibility of shorting bonds without limitations or cost, and the absence of tax effects, among other things (Duffie, 1999). Moreover, floating-rate notes are relatively rare, especially for sovereign entities (Gyntelberg et al., 2018). Given that fixed-rate bonds are often used as replacements, the maturity of these is unlikely to correspond precisely to that of standard CDS contracts (Gyntelberg et al., 2018). This suggests that the difference between the CDS premium and the bond spread, also known as the basis, is typically not zero (Longstaff et al., 2011). Indeed, as market imperfections increase—a common occurrence during stressful periods—the basis can become significant, either positive or negative, and exceedingly persistent (Gyntelberg et al., 2018).

In the straightforward scenario of a fixed-coupon bond hedged via a credit default swap (CDS), the basis becomes negative when the credit risk premium on a volatile bond surpasses its theoretical value or the CDS spread is undervalued (Palladini & Portes, 2011). Consequently, the basis becomes positive when the risk premium on the volatile bond is undervalued or the CDS spread is overvalued (Palladini & Portes, 2011). While a positive basis can be adjusted back to neutrality through short selling the risky bond, such adjustment might be time-consuming due to inefficiencies in the cash market, leading to a prolonged positive basis (Palladini & Portes, 2011). An arbitrage trade on a negative basis is therefore easier as it requires going long in the bond and therefore the basis should theoretically be less persistent (Palladini & Portes, 2011).

Beyond its hedging utility, a CDS contract can serve a speculative function for an investor not holding any debt to hedge (naked), who then purchases only the CDS (Palladini & Portes, 2011). This investor is betting on a decline in the creditworthiness of the reference entity, as they can then sell the CDS contracts linked to the reference asset at a higher price (Palladini & Portes, 2011). In terms of risk profile, a naked CDS holder profits only if a credit event occurs (Palladini & Portes, 2011). Their position in the credit market echoes the act of short selling a bond—they have taken a short position in credit risk (Palladini & Portes, 2011).

Nonetheless, there are boundaries to the extent the basis can expand (Duffie, 1999). Eventually, arbitrage strategies will become profitable even under strained market conditions (Palladini & Portes, 2011). As a result, we could anticipate that even though the basis can substantially and persistently deviate from zero, it would tend to revert towards zero over the long term (Palladini & Portes, 2011). This is one of the primary aspects we will explore in the subsequent empirical analysis.

2.3   EU Regulation on Short Selling and Credit Default Swaps

The International Organization of Securities Commissions (2009), hereafter referenced as IOSCO, describes short selling as a trading strategy that involves selling a security that the seller does not own, with a plan to buy back the same security at a later date to fulfil the sale and contains two primary forms. In "covered" short selling, the seller has either borrowed the securities in advance or ensured they could be borrowed before initiating the short sale. On the other hand, "naked" or "uncovered" short selling is when the seller has not borrowed the securities or made sure they can be borrowed at the time of the short sale. The practice of short selling is employed by various market participants, including hedge funds, traditional fund managers such as pension funds and insurance companies, investment banks, market makers, and individual investors. These entities and individuals use short selling for a range of purposes. Some engage in short selling for speculative purposes, hoping to profit from the anticipated decline in a share's price. Others use it to hedge a long position, aiming to limit potential losses in similar shares where a long position is held. Short selling can also be used for arbitrage, where the intent is to profit from the difference in price between two related shares. Lastly, in market making, short selling is used to meet customer demand for shares that are not immediately available (IOSCO, 2009).

The IOSCO (2009) stated that the financial crisis and subsequent market volatility in euro-denominated sovereign bonds elicited diverse reactions from member states regarding short selling and credit default swaps. Some member states enacted various measures using different authorities, while others did not act. There needed to be a unified legislative framework at the European level to handle these issues as the fragmented approach undermined the effectiveness of the measures imposed and provoked regulatory arbitrage (seeking the least restrictive regime) which imposed additional costs and challenges for investors. While the commission recognizes the economic advantages of short selling, such as enhancing market liquidity, facilitating efficient price discovery, and helping to curb securities overpricing, it also recognizes the associated risks. The commission's regulation addresses three primary risks: lack of transparency, the potential for negative price spirals, and risks of settlement failure associated with naked short selling (IOSCO, 2009). The fragmentation eventually culminated in the implementation of the EU regulation 236/2012, which permanently prohibits the outright short selling of sovereign CDS contracts. This regulation was applied uniformly across all European Economic Area (EEA) member countries.

2.4   Recent Findings on Price Discovery

Empirical evidence regarding price discovery impacts after the naked CDS ban is relatively sparse. However, research in other markets subject to short-selling bans has demonstrated that these restrictions often lead to a slowdown in the price dis-

covery process, with asset prices deviating and tending to be overvalued (Boehmer & Wu, 2013; Chang et al., 2007). Duffie (2010) argues that curbing speculation in sovereign bond markets results in lessened market liquidity, inflated trade execution costs, and a deceleration of price discovery (the quality of information offered by CDS). Capponi and Larsson (2014), who designed a partial equilibrium model to examine the fallout on the bond market from a naked CDS position ban, concluded that the ban primarily affects moderately pessimistic investors, while the most pessimistic investors pursue their short-selling strategies via alternative routes. They argue that the naked CDS ban reduces bond yields but comes at the expense of liquidity and borrowing capacity. Silva et al. (2016), using a panel of 28 countries, demonstrated that the ban has depleted market liquidity for sovereign credit risk and caused a drop in price informativeness, leading to longer adjustment periods following the introduction of new market information related to sovereign risk. However, their use of a random effects panel in the first differences may cause issues when drawing conclusions about market efficiency regarding price discovery, as it overlooks the estimation of long-term equilibrium dynamics that is possible with an error-correction framework for non-stationary and cointegrated time series. The IMF (2013) underlines the role of sovereign CDS in swiftly revealing new information during periods of market stress and argues that a ban on naked sovereign CDS positions could reduce market liquidity to such an extent that the market becomes ineffective for hedging and, as a signal for market-implied credit risk. ESMA (2013) report a relative decrease in spreads for EU countries compared to non-EU countries following the ban, with around a 26 basis point decrease in the CDS spread of regulated countries. However, this decrease is only statistically significant at the 10% confidence level. Finally, Gyntelberg et al. (2018) analyze the price discovery process on the GIIPS countries prior and after the implementation of the ban on naked short selling. They found that the CDS market was leading the bond market in terms of price discovery and that the ban did not change the dynamics in the price discovery process for sovereign credit risk. This study aims to investigate price discovery dynamics after the ban on naked short selling by analyzing a much longer time span after the ban compared to existing studies and therefore contributing to the existing literature with the aim to get a better understanding on the effectiveness of the EU regulation.

3 Data

All bond yields and CDS spreads series used in this chapter are collected from Refinitv Eikon. We use daily price quotes for CDS contracts and government bonds for France, Germany, Greece, Ireland, Italy, Portugal, and Spain for the sample period 14 March 2012 through the end of March 2023. Greek CDS data was only available until 19 September 2022. Our sample includes the GIIPS countries as those were most affected by the euro sovereign debt crisis. Also, Germany is included as a near risk-free reference country, France, which we consider a low-risk control

country. We use the 5-year USD-denominated CDS quotes for all countries in our sample, based on the finding by Gyntelberg et al. (2013) that the 5-year segment is most liquid in contrast to the 2- and 10-year segment, specifically as the sovereign debt crisis intensified.

Refinitv 5-year benchmark government bond yield curves are available for observed sovereigns, providing a comparable dataset. In order to determine the government bond yield spread (credit spread) for each country, we compare the risky government bond yield for each country with its comparable risk-free benchmark across the entire sampling period. Consistent with previous studies on sovereign credit spreads, we refer to the 5-year German government bond yield as the risk-free reference rate.

According to the literature (Palladini & Portes, 2011), to estimate the CDS-bond basis, we should calculate the difference between the CDS spread and the bond yield spread for each country, which is defined as:

$$\text{BASIS} = \text{CDS} - \left(\text{BY} - \text{BY}_{rf}\right) \tag{1}$$

The basis are shown in Figs. 1, 2, and 3 to provide a visual insight into the dynamics and developments of the basis for each country. For the empirical analysis, we follow the approach applied by Gyntelberg et al. (2018), where we run a unit root and a stationarity test to confirm that the spread series contains a unit root. Next, we
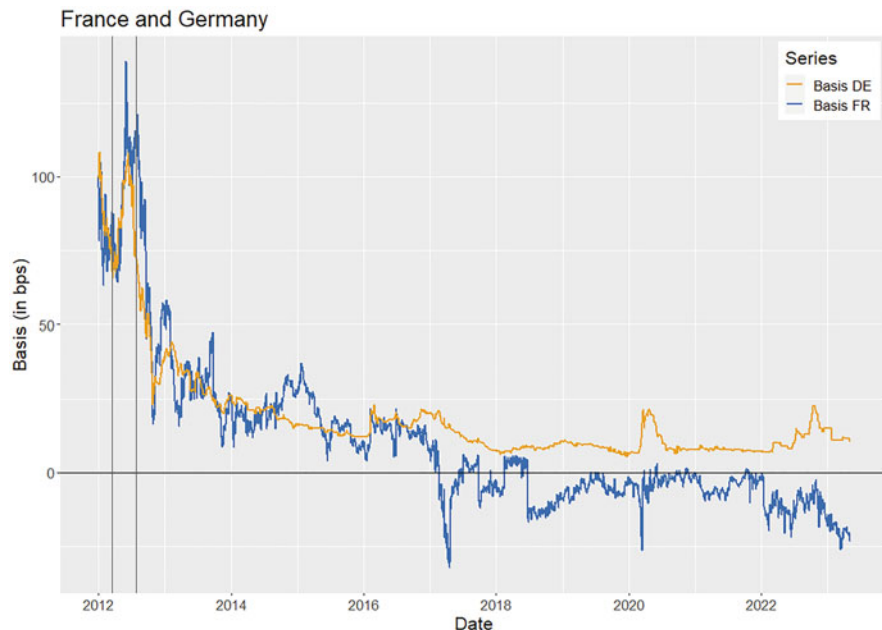
Fig. 1 CDS-bond yield spread basis for France and Germany, in basis points
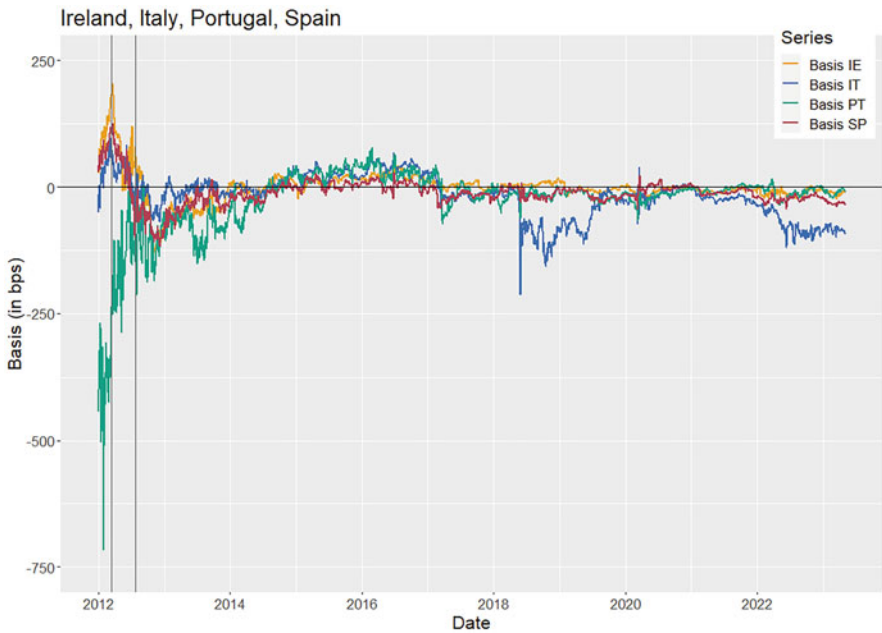
Fig. 2 CDS-bond yield spread basis for Ireland, Italy, Portugal, and Spain, in basis points
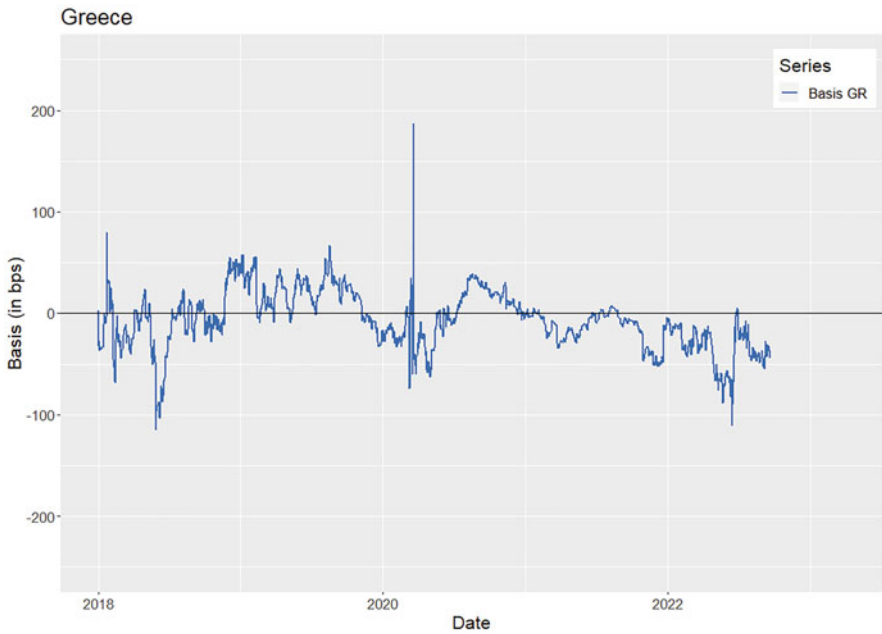
Fig. 3 CDS-bond yield spread basis for Greece, in basis points

perform cointegration tests to identify that the CDS and bond yield spreads (BYS) are cointegrated. Based on these results, we continue to estimate the vector error correction models (VECM) for each country in our sample to analyze the daily price discovery process.

As suggested by Gyntelberg et al. (2018) and Palladini & Portes (2011), we test for unit roots and stationarity in the CDS and BYS time series using the Augmented Dickey-Fuller (ADF) test and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test. Based on these tests, we conclude that both series have a unit root and are non-stationary for all countries in our sample for the period from March 2012 to end of March 2023.

The theoretical framework suggests that credit default swaps (CDS) and bond yield spreads (BYS) of the same reference entity and tenor should price credit risk equally on average (Gyntelberg et al., 2018). Recognizing that practical limitations can disrupt this relationship, we conduct tests to ascertain a long-term relationship that is integrated of order I(0), also known as cointegration. Cointegration is tested by using the Phillips and Ouliaris (1990) test and the Johansen (1988) test methodologies. Two time series are deemed cointegrated if the null hypothesis of no cointegration is rejected at a 5% significance level either in the Johansen or Phillips-Ouliaris test. We execute the Johansen test with an intercept but without a deterministic trend in the cointegrating equation which represents the long-term equilibrium relationship (basis). The Schwarz information criterion is used to estimate the optimal lag length for the Johansen test. In all instances, a cointegration relationship is observed between the CDS and bond market credit spreads, except for Italy. This observation is confirmed by Anelli et al. (2021). They find that market pricing dynamics are disrupted by the unconventional policy measures undertaken by the ECB in the form of its QE program, leading to undervalued credit spreads in the bond market in Italy.

Given that our time series are integrated of order one I(1), we can apply a vector error correction model (VECM) to examine the combined price formation mechanism between the CDS and the bond market. Further, we can then determine metrics that signify which of the two markets predominates in the price discovery process (Endres, 2015). Lag lengths are determined by the Schwarz information criterion (SIC). We use the following VECM to estimate the contributions to price discovery from the two markets.

$$
\begin{aligned}
\Delta \mathrm{CDS}_t = {} & \lambda_1 \left(\mathrm{CDS}_{t-1} - \alpha_0 - \alpha_1 \mathrm{BYS}_{t-1} \right) \\
& + \sum_{j=1}^{p} \beta_{1j} \Delta \mathrm{CDS}_{t-j} + \sum_{j=1}^{q} \gamma_{1j} \Delta \mathrm{ASW}_{t-j} + \varepsilon_t^{\mathrm{CDS}}
\end{aligned} \tag{2}
$$

$$
\begin{aligned}
\Delta \mathrm{BYS}_t = {} & \lambda_2 \left(\mathrm{CDS}_{t-1} - \alpha_0 - \alpha_1 \mathrm{BYS}_{t-1} \right) \\
& + \sum_{j=1}^{p} \beta_{2j} \Delta \mathrm{BYS}_{t-j} + \sum_{j=1}^{q} \gamma_{2j} \Delta \mathrm{CDS}_{t-j} + \varepsilon_t^{\mathrm{BYS}}.
\end{aligned} \tag{3}
$$

In Eqs. (2) and (3), CDS_t and BYS_t stand for CDS spread and bond yield spread at time t for a specific sovereign entity, while $\varepsilon_t^{\mathrm{CDS}}$ and $\varepsilon_t^{\mathrm{BYS}}$ constitute i.i.d. shocks (Gyntelberg et al., 2018). The two equations constitute a vector autoregressive

model in first-order difference with an additional error correction term. This term would be equal to the observed CDS-bond basis if $a_0 = 0$ and $a_1 = 1$. The long-run equilibrium of the two time series is represented by the error correction term and the VAR-term represents the short-run dynamics coming from market imperfections (Baillie et al., 2002; Gyntelberg et al. 2018).

The adjustment speed parameters, λ_1 and λ_2, quantify the extent to which prices in a particular market adapt to rectify deviations from their long-term equilibrium. If price discovery is solely occurring in the cash bond market, we would expect to see a negative and statistically significant λ_1 and a statistically insignificant λ_2, as it is the CDS market that adjusts to reconcile the pricing differences from the long-term relationship. In other words, the cash bond market precedes the CDS market as pertinent information becomes available. On the other hand, if λ_1 is not statistically significant while λ_2 is positive and statistically significant, the price discovery process is happening exclusively in the CDS market—meaning the CDS market is ahead of the cash bond market. When both λ parameters are significant, with λ_1 being negative and λ_2 being positive, it implies that price discovery is occurring in both markets.

To quantify the price discovery process we employ the Gonzalo Granger (GG) measure. GG breaks down the common factor but does not consider the correlation of the innovations in the two markets (Baillie et al., 2002). The GG measure is calculated as follows:

$$GG^{CDS} = \frac{-\lambda_2}{\lambda_1 - \lambda_2} \tag{4}$$

$$GG^{BYS} = \frac{\lambda_1}{\lambda_1 - \lambda_2}, \tag{5}$$

whereby the definition $GG^{CDS} + GG^{BYS} = 1$.

For simplification reasons, we only consider GG^{CDS} and thus omit the superscript *BYS*. Given by the definition, GG measures above 0.5 imply than more than half of the price discovery occurs in the CDS market. Measures close around 0.5 state that both markets contribute to price discovery without evidence that one specific market is dominant. Conclusively, a GG below 0.5 assumes price leadership for the bond market.

4   Results

In the first part of this section, we will present the findings on whether the no-arbitrage theory holds and, thus, the basis should be clustered around zero. These results are followed by the findings of the VECM and Gonzalo Granger (GG) measure regarding the credit risk price discovery process.

According to Palladini & Portes, 2011, assuming perfect arbitrage between the two markets, the basis should equal zero in equilibrium. However, the daily basis plots in Figs. 1–3 show that this condition does not hold for all our observed countries. Greece has no data availability until 26 November 2014 due to their debt cut that lead to a credit event and for CDS price information from 19 September 2022 on. Therefore, the Greek time series starts only on 27 November 2014 and runs until 19 September 2022, whereas all other countries cover the entire sampling period. Figures 1–3 show a basis-decline after the ban's implementation for France, Germany, Italy, Ireland, Spain, and Portugal. However, as previously found by Gyntelberg et al. (2018) and the IMF (2013), the specific effects of the ban on the sovereign debt market (first vertical line) cannot be isolated due to several other major events happening during 2012, such as the ECB's Outright Monetary Transactions (OMT) program announcement on 6 September 2012 or the famous "whatever it takes" speech by ECB President Mario Draghi on 26 July 2012 (second vertical line).

Figures 1–3 show that for France, Ireland, Italy, Portugal, and Spain, the CDS-bond credit spread basis has narrowed compared to the period around the introduction of the ban and Draghi's "whatever it takes" speech, but mostly been negative. As Palladini & Portes (2011) emphasize, the size of the CDS-bond basis provides a rough measure of the gain arising from arbitrage opportunities that can result from pricing inefficiencies in the credit market. On the contrary, if the basis is negative, the prospective arbitrage operation is to purchase the basis, which implies buying the cash bond and concurrently purchasing its protection in the CDS market. Once more, the trade's profitability is associated with a decline in the reference entity's credit quality. In the event of a default, the protection buyer receives a payout from the protection seller. Even if there is no credit event, he can potentially sell the protection on the reference asset at a higher rate, as the reference entity is now perceived as riskier. Once a non-zero basis is established in the market, the dynamics of basis trades could potentially maintain it distant from its theoretical value. High market demand from protection buyers will push the basis upwards, while a strong market supply from protection sellers will pull the basis downwards (Palladini & Portes, 2011).

Table 1 presents our findings with respect to price discovery for daily credit spreads for the post-ban period from 14 March 2012 to end of March 2023. Therefore, Table 1 provides estimates for the speed of adjustment parameters λ_1 and λ_2 and the corresponding $\mathsf{GG}^{\mathsf{CDS}}$ measures.

As expected, all λ_1 are either negative or not statistically significant from zero at the 5% confidence level. λ_1 equal to zero means that the CDS market does not adjust to variations in the basis. Implicitly, this means that new information is instantaneously reflected in CDS spreads. For Italy, λ_1 has been found significant only at the 10% level. For Portugal and Spain, the λ_2 parameters are positive and

Table 1 Price discovery in the post-ban period from 14 March 2012 to end of March 2023. The CDS market is more important in the price discovery process for credit risk whenever GG is above 0.5, and the bond market dominates when it is below 0.5. The superscript [a] has to be interpreted as 0, because the VECM coefficient λ_2 is not significant. Superscript [b] indicates that estimates for Greece start only after 27 November 2014 and end on 19 September 2022, due to unavailable CDS data for the period up to 26 November 2014 and from 20 September 2022 onwards. The superscript [c] indicates that the GG measure has to be interpreted as 1, since the VECM coefficient λ_1 is not significant

Post-ban period							
Sovereign	GG^{CDS}	$\lambda_1 \times 10^3$	Std. err.	Sign. level	$\lambda_2 \times 10^3$	Std. err.	Sign. level
France	0.15^a	-5.8	1.2	***	1.0	2.0	
Greece[b]	0.35	-18.3	4.6	***	9.8	4.6	**
Ireland	0.42	-12.2	2.1	***	9.0	3.0	***
Italy	0.31^a	-4.2	2.1	*	1.9	3.1	
Portugal	0.77^c	-5.9	4.1		19.8	5.7	***
Spain	1.13^c	3.8	3.8		33.4	5.3	***

*, **, *** indicates significance at the 90%, 95%, and 99% level, respectively

statistically significant at the 5% level, suggesting a clear CDS leadership as the bond market adjusts to information first reflected in the CDS market. The results for Greece and Ireland, where both λ_1 and λ_2 have been found to be statistically significant at the 5% level and the GG is around 0.5, indicate price discovery takes place in both markets. Only for France and Italy, the bond market has been found to be leading the price discovery process, meaning that the CDS market reacts to information first reflected in the bond market. Therefore, our results suggest that price leadership for the CDS market has not been eliminated through the ban for every country and it still importantly contributes to the price discovery process in euro area sovereign credit markets. However we do not find that CDS typically lead in the price discovery process which in our results can only be confirmed for Portugal and Spain. Therefore, we can show some evidence, that the ban might have altered dynamics in the market for sovereign risk as the bond market has become more important in the price discovery process compared to empirical results found before the ban where the CDS market was dominant in the price discovery process (e.g., Palladini & Portes, 2011; Gyntelberg et al., 2018).

Affected by the excessive outstanding liquidity due to unconventional measures taken by the European Central Bank (ECB), the Italian market functioning was completely altered, and the two series have been found no longer being cointegrated which confirms the finding by Anelli et al. (2021).

5   Conclusion

In this chapter, we analyze the market microstructure in the European credit risk
market in GIIPS countries and Germany and France by analyzing the dynamics
of sovereign credit spreads in CDS and bond markets after the implementation of
the regulatory ban on outright short selling of sovereign CDS contracts. We focus
primarily on the price discovery process—the efficient and timely incorporation of
information implicit in investor trading into market prices. Our main finding, 10
years after the implementation of the ban, is that the CDS market is still relevant
for price discovery in euro area sovereign credit markets. However, in contrast to
earlier studies with much shorter sample periods, we find that the bond market
has been observed to incorporate information quicker than the CDS market for
most countries in our sample, except Portugal and Spain. However, in Ireland and
Greece, both markets significantly contribute to the price discovery process, while
the bond market is however faster in the adjustment dynamics. In Portugal and
Spain, the CDS market leads the bond market in terms of price discovery. That is,
new information is reflected in both markets, but it tends to get incorporated quicker
in the CDS market than in the bond market. This finding stands in contrast to earlier
research conducted by Gyntelberg et al. (2018) with much shorter sample periods,
who emphasize through their analysis of intraday data, that the CDS markets tend
to lead the bond market in terms of price discovery. However, while their findings at
that time held true for all markets except one, we observed CDS leadership for our
sample period only in two markets, Portugal and Spain.

An interesting finding is attributed to the Italian credit market. In the period
when markets started to be affected by the unconventional ECB monetary policy, the
market functioning was altered entirely due to the excessive outstanding liquidity.
In January 2015, the ECB announced the Quantitative Easing (QE) program, which
affected the markets that were already enormously drugged of outstanding liquidity.
These unconventional measures undertaken by the ECB caused the two Italian credit
spread series, CDS and BYS, to be no longer cointegrated during that period. As a
result, specialized financial products, such as CDS, can lose their core function in
the price discovery process due to the undermined CDS market liquidity.

Given that our research employs the 5-year CDS and 5-year government bond
yields for the GIIPS countries for the post-ban period 2012–2023, the sample
size and the observed time horizon are limited to unique market conditions with
historically low interest rates and unconventional measures implemented by the
ECB. Therefore, although CDS and bond yield spreads should cointegrate in the
long run per construction, these market-altering measures caused both series in the
Italian market to no longer being cointegrated, at least for the observed sampling
period. Since empirical research and its outcomes depend highly on the observed
data, the price discovery process within the sovereign credit market should be
investigated further.

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Evolution of Sovereign Risk of European G-SIBs

Loïc Alvarez and Kristyna Ters

Abstract This chapter shows some evidence that sovereign risk remains a significant concern for European 'Global Systemically Important Banks' (G-SIBs) despite the lessons learned from the euro area sovereign debt crisis. Analysis of data from the European Banking Authority (EBA) reveals that many of these banks continue to hold substantial levels of sovereign debt exposure to GIIPS (Greece, Ireland, Italy, Portugal, and Spain) countries, with exposure ranging from 10% to 20%. Notably, UniCredit and Santander stand out with exposure levels exceeding 25% towards GIIPS nations, exposing them to potential sovereign risk from market disturbances within those countries. We also show that partial correlations between Credit Default Swaps (CDS) spreads of certain G-SIBs and GIIPS countries remain relatively high, likely influenced by the significant sovereign debt exposure these banks maintain. Furthermore, the high Debt-to-GDP ratios of GIIPS countries, along with the potential cascading effects of a government's failure on financial institutions, highlight the interconnectedness and vulnerability of the European banking system.

While regulatory frameworks like the Basel Accords have played a crucial role in maintaining financial stability, the approach to risk-weighted assets associated with sovereign debts remains contentious. The allowance for a 0% risk weight on sovereign bonds issued by EU member states, as part of the Capital Requirements Regulation (CRR), may incentivize increased holdings of such debts, amplifying sovereign risk. Moreover, High Quality Liquid Assets (HQLA) regulations encouraging banks to retain sovereign debt result in an increased risk for a new sovereign-bank nexus. Our findings reveal potential weaknesses within the European banking system, emphasizing the need for thorough scrutiny and systemic management of this persisting issue.

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1 Introduction

This chapter undertakes an examination of the sovereign risk associated with Europe's 'Global Systemically Important Banks' (G-SIBs), tracing the trajectory of sovereign risk during and in the aftermath of the euro area sovereign debt crisis. Key to this analysis is the critical evaluation of regulators' role in addressing sovereign risk, with particular emphasis on the approaches of the Basel Committee on Banking Supervision (BCBS) and European authorities.

Our primary objective is to assess the effectiveness of the regulatory measures implemented by analyzing their impact on sovereign risk as a measure to mitigate the risk of a new sovereign-bank nexus after the last euro area sovereign debt crisis. In our analysis, we investigate the interconnectedness between euro area sovereign risk and systemically important banks in the euro area. By comparing the partial correlations between the daily returns of Credit Default Swaps (CDS) of European G-SIBs and the sovereigns that have been most affected during the last crisis such as Greece, Ireland, Italy, Portugal, and Spain (GIIPS countries) during the two aforementioned time periods. Additionally, we also investigate the evolution of GIIPS sovereign exposures of euro area G-SIBs from 2013 onward. Simultaneously, we will analyze the evolution of the Debt-to-GDP ratio in GIIPS countries to enhance our understanding of the evolving landscape of sovereign risk for European G-SIBs over the past decade.

Ultimately, our chapter will give insights, whether regulatory measures taken after the last euro area sovereign debt crisis were able to decrease the potential risk of a new sovereign-bank nexus in the euro area.

2 Evolution of Basel Accords with an Emphasis on Risk-Weighted Sovereign Assets

The Basel Accords, a series of banking regulations put forth by the BCBS, represent significant regulatory measures in the global effort to ensure financial stability. These international banking standards have been instrumental in shaping the modern banking landscape, particularly in response to financial crises and the evolving complexities of the global financial system.

The inaugural Basel Accord, known as Basel I, was introduced in 1988, marking the inception of international standards for bank capital that were uniformly applicable to active financial institutions. Basel I introduced the pivotal concept of risk-weighted assets, recognizing that the various assets on a bank's balance sheet inherently carry different risk levels. The underlying principle was that an asset deemed risk-free would not necessitate the bank to hold additional capital. In the context of Basel I, claims on most central governments and central banks were assigned a risk-weight of 0%, thereby signifying no capital reserve requirement for these particular assets (Basel Committee on Banking Supervision, 1988).

In 2004, the BCBS implemented Basel II, which represented a significant evolution from the original framework. In particular, this accord granted banks the autonomy to assign risk weights to their own assets, based on the institution's internal risk assessments. According to Bodellini (2019), the outcome of Basel II primarily led to a substantial reduction in the amount of capital held by banks, a trend partly fueled by the supervisors' internal lack of sophisticated skills needed to assess the banks' internal risk models.

The trajectory of regulatory evolution persisted with the introduction of Basel III in 2011, in response to the global financial crisis. Among its various enhancements, Basel III underscored the critical importance of liquidity. Specifically, two liquidity coverage ratio (LCR) were instituted in order to ensure bank liquidity. To fulfill the regulatory LCR, banks must hold a substantial amount in so-called High Quality Liquid Assets (HQLA). HQLA are assets that can be swiftly sold to meet withdrawals and therefore became an integral part of the new regulatory landscape.

The latest evolution, adopted in 2017, is often referred to as Basel IV and represents substantial revisions to Basel III, particularly in relation to the calculation of risk-weighted assets. Banks now face restrictions regarding the inputs they can employ to calculate capital requirements under their internal approach for credit risk. Nonetheless, the amendments made to Basel III have not further restricted the treatment of sovereign exposures: banks have the flexibility to assign a lower risk weight to sovereign exposures that are denominated and funded in their own domestic currency. As underscored by the Basel Committee on Banking Supervision (2017), assigning a 0% risk weight to domestic sovereign exposures is a widely adopted practice. For all other sovereign exposures, risk weights are determined by respective credit ratings. Sovereign exposures from countries with the highest creditworthiness receive a risk weight of 0%, whereas those from countries with the poorest credit ratings are assigned a significantly higher risk weight of 150%.

However, the Capital Requirements Regulation (CRR), which serves as a binding regulation for all banks operating within the European Union (EU), follows a somewhat less stringent interpretation of the Basel framework, thereby leaving the issue of sovereign risk somewhat unresolved (Deslandes & Magnus, 2019). In fact, Article 114(4) of the CRR mandates that "exposures to Member States' central governments and central banks, when denominated and funded in the domestic currency of the respective central government and central bank, shall be assigned a risk weight of 0%" (Article 114 – European Banking Authority, 2022).

This specific regulatory aspect highlights the encouragement for euro area banks to retain sovereign bonds issued by EU member states, as these assets can bolster their balance sheets without requiring additional capital reserves due to their 0% risk weight classification.

Having addressed the regulatory considerations, the next section will explore the literature analyzing the determinants of banks' sovereign exposures.

3 Determinants of Banks Sovereign Exposures

The existing literature has extensively researched the various determinants of banks' sovereign exposures. Numerous factors account for why banks retain holdings in sovereign debt. This section offers a summary, albeit not exhaustive, of these determinants as addressed in the existing academic literature.

Firstly, banks often hold sovereign debt as it is typically classified as HQLA, characterized by its high liquidity. As a matter of fact, some regulatory jurisdictions stipulate that a particular percentage of a bank's asset portfolio must be allocated to sovereign exposures (Basel Committee on Banking Supervision, 2017). Banks also engage in diversification of their sovereign debt portfolio across multiple governments as a risk management strategy to mitigate potential financial losses in the event of a specific country defaulting on its debt. While such diversification typically offers benefits through risk reduction, it can also lead to contagion. That is, the default of one government can potentially affect a broad spectrum of financial institutions due to their interconnectedness. Moreover, sovereign debt serves as collateral in interbank lending and refinancing operations, offering banks extra liquidity. Indeed, a country's government debt can typically be used as a collateral in the financial system of all countries (Bolton & Jeanne, 2011).

An additional motive often identified in the literature is the pursuit of yield. Operating within the parameters of the prevailing regulatory structure (as described in Sect. 2), banks strategically seek transactions that offer higher yields, albeit at greater risk, while meeting their regulatory obligations concerning risk-weighted assets and capital requirements. Acharya and Steffen's (2015) empirical investigation demonstrated that banks frequently focus on the GIIPS countries, as these nations offer higher potential returns due to the associated risks of investment.

Furthermore, during periods of instability, a phenomenon known as 'flight-to-safety' often occurs, characterized by banks purchasing more of their own country's sovereign debt as the perceived risk of other financial assets escalates. Interestingly, a study by Vlassopoulos and Andreeva (2016) reveals that not only banks from less-vulnerable euro-area countries but also those from vulnerable euro-area countries (such as the GIIPS countries and Slovenia) engage in this 'flight-to-safety' activity. According to the same study, one reason behind this strategy is that it potentially enhances equity returns by transferring some of the additional risk to the bank's creditors—given that a sovereign default is likely to cause a bank default anyway. Moreover, during a crisis or when other viable investment opportunities are scarce, investing in sovereign debt may be seen as the best choice considering the trade-off between risk and return (Basel Committee on Banking Supervision, 2017).

Another factor is 'moral suasion', or the pressure to support the domestic economy. Since the risk weight of domestic bonds is typically zero, as seen in the previous section, banks are incentivized by their government (usually peripheral governments) to buy substantial amounts of domestic government debt (Acharya & Steffen's, 2015).

In their comprehensive analysis of German banks and debt exposures from 2005 to 2013, Buch et al. (2016) concluded that determinants of sovereign exposure are not static but shift over time. They noted that the introduction of low interest rates, for instance, spurred a search for yield and necessitated collateral to cushion against liquidity shocks. Interestingly, macroeconomic factors appeared to exert negligible influence on banks' sovereign bond investments before the 2007–2008 financial crisis. Yet during and subsequent to the crisis, evidence of active restructuring in banks' sovereign portfolios emerged from the data. Buch et al. (2016) also found that characteristics of the banks themselves may induce shifts in the determinants of sovereign bond holdings. Larger influences were found among weakly capitalized banks, banks active in capital markets, and larger financial institutions. Increasing the exposure to higher yield sovereign debt with 0% risk-weight is also called regulatory arbitrage as the current regulatory framework gives banks no incentive to hold a diversified sovereign debt portfolio.

4   The European Sovereign Debt Crisis and Regulatory Responses

In the aftermath of the global financial crisis, towards the end of 2009, numerous euro area countries experienced a by investors unexpected and steep increase in their deficit-to-GDP ratios. This surge was particularly pronounced as the decline in fiscal revenues in many of these countries outpaced their GDP contraction. Moreover, fiscal reports repeatedly indicated larger deficits than what had been initially projected. These fiscal inconsistencies fostered a narrative attributing the financial instability to the fiscal irresponsibility of peripheral countries in the euro area, particularly the GIIPS countries, as noted by Lane (2012).

These numerous announcements triggered an increase in spreads on euro area sovereign bonds. The annual spread on 10-year sovereign bond yields between Germany and the GIIPS countries was almost negligible before the crisis. However, it experienced a sharp rise during the euro area sovereign debt crisis. It is critical to note that all sovereign debts from these nations are denominated in a singular currency—the euro. Thus, any observed variations in expected yield primarily signify the perceived credit risk and differing levels of volatility associated with each country. In response to this escalating crisis, bailout packages were assembled. Greece received assistance three times: in 2010, 2012, and 2015. Ireland secured a bailout in 2010, and Portugal followed in 2011 (Lane, 2012; Zahariadis, 2017).

In response to the Sovereign Debt Crisis, the European Union implemented several measures. Countries receiving financial aid were offered bailout packages, provided they adhered to certain conditions. These prerequisites necessitated that recipient nations enforce fiscal austerity measures and initiate structural reforms to stimulate economic growth, in addition to recapitalizing their banking systems. This recapitalization formed a pivotal component of the bailouts extended to Ireland and

Spain, while also playing a significant role in the bailouts received by Greece and Portugal (Lane, 2012).

The EU also established institutional mechanisms for delivering financial assistance and enacted new legislation to support these initiatives (Verdun, 2015). Additionally, the EU imposed a prohibition on the short-selling of CDS (so-called naked CDS) throughout the European Economic Area, a practice frequently linked to escalating sovereign bond yields (Gyntelberg et al., 2018).

Despite the introduction of Basel III and the LCR, the problem of sovereign risks on bank balance sheets in the euro area persists. Many banks still have significant amounts invested in sovereign bonds. The impact of losses on sovereign exposures can be severe as shown during the last euro area sovereign debt crisis where sovereign risk contagiously spilled over onto banks due to their balance sheet exposure. The euro area sovereign debt crisis has shown that this can lead to a vicious cycle, destabilizing the financial system through a sovereign-bank nexus.

5 Analysis

In this section we analyze the potential risk of a new sovereign-bank nexus. We examine the interconnectedness through partial correlations between the daily variations in 5-year CDS spreads of euro area G-SIBs and those of GIIPS countries. Our analysis is set within two distinct timeframes: the euro area sovereign debt crisis period and its aftermath. The crisis phase extends from January 1, 2010 to December 31, 2012, and the post-crisis period encompasses from January 1, 2013 to March 31, 2023.

The specific temporal demarcation of the euro area sovereign debt crisis may be subject to debate. Nevertheless, we believe that the crisis peaked between 2010 and 2012, characterized by the provision of financial bailouts to Greece, Portugal, and Ireland. Additionally, the notable 'whatever it takes' speech in July 2012 played a significant role in mitigating the crisis.

In our analysis, we draw comparisons between the partial correlations across these two designated periods. Furthermore, for the post-crisis phase starting January 1, 2013, we place side by side the partial correlations with two key reference metrics: the sovereign holdings data of European G-SIBs as provided by the European Banking Authority (EBA), and the evolution of Debt-to-GDP ratios of GIIPS countries. The ultimate aim is to trace the trajectory of sovereign risk for euro area G-SIBs over the past decade.

The CDS data under analysis spans from January 1, 2010 to March 31, 2023. We chose to focus on euro area G-SIBs because of their systemic importance, which reflects their "too big to fail" designation, implying that their failure could pose a significant risk to the stability of the global financial system. According to the November 2022 G-SIBs list from the Financial Stability Board, the euro area G-SIBs includes the following institutions: BNP Paribas from France, BPCE from France, Credit Agricole (CA) from France, Deutsche Bank (DB) from Germany,

ING from the Netherlands, UniCredit (UNI) from Italy, Santander (SAN) from Spain, and Société Générale (SG) from France (Financial Stability Board, 2022). The analysis will not include BPCE, as this institution is not publicly traded on the stock market. Additionally, the inclusion of GIIPS countries in this analysis is particularly important given their significant historical economic and fiscal hardships as discussed in Sect. 4.

Figures 1 and 2 depict the evolution of the CDS spread of both GIIPS countries and European G-SIBs over the aforementioned period.

Figures 1 and 2 illustrate the profound impact of the euro area sovereign debt crisis on the 5-year CDS spreads of both GIIPS countries (Fig. 1) and euro area G-SIBs (Fig. 2). In the segments to the right of the black lines (01.01.2013–31.03.2023), indicating the termination of the crisis' core phase, it becomes clear that the 5-year CDS spreads for most countries and banks returned to lower levels. The exception to this trend was Greece, where the bailout measures were extended until 2015. As a result, Greece's 5-year CDS spread remained notably high compared to other GIIPS nations, underscoring the country's persistent high-risk status.

Presented in Figs. 3 and 4 are two heatmaps that depict the partial correlations between the CDS spreads (daily returns) of the GIIPS countries and the European G-SIBs for the previously specified periods. These heatmaps are based on the inverse variance-covariance matrix, following the approach described by Kim (2015). Partial correlation is a statistical method used to measure the relationship between two variables, in this case, one of the G-SIBs and a specific GIIPS country, while controlling for the influence of other variables. These other variables are all other banks and sovereign CDS in our sample.

As displayed in Figs. 3 and 4, there have been changes in the partial correlations between the daily returns of 5-year CDS spreads for GIIPS countries and European G-SIBs throughout and following the euro area sovereign debt crisis. A closer examination of these figures reveals a noticeable increase in partial correlations for certain banks and countries during the post-crisis period. This increase is particularly notable in the case of UniCredit with Italy, Credit Agricole with Portugal, ING with Portugal, UniCredit with Portugal, and Santander with Portugal. Additionally, a consistently high level of partial correlation persists between BNP Paribas and Italy for the crisis and post-crisis period.

Data from the EBA, detailing the sovereign holdings of banks within the European Union, may explain the increase and/or high partial correlation observed for certain banks and countries during the post-crisis period from January 1, 2013 to March 31, 2023. Tables 1 and 2 cover the period from the December 2012 to the June 2022 EU-wide transparency exercises. To conserve space, only the end-of-year figures and the latest available data from June 2022 have been retained. Table 1 illustrates each euro area G-SIB's exposure towards each of the GIIPS countries in billion EUR, and Table 2 provides the exposure towards GIIPS countries as a percentage of each bank's total sovereign bond holdings.

Upon examining Table 1, several key observations emerge. Primarily, the negligible exposure to Greece among euro area G-SIBs is striking. This suggests that these
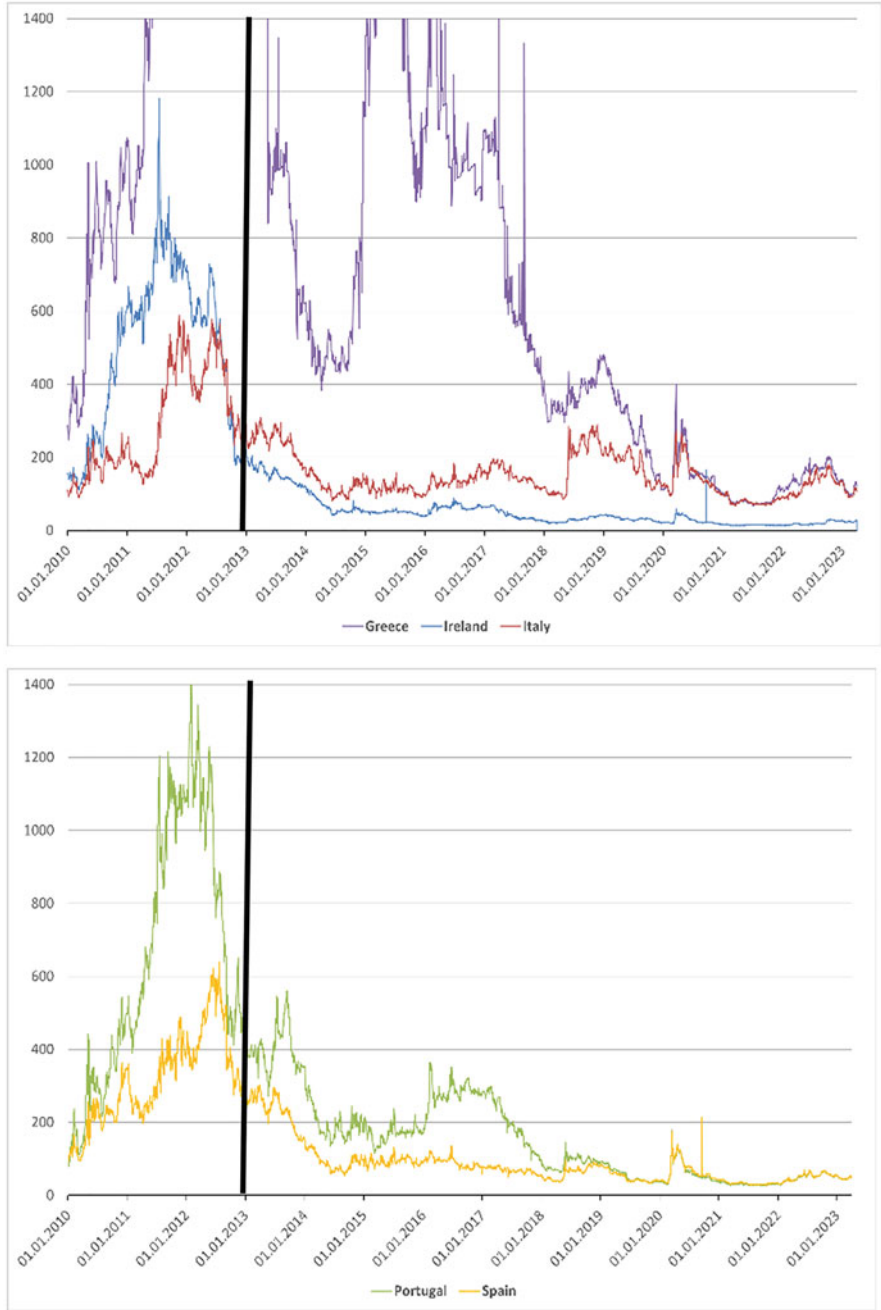
Fig. 1 Greece, Ireland, Italy, Portugal, Spain (GIIPS)—5-year CDS spreads. *The evolution of the 5-year CDS spreads of the GIIPS countries during the euro area sovereign debt crisis and the post-crisis period, as delimited by the vertical black lines*
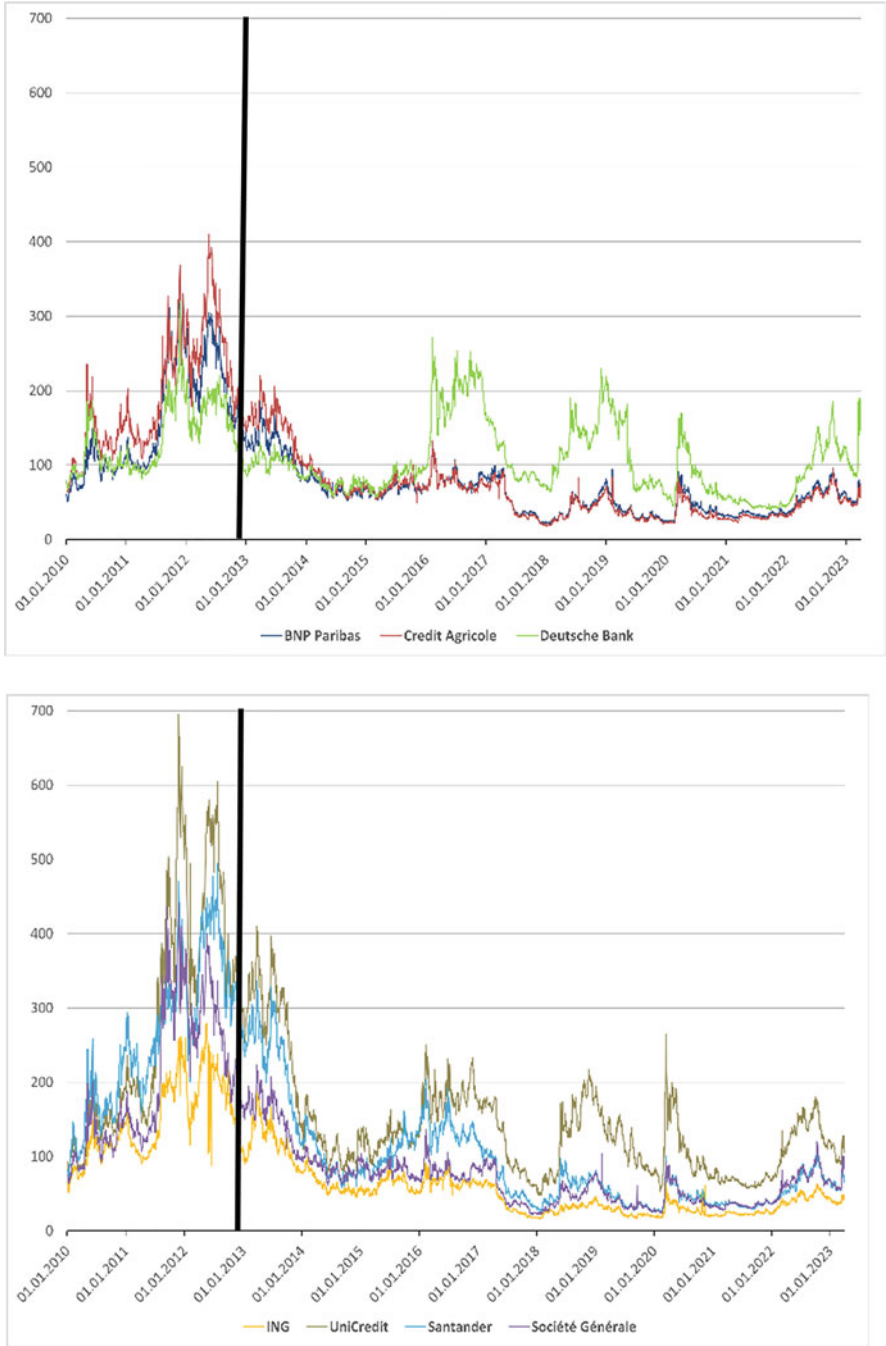
Fig. 2 BNP Paribas, Credit Agricole, Deutsche Bank, ING, UniCredit, Santander, Société Générale—5-year CDS spreads. *The evolution of the 5-year CDS spreads of the European G-SIBs during the euro area sovereign debt crisis and the post-crisis period, as delimited by the vertical black lines*

Heatmap of the partial correlations between the daily returns of 5-year CDS spreads for GIIPS countries and European G-SIBs. Each cell shows the strength and direction of the partial correlation between the daily returns of 5-year CDS spreads for a specific GIIPS country and a specific European G-SIB, while taking into account the effects of other variables, during the period from January 1, 2010, to December 31, 2012.
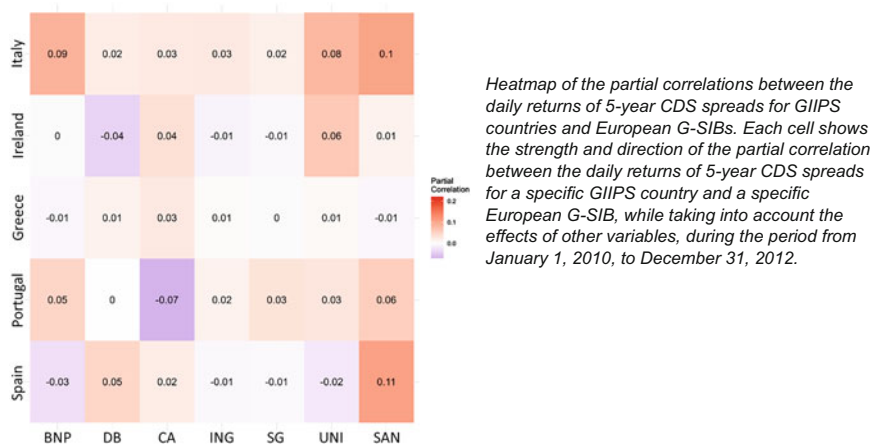
Fig. 3 Heatmap of the partial correlations between the daily returns of 5-year CDS spreads for GIIPS countries and European G-SIBs, between 01.01.2010 and 31.12.2012 crisis period. *Heatmap of the partial correlations between the daily returns of 5-year CDS spreads for GIIPS countries and European G-SIBs. Each cell shows the strength and direction of the partial correlation between the daily returns of 5-year CDS spreads for a specific GIIPS country and a specific European G-SIB, while taking into account the effects of other variables, during the period from January 1, 2010, to December 31, 2012*

Heatmap of the partial correlations between the daily returns of 5-year CDS spreads for GIIPS countries and European G-SIBs. Each cell shows the strength and direction of the partial correlation between the daily returns of 5-year CDS spreads for a specific GIIPS country and a specific European G-SIB, while taking into account the effects of other variables, during the period from January 1, 2013, to March 31, 2023.
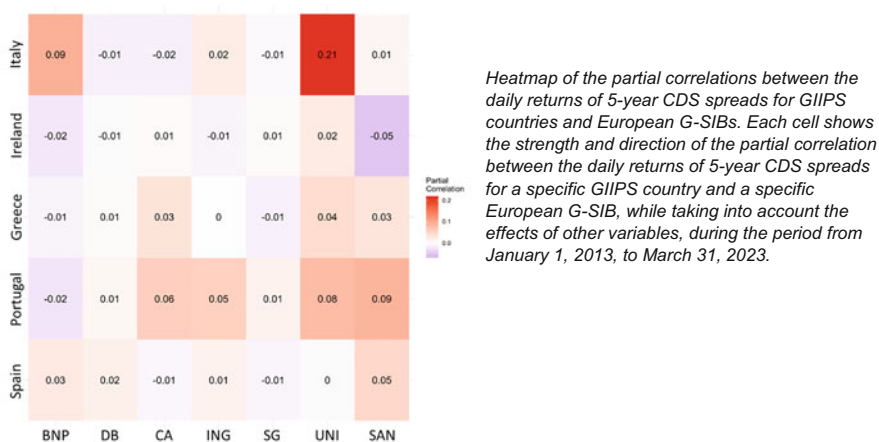
Fig. 4 Heatmap of the partial correlations between the daily returns of 5-year CDS spreads for GIIPS countries and European G-SIBs, between 01.01.2013 and 31.03.2023 post-crisis period. *Heatmap of the partial correlations between the daily returns of 5-year CDS spreads for GIIPS countries and European G-SIBs. Each cell shows the strength and direction of the partial correlation between the daily returns of 5-year CDS spreads for a specific GIIPS country and a specific European G-SIB, while taking into account the effects of other variables, during the period from January 1, 2013, to March 31, 2023*

Table 1 Illustration of European G-SIB's exposure towards GIIPS countries

In mn EUR	12.2012	12.2013	12.2014	12.2015	12.2016	12.2017	12.2018	12.2019	12.2020	12.2021	06.2022
BNP Paribas	20,149	24,046	27,885	25,525	29,810	24,539	30,002	39,223	43,278	40,940	46,052
Greece	35	30	58	0	1	7	14	12	728	1581	586
Ireland	245	378	1575	902	1159	1195	1540	2092	2309	2221	3015
Italy	17,398	18,949	20,008	16,803	20,194	16,610	19,292	20,937	19,632	15,438	22,025
Portugal	788	766	828	1204	937	752	1774	4164	4848	4844	4988
Spain	1684	3923	5416	6617	7520	5976	7383	12,018	15,761	16,855	15,437
Crédit Agricole	11,885	16,334	17,988	13,766	12,862	12,624	11,727	12,653	15,927	17,387	22,093
Greece	0	0	0	0	0	0	1	0	0	0	0
Ireland	129	132	282	225	288	159	8	2	1	14	54
Italy	8953	12,378	11,535	8820	7853	10,041	10,481	10,167	13,235	16,344	20,806
Portugal	225	177	77	708	258	194	6	20	67	77	96
Spain	2578	3647	6094	4013	4463	2229	1231	2464	2624	952	1137
Deutsche Bank	12,506	13,289	7214	2782	4610	6613	7331	9429	14,545	12,927	24,005
Greece	39	52	115	25	7	6	17	21	487	581	391
Ireland	970	1003	689	81	752	815	432	412	511	363	570
Italy	8845	9834	5156	1442	1695	3096	3791	6285	7292	4219	16,906
Portugal	397	268	160	287	335	121	136	358	324	190	149
Spain	2254	2132	1094	948	1821	2575	2956	2353	5930	7574	5989
ING	3910	4081	7214	7533	3940	3124	4711	4754	7333	6190	7026
Greece	0	0	0	0	0	0	0	0	0	0	0
Ireland	1	35	35	56	3	0	0	55	101	175	184
Italy	2599	2863	4958	4528	1097	786	383	84	2780	1592	2225
Portugal	620	496	191	3	7	0	0	0	0	0	0
Spain	689	687	2030	2947	2833	2338	4328	4615	4452	4422	4618

(continued)

Table 1 (continued)

In mn EUR	12.2012	12.2013	12.2014	12.2015	12.2016	12.2017	12.2018	12.2019	12.2020	12.2021	06.2022
Santander	50,561	45,902	59,986	65,625	61,524	82,317	73,059	53,650	41,520	34,877	38,894
Greece	0	0	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	2	201	21	0	9	50
Italy	464	2648	3454	4094	3268	6539	3326	4083	4697	1893	7785
Portugal	2299	2808	8576	10,254	7901	10,024	8449	8872	8980	6727	6107
Spain	47,798	40,446	47,956	51,278	50,355	65,752	61,083	40,674	27,842	26,249	24,952
Société Générale	6244	9583	10,727	4810	3973	2662	3415	2439	4420	446	1408
Greece	0	0	0	0	0	0	2	1	3	4	36
Ireland	381	43	211	59	172	43	41	56	38	8	18
Italy	3793	6172	6264	2532	2119	1570	2038	1304	2593	323	724
Portugal	96	161	341	215	68	71	125	101	88	3	12
Spain	1975	3207	3911	2004	1613	978	1209	976	1698	108	617
UniCredit	51,708	57,311	72,726	84,220	83,562	84,392	87,427	75,164	72,850	76,831	69,708
Greece	5	8	1	1	0	1	0	0	0	0	0
Ireland	53	52	1	8	31	40	442	241	1135	1087	1011
Italy	50,199	56,704	68,549	68,807	66,975	67,213	68,282	56,937	53,869	56,807	50,540
Portugal	29	30	105	107	104	132	574	556	1707	1636	2054
Spain	1421	517	4070	15,297	16,451	17,005	18,129	17,429	16,138	17,301	16,104

Source: EBA EU-wide transparency exercises, from December 2012 to June 2022. Labels: GROSS DIRECT LONG EXPOSURES (accounting value gross of provisions); Financial assets: Carrying Amount—broken down by country; Direct exposures—On balance sheet—Total gross carrying amount of non-derivative financial assets

Table 2 Exposure towards GIIPS countries as a percentage of each bank's total sovereign bond holdings

	12.2012	12.2013	12.2014	12.2015	12.2016	12.2017	12.2018	12.2019	12.2020	12.2021	06.2022
BNP Paribas	15.06	16.23	18.12	11.80	13.73	12.18	14.59	17.16	16.20	15.14	15.29
Crédit Agricole	12.30	16.12	18.15	11.35	10.27	10.56	9.53	9.92	11.57	11.22	13.16
Deutsche Bank	7.46	8.57	5.57	2.24	4.07	5.90	6.16	7.93	11.44	12.26	19.15
ING	4.63	4.94	7.28	8.20	4.90	4.27	7.01	6.56	9.22	8.06	8.50
Santander	44.38	44.43	41.93	49.52	38.66	47.34	42.06	35.01	29.47	25.75	27.50
Société Générale	6.22	7.92	7.81	7.87	7.71	3.13	3.84	2.73	4.50	0.51	1.40
UniCredit	42.13	46.13	49.84	50.34	51.92	55.10	56.74	53.12	51.03	50.05	48.92

Source: EBA EU-wide transparency exercises, from December 2012 to June 2022. Labels: GROSS DIRECT LONG EXPOSURES (accounting value gross of provisions); Financial assets: Carrying Amount—broken down by country; Direct exposures—On balance sheet—Total gross carrying amount of non-derivative financial assets

banks might perceive the sovereign risk associated with Greece as overly substantial, thereby deterring investment in the nation's government bonds. A notable exception to this pattern is BNP Paribas, which demonstrates a clear increase in Greek bond investment between 2019 and 2021.
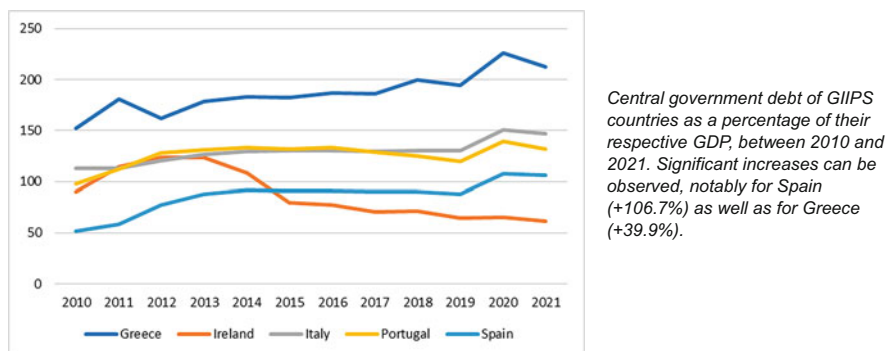
Investments in both Irish and Portuguese government bonds continue to remain consistently low among euro area G-SIBs. However, Santander appears to diverge from this trend by having a relatively larger allocation towards Portuguese government bonds compared to other euro area G-SIBs.

A pronounced home bias is evident among banks such as Santander and UniCredit towards Spanish and Italian government bonds, respectively, as revealed in both Tables 1 and 2. This bias has led to significant exposure to GIIPS countries, with Santander's exposure standing at 27.50%, and UniCredit's at an even higher level of 48.92% as of June 2022.

Despite this, it is worth noting that Santander appears to have reduced its exposure to Spanish government bonds, with its holdings diminishing from 48 billion EUR at the end of 2012 to 25 billion EUR by June 2022. In contrast, UniCredit has consistently demonstrated considerable exposure to Italian government bonds. Furthermore, Deutsche Bank appears to have increased its exposure to Italy between the end of 2021 and June 2022. Lastly, the exposures of ING and Société Générale to GIIPS countries remain generally low.

Figure 5 offers insights into the Debt-to-GDP ratios of the central governments in GIIPS countries, serving as a measure of each country's public debt level relative to the size of its economy.

The Debt-to-GDP ratio is a pivotal metric for assessing a country's economic vitality and fiscal sustainability. High levels of this ratio frequently suggest potential challenges a nation may face in servicing its external debt. Moreover, if the ratio escalates persistently, it could signal that the country's debt is proliferating more rapidly than its economic growth.

Central government debt of GIIPS countries as a percentage of their respective GDP, between 2010 and 2021. Significant increases can be observed, notably for Spain (+106.7%) as well as for Greece (+39.9%).

Fig. 5 Central government debt of GIIPS countries as a percentage of their respective GDP between 2010 and 2021. *Central government debt of GIIPS countries as a percentage of their respective GDP, between 2010 and 2021. Significant increases can be observed, notably for Spain (+106.7%) as well as for Greece (+39.9%).* Source: IMF, data from 2010 to 2021

Upon examining Fig. 5, a marked increase in the Debt-to-GDP ratio for several GIIPS countries between 2010 and 2021 becomes evident. Notably, Spain's ratio surged by 106.7%, while Greece, Portugal, and Italy experienced substantial increases of 39.9%, 35.4%, and 30.3% respectively. Contrarily, Ireland distinguishes itself as the sole GIIPS member that succeeded in reducing its Debt-to-GDP ratio, registering a significant reduction of 31.1%.

6   Findings

In our analysis of the partial correlations between the daily returns of 5-year CDS spreads for GIIPS countries and European G-SIBs, both during and following the European Sovereign Debt Crisis, we observe changes of different magnitudes.

Specifically, in the case of UniCredit and Italy, a substantial increase in partial correlation could be attributed to UniCredit's significant holdings of Italian sovereign debt, as corroborated by Tables 1 and 2. On the other hand, the escalated partial correlations between Credit Agricole and ING with Portugal do not align with these banks' exposures, which remain low.

Furthermore, the rise in partial correlation between UniCredit and Portugal could be traced back to an increment in UniCredit's exposure to Portuguese debt between 2020 and 2022, despite its modest magnitude when compared to the bank's exposure to Italian sovereign bonds.

Similarly, the sustained high partial correlation between Italy and BNP Paribas across both periods could be explained by the bank's substantial exposure towards Italy, which constitutes almost half of the bank's total GIIPS exposure. Meanwhile, the augmented partial correlation between Santander and Portugal during the two periods can potentially be rationalized by Santander's exposure to Portuguese sovereign debt. Finally, the relatively high partial correlation observed between Santander and Spain may be attributed to the bank's pronounced home bias favoring investments in its native government's debt.

The Debt-to-GDP ratio serves as a potential indicator for pinpointing significant surges in sovereign risk. Given the substantial escalation in this ratio for both Spain and Italy from 2010 to 2021, it could be inferred that the holdings of UniCredit and Santander in their respective domestic sovereign debt represent considerable sovereign risk exposure for these banks.

7   Conclusion

This chapter shows some evidence that sovereign risk is still a major concern for European G-SIBs, despite the lessons learned from the euro area sovereign debt crisis. Data from the EBA clearly shows that most of these banks continue to have significant levels of sovereign debt exposure to GIIPS countries, usually in the range

of 10–20%. For some banks we can even see an increase in sovereign debt exposure towards GIIPS countries. Specifically, UniCredit and Santander exhibit exposure levels exceeding the norm, more precisely, above 25% towards GIIPS nations. This is largely attributed to their substantial exposure to sovereign debts in their respective domestic markets—Italy for UniCredit, and Spain for Santander. Such high exposure levels underline the potential sovereign risk these banks face from any financial disturbances within these markets. Factors including the pursuit of higher yields (regulatory arbitrage) and moral suasion, which refers to the pressure to bolster domestic economies, may be contributing to this situation.

The conducted analysis reveals that partial correlations between 5-year CDS spreads of UniCredit and Italy, Santander and Portugal, Santander and Spain, as well as BNP Paribas and Italy, remain relatively high. This pattern could potentially be attributed to the high levels of sovereign debt exposure that these banks maintain towards each of these governments. Furthermore, the Debt-to-GDP ratios of Greece, Italy, Portugal, and Spain remain notably high and have experienced dramatic increases since 2010.

Even though sovereign exposure levels of 10–20% might seem marginal in the context of risk, one must not overlook the potential cascading effects. The failure of one government could trigger a domino effect, given the high degree of interconnectedness among financial institutions. Moreover, it remains a fact that most G-SIBs still maintain various levels of exposure to multiple GIIPS countries.

Regulatory frameworks like the Basel Accords, created by the BCBS, have been instrumental in setting global banking standards to safeguard financial stability. However, their approach towards risk-weighted assets associated with sovereign debts is still a subject of controversy. The provision within the CRR permitting European banks to assign a 0% risk weight to sovereign bonds issued by EU member states potentially fuels an increased appetite for such debts, thereby escalating sovereign risk. Additionally, the HQLA regulations, which advocate for banks to hold onto sovereign debt, may exacerbate this issue.

In conclusion, these findings strongly show that sovereign risk and its potential for a new sovereign-bank nexus is still a major issue for euro area G-SIBs, and reveal potential weaknesses that could cause problems in the European banking system. Therefore, there is a critical need for further scrutiny and systemic management of this persistent issue.

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Electricity Trading with Derivative Instruments: Speculation, Hedging, or Speculative Hedging?

Matthias Härri

Abstract The physical nature of electricity makes it difficult to store, which means that current demand must always match current production. This requires both flexible and internationally interconnected generation capacity and appropriate hedging strategies. Electricity is typically traded 'forward', i.e., future energy volumes and prices are hedged in advance with derivative instruments to minimize price risks. In times of crisis, when energy prices can be highly volatile, such instruments can also be used for speculative purposes. However, hedging and speculative positions can trigger margin calls on derivatives exchanges or increased collateral requirements in the over-the-counter (OTC) market. The causes, interrelationships and possible consequences of such margin calls on the financial situation of buyers and sellers of electricity (e.g., on balance sheet liquidity) are discussed.

Paradoxically, the use of hedging instruments to protect against price volatility, together with prudential accounting standards, has led to financial problems for many electricity producers during the market turmoil of 2022, and to governmental bail outs. Whether the problems of large energy companies in Switzerland are due solely to hedging motives or to speculative proprietary trading is difficult for outsiders to judge.

1 Pricing in Electricity Markets

According to Schleiniger et al. (2019, p. 9), the trade of electricity is special in at least two relationships: first, it is grid-bound, and second, a balance between supply and demand must be always ensured in the transmission and distribution.

There are various economic models for pricing on the electricity market. The best-known model for short-term pricing is the so-called merit order model, as explained by Linnemann (2020, p. 144ff): Here, short-term means that there is no

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adjustment of the installed production capacity. As a market model, it includes aggregated supply and aggregated demand. The merit order model, like any model, is a simplification of reality. For example, it only considers the short-term variable costs of power plants, not the fixed costs. Nor does it consider longer-term investment decisions or decommissioning decisions. In addition to prices and volumes, the model also provides information on the order in which the generation units will be used.

The model is based on the assumption that a generator will only produce electricity if at least its variable costs are fully covered. This explains why power plants without significant marginal costs, such as renewables (hydro, wind, solar), which do not require fuel or CO_2 certificates to produce electricity, come first and produce according to physical conditions, not the current market price. Then come nuclear power plants, which also do not require CO_2 certificates. Coal-fired power plants follow, and finally gas-fired power plants. Demand is assumed to be inelastic in the model. This is due to the assumption that there is not enough flexibility on the demand side to react in the short term.

The market clears when demand equals the sum of supply. This results in the price (in monetary units per megawatt hour, MWh) and the total amount of electricity traded. *Uniform pricing* now applies: This means that every power plant operator receives the same price for every megawatt hour it generates, regardless of its cost structure. In somewhat simplified terms: 'The costs of the most expensive power plant determines the price for all'. If the short-term variable costs for an electricity producer are now below the current market price, this results in a contribution margin (= sales minus variable costs) which can be used to (at least partially) cover the fixed costs. Power plants with variable costs above the market price do not produce electricity in this model, because not even their variable costs (let alone their fixed costs) are covered.

This short-term merit order model implies and explains at least two remarkable developments and observations in the electricity market (Linnemann, 2020, p. 145):

- Due to a continuous addition of renewable generation plants (wind, solar) the share of power plants with very low marginal costs increases. As a result, for a given demand, a new, usually lower market price is achieved, which is lower than the original price. This price decline means that conventional power plants, such as coal- or gas-fired power plants, are no longer able to cover their variable costs, so they stop operating their plants and, in the long term, will be forced out of the market for economic reasons. This could lead to problems in the future if gas- and coal-fired power stations, which respond flexibly to fluctuations in demand on the electricity grid, are no longer operated.
- As the most expensive power plant (more precisely, the one with the highest variable costs) determines the price of electricity, and this is usually the gas-fired power plant, the short-term price of electricity is strongly correlated with the price of gas. If the gas price fluctuates strongly due to possible market distortions

(supply shortages, geopolitical upheavals, sanctions, etc.), this has quite a direct impact on the electricity price, which serves as the "underlying" for derivative trading instruments (see Sect. 2.3).

2 Electricity Markets and Trading Products

This section begins with a summary of the different forms of organization of electricity trading. It then looks at short-term electricity markets. This is followed by a discussion of medium- and long-term markets and the products traded there.

2.1 Organization Forms of Electricity Markets

The price-determining wholesale trading in electricity products can be divided into two distinct areas in terms of where it takes place: trading on an institutionalized, legally regulated exchange, and over-the-counter (OTC) trading. OTC trading is decentralized, bilateral trading between two private parties that can respond very flexibly to the needs of market participants, as there is significantly less regulation and standardization than on exchanges. However, this reduces the transparency of the market. In addition, the counterparties bear the default risk of their counterparties (Frauendorfer et al., 2020, p. 19). Therefore, bilateral collateral can and is set depending on market prices and the creditworthiness of the counterparties (Frauendorfer & Gutsche, 2018, p. 11). However, these individual agreements are generally much less restrictive than for futures.

2.2 Short-Term Electricity Markets

Spot Market/Day-Ahead Market
The spot market trades those products that represent delivery periods (usually hours) for today and the following trading day (hence 'day-ahead'). It includes electricity deliveries with a constant output over 1 h. This results in 24 tradable hourly products per day. Only physical deliveries of electricity are traded on this exchange-based market. Pricing takes place via an exchange auction at noon. Buy and sell bids for the following day's hourly products are collected during the morning, matched by the exchange and, through aggregated hourly supply and demand curves, result in the hourly market clearing balances in prices and volumes for the following day (Frauendorfer et al., 2020, p. 10).

Intraday Market

The so-called intraday market is even more short-term. It also deals exclusively with physical deliveries. According to Linnemann (2020, p. 136) both hourly and quarter-hourly products can be traded. In contrast to the spot market, trading takes place around the clock and ends only a few minutes before the actual delivery period begins. The volumes traded are much smaller than on the day-ahead market, as only the quantities that are missing or no longer needed due to short-term events are usually traded (Schleiniger et al., 2019, p. 37). Price volatility is significantly higher on the intraday market than on the spot market, partly because of the lower liquidity of the quantities traded, and partly because of forecast fluctuations in the stochastic energy production of wind turbines and photovoltaic plants (Frauendorfer et al., 2020, p. 11). Electricity is therefore a commodity whose price can be very volatile compared to other commodities. The main reason for this is the difficulty of storing electricity, which allows only limited arbitrage over time (Schleiniger et al., 2019, p. 39).

2.3   Medium- and Long-Term Electricity Markets

Market participants have different interests. Power plants sell their electricity production in advance to obtain planning certainty with regard to the selling price. Consumers try to stabilize the prices they have to pay. Both have a hedging motive. In addition, banks, hedge funds or electricity market participants themselves may try to speculate due to the high price volatility in the electricity market. Futures and forwards are the main instruments used to implement these different motivations (Linnemann, 2020, p. 135ff).

Stock Exchanges: Futures Trading

Futures are standardized forward contracts that are publicly traded on exchanges. The standardized delivery periods on power exchanges include individual days, weeks, months, quarters, and years (Frauendorfer et al., 2020, p. 13). If such futures are not closed out with a corresponding offsetting transaction before the start of the delivery period, the electricity must be physically delivered at the contractually agreed output, or financial settlement takes place. Financial settlement is the rule. The reference price (price of the underlying) is the spot market price, i.e. the market clearing price of the daily day-ahead auctions.

Example:
Cash flows at the end of the term of a future

A power plant has hedged its production with a futures contract and has not offset it before expiration (based on Frauendorfer et al., 2020, p. 16):

- The power plant offers its hourly production *physically* and independently of the current price in the day-ahead market (spot).
- The published market clearing price (day-ahead price) corresponds to the hourly revenue per unit sold.
- The difference between the market clearing price and the futures price is *financially* settled via the futures and corresponds to the hedging proceeds.

  – It is positive if the spot price is below the futures price
  – It is negative when the spot price is higher than the futures price

- In any case, the futures price is achieved in *total* per unit of energy sold, and thus the power plant has successfully hedged the proceeds from the sale.

In contrast to over-the-counter (OTC) trading, where market participants bear the counterparty risk, the exchange bears this risk in futures. To ensure this guarantee, market participants are therefore obliged to always have sufficient liquidity as collateral in their *margin account*. This is an account that all market participants must maintain with the exchange's clearing house (Frauendorfer et al., 2020, p. 17) so that the exchange can financially cover a possible default of a market participant. The *initial margin* depends on the creditworthiness of the market participant and the agreed trading volume. The *variation margin* in the form of additional liquidity is demanded by the exchange if the spot price moves away from the original futures price (Linnemann, 2020, p. 151). On futures exchanges, this variation margin must be deposited as collateral for the entire term of a futures contract. It is calculated from the gains and losses resulting from changes in the price of the underlying asset of a futures contract. The variation margin is settled daily *in cash*.

Example:
Calculation of a variation margin
  At the beginning, an industrial company buys a futures contract (long) on the power exchange at a price of € 100, with a contract volume of 720 MWh to secure a fixed purchase price (based on Linnemann, 2020, p. 152).

- The next day, the day-ahead market price (underlying) and therefore the settlement price of the future rises by € 1 to € 101.
- This price change must be compensated by the variation margin:
  € 1 per MWh * 720 MWh = € 720. This is credited to the long position.

- The next day, the spot price increases by another € 2 to € 103: the variation margin increases by € 1440 to € 720 + € 1440 = € 2160.
- This means that by the end of the second day, this long position has € 2160 credited to its margin account.
- This amount, on the other hand, has been debited from the margin account of a short position.

    Variation margin is calculated daily for the entire holding period, including the delivery period. In the case of a financial future (usual), there is a cash settlement at the end.

However, power generators are usually *short*, i.e. they hedge their *selling price* with futures contracts. If the spot price rises above the original futures price, they must gradually inject liquidity. Such *marking-to-market* (also known as *daily settlement*) takes place daily and can have a significant impact on a company's liquidity position when spot prices are volatile. If a requested *margin call* on a margin account is not met immediately (within a few hours), the market participant's open position may be closed by the exchange with the accumulated losses.

Cash flows occur at margin payments, at a close-out (offsetting a future), or at the end of the delivery period (Frauendorfer et al., 2020, p. 17). A market participant's liquidity can therefore fluctuate significantly because of trading in futures, and the treasurer of a company involved in trading must always be aware of this and manage it. In terms of a company's balance sheet, futures trading exposes the company's liquidity to high volatility. The margin account therefore shows unrealized gains and losses on a daily basis.

Over the Counter: Forward Trading
Another way to trade electricity is outside of institutionalized exchanges. According to Frauendorfer et al. (2020, p. 19ff), bilateral, private trading takes place outside of centrally organized and legally regulated exchanges and is conducted via brokers or electronic over-the-counter (OTC) trading platforms. In terms of volume, significantly more electricity is traded via OTC than on exchanges. However, this does not necessarily mean that liquidity is greater in the OTC market. Due to many non-standardized trading products, liquidity is highly fragmented.

The most important form of energy derivatives are so-called *forwards* with their linear pay-off structure. These contracts can include delivery dates and qualities that may differ significantly from the standardization defined in futures. In these bilateral contracts, the contracting parties bear the counterparty risk, therefore creditworthiness plays a major role in the design of the contract specifications. The posting of collateral and the terms of any margin payments are thus agreed bilaterally, taking into account the credit ratings of the counterparties (Frauendorfer & Gutsche, 2018, p. 11). Gains and losses in OTC trading are typically *not* settled daily. Because of this, forwards generally have a nonzero replacement value at

a given balance sheet date. The value of a forward is linearly dependent on the prices of the underlying (spot market price) during the delivery period. Forwards are therefore equivalent to assets or liabilities and therefore affect the length of the balance sheet at the end of a financial year.

3 Accounting Issues for Electricity Generators

In Switzerland, there are three major electricity companies that are seen as systematically relevant, or 'Too big to fail': Axpo Holding AG (hereafter Axpo), BKW Energie AG (BKW), and Alpiq Holding AG (Alpiq). BKW shares are listed at the SIX Swiss Exchange, the canton of Berne is the majority shareholder. Alpiq and Axpo are not listed, their main shareholders are also cantons, and other, mainly publicly owned, energy companies. These three companies are reporting under the International Financial Reporting Standard (IFRS).

The use of futures and forwards implies different effects on the balance sheet and the income statement of electricity generators.

3.1 *Futures*

Futures are settled daily. This daily settlement triggers regular cash flows in and out of the margin account and influences the balance sheet item 'Cash and cash equivalents', and the unrealized gains and losses in futures trading are included in the income statement. But, due to this daily marking to market, their balance sheet replacement value is zero at the end of each trading day (Frauendorfer et al., 2020, p. 18).

When choosing and using *futures*, the management of electricity generators should consider the following impacts on corporate accounting:

Impact of the use of futures on the balance sheet and income statement:
• Balance sheet item 'Cash and cash equivalents': high impact, as daily payments into and out of margin account
• Balance sheet item 'Replacement values of energy derivatives': low impact, as their value is zero after each daily settlement
• Income statement: high impact, unrealized gains and losses

3.2 *Forwards*

Forwards are not settled daily, so they do not affect the liquidity of a company in the same way as futures. But they can have a replacement value which is different from zero. Under IFRS 9 (Financial Instruments), energy derivatives must be shown

in the balance sheet separately, both long and short positions (Frauendorfer et al., 2020, p. 21). If the replacement value of a forward is positive, it must be reported as an asset on the assets side of the balance sheet. It reflects the amount of money the company receives when a forward is or would be closed out. A forward with a negative replacement value must be shown on the liabilities side of the balance sheet. It reflects the amount that the company must raise to close out the forward. The netting prohibition according to IFRS can now lead to the fact that the balance sheet of an electricity generator, which may have, economically, closed out an earlier short forward with a later long forward, must continue to list these two positions in the balance sheet until the delivery dates. Both positions are affected by the current electricity price (spot), and with them, both, assets and liabilities, and thus the entire balance sheet, fluctuate almost in line with the current market price. This can, as happened in 2022 and discussed in Sect. 4.1, lead to remarkable balance sheet extensions when electricity prices rise, see, e.g., Alpiq Holding AG (2022b), or Eisenring (2022e).

When choosing and using *forwards*, the management of electricity generators should consider the following impacts on corporate accounting:

Impact of the use of forwards on the balance sheet and income statement:
• Balance sheet item 'Cash and cash equivalents': low impact if no bilateral settlement payments take place
• Balance sheet item 'Replacement values of energy derivatives': high impact. Positive values to be recorded as assets, negative values as liabilities
• Income statement: low impact

3.3   Accounting Mismatch

In addition, the application of IFRS can create the following problems: risks for possible production failures must be shown in the financial report, which can have a massive impact in the event of higher prices. At the same time, however, according to IFRS with its principle of prudence, the higher value of the current and future electricity produced is *not* reflected in the balance sheet (Eisenring, 2022b, 2022c). Another problematic accounting asymmetry: If electricity prices rise, the forwards used to hedge increase in value, but as electricity companies are typically short, the liability side of the balance sheet increases. But on the other hand, as energy prices increase, and with them the expected cash flows for the company in the future, the power plants are also worth more, from an economic point of view, which should also be reflected on the assets side of the balance sheet. However, IFRS, with its principle of prudence, does not allow an adjustments here, which leads to the so-called *accounting mismatch* (Eisenring, 2022a).

Alpiq refers to this situation in its Annual Report 2022 as follows:

Fair value changes (accounting mismatch)

Negative fair value changes of energy derivatives entered into to hedge future power production (. . .) do not reflect operating performance because they are economically linked with the changes in value of the hedged transactions. Rising forward prices cause the future production volumes and power purchase agreements to increase in value and the corresponding hedges to lose value. According to IFRS accounting policies, the fair value changes of financial hedges between the last and the current balance sheet date have to be recognised in the reporting year. As the future production volumes and the power purchase agreements are not measured at fair value and positive changes in value therefore cannot be recognised in the reporting year, this results in an accounting mismatch.

(Alpiq Holding AG, 2023, p. 45, omission and emphazises by the author)

4   Recent Developments in the Electricity Markets

Section 4 discusses the turbulences and price fluctuations in the electricity markets in Switzerland in the years 2021 and 2022, sets a spotlight at some financial problems for Swiss electricity producers arising from these turbulences, and sketches the political answers in form of rescue packages in Switzerland and Europe.

4.1   Turbulence in the Electricity Markets 2021–2022

After the lifting of most restrictions in the wake of the Covid-19 pandemic, economic activity picked up again in 2021 and 2022. Demand for goods and services experienced a catch-up effect, although there were delays in production and supply chains, resulting in remarkable price increases. Energy markets have also had an impact. Crude oil as well as gas and electricity prices rose continuously since the lows in spring 2020. In the case of electricity prices, an accelerated rise was observable from summer 2021, due to low gas supplies, poor availability of French nuclear power plants, dry periods, and low-wind months in Germany. In spring 2022, Russia's attack on Ukraine shook energy markets: before the assault, Russia was the most important gas supplier for Western Europe, and notable gas pipelines run through Ukraine. As illustrated in Sect. 1, the price of gas is one of the most important factors influencing the price of electricity, at least in the short term, due to the discussed price determination in the merit order model. Uncertainty in the markets about possible supply disruptions, fears of gas supply disruptions, more expensive alternative sourcing via liquefied gas supplies, and, not least, planned and unplanned outages and maintenance work at France's nuclear power plants caused electricity prices to rise to historic highs in the summer of 2022. Figure 1 illustrates this development and shows the monthly average spot market (day-ahead) prices for Switzerland from January 2020 to June 2023.
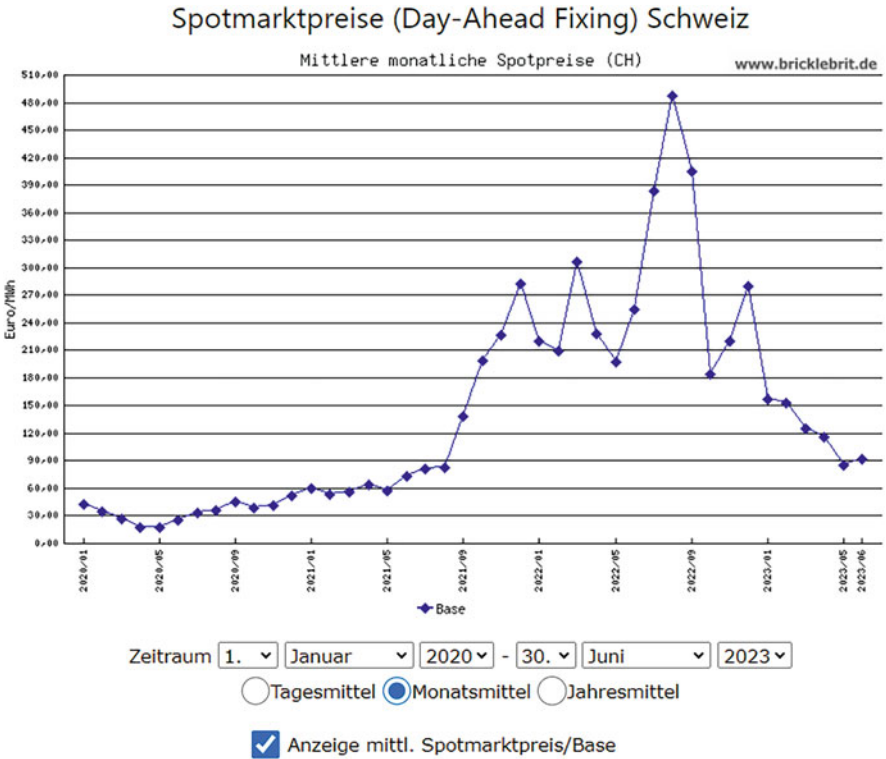
Fig. 1 Average monthly spot prices (day-ahead fixing) Switzerland (www.bricklebrit.de)

The monthly average in summer 2021 was already more than twice as high as in summer 2020 (about EUR 80 per MWh compared to about EUR 35), only to rise further and reach a monthly peak price of over EUR 480 per MWh in August 2022.

It should be noted that these are monthly *averages*; the individual daily values were even more volatile and rose to around EUR 720 in the spot market at the end of August 2022, see Fig. 2.

4.2   Impact on Liquidity of Electricity Producers

Do these price developments have a positive impact on the business success of electricity producers? In the medium and long term, high electricity prices are positive for producers, at least for those whose production costs do not rise in line with sales prices. However, in the short term, electricity trading practices, market regulations, and accounting rules can lead to uncomfortable or even life-threatening liquidity bottlenecks for generators (Eisenring, 2022d). So why is this?
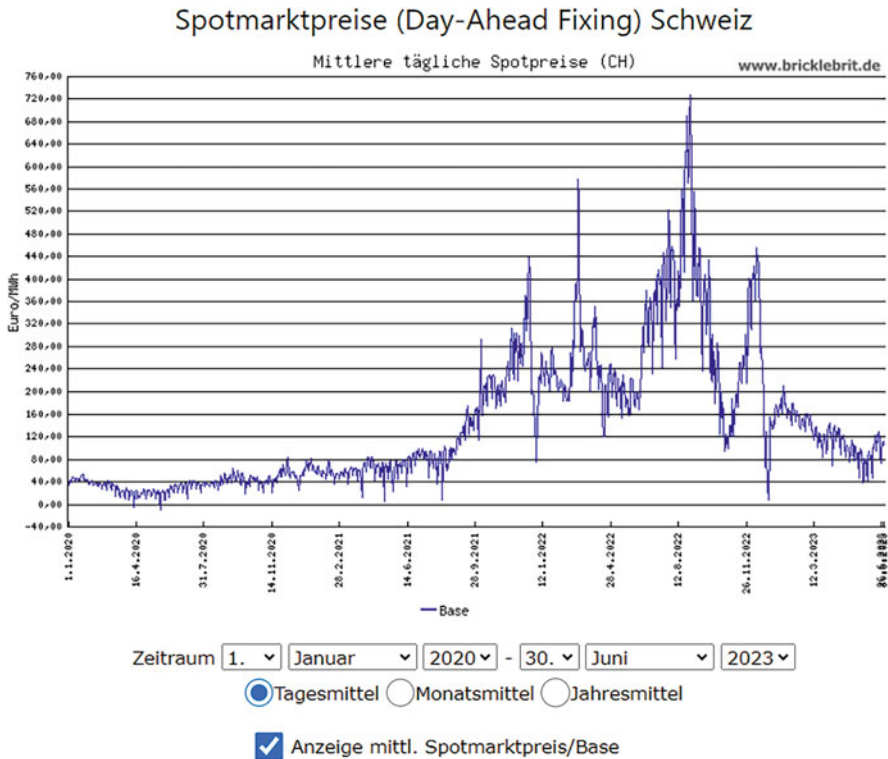
Fig. 2 Average daily spot prices (day-ahead fixing) Switzerland (www.bricklebrit.de)

As mentioned earlier, much of the electricity produced is traded through forward contracts, where generators agree with a buyer to deliver a certain amount of electricity during a predetermined period in the future (Häberli, 2022). The basic idea of forward contracts is to hedge and thus eliminate price fluctuations, to the benefit of both sides: the electricity producer hedges against falling prices because he already knows today how much it will earn with the electricity he produces. Buyers also gain planning security: they protect themselves against rising prices and know in advance how much electricity will cost them.

If the price of electricity fluctuates only slightly, this hedging strategy is good for both sides. However, if electricity prices rise by one order of magnitude and fluctuate wildly, as in 2021 and 2022, features of trading that are designed as hedging mechanisms may have unintended consequences. If the delivery price is fixed in advance and the spot price rises sharply, this is basically good news for the hedging buyer, who receives electricity that is worth much more than he will have to pay for it. At the same time, however, its counterparty risk increases: if the seller were to go bankrupt in the meantime and no longer be able to deliver, the buyer would have to buy its electricity on the market at short notice at high cost,

despite having hedged. For this reason, when trading via the futures exchange, the exchange requires liquid collateral (initial margin, variation margin, see Sect. 2.3) from the seller if it is unable to deliver the promised amount of electricity. With this deposited liquidity, the exchange, which in turn has committed to deliver the agreed amount of power, could purchase the power in the market, thereby satisfying the buyer. In the summer of 2022, due to the massive increase in day-ahead prices (spot, i.e., the underlying of the futures), the exchanges demanded security deposits in the form of cash payments of unprecedented magnitude. These security deposits must be paid in cash and are similar to a pledge or a rental deposit: The money deposited is the property of the market participant, and once the agreed amount of electricity has been delivered and the contract fulfilled, the money is returned to the producer. However, due to the long-term nature of the contracts, this can take some time, during which this *liquidity is tied up* and is not available as liquid funds. With such short-term and massive price increases as in 2022, these high collateral requirements can present energy suppliers with massive liquidity problems.

4.3   Rescue Packages as an Answer

Against this background, it is understandable that discussions about state support measures for electricity producers in liquidity bottlenecks flared up in Switzerland at the end of 2021, and then even more intensively in 2022. These discussions then led to the establishment of a governmental rescue package, the so-called Rettungsschirm (rescue umbrella), on September 5, 2022, following a request from the Swiss electricity producer Axpo. It is based on emergency law set by the Federal Council, and grants Axpo a credit line of CHF 4 billion, as well as a commitment credit to rescue other system-critical companies in the electricity industry, like Alpiq and BKW, as well (see Bundesrat, 2022):

> Some key points of the Swiss rescue package, September 5, 2022 ("Rettungs-schirm"):
>
> - Credit line of CHF 4 billion for Axpo Holding AG
> - Activated by the Federal Council
> - Based on an emergency ordinance ("Verordnung über subsidiäre Finanzhil-fen zur Rettung systemkritischer Unternehmen der Elektrizitätswirtschaft» [FiREVO])").
> - Interest rate: Market interest rate plus risk premium of 4–8%
> - Dividend ban
> - No assets may be sold, and no restructuring may be carried out that could jeopardize the repayment of the loans or any securities

- Duty to provide ElCom and the Swiss Federal Audit Office with information on the financial situation, the utilization of loans and on energy trading transactions
- Commitment fee: the system-critical electricity companies Alpiq, Axpo and BKW must pay a commitment fee ("Bereitstellungspauschale") of CHF 15–20 million Swiss francs annually, even if no credit is drawn down

However, Switzerland was not the only country affected by the turmoil in the energy markets: Finland granted a credit line of EUR 2.35 billion to electricity producer Fortum, and the entire sector was supported with a maximum of EUR 10 billion. Sweden provided a credit line of EUR 23.4 billion on September 5, 2022. In the UK, where many utilities are privately owned, the Treasury and the Bank of England provided a temporary support program equivalent to EUR 46 billion in early September 2022. Despite this, more than 30 energy producers have gone bankrupt in the UK since the start of the energy crisis. In Germany, energy trader Uniper received a support package worth up to EUR 15 billion. In Austria, the largest utility, Wien Energie, was granted a loan of EUR 2 billion (Alpiq Holding AG, 2022a). This list is only anecdotal and does not claim to be exhaustive.

5   Hedging, Speculation, or Speculative Hedging?

In\enlargethispage{12pt} the debate about the need for the above-mentioned Swiss bailout, doubts have repeatedly arisen as to whether the enormous liquidity requirements and high derivative positions of the three large electricity companies, Alpiq, Axpo and BKW, were only invested for *hedging* purposes (pure hedging), or whether they also engaged in substantial so-called proprietary trading for *speculative* purposes (Chassot, 2022).

Prominent participants in this discussion are Karl Frauendorfer and Robert Gutsche from the University of St. Gallen (2022b). For years, they have been analyzing publicly available data and information from the annual reports of the three major Swiss electricity producers. The two authors state that the trading units of the electricity companies would have a large discretion to show derivatives, which are only used for speculative purposes, as hedges in the balance sheets. Based on their own models and assumptions, they conclude that the power companies also exploit this vagueness and use many more derivative instruments (for speculative rather than hedging purposes) than would be necessary for a pure hedging strategy (Frauendorfer & Gutsche, 2022b; Eisenring, 2022b).

> (. . .). This additional trading latitude allows for speculative elements in deciding when and how much to open short positions in the trading book, and is the exact opposite of an even hedge that rolls over years in advance.
> (Frauendorfer & Gutsche, 2022b, p. 7, translated from German)

Die Derivatepositionen explodieren

Energiederivate brutto, in Milliarden Franken
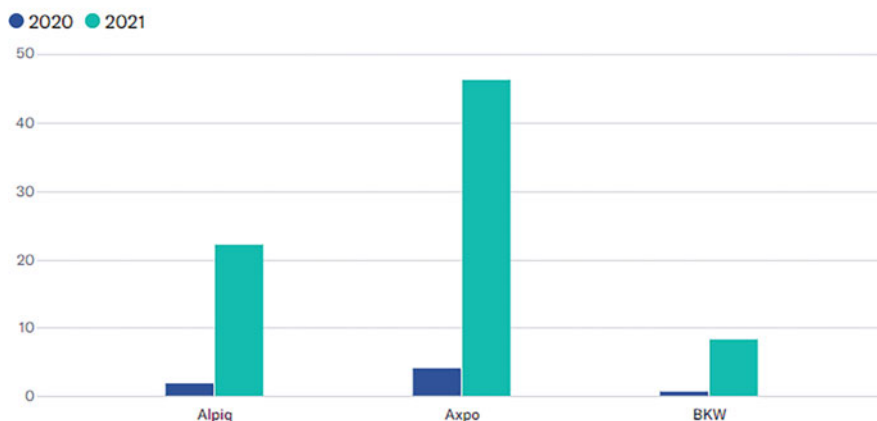
● 2020 ● 2021

Fig. 3 Energy derivatives of Alpiq, Axpo, BKW, in 2020 and 2021 (Eisenring, 2022b)

In fact, the replacement value of energy derivatives at the electricity companies balance sheets increased more than tenfold during the enormous price increases in 2021 and 2022 and amounted to CHF 46 billion at Axpo, for example (Eisenring, 2022b), with their annual sales being 'only' around CHF 6 billion. As shown in Figs. 3 and 4, energy derivatives have already increased by a factor of 8 in Axpo's balance sheet as of September 30, 2021, compared to the previous year, resulting in a balance sheet extension, and a decline in the equity ratio from 31.1% to 16.2%. At Alpiq, the volume of derivatives increased by a factor of 10 as of December 31, 2021, and the equity ratio declined from 51.1% to 26.2% (Frauendorfer & Gutsche, 2022a, p. 3, 2022b, p. 9). Based on their analyses and models, the authors conclude that primarily a successive build-up of speculative proprietary trading positions (Frauendorfer & Gutsche, 2022b, p. 8), i.e., *speculation*, has led to the observed balance sheet extensions and the liquidity problems.

Axpo and Alpiq commented on these allegations, emphasizing that the observed increase in derivative positions can be explained by the tenfold increase in prices on the electricity market. As a result of the extreme developments on the energy exchanges, practically the entire trading business had shifted to OTC trading with forwards. However, this has meant that these OTC transactions, unlike exchange transactions with futures, have been included in the annual reports of the electricity traders under 'derivative financial instruments'. This, however, reduced the need for liquidity, as intended (see Sect. 3.2).

Industry representatives acknowledge that while the shift to the OTC market has reduced liquidity risk, it has also increased credit risk because a counterparty in bilateral trading could default.

Schmalbrüstige Stromkonzerne

Eigenkapitalquote, in Prozent

● 2020 ● 2021
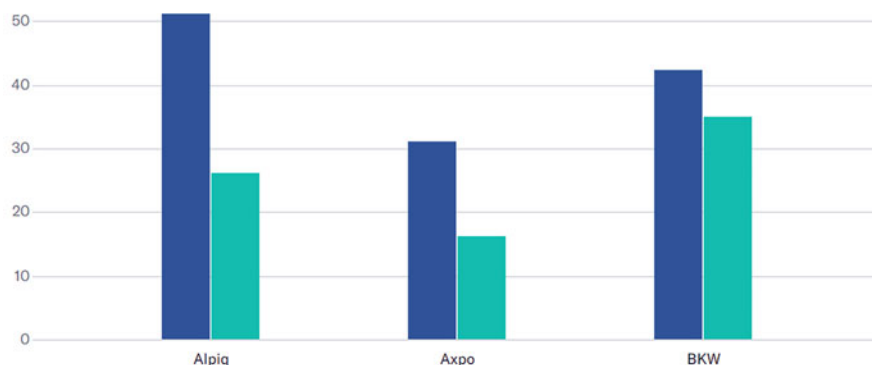
Fig. 4 Equity ratio of Alpiq, Axpo, BKW, in 2020 and 2021 (Eisenring, 2022b)

The Swiss Federal Electricity Commission ElCom is the state regulatory authority in the electricity sector in Switzerland. It is aware of the points of criticism in the studies by Frauendorfer and Gutsche, which are based on public data, but it was not possible for it to reproduce the figures and models when asked in May 2022 (Eisenring, 2022b). ElCom had to admit, however, that it too had no comprehensive insight into the trading transactions of energy companies at that time, since there was no legal obligation to provide information for forward transactions with a delivery location in Switzerland. This intransparency is addressed, among other things, in the detailed regulations of the Swiss 'Rettungsschirm' (see Sect. 4.3).

6   Summary

We have shown in broad terms how market prices for electricity are formed, how market participants trade and hedge electricity, and we have addressed market turbulence in 2021 and 2022. Derivatives, such as forwards and futures, can be used for a variety of reasons: Hedging, speculation and arbitrage. The price rises in 2021 and 2022 were historically unprecedented and unpredictable by anyone.

Paradoxically, it seems that it was mainly the use of *hedging* instruments to protect against excessive price movements and to minimize risk, together with prudent accounting standards, that led to financial problems for electricity producers during this period. Less hedging (more speculation?) would have reduced this problem at that time. Every decision and choice of hedging measures and the definition of a hedging strategy itself contains speculative elements, since no one can

predict future developments in detail: if you hedge as a seller with derivatives, you are in a sense speculating on falling prices; if you hedge as a buyer with derivatives, you are in a sense speculating on rising prices.

The extent to which the financial problems of Switzerland's major energy companies in 2022 are due to speculative proprietary trading is difficult for outsiders to assess. In this respect, the obligation of the major Swiss energy companies to provide information to ElCom and the Swiss Federal Audit Office, as stipulated in the rescue package (see Sect. 4.3), may at least enable these authorities to make a somewhat more accurate assessment of the question in place.

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He has lectured on Finance, Banking, Risk, and Derivative Instruments.

In this book, Matthias Härri draws on his extensive knowledge and experience to provide a comprehensive analysis of electricity markets and derivative instruments.

Gauss Versus Cauchy: A Comparative Study on Risk

Andreas Blöchlinger

Abstract In risk management, the probability distribution must adequately capture the risks that matter most, namely the outliers. I estimate the parameters as if the sample were upper censored to put the focus to the most negative observations (non-censored outliers) and then only estimate the probability that I obtain an "ordinary" observation (censored). The left tail is assumed to follow a location-scale Student's t-distribution, yet no distributional assumptions are made outside the tail. Cauchy's and Gauss' distributions are two special cases of Student's t-distribution. For empirical stock index returns, the left tail is neither Gauss nor Cauchy, a Student's t-distribution with around four degrees of freedom offers the best fit. As an empirical application, I compare the pricing of a short-term far out-of-the-money put option on the Dow Jones with a Gauss, a Cauchy, and a Student left tail. The Gaussian Black–Scholes model underprices such insurance contracts, Cauchy overprices them, and the Student model, however, is a good match.

1   Introduction

The Gauss and Cauchy distributions are stable probability distributions. That is, the sum of independent Gauss or Cauchy random variables again follows a Gauss or Cauchy distribution, respectively. In a Gauss world, under the assumption of independent and identically distributed daily returns, the one-day return has the same mean but a T times greater variance than the average daily return over T days. In a Cauchy world, the average return over T days has the same location and the same scale as the one-day return (or the average over a century of daily returns for that matter). This divisibility for both the Cauchy and Gauss distributions allows for straightforward financial risk management applications for any risk horizon such as simple closed-form solutions for the pricing of stock options in the case of Gauss or the value-at-risk in the case of both Cauchy and Gauss. Gauss and Cauchy, however,

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are both not a good fit when it comes to actual stock returns. For daily stock market returns, I will reject both. The Student's t-distribution is a generalization of both Gauss and Cauchy, and it is a better match, especially for the left tail. Unfortunately, in a Student's world with the number of degrees of freedom strictly greater than one, the sum of independent variables is no longer t-distributed. The t-distribution is not stable and thus not divisible, which complicates risk management such as the pricing of options. On the plus side, however, our empirical evidence indicates that the number of degrees of freedom is strictly greater than two so that the variance is finite and the mean of independent returns converges (in distribution) to Gauss.

In this chapter, I propose to estimate the parameters of the probability distribution as if it were censored to put the focus to the most negative returns. The main idea is to model the outliers and not the regular ones because the outliers matter for the risk manager. In particular, for any given risk horizon, the tail risk is assumed to follow a Student's t-distribution without any distributional assumptions on the right tail. The parameters for location, scale, and the number of degrees of freedom are then estimated by maximizing the upper censored likelihood function. Finally, I demonstrate a valuation application to insure the Dow Jones against strongly negative returns.

2   Theoretical Background

The most commonly used model to measure financial risks is the so-called value-at-risk (see, e.g., Mefford et al. 2017). It is usually based on the Gauss distribution widely used for many applications in medicine, economics, business, science, education, and other fields. The analog of a Gaussian random walk in discrete time is the Brownian motion in continuous time. But according to Mandelbrot (1963), financial asset returns are not only non-Gaussian, but return variances are infinite, and the central limit theorem is therefore not applicable. An asset price can teleport from one level to another without warning, skipping all steps in between Mandelbrot comments:

> Despite the fundamental importance of Bachelier's process, which has come to be called 'Brownian motion,' it is now obvious that it does not account for the abundant data accumulated since 1900 by empirical economists, simply because the empirical distributions of price changes are usually too 'peaked' to be relative to samples from Gaussian populations.

The Cauchy distribution is, unlike the Gauss distribution, heavy-tailed and has an infinite variance. By definition, a random variable X is said to have a heavy (right) tail if the moment generating function $\mathbb{E}\left[e^{tX}\right]$ of X is infinite for all $t > 0$. In other words, the probability density function (pdf) of a heavy-tailed random variable goes to zero slower than the exponential function. The heavier the tail, the slower the pdf tends to zero and the higher the probability that we obtain one or more disproportionate values in a sample. The moment generating function of the

location-scale Gauss distribution exists, and therefore, the Gauss distribution is not heavy-tailed. A probability distribution with an infinite variance, such as Cauchy, is a sufficient condition for the distribution to be heavy-tailed but not necessarily the other way around. For example, the Student's t-distribution is heavy-tailed, but the variance is infinite only when the number of degrees of freedom is equal to two or smaller. According to Fama (1963), return distributions with an infinite variance such as Cauchy have massive implications on risk management:

> The infinite variance assumption of the stable Paretian model [of Mandelbrot (1963)] has extreme implications. From a purely statistical standpoint, if the population variance of the distribution of first differences is infinite, the sample variance is probably a meaningless measure of dispersion. Moreover, if the variance is infinite, other statistical tools (e.g., least-squares regression) which are based on the assumption of finite variance will, at best, be considerably weakened and may in fact give very misleading answers.

Extreme events happen much more often under Cauchy with an infinite variance than under Gauss with a finite variance. As extreme stock market shocks in March 2020, at the beginning of the Corona pandemic, have once again demonstrated, the Gaussian assumption seems to be seriously flawed for financial returns.

Table 1 lists the ten highest and lowest daily returns of the Dow Jones Industrial Average Index over a history of more than 126 years, three out of 20 extreme returns are from March 2020. Hence, Table 1 provides some evidence that stock returns

Table 1 The ranking is an excerpt of 31,835 daily logarithmic returns and normalized returns of the Dow Jones Industrial Average Index from 27 May 1896 to 17 February 2023 with the ten highest and lowest returns. In the last column, the daily returns are normalized by the estimated standard deviation of 1.1519%

#	Date	Log Return	Std Dev
1	15-Mar-1933	14.27%	12.39
2	06-Oct-1931	13.86%	12.04
3	30-Oct-1929	11.64%	10.10
4	22-Jun-1931	11.25%	9.76
5	24-Mar-2020	10.76%	9.34
6	21-Sep-1932	10.76%	9.34
7	13-Oct-2008	10.51%	9.12
8	28-Oct-2008	10.33%	8.96
9	21-Oct-1987	9.67%	8.39
10	03-Aug-1932	9.09%	7.89
⋮	⋮	⋮	⋮
31,826	12-Aug-1932	−8.78%	−7.62
31,827	06-Nov-1929	−10.44%	−9.07
31,828	12-Mar-2020	−10.52%	−9.14
31,829	05-Oct-1931	−11.36%	−9.86
31,830	29-Oct-1929	−12.48%	−10.83
31,831	18-Dec-1899	−12.77%	−11.09
31,832	16-Mar-2020	−13.84%	−12.02
31,833	28-Oct-1929	−14.47%	−12.56
31,834	14-Dec-1914	−22.97%	−19.95
31,835	19-Oct-1987	−25.63%	−22.25

follow a distributive pattern that might be closer to Cauchy than to Gauss. In a Gauss world, a three-sigma event indicates a realization that is three standard deviations or more below its expected value and has a 0.135 percent chance (135 in 100,000) of occurring. The expected frequencies according to Gauss diverge rapidly as I evaluate higher sigma levels. Historically, the standard deviation of daily returns on the Dow Jones is roughly 1%. Therefore, a daily return of −4% (or lower) is a four-sigma event and according to Gaussian principles highly unlikely. A four-sigma event is to be expected about every 31,574 days, or about once in 126 years (assuming 252 trading days per calendar year). Coincidentally, we have observed 31,835 daily returns from the Dow Jones, but instead of only one expected four-sigma event, we observe 125 (!) four-sigma events. According to the binomial distribution and 31,835 independent Gaussian draws, the probability of observing more than three four-sigma events is 0.38%. A daily return of −4% on the Dow Jones is therefore under Gauss roughly a once-in-a-century event, yet in the real world it happens on average once a year. A five-sigma event is to be expected according to Gauss every 3,488,556 days, or about 1 trading day every 13,843 years, yet we observe 57 such five-sigma events in 126 years (or around every second year). For events with sigmas as high as six or seven, the Gaussian distribution predicts their probabilities of occurrence as unbelievably low, yet we observe 36 six-sigma, 17 seven-sigma events, and even a 22-sigma event on 19 October 1987.

According to Mandelbrot and Taleb (2010), big jumps, such as the 22-sigma event on Black Monday (19 October 1987), often happen in financial markets because these institutions are social beasts subject to "wild randomness". But what is wild randomness according to Mandelbrot and Taleb?

> Simply put, it is an environment in which a single observation or a particular number can impact the total in a disproportionate way. The bell curve has 'thin tails' in the sense that large events are considered possible but far too rare to be consequential. But many fundamental quantities follow distributions that have 'fat tails' - namely, a higher probability of extreme values that can have a significant impact on the total.

To illustrate this point, a very small number of days account for the bulk of the stock market return as can be seen in Table 2. Going back to May 1896, in Table 2, we find that if an investor invested in the Dow Jones only for the 10 best days each decade, the average return per decade would stand at 48.0%. Conversely, if she invested throughout the whole decade without missing any trading day, the average return would stand at 48.3%. Thus, the average return by missing the 10 best days per decade is 0.3%, roughly zero, a negative real return and below the risk-free rate of return. Notably, in 9 out of the 14 decades, the cumulated return of the 10 best days is greater than the cumulated return throughout the whole decade. In other words, over the last 126 years of the history of the Dow Jones, just 10 trading days per decade (or the outliers of 0.4% of the number of observations) account for the average performance of 48%. The "regular" trading days (or 99.6% of the number of observations) have an average return of roughly zero. Therefore, while large deviations are rare, they cannot be pushed aside as "outliers" because, cumulatively, their impact over the long run is material.

Table 2 The table shows the cumulative logarithmic index return of the Dow Jones Industrial Average per decade of the 10 worst trading days and the 10 best trading days. The average stock market return per decade without the 10 best days is with 0.3% close to zero

Start	End	10 worst days	10 best days	Index return
27-May-1896	31-Dec-1899	−55.9%	51.3%	47.3%
01-Jan-1900	31-Dec-1909	−55.2%	44.7%	41.0%
01-Jan-1910	31-Dec-1919	−71.6%	40.6%	7.9%
01-Jan-1920	31-Dec-1929	−77.9%	58.6%	84.0%
01-Jan-1930	31-Dec-1939	−81.6%	103.7%	−50.5%
01-Jan-1940	31-Dec-1949	−49.9%	33.6%	29.0%
01-Jan-1950	31-Dec-1959	−34.5%	24.3%	122.0%
01-Jan-1960	31-Dec-1969	−28.6%	30.2%	16.4%
01-Jan-1970	31-Dec-1979	−30.7%	39.7%	4.7%
01-Jan-1980	31-Dec-1989	−74.6%	48.3%	118.9%
01-Jan-1990	31-Dec-1999	−41.8%	37.4%	142.9%
01-Jan-2000	31-Dec-2009	−66.3%	66.9%	−9.8%
01-Jan-2010	31-Dec-2019	−41.9%	36.4%	100.7%
01-Jan-2020	17-Feb-2023	−70.0%	60.0%	17.0%
Average per decade		−55.7%	48.0%	48.3%

The relevance of the outliers was the main lesson of the book "The Black Swan," written by Taleb (2008) before the financial market crisis that found bankers completely ignorant of randomness and risks. Such black swans means that rare events such as a sharp fall in a stock market occur more frequently than a Gauss distribution will forecast. Thus, as illustrated by Eberlein and Keller (1995), the Gauss curve is a poor model for stock returns. More recent research by Taleb (2008); Mandelbrot and Hudson (2010) came to the same conclusion as Mandelbrot (1963), confirming that returns are heavy-tailed and thus cannot follow a Gauss distribution. Mandelbrot (2009) shows that time series of financial asset prices are "dominated by details" or by extreme values ("black swans").

How much does it cost to protect a stock portfolio against "black swans"? Merton (1973); Black and Scholes (1973) provide an option pricing model to value such insurance contracts or far out-of-the-money put options, respectively. Surprisingly, against earlier empirical evidence provided by Mandelbrot (1963); Merton (1973), and Black and Scholes (1973) assume that logarithmic stock prices follow a Brownian motion, i.e., logarithmic returns are assumed to be Gaussian and the path of stock prices is continuous with no jumps (no black swans). By continuous dynamic hedging, in such a Gauss world, the put option payoff can perfectly be replicated with a long position in a risk-free zero-coupon bond and a short position in the underlying stock. Discontinuities, however, cannot be dynamically replicated. Therefore, Benoît Mandelbrot has beef with economists who model asset prices using Gaussian random walks. Asset prices, Mandelbrot noted, can be discontinuous, jumping instantly from one value to another without any graduated transition. Nonetheless, the entire basis behind Black–Scholes rests

on the possibility and necessity of dynamic hedging in a Gaussian world (see Derman and Taleb 2005). Hakansson's paradox (see Hakansson 1979) encapsulates the skepticism about dynamic replication: if options can only be priced because they can be replicated, then, since they can be replicated, why are they needed at all?

Not surprisingly then, Jarrow and Rudd (1982) show that the option pricing model of Merton (1973); Black and Scholes (1973) tends to undervalue far out-of-the-money put options. In fact, to adequately price out-of-the-money options, we have to resort to other probability distributions. Fama (1965) argues that a Cauchy distribution is a better fit than the Gauss distribution for stock returns. Blattberg and Gonedes (1974) argue that stock returns follow a Student's t-distribution. The non-parametric probability distribution estimated from option prices by using the method of Rubinstein (1994) also has a fatter tail than Gauss. Rubinstein (1994); Foresi and Wu (2005) refer to the fat left tail as "crash-o-phobia," alluding to the strong demand for put options on the S&P 500 Index to hedge against market crashes or black swans.

Taken together, all these facts should be enough to show that it is the so-called outlier and not the regular observation that we need to model in risk management. Hence, let us have a look at potential probability distributions to model asset returns.

3 Student, Cauchy, Gauss Distribution

The Student's t-distribution is the generalization of both Gauss and Cauchy. However, unlike the two latter distributions the former is in general not stable. In probability theory, a distribution is said to be stable if a linear combination of two independent variables with this distribution has the same distribution, up to location and scale.

3.1 Student's Distribution

The probability density function (pdf) of the location-scale Student's t-distribution is

$$\phi(x \mid \mu, \sigma, \nu) = \frac{1}{\sigma\sqrt{\pi}} \frac{\Gamma(\frac{\nu+1}{2})}{\sqrt{\nu}\,\Gamma(\frac{\nu}{2})} \left(1 + \frac{1}{\nu}\left(\frac{x-\mu}{\sigma}\right)^2\right)^{-\frac{\nu+1}{2}}, \qquad (1)$$

where $\nu \geq 1$ is the number of "degrees of freedom" and Γ is the gamma function:

$$\Gamma(z) = \int_0^\infty t^{z-1}e^{-t}\,dt,$$

with $\Gamma(1) = 1$ and $\Gamma(\frac{1}{2}) = \sqrt{\pi}$. The former equality is trivial, and the latter can be proven via the Gaussian integral (and a change from Cartesian coordinates to polar coordinates). The median of the location-scale Student's t-distribution is μ. If $\nu > 1$, then the expectation is μ; otherwise, the mean is undefined. If $\nu > 2$, then the variance is $\sigma^2 \frac{\nu}{\nu-2}$, for other values of ν the variance is undefined. The Student's t-distribution approaches the Gauss distribution as ν tends to infinity and smaller values of ν yield fatter tails. The t-distribution becomes the Cauchy distribution when ν is equal to one. Thus, the t-distribution can be regarded as the generalization of both the Gauss and Cauchy distributions.

By $\Phi(t \mid \mu, \sigma, \nu)$, we denote the corresponding cumulative distribution function (cdf) of the location-scale Student's t-distribution:

$$\Phi(t \mid \mu, \sigma, \nu) = \int_{-\infty}^{t} \phi(\xi \mid \mu, \sigma, \nu) \, d\xi = \int_{-\infty}^{\frac{t-\mu}{\sigma}} \sigma \, \phi(z \mid 0, 1, \nu) \, dz, \qquad (2)$$

where the second equality follows from the standardization $z = \frac{\xi - \mu}{\sigma}, dz = \frac{1}{\sigma} d\xi$. The location-scale t-distribution is useful for modeling financial returns with fatter tails (more prone to outliers) than the Gauss distribution yet thinner tails than the Cauchy distribution.

3.2 Cauchy's Distribution

For $\nu = 1$ in (1), we obtain the pdf of Cauchy. In other words, Cauchy is a special case of Student's t-distribution:

$$\phi(x \mid \mu, \sigma, 1) = \frac{1}{\sigma \pi} \left(1 + \left(\frac{x - \mu}{\sigma} \right)^2 \right)^{-1}. \qquad (3)$$

The characteristic function $\varphi_{X_1}(t)$ of the location-scale Cauchy random variable X_1 with the probability distribution function in (3) is a function of t:

$$\varphi_{X_1}(t) = \mathbb{E}\left[e^{it X_1} \right] = \frac{1}{\sigma \pi} \int_{-\infty}^{\infty} e^{itx} \left(1 + \left(\frac{x - \mu}{\sigma} \right)^2 \right)^{-1} dx = e^{\mu i t - \sigma |t|},$$

where i is the so-called imaginary unit or unit imaginary number. The distribution of a random variable is determined uniquely by its characteristic function (see Karr 1993, p. 167). The average $\frac{1}{n}(X_1 + X_2 + \cdots + X_n)$ of n independent and identically distributed (i.i.d.) Cauchy random variables has the same distribution as X_1:

$$\varphi_{\frac{1}{n}(X_1 + X_2 + \cdots + X_n)}(t) = \prod_{j=1}^{n} \mathbb{E}\left[e^{it \frac{X_j}{n}} \right] = e^{\sum_{j=1}^{n} \mu i \frac{t}{n} - \sum_{j=1}^{n} \sigma |\frac{t}{n}|} = e^{\mu i t - \sigma |t|} = \varphi_{X_1}(t).$$

In fact, today's return has the same distribution as the average over a century of daily returns. Thus, under Cauchy, the interquartile range as a measure of dispersion of the average is the same whether you have one or 25,200 observations.

3.3   Gauss' Distribution

For $\nu \to \infty$ in (1), we obtain the probability density function of Gauss. In other words, Gauss is like Cauchy also a special case of the Student's t-distribution:

$$\lim_{\nu \to \infty} \phi(x \mid \mu, \sigma, \nu) = \frac{1}{\sigma \sqrt{2\pi}} \exp\left(-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right). \tag{4}$$

To see that Student's t-distribution converges to the Gauss distribution for $\nu \to \infty$, note first that the probability density function $\phi(x \mid \mu, \sigma, \nu)$ is absolutely continuous with the property that $\int_{-\infty}^{\infty} \phi(\xi \mid \mu, \sigma, \nu)\, d\xi = 1$ so that for any $\nu \in \mathbb{R}$:

$$\int_{-\infty}^{\infty} \left(1 + \frac{1}{\nu}\left(\frac{x-\mu}{\sigma}\right)^2\right)^{-\frac{\nu+1}{2}} dx = \sigma \sqrt{\pi} \frac{\sqrt{\nu}\,\Gamma(\frac{\nu}{2})}{\Gamma(\frac{\nu+1}{2})}. \tag{5}$$

For large ν, the sequence $\frac{\sqrt{\nu}\Gamma(\frac{\nu}{2})}{\Gamma(\frac{\nu+1}{2})}$ in (5) converges to $\sqrt{2}$, as can be seen via an application of Laplace's method. Second, by the so-called product rule of limits, sometimes also called the multiplication property of limits, the limit of the sequence of the functions in (1) can be written as

$$\lim_{\nu \to \infty} \phi(x \mid \mu, \sigma, \nu) = \frac{1}{\sigma \sqrt{\pi}} \lim_{\nu \to \infty} \frac{\Gamma(\frac{\nu+1}{2})}{\sqrt{\nu}\,\Gamma(\frac{\nu}{2})} \frac{\lim_{\nu \to \infty}\left(1 + \frac{1}{\nu}\left(\frac{x-\mu}{\sigma}\right)^2\right)^{-\frac{1}{2}}}{\lim_{\nu \to \infty}\left(1 + \frac{1}{\nu}\left(\frac{x-\mu}{\sigma}\right)^2\right)^{\frac{\nu}{2}}}. \tag{6}$$

Trivially, the sequence of functions in the numerator in (6) converges to one. By the definition of Euler's exponential function, $e^x = \lim_{n \to \infty}\left(1 + \frac{x}{n}\right)^n$, we obtain the following limit for the sequence of functions in the denominator in (6):

$$\lim_{\nu \to \infty} \left(1 + \frac{1}{\nu}\left(\frac{x-\mu}{\sigma}\right)^2\right)^{\frac{\nu}{2}} = \lim_{n \to \infty}\left[1 + \frac{\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}{n}\right]^n = e^{\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}.$$

Third and lastly, the first factor in (6) is the reciprocal of (5) and converges to $\frac{1}{\sigma\sqrt{2\pi}}$ by Laplace's method. Alternatively, we can make use of the fact that the area under

the probability density function must be one. Hence, by variable substitutions $z = \frac{x-\mu}{\sigma}$, $dx = \sigma\, dz$ and $z = \sqrt{2\,y}$, $dz = 2^{-\frac{1}{2}} y^{-\frac{1}{2}} dy$, we also obtain

$$\int_{-\infty}^{\infty} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2} dx = 2\sigma \int_{0}^{\infty} e^{-\frac{1}{2}z^2} dz = \sqrt{2}\,\sigma \int_{0}^{\infty} y^{-\frac{1}{2}} e^{-y} dy$$

$$= \sqrt{2}\sigma\, \Gamma\left(\frac{1}{2}\right) = \sigma\sqrt{2\pi}.$$

In the following, I will use the shorthand $\Phi(t \mid \mu, \sigma, \infty) = \int_{-\infty}^{t} \lim_{v\to\infty} \phi(\xi \mid \mu, \sigma, v)\, d\xi$ to denote the cumulative distribution function (cdf) of a Gauss distribution with mean μ and variance σ^2.

The characteristic function $\varphi_{Y_1}(t)$ of the location-scale Gauss random variable Y_1 with the probability distribution function in (4) is given by:

$$\varphi_{Y_1}(t) = \mathbb{E}\left[e^{itY_1}\right] = \frac{1}{\sigma\sqrt{2\pi}} \int_{-\infty}^{\infty} e^{ity} e^{-\frac{1}{2}\left(\frac{y-\mu}{\sigma}\right)^2} dy = e^{\mu\, i\, t - \frac{1}{2}\sigma^2 t^2},$$

so that the average $\frac{1}{n}(Y_1 + Y_2 + \cdots + Y_n)$ of n independent and identically distributed Gaussian variables is again Gaussian with location μ but with a scale of $\frac{\sigma}{\sqrt{n}}$:

$$\varphi_{\frac{1}{n}(Y_1+Y_2+\cdots+Y_n)}(t) = \prod_{j=1}^{n} \mathbb{E}\left[e^{it\frac{Y_j}{n}}\right] = e^{\sum_{j=1}^{n} \mu\, i\, \frac{t}{n} - \sum_{j=1}^{n} \frac{1}{2}\sigma^2\left(\frac{t}{n}\right)^2} = e^{\mu\, i\, t - \frac{1}{2}\frac{\sigma^2}{n} t^2}.$$

In fact, the expectation of today's return is the same as the expectation of the average over a century of daily returns, yet the variance over 1 day is 25,200 times greater. The standard deviation of daily returns is roughly 1% and the mean close to zero. Thus, under Gauss, the average return over a decade with 2520 trading days has a standard deviation of 0.02%.

4   Empirical Analysis

In this section, I first introduce the uncensored and the censored likelihood model (see Maddala (1983) for an introduction) to estimate the parameters of the location-scale t-distribution from the time series of daily returns. I then present the empirical results and the goodness-of-fit.

4.1 Estimation Methodology

The standard way to estimate the parameters μ, σ, ν of a location-scale t-distribution in (1) for the time series of logarithmic returns is to maximize the likelihood given the observed sample $\{R_1, R_2, \ldots, R_T\}$. The random variable R_t is the logarithmic return from trading day $t - 1$ to t:

$$R_t = \log I_t - \log I_{t-1}, \tag{7}$$

where the log operator describes the natural logarithm and I_t is the closing price at trading day t of the underlying asset such as the Dow Jones Industrial Average Index. Under independent and identically distributed (i.i.d.) daily returns, the (uncensored) logarithmic likelihood function L looks as follows:

$$L(\mu, \sigma, \nu \mid R_1, \ldots, R_T) = \sum_{t=1}^{T} \log \phi(R_t \mid \mu, \sigma, \nu). \tag{8}$$

I speak of a constrained optimization if I fix one or two parameters, say $\nu = 1$, and then maximize the logarithmic likelihood function under this restriction. The assumption of an i.i.d. sample contradicts the findings of Engle (1982); Bollerslev (1986) and others of strong serial correlations in squared returns, but it is nonetheless more general than the i.i.d. Gaussian assumption of Black and Scholes (1973).

I will impose less stringent distributional assumptions than needed for the likelihood function in (8). I assume that the variables $\{R_1, \ldots, R_T\}$ of the time series of logarithmic returns are i.i.d. in the left tail only, in the sense that for a fixed and known $c \in \mathbb{R}$, $\mathbb{P}\{R_t > c, R_s > c\} = \mathbb{P}\{R_t > c\}\,\mathbb{P}\{R_s > c\}$ for all $t \neq s$ and $\mathbb{P}\{R_t \leq x, R_s \leq y\} = \mathbb{P}\{R_t \leq x\}\,\mathbb{P}\{R_s \leq y\}$ for all $t \neq s$ and all $x \leq c, y \leq c$. Furthermore, I assume that the left tail follows a location-scale t-distribution in the sense that $\mathbb{P}\{R_t \leq x\} = \Phi(x \mid \mu, \sigma, \nu)$ for all $x \leq c$ and all t. Note the random variables $\{R_1, \ldots, R_T\}$ are not assumed to be i.i.d., and I do not impose explicit distributional assumptions on realizations greater than the fixed and known cutoff value c. I only say that the left tail, for values smaller than the cutoff c, follows a Student's t-distribution and with a probability of $\mathbb{P}\{R_t > c\} = \Phi(-c + 2\mu \mid \mu, \sigma, \nu)$ I do not end up in the left tail. As a consequence, the probability density function on the left tail for realizations R_t smaller than c is $\phi(\cdot \mid \mu, \sigma, \nu)$. Hence, under my assumptions, the (upper censored) logarithmic likelihood function $\mathcal{L}$ for the estimation of the parameters μ, σ, ν for a fixed cutoff value c is given by

$$e^{\mathcal{L}(\mu, \sigma, \nu \mid R_1, \ldots, R_T, c)} = \prod_{\{R_t \leq c\}} \phi(R_t \mid \mu, \sigma, \nu) \prod_{\{R_t > c\}} [1 - \Phi(c \mid \mu, \sigma, \nu)]$$

$$\mathcal{L}(\mu, \sigma, \nu \mid R_1, \ldots, R_T, c) = \sum_{\{R_t \leq c\}} \log \phi(R_t \mid \mu, \sigma, \nu)$$

$$+ \sum_{\{R_t > c\}} \log [1 - \Phi(c \mid \mu, \sigma, \nu)] \tag{9}$$

$$= \sum_{\{R_t \leq c\}} \log \phi(R_t \mid \mu, \sigma, \nu)$$

$$+ \log\left[1 - \Phi(c \mid \mu, \sigma, \nu)\right] \sum_{t=1}^{T} \mathbf{1}_{\{R_t > c\}},$$

where $\mathbf{1}_{\{\cdot\}}$ is the indicator function. All observations greater than c have exactly the same contribution to the likelihood value $\mathcal{L}$. The function $\mathcal{L}$, however, distinguishes among the relevant observations smaller than c. Finally, the censored likelihood function $\mathcal{L}$ in (9) becomes the uncensored likelihood function L in (8) when $c \to \infty$, because all observations are then smaller than c and become relevant.

4.2 Estimation Results

Figure 1 shows the histogram of daily returns of the Dow Jones from May 1896 to February 2023 and the fitted theoretical distributions. The parameters of the Cauchy, Gauss, and Student distribution are estimated by maximizing the constrained (with
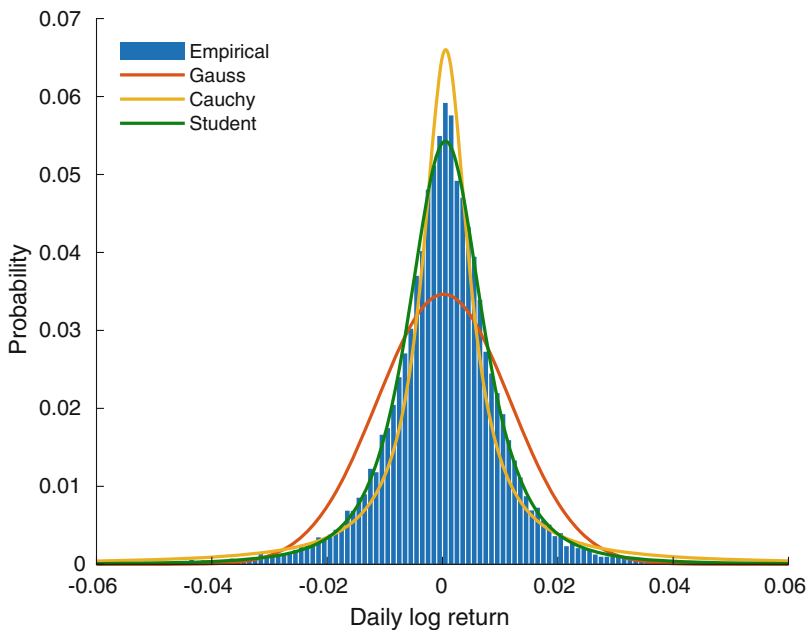
Fig. 1 The figure shows the histogram of observed daily returns from May 1896 to February 2023 of the Dow Jones Industrial Average Index with a bin size of 0.1% and the fitted distributions of Gauss, Cauchy, Student
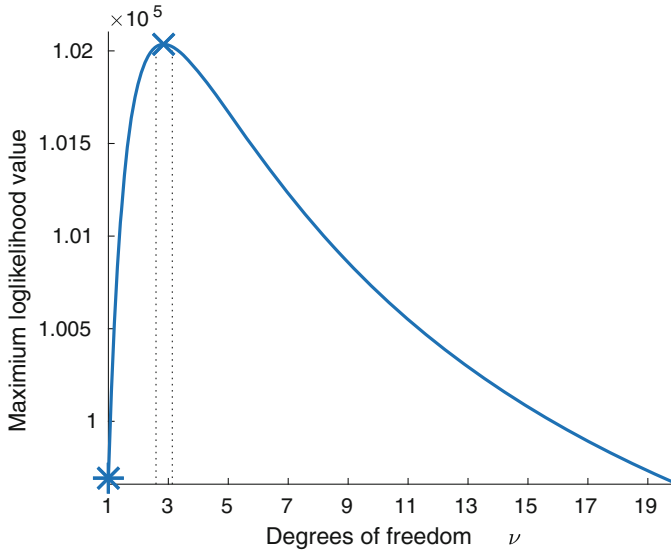
Fig. 2 The figure shows the constrained logarithmic maximum likelihood value L for different fixed degrees of freedom ν with the sample of daily logarithmic returns. The maximum of 102,035.37 is at the point $\hat{\nu} = 2.843$. The confidence interval between 2.589 and 3.132 at the 99% confidence is computed via the likelihood ratio test, $-2 \times \log \frac{\text{likelihood}(\nu)}{\text{likelihood}(\hat{\nu})} \sim \chi^2_{<1>}$, i.e., values of ν that result in a p-value greater than 1% are within the 99% confidence interval. The null of a Cauchy distribution ($\nu = 1$) and of a Gaussian distribution ($\nu = \infty$) are clearly rejected. Gauss has a logarithmic maximum likelihood value of 97,103.75, Cauchy of 99,693.17. Based on the likelihood ratio test, Cauchy provides a significantly better fit to daily returns than Gauss

a fixed parameter $\nu = 1$ and $\nu \to \infty$, respectively) and the unconstrained likelihood function L in (8), respectively. Just by visual inspection, we see that the Cauchy distribution produces too many outliers compared to the actual returns, i.e., the tails are too fat. Conversely, the tails of Gauss are too thin and the peak too flat. Thus, Fig. 1 graphically illustrates the departure from both the Gauss and Cauchy distributions. The Student's t-distribution, however, seems to be an adequate description of the empirical distribution.

Figure 2 shows the (constrained) logarithmic maximum likelihood value L in (8) as a function of a given ν. The confidence interval for ν is between 2.589 and 3.132 at the 99% confidence level. Therefore, the Gauss and Cauchy distributions are outside the confidence bounds, i.e., I reject both distributions. I therefore implicitly accept the null hypothesis of a heavy-tailed distribution. But I clearly reject the infinite variance hypothesis of Mandelbrot (1963), ν is significantly greater than two. Cassidy et al. (2010) find that a t-distribution with $\nu = 2.65$ number of degrees of freedom provides the best fit when looking at the past 100 years of daily Dow Jones returns or 21,186 data points. I have 31,835 data points and a slightly higher maximum likelihood estimate of $\nu = 2.84$, but $\nu = 2.65$ is within my 99% confidence bounds.

Table 3 The table lists the maximized logarithmic likelihood value L in (8) for daily, weekly, and monthly logarithmic returns of the Dow Jones Industrial Average Index from May 1896 to February 2023. For all three horizons the Student is significantly better than both Gauss and Cauchy

Distribution	Daily	Weekly	Monthly
Gauss	97,103.75	15,003.78	2290.76
Cauchy	99,693.17	15,007.89	2268.50
Student	102,035.37	15,608.69	2416.17

By performing the so-called likelihood ratio test, we observe that the Cauchy distribution offers a significantly better fit than the Gauss distribution as can be obtained from Table 3. Namely, logarithmic likelihood differences smaller than 7.7 are insignificant at the 95% confidence level according to the likelihood ratio test (and a one-parameter restriction). Differences greater than 13.3 are significant at the 99% confidence level. Similarly, we see in Table 3 that for weekly returns the difference between Cauchy and Gauss is insignificant. For monthly returns, the goodness-of-fit for Gauss is significantly better than for Cauchy. But for all three time horizons Student's t-distribution is a significantly better match than both Gauss and Cauchy.

The two time series in Fig. 3 represent the sequentially estimated volatility $\hat{\sigma}_T$ of daily logarithmic returns at day $T > 1$:

$$\hat{\sigma}_T^2 = \frac{1}{T-1} \sum_{t=1}^{T} R_t^2, \tag{10}$$

by assuming that the expected daily return is zero. The first time series is calculated from observed daily returns, and the second series is a simulated time series of i.i.d. t-distributed variables with $\nu = 2.84$ degrees of freedom. The estimated volatility $\hat{\sigma}_T$ of the observed time series seems to converge very slowly because of a few but large jumps. The same is true for the simulated time. Mandelbrot (1963) argued that the estimated variance does not seem to converge:

> The tails of the distributions of price changes are in fact so extraordinarily long that the sample second moments [estimated variances] typically vary in an erratic fashion. For example, the second moment [variance] [. . .] does not seem to tend to any limit even though the sample size is enormous by economic standards.

If daily returns are i.i.d. t-distributed with degrees of freedom smaller than two, then the estimated variance will indeed not converge (in probability) to a constant since the true variance is then not defined. Hence, in our case, since ν is greater than two, the true variance is finite and the time series (10) will eventually converge (in probability) for $T \to \infty$ due to the weak law of large number (see, e.g., Karr 1993), even if only very slowly. Figure 3 ultimately indicates that daily returns cannot be Cauchy since the sample variance (10) seems to converge and does not "vary in an erratic fashion."
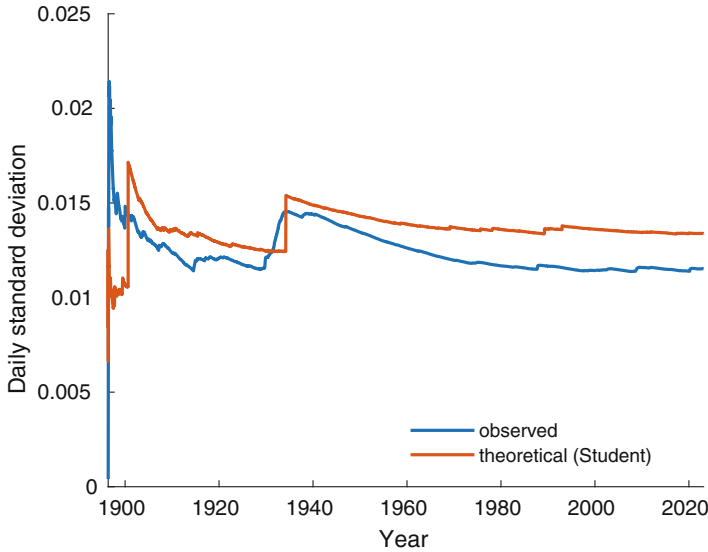
Fig. 3 The figure shows the estimated rolling standard deviation under the realized daily logarithmic returns of the Dow Jones and the estimated standard deviation under a simulated time series of i.i.d. Student's t-distribution with $\nu = 2.84$ number of degrees of freedom

The generalization of the uncensored likelihood L in (8) is the censored likelihood $\mathcal{L}$ in (9) by supposing that only the left tail for values smaller than c is t-distributed. Table 4 lists the censored maximum likelihood values $\mathcal{L}$. For a cutoff of $c = -3\%$, the left tail of the return distribution is best modeled with $\nu = 3.93$ number of degrees of freedom. For a cutoff of $c = -2\%$, the optimal value is at $\nu = 3.75$. Of course, for $c \to \infty$, the censored and uncensored models coincide and the maximum likelihood value is again at $\nu = 2.84$. In other words, the estimated number of degrees of freedom for the left tail is greater than for the right tail. The fact that the estimated ν differs materially for different cutoff values c shows that the actual time series cannot be i.i.d. t-distributed; otherwise, the cutoff c must have no impact on the estimated parameters. Similarly, the fact that the estimated σ under Gauss differs significantly for different cutoffs implies that the actual observations cannot be i.i.d. Gaussian distributed.

4.3   Goodness-of-Fit

How well can a left tail that follows a location-scale t-distribution explain actual outliers? In particular, how well can the t-distribution describe the sum of the 10 worst daily returns per decade? We therefore compare, via a bootstrap analysis, Laplace's and Gauss' distribution with Student's t-distribution. The probability

Table 4 The table shows, for a fixed number of degrees of freedom (dof) ν, the location parameter μ, the scale parameter σ, both estimated by the upper censored likelihood function in (9) and the maximized logarithmic likelihood value $\mathcal{L}$ for two different cutoff values $c = -3\%$ and $c = -2\%$

Tail	dof	$c = -3\%$			$c = -2\%$		
	ν	$\mu \times 10^4$	$\sigma \times 10^4$	$\mathcal{L}$	$\mu \times 10^4$	$\sigma \times 10^4$	$\mathcal{L}$
Cauchy	1	−0.00	12.73	−1061.18	−0.00	21.92	−1352.43
Student	1.5	−0.00	32.70	−960.85	−0.00	41.53	−1128.61
Student	2	−0.00	50.13	−911.52	−0.00	55.40	−1030.51
Student	2.5	−0.00	63.59	−888.21	−0.00	65.22	−991.16
Student	3	−0.00	73.90	−879.24	6.64	74.77	−981.33
Student	3.5	2.47	82.61	−878.37	32.75	90.14	−979.57
Student	3.75	41.95	97.01	−877.64	44.67	97.32	−979.39
Student	3.93	55.32	103.32	−877.61	52.71	102.22	−979.47
Student	4	60.04	105.57	−877.61	55.53	103.95	−979.53
Student	5	124.30	137.08	−878.29	93.21	127.46	−982.01
Student	6	176.64	163.79	−879.58	123.02	146.52	−985.88
Student	7	219.96	186.45	−881.08	147.19	162.21	−990.11
Student	8	256.37	205.82	−882.61	167.20	175.32	−994.31
Student	9	287.43	222.54	−884.11	184.08	186.45	−998.31
Student	10	314.26	237.10	−885.53	198.53	196.02	−1002.06
Student	100	658.48	426.20	−912.88	378.11	314.24	−1072.40
Student	200	693.95	445.20	−916.31	397.78	326.58	−1082.14
Student	500	717.61	457.78	−918.61	411.62	335.13	−1088.98
Student	1000	725.96	462.20	−919.42	416.70	338.24	−1091.47
Gauss	∞	734.57	466.75	−920.24	422.06	341.51	−1094.05

density function of Laplace is an alternative to the t-distribution and given by

$$f(x \mid \mu, b) = \frac{1}{2b} \exp\left(-\frac{|x - \mu|}{b}\right). \tag{11}$$

The mean and variance of Laplace's distribution are μ and $2b^2$. The mean and variance of Gauss' distribution in (4) are μ and σ^2. We will estimate μ, σ^2, and b by the method of moments (see, e.g., Chapter 14 in Hamilton (1994)) from the sample of daily returns.

The bootstrap was originally introduced by Efron (1979). The main idea of bootstrapping is that inference about a sample statistic (e.g., the sum of the ten worst log returns in a decade) from an unknown population (theoretical distribution of daily returns) can be modeled by resampling the sample (empirical distribution of daily returns) and performing inference about sample statistic (distribution of the ten worst log returns in a decade) from resampled data (e.g., by assuming that daily returns are independent and identically distributed).

Here, our statistic of interest is the sum of the 10 lowest daily returns over a decade or 2520 draws. We sample with replacement 2520 times from our set of 31,835 observed daily returns, select the 10 lowest returns among the 2'520 draws, and calculate the sum of these 10 logarithmic returns. We redo this sampling from the empirical distribution 10 million times to obtain the bootstrapped distribution of our statistic of interest, namely the sum of the ten lowest logarithmic returns.

To compare the bootstrapped distribution to theoretical alternatives, we also sample from the Gauss distribution in (4), the Laplace distribution in (11) with the parameters μ, σ, b estimated via the method of moments:

$$\hat{\mu} = \frac{1}{T} \sum_{t=1}^{T} R_t, \ \ \hat{\sigma}^2 = \frac{1}{T-1} \sum_{t=1}^{T} \left(R_t - \hat{\mu} \right)^2 \text{ and } \hat{b}^2 = \frac{1}{2} \hat{\sigma}^2,$$

and from Student's location-scale t-distribution in (1) with the parameters $\hat{v} = 3.934$, $\hat{\mu} = 0.553\%$, $\hat{\sigma} = 1.033\%$, estimated by the censored maximum likelihood estimator in Eq. (9) and a cutoff value of -3%.

As can be seen in Fig. 4, the distribution of the ten worst returns bootstrapped from the empirical distribution is not well described by Laplace and Gauss. In fact, the distributions of the sum of the ten worst days between the empirical distribution
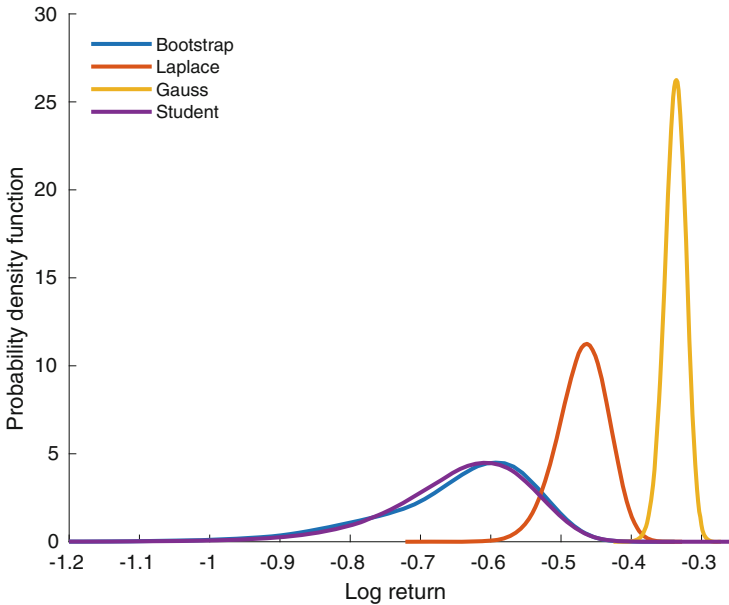
Fig. 4 The figure shows the cumulative return distribution over the worst 10 days from 2520 draws, when the 2520 daily returns are bootstrapped from the empirical distribution, drawn from the Laplace distribution, from the Gauss distribution, and from Student's t-distribution with $v = 3.934$ number of degrees of freedom
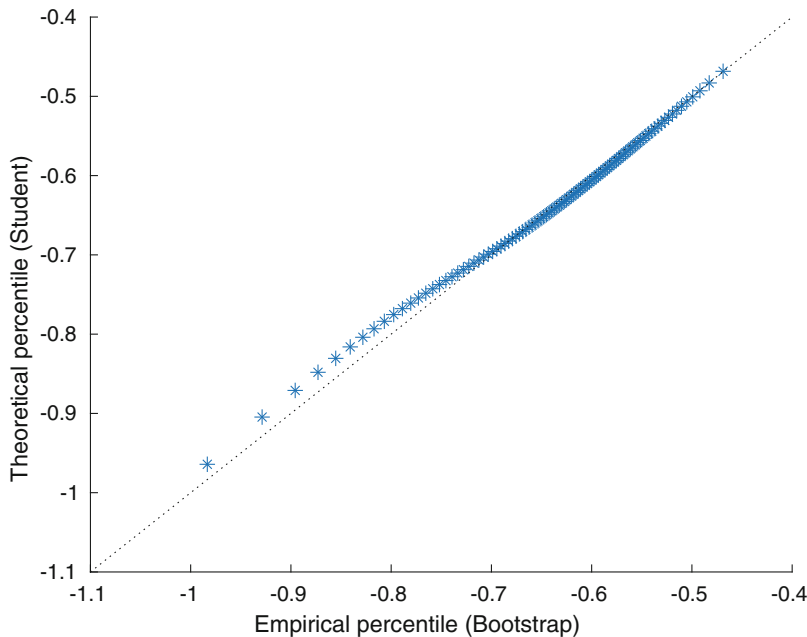
Fig. 5 The figure shows the percentile–percentile plot of the cumulative return distribution of the 10 worst daily returns out of 2'520 draws when the returns are bootstrapped from the empirical distribution and from the theoretical t-distribution with $\nu = 3.934$, $\mu = 0.553\%$, $\sigma = 1.033\%$ (estimated by the censored maximum likelihood and a cutoff value c of -3%)

and the Laplace distribution hardly intersect, i.e., Laplace's first decile of -51.6% is greater than the ninth decile of the bootstrapped distribution of -52.7%. In other words, if the daily returns were i.i.d. drawn from the Laplace distribution, then the probability for the sum of the 10 worst days being -51.6% or worse was only 10% when in fact the bootstrap says it is more than 90%. The Gauss distribution is even worse, a complete misfit, and Gauss' first percentile of -37.5% is even greater than the 99th percentile of the bootstrapped distribution of -46.9%. Student's t-distribution, however, offers a good fit as can especially well be observed in the percentile–percentile plot in Fig. 5, i.e., the bootstrapped quantiles coincide quite exactly with the theoretical quantiles. For instance, the fifth percentiles are -85.6% (bootstrapped) and -84.3% (t-distribution), and the second percentiles are -92.9% (bootstrapped) and -92.2% (t-distribution). Both Laplace and Gauss are not heavy-tailed, unlike the Student's t-distribution. Therefore, to explain the outliers in daily stock market returns, we have to resort to heavy-tailed probability distributions, at least to adequately model the left tail.

5 Application

The Student's t-distribution seems to be an adequate fit to describe stock market returns, especially for the left tail. Not heavy-tailed distributions do not provide a good fit. As a proof of concept, let us apply the empirical findings from the above for the purpose of option pricing. Imagine you want to protect a well-diversified stock portfolio replicating an equity index such as the Dow Jones Industrial Average Index or the S&P 500 against extremely negative daily returns, say -10% or worse. You pay at the end of each trading day an insurance fee relative to the value of the stock portfolio at closing. In return you obtain portfolio protection: If the next day index return is worse than -10%, the difference between -10% and the realized index return times the portfolio value at the previous close is the insurance payoff. For instance, yesterday's portfolio value was 10,000 dollars, and the next day's index return is -15%. The portfolio value is now 8500 dollars, and your insurance contract pays off 5% of 10,000 dollars or 500 dollars. Hence, the total portfolio loss is only 1000 dollars or 10%. Of course, if the return is greater than -10%, there is no insurance payoff. You buy protection at the end of each trading day for the following trading day. Such a contract is in essence a swap agreement in which one party, the insuree, makes payments based on a fixed rate, while the other party, the insurer, makes payments based on the return of the underlying asset. What is the fair rate or the insurance fee, respectively? It depends on the probability distribution, and Gauss and Cauchy are two possible candidates. The Student's location-scale t-distribution is a generalization of both and therefore my distribution of choice.

In effect, in order to price this insurance contract, I have to value a European put option on the stochastic logarithmic return R with a fixed floor c and therefore the following payoff at the end of the period (i.e., payout at the following day):

$$(e^c - e^R)\,\mathbf{1}_{\{R \leq c\}}, \tag{12}$$

where the cutoff value c is fixed, $(e^c - e^R)$ is the payoff of a short position in a forward contract, $(e^R - e^c)$ is the payoff of the corresponding long position, $\mathbf{1}_{\{R \leq c\}}$ is the payoff of a digital put option, $\mathbf{1}_{\{R > c\}}$ is the payoff of the corresponding binary call option. In our above example, R is the one-day return of the Dow Jones and the cutoff c is -10%.

The left tail of R for realizations smaller than c is assumed to follow a location-scale t-distribution with the parameters μ, σ, ν. Therefore, the expectation of the payoff in (12) is given by

$$\mathbb{P}\{R \leq c\}\left\{e^c - \mathbb{E}\left[e^R \,\middle|\, R \leq c\right]\right\} = e^c\,\Phi(c \mid \mu, \sigma, \nu) - \int_{-\infty}^{c} e^\xi\,\phi(\xi \mid \mu, \sigma, \nu)\,d\xi, \tag{13}$$

where the discounted expected payoff is today's option price. Since the risk-free rate and the risk premium are negligible over short time horizons such as 1 day or

1 week, the expected payoff in (13) is already a close approximation of the option price.

Table 5 lists the expected payoff in (13) under a Student tail, a Cauchy and a Gauss tail as well as the historical conditional mean as our non-parametric benchmark for different cutoff values c. The parameters μ, σ, ν of the location-scale t-distribution used to produce Table 5 are estimated with the unconstrained and constrained (with $\nu \to \infty$ and $\nu = 1$) censored likelihood function $\mathcal{L}$ in (9) with the cutoff value $c = -3\%$. In our above example with $c = -10\%$ and an average portfolio value of USD 10,000, the insuree would have to make a yearly payment of only USD 2.51 under Gauss, USD 1861.70 under Cauchy, USD 22.46 under Student, and USD 30.27 under the empirical distribution. From Table 5, it is evident that Gauss highly underestimates the put option value for strongly negative returns when compared with the empirical distribution. Conversely, Cauchy highly overestimates the put price. The Student's t-distribution, however, seems to adequately price the far out-of-the-money put options. For the binary put option payoff $\mathbf{1}_{\{R \leq c\}}$ with $c = -15\%$ and an average portfolio value of USD 10,000, the insuree would have to make a yearly payment to the insurer of only one cent under the Gauss distribution, USD 27.02 under the Cauchy distribution, 63 cents under Student's distribution, and 63 cents under the empirical distribution. Again, we observe an overestimation of Cauchy, an underestimation of Gauss, and a good match of the Student. If the censored likelihood model in (9) is estimated with a threshold that equals the strike value (i.e., if the same c in (9) and (13) is used), then the Gauss tail provides an adequate option value as well, but the scale estimate σ increases with a decreasing cutoff c producing the famous volatility smile (see, e.g., Dupire (1994), Derman et al. (1996)). For instance, in Table 4, the volatility estimate σ under Gauss is 3.41% with $c = -2\%$ and 4.67% with $c = -3\%$. Without this volatility adjustment based on the strike level e^c, the Black–Scholes model completely underprices far out-of-the-money put options.

6 Conclusion

Given the same median and interquartile range, the Cauchy distribution produces more extreme outcomes than the Gauss distribution. For daily stock market returns, I show that the Cauchy distribution is a significantly better fit than the Gauss distribution. The problem with the Gauss curve is that it disregards the possibility of sharp jumps. Mandelbrot and Taleb (2010) once famously noted that financial time series are "dominated by details" or the extreme observations. To showcase Mandelbrot's and Taleb's point, I compute the average return per decade (with 14 decades observed) of the Dow Jones starting in May 1896 with and without the ten largest daily observations. The two averages are 48.3% and 0.3% and hence completing different, implying that the ten best days per decade with an average of 48.0% explain the whole return. To ignore the outliers (or the details in Mandelbrot's vocabulary) is to ignore reality.

Table 5 The table shows the expected payoffs in basis points for a put option with payoff $N\,(e^c - e^R)\,\mathbf{1}_{\{R \le c\}}$ with $N = 252$ for the average number of trading days per calendar year and the value in basis points for a digital put option with payoff $\mathbf{1}_{\{R \le c\}}$ under a Gauss tail with mean $\mu = 7.35\%$, standard deviation $\sigma = 4.67\%$, a Cauchy tail with location $\mu = -1.36 \times 10^{-8}$, scale $\sigma = 0.1273\%$, a Student tail with location $\mu = 0.55\%$, scale $\sigma = 1.03\%$, $\nu = 3.93$ number of degrees of freedom, and the historically observed empirical tail

Cutoff	$N\,\mathbb{E}\left[(e^c - e^R)\,\mathbf{1}_{\{R \le c\}}\right] \times 10^4$				$\mathbb{P}\{R \le c\} \times 10^4$			
c	Gauss	Cauchy	Student	Historic	Gauss	Cauchy	Student	Historic
-26%	0.00	1035.46	1.23	0.00	0.00	15.59	0.08	0.00
-25%	0.00	1066.50	1.40	0.39	0.00	16.21	0.09	0.31
-24%	0.00	1099.14	1.59	1.01	0.00	16.89	0.11	0.31
-23%	0.00	1133.50	1.82	1.63	0.00	17.62	0.13	0.31
-22%	0.00	1169.75	2.10	2.88	0.00	18.42	0.15	0.63
-21%	0.00	1208.07	2.43	4.16	0.00	19.30	0.18	0.63
-20%	0.00	1248.67	2.83	5.45	0.00	20.26	0.21	0.63
-19%	0.00	1291.77	3.32	6.75	0.00	21.33	0.26	0.63
-18%	0.00	1337.67	3.92	8.07	0.00	22.51	0.32	0.63
-17%	0.00	1386.67	4.67	9.40	0.00	23.84	0.40	0.63
-16%	0.01	1439.17	5.62	10.74	0.00	25.33	0.50	0.63
-15%	0.02	1495.62	6.83	12.09	0.01	27.02	0.63	0.63
-14%	0.05	1556.57	8.40	13.79	0.02	28.95	0.82	0.94
-13%	0.14	1622.70	10.47	16.44	0.06	31.17	1.08	1.26
-12%	0.38	1694.85	13.25	20.11	0.17	33.77	1.45	1.88
-11%	1.00	1774.06	17.08	24.60	0.42	36.84	1.99	2.20
-10%	2.51	1861.70	22.46	30.28	0.99	40.52	2.82	2.83
-9%	6.07	1959.55	30.29	36.76	2.27	45.03	4.11	2.83
-8%	14.09	2070.04	42.06	45.44	4.98	50.65	6.24	5.65
-7%	31.42	2196.56	60.55	62.00	10.45	57.89	9.93	10.99
-6%	67.30	2344.09	91.18	92.98	21.04	67.54	16.73	15.71
-5%	138.54	2520.32	145.38	145.54	40.59	81.04	30.34	30.47
-4%	274.20	2738.17	249.64	251.11	75.11	101.28	60.34	63.45
-3%	522.01	3021.81	473.02	475.45	133.31	135.01	135.09	135.07

The Student's t-distribution is a generalization of both Cauchy and Gauss. I reject the null hypothesis of a Cauchy distribution for daily returns in favor of the alternative hypothesis of a Student's t-distribution. But I also reject the null hypothesis that the number of degrees of freedom is two or smaller. Thus, the variance is a valid measure of dispersion, i.e., I cannot accept the infinite variance hypothesis of Mandelbrot (1963).

I propose to estimate the parameters of the probability density function as if the sample were upper censored to put the focus to the extremely negative observations. In particular, for any given risk horizon, the tail risk is assumed to follow a Student's t-distribution without any distributional assumptions on the rest of the distribution. The parameters for location, scale, and the number of degrees of freedom are then

estimated by maximizing the upper censored likelihood function. As a proof of concept, I show an option pricing application under a Gauss-distributed, a Cauchy-distributed, and a t-distributed left tail to insure the Dow Jones against materially negative daily returns. My findings demonstrate that the standard Gaussian option pricing model of Black and Scholes (1973); Merton (1973) massively underprices such insurance contracts. On the other hand, the Cauchy model extremely overprices such far out-of-the-money put options. The Student's t-distribution, however, offers sensible valuations.

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Household Saving in Times of Crisis

Daniel Hoechle and Frank Graef

Abstract In times of economic uncertainty, understanding household saving behavior is of particular importance to researchers and policymakers alike. We review the recent empirical literature on household saving over the life cycle, cross-sectional determinants of saving rates, and retirement saving, focusing on studies based on high-quality administrative data. We also discuss recent evidence on similarities in economic behavior and outcomes across generations. There are some common themes. While less financially savvy and low-income households are particularly at risk of under-saving, the literature also shows surprising differences in savings rates among financially well-off households. Individuals tend to exhibit present bias and inertia in their saving and consumption behavior and are strongly influenced by their upbringing and genetic predisposition.

1 Introduction

Managing personal finances is a complex task for private households. Balancing saving and spending, making investment decisions, and choosing between home ownership and renting must all be carefully considered. Financial decision making can already be challenging in normal times, but it becomes even more complicated in times of crisis, such as in periods of rapidly rising inflation and economic uncertainty. To make matters worse, most households have limited financial knowledge and often rely on simple heuristics that can be detrimental to their long-term financial well-being. Bridging the gap between optimal financial decision making and actual household behavior is at the heart of household finance (Campbell, 2006). With the increasing availability of high-quality datasets, research in this area has grown rapidly: Beshears et al. (2018), Agarwal et al. (2020), and Gomes et al. (2021) provide a general review of the household finance literature, Lusardi and Mitchell

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(2014) focus on financial literacy, and Zinman (2015) focuses on household debt and borrowing. Since a comprehensive literature review is beyond the scope of this chapter, we focus on providing a selected overview of recent empirical research on household saving decisions.

Saving a portion of one's income for the future is a fundamental requirement for any investments that households plan to make. However, households also save for a variety of other reasons, such as to hedge against unforeseen events, to enjoy higher future consumption, to make down payments on houses, or to acquire assets for future generations (Browning & Lusardi, 1996). Finally, heterogeneity in savings rates has been identified as one of the main causes for the dramatic rise in wealth inequality (De Nardi & Fella, 2017; Bach et al., 2018).

In selecting studies for review, we follow three guiding principles. First, we focus on studies published after the global financial crisis of 2007–2009 to capture current trends in the literature. Second, we place more emphasis on studies that do not use survey data, because when people are asked about their saving behavior in a survey, they may give socially desirable answers or underestimate large but infrequent purchases. Third, we acknowledge the role of genetics and education in financial decision making. To this end, we highlight a strand of the literature that analyzes similarities in economic behavior and outcomes across generations.

The remainder of this chapter is organized as follows. Section 2 presents new evidence on the life-cycle model of saving and consumption. Section 3 examines the cross-sectional determinants of saving behavior. Section 4 summarizes research on the effectiveness of measures aimed at increasing retirement savings. Section 5 examines intergenerational similarities in financial decision making, and Sect. 6 concludes.

2   Saving and Consumption over the Life Cycle

The canonical life-cycle model proposed by Modigliani and Brumberg (1954) provides a concise framework for understanding the relationship between income, saving, and consumption over a person's lifetime. According to this model, individuals generally exhibit a hump-shaped pattern in their income, with income rising in early adulthood, peaking in the prime working years, and declining after retirement. To ensure a smooth consumption profile, the model suggests that savings rates should be low or negative when individuals are young, high during their peak earning years, and negative in retirement as accumulated wealth is gradually spent.

Empirical studies, however, have consistently shown a startling divergence from this idealized life-cycle pattern of consumption. Attanasio and Weber (2010), among others, emphasize that in reality people exhibit a different consumption profile. Contrary to the expectations of the standard life-cycle model, consumption peaks a few years before retirement and then declines. This suggests that people tend to smooth their consumption less than the traditional model assumes.

Building on these results, Aguiar and Hurst (2013) examine the dynamics of consumer spending in more detail. They find that the well-documented post-midlife decline in spending on durable goods is primarily due to lower spending on food, transportation, clothing, and personal care items. Interestingly, most other categories of nondurable spending remain relatively stable after age 45 and decline only slightly after retirement. Furthermore, they show that the aforementioned expenditure categories are also responsible for the observed increase in cross-household variation in nondurable expenditure over the life cycle.

The basic life-cycle model framework has been extended along several dimensions. Attanasio and Weber (2010) conclude that "[c]urrent models are able to consider, in very sophisticated fashion, housing choices, labor supply, liquidity constraints, and a number of other factors. Much work, however, remains to be done to develop these models" (p. 742).

2.1 Consumption Response to Predictable Income Changes

The life-cycle model is based on the premise that individuals are rational decision makers endowed with the cognitive abilities to make intertemporal decisions (see Ericson & Laibson, 2019 for a review of intertemporal decision making). Their overarching objective is to smooth consumption over time, which leads them to adjust their saving and borrowing behavior in anticipation of predictable income changes. Guided by their subjective time preferences, which reflect their valuation of future consumption, individuals try to follow an optimal consumption path. Typically, they deviate from this path only when new information necessitates a reassessment of expected lifetime income. Conversely, temporary, recurrent, and predictable income changes, such as a constant year-end bonus, are not expected to trigger a consumption response.

Kueng (2018) examines how consumption responds to an annual payment from a state investment fund that pays out a predetermined dividend to every Alaskan citizen. Since the exact amount is known beforehand and typically represents a sizable portion of annual income, one would expect households to anticipate the resulting income change and to smooth their consumption over time. However, he documents significant excess sensitivity of (nondurables) consumption to this predictable payment. The marginal propensity to consume the extra income within the next 3 months increases with total household income, indicating that high-income households display a lesser concern for consumption smoothing. Kueng (2018) concludes that the observed behavior is consistent with models of near-rationality, where deviations from consumption smoothing are less (more) costly for high-income (low-income) households, because the annual dividend represents a smaller (larger) share of their total annual income.

Ganong and Noel (2019) shed light on the forward-looking behavior of individuals and find that it is largely at odds with the predictions of standard life-cycle models. Analyzing bank account data on U.S. unemployment insurance recipients,

they find that spending declines sharply in the months after these benefits are exhausted. In contrast, a life-cycle model with liquidity constraints would predict a gradual adjustment in consumption and higher savings before the anticipated drop in income. The notable aspect of their findings is that not only does spending decrease, but actual consumption in categories with a short time lag between spending and consumption (e.g., groceries) also experiences a significant decline. This suggests that people are strongly fixated on the present. An interesting policy implication of their study is that myopic individuals may benefit more from extending the duration of unemployment insurance payments than from increasing them.

2.2   Precautionary Savings

In addition to saving for old age, people also save for a rainy day. Life-cycle models with uncertainty therefore typically account for precautionary saving, where individuals save a buffer to protect themselves against labor income risk or other adverse shocks (Carroll, 1992; Carroll & Samwick, 1997, 1998). The relative importance of precautionary saving depends on the individual's long-term income uncertainty and subjective risk preferences, where risk-averse individuals will choose to accumulate a larger buffer stock.

The results of Fuchs-Schundeln (2008) suggest the existence of a precautionary savings motive. Her study reveals that, following the German reunification, former East Germans exhibited higher saving rates than their West German counterparts. Notably, this difference was more pronounced among older cohorts and gradually decreased over time. Fuchs-Schundeln (2008) argues that, because East German households (and especially older ones) had much lower wealth compared to their West German counterparts before reunification, they needed to compensate for this by strongly increasing their saving rates after reunification. A precautionary savings motive then predicts that the saving rate will decrease when the difference between the actual wealth of the household and its target wealth, including a buffer stock, narrows. Consistent with this hypothesis, Fuchs-Schundeln (2008) finds that East Germans' initial wealth was far below their target wealth, so they saved a lot and, after successfully building up a sufficiently large buffer stock, their saving rate subsequently declined.

2.3   Portfolio Allocation

The life-cycle model predicts different asset allocation decisions as people age. Retirees, for example, are expected to choose a less risky asset allocation compared to people in mid-life, assuming similar risk aversion.

Fagereng et al. (2017) test this prediction through a detailed analysis of Norwegian households' portfolio holdings. In line with prior studies, they find that

stock market participation follows a hump-shaped pattern, with relatively low participation across all age groups. However, for households holding common stocks, their results corroborate with the expectations of the life-cycle model. In particular, Fagereng et al. (2017) demonstrate that the portfolio share invested in risky assets exhibits an age profile consistent with the predictions of the life-cycle model. At a young age, the proportion allocated to risky assets is approximately 50%. As individuals approach retirement, they tend to rebalance their portfolios by gradually reducing their exposure to equities. While some households opt to exit the stock market entirely upon retirement, those who continue to invest tend to allocate around 30% of their portfolio to risky assets on average.

2.4 Life Expectancy

To optimally smooth consumption over time, people must also make rational assumptions about their remaining life expectancy.

Heimer et al. (2019) present evidence that, depending on their age, individuals may systematically misjudge their survival probabilities, with young individuals underestimating and older individuals overestimating their chance of survival. These distorted beliefs may explain that young people do not save enough for retirement, while older individuals consume their wealth at a slower pace than fully rational individuals who consider age-specific survival probabilities derived from actuarial data. Besides, Heimer et al. (2019) show that subjective mortality beliefs correlate with saving behavior, even after controlling for risk preferences, cognitive abilities, and socioeconomic factors.

3 Cross-Sectional Determinants of Saving Behavior

According to the life-cycle model, saving behavior depends on age, subjective time discounting, and (in models with income uncertainty) risk aversion. This raises the question how other variables, such as wealth and long-term income, influence saving behavior in the cross section.

3.1 Wealth

Against the backdrop of worsening wealth inequality in Western societies (see, e.g., Piketty, 2014; Saez & Zucman, 2016), the relationship between saving behavior and wealth is of particular concern to academics and policymakers alike. Wealthy households tend to save more in absolute terms, resulting in the wealth distribution becoming more unequal. Another question is how savings *rates* relative to income

vary across the wealth distribution. A widespread assumption is that wealthy households also save more in relative terms because wealth is associated with high income and more scope for saving.

Perhaps surprisingly, Bach et al. (2018) find that the wealthy exhibit lower saving rates in a large sample of Swedish individuals. They obtain the same result for active savings, defined as disposable labor income minus consumption, and total savings, which additionally include capital gains. In addition, they find that saving rates are highly dispersed within wealth brackets. However, they (somewhat counter-intuitively) calculate saving rates relative to wealth rather than disposable income.

Fagereng et al. (2019) analyze saving rates of Norwegian households. They similarly distinguish between net savings (without capital gains) and gross savings (including capital gains) but calculate saving rates relative to disposable income. They find that the net saving rate is almost constant across the wealth distribution, while the gross saving rate increases markedly with wealth, since rich households hold more of their wealth in assets with high expected returns. They conclude that the relation between saving rates and wealth crucially depends on whether saving includes capital gains.

Other recent studies support the finding that wealthy households choose different portfolios.

Bach et al. (2020) analyze a large panel of Swedish households and show that returns on wealth are larger for the wealthy. They further show that this is not because of superior investment skill or information. Instead, high net worth households are simply more exposed to priced risk factors and consequently achieve higher expected returns.

Calvet and Sodini (2014) investigate the risk profile of portfolios held by Swedish twins. Including twin fixed effects allows them to control for genetically determined differences in risk tolerance and other time-invariant characteristics that may simultaneously affect an individuals' wealth and asset allocation. They find that the portfolio share invested in stocks and mutual funds is an increasing and concave function of financial wealth.

Subjective time discounting could explain a positive relationship between saving rates and wealth. For example, we would expect very impatient individuals to save less (and thus accumulate less wealth) than their peers who are more likely to postpone consumption.

Epper et al. (2020) analyze Danish data and measure subjective time preferences directly through an incentivized online experiment. They find that patient individuals rank higher in the wealth distribution, after controlling for education, income, parental wealth, and risk preferences. They argue that the most likely candidate for the remaining effect are differences in saving behavior.

3.2 Lifetime Income

While one might reasonably expect high-income individuals to save a larger share of their earnings, the permanent income hypothesis of Friedman (1957) predicts a linear relationship between lifetime income and total savings, with no effect on saving rates. On the empirical side, however, Dynan et al. (2004) document a positive relationship between saving rates and several proxies of lifetime income. The use of proxies is necessary because actual lifetime income is unobservable, unless the sample period spans the entire lives of the individuals in the sample.

More recently, Straub (2019) examines how rising income inequality affects aggregate savings. To this end, he estimates the elasticity of consumption with respect to permanent income and reports a value of 0.7, implying that high-income households save a larger share of their income than low-income households. This is inconsistent with canonical models of permanent income, which predict an elasticity of one, and thus no impact of income inequality on savings at a macroeconomic level.

3.3 Language

Past research has also investigated how saving behavior is influenced by people's language background, following the idea that language shapes one's perception of time and subjective discounting of future utility from consumption.

Guin (2016) analyzes data from the Swiss Household Panel to examine how language affects households' propensity to save. His study takes advantage of the fact that languages in Switzerland can differ within a small geographic area. This allows him to isolate the net effect of language for households that live close to language borders. He finds German-speaking households to save more than French-speaking households in the same geographic region, and attributes this effect to different time preferences.

Chen (2013) tests whether speaking a language that grammatically links the future and the present affects saving and other future-oriented behaviors. His study is broader in scope, as he examines the effects of language on time preferences both *across* countries and *within* multilingual countries for otherwise similar individuals that speak different languages. In both cases, he finds that speakers of languages that do not require grammatical marking of future events when making predictions (e.g., German) save more.

3.4 Financial Literacy

Financial literacy may also affect saving behavior, for example, if greater financial knowledge improves people's ability to manage their finances and follow a saving plan.

Using U.S. data for individuals beyond age 50, Lusardi and Mitchell (2011) analyze how financial literacy affects the ability to design and execute a saving plan for retirement. They first show that older individuals are more likely to lack financial knowledge, especially if they are female, have a low level of education, or belong to a racial minority. Furthermore, they find that financially literate persons devise better retirement plans and use more sophisticated planning methods.

Brounen et al. (2016) use Dutch survey data and define "savers" as households which state that they are "willing to sacrifice their well-being in the present to achieve certain results in the future" (p. 99). They find saver status to be more prevalent amongst households with high levels of financial literacy. Moreover, they document that the baby boomer generation (i.e., persons born between 1945 and 1960) exhibits an above average propensity to save.

3.5 Mortgage Borrowing

In addition to financial savings, savings in real estate represent an important component of total household wealth accumulation. As noted by Beshears et al. (2018, p. 182), many households tend to hold most of their savings in illiquid assets, while holding little (or negative) liquid net wealth.

Bernstein and Koudijs (2021) analyze the net effect of mortgage amortization on wealth accumulation in a sample of Dutch homebuyers. Identifying the net effect is challenging because people who are paying off a mortgage may be reducing other forms of savings. To address this problem, they compare people's saving decisions immediately before and after a 2013 reform that increased amortization requirements for new mortgages. They find that households leave their nonmortgage savings unchanged and instead consume less. As a result, the total savings of people paying off a mortgage tend to exceed those of people without a mortgage by the amortization amount.

4 How to Increase Retirement Savings?

There are several reasons why saving in dedicated retirement accounts is of particular interest to researchers. First, there is a general trend in Western countries to shift more of the responsibility for retirement planning from the state to the individual, and from defined benefit to defined contribution plans. However, even

people in favorable economic circumstances oftentimes do not save enough for retirement, which puts pressure on public pension systems. Venti and Wise (1998) show that retirement wealth varies greatly *within* lifetime income brackets. Many households with high lifetime incomes could have saved a great deal for retirement but chose to save little, while some low-income households lived frugally and accumulated substantial retirement wealth. Second, retirement savings are taxed at a lower rate (or not at all) in many countries, so people who do not take advantage of these tax benefits leave money on the table. Third, inadequate financial literacy can have dramatic consequences for retirement savings, for example when people underestimate the impact of small differences in expected returns over long investment horizons.

4.1 Policy Interventions

An important question for policymakers is how to get people to save more for retirement, for example, through favorable tax treatment of retirement assets, automatic enrollment in a retirement plan, or requiring employers to make matching contributions.

Chetty et al. (2014a) use Danish data to examine the effectiveness of such policies. First, they analyze employer pension plans and government mandates that make automatic contributions if people do not opt out. For people who change jobs, they find that moving to a firm that contributes 100 Danish kroners more to their retirement account increases total savings by 80 Danish kroners, i.e., only 20% is offset by reductions in other forms of savings. They find that these additional contributions persist for more than 10 years after a job change and eventually lead to higher wealth at retirement age. Similarly, the introduction of a mandatory, government-sponsored retirement plan requiring people to save 1% of their earnings resulted in an increase of total savings close to 1%. They then turn to government tax subsidies and analyze their impact on total retirement savings. Taking advantage of tax subsidies for retirement savings requires both knowledge of the subsidy and, more importantly, an active decision. Chetty et al. (2014a) show that the effect of tax subsidies for people's retirement savings is very limited. As such, they estimate that 100 Danish kroners spent in tax subsidies only increase total retirement savings by 1 single Danish krone. They therefore conclude that due to people's apparent inertia, automatic contributions are a much more effective means for increasing retirement savings than tax subsidies.

Beshears et al. (2022) examine whether automatic plan enrollment has unintended negative consequences for the liability side of a household's balance sheet. They analyze a natural experiment in which U.S. Army civilian employees hired after August 2010 were automatically enrolled in a pension plan and given the option to opt out. Prior to that date, there was no automatic enrollment and people had to actively opt into the plan. They then analyze household liabilities, credit scores, and negative credit events for employees hired 1 year before and after the

policy was implemented and find no significant differences. They therefore conclude that potential concerns that automatic enrollment could lead to additional borrowing or an increase in the likelihood of financial distress are unfounded.

4.2   Financial Advice

Hoechle et al. (2023) use detailed account data for clients of a Swiss retail bank to investigate the impact of financial advice on retirement saving decisions. They show that retirement-related contacts initiated by the bank's client advisors are associated with higher inflows into tax-exempt retirement accounts. For clients not yet owning such an account, advisor-initiated contacts significantly increase the likelihood of opening one. The unconditional probability that a client opens an account in a given month is 0.3%, increasing by 3.9% in months with advisor-initiated contacts. Clients are also more likely to enter the stock market for the first time after being contacted by an advisor, while clients who already own stocks tend to increase their stock investments. However, the chances of being contacted by an advisor are not higher for clients that might disproportionately benefit from retirement-related advice (e.g., female, poorer, or less-educated clients). Finally, they show that additional inflows to retirement savings accounts come primarily from external sources and checking accounts, and that providing retirement-related advice not only helps customers but also increases the bank's profits.

4.3   Peer Effects

Behavioral economics suggests that people's financial decisions are strongly influenced by their observation of others whom they consider their peers (Beshears et al., 2018, p. 224). Duflo and Saez (2002) find that university employees are more likely to participate in a retirement plan, if other employees in the same department do so as well and Duflo and Saez (2003) show that participation in an information event increased plan enrollment for both treated individuals and their colleagues.

Beshears et al. (2015) investigate how receiving information about the 401(k) retirement contributions of similar-aged peers influences U.S. workers' saving decisions. They find that learning about their colleagues' contributions actually *decreased* low-saving individuals' saving rates and propensity to enroll in a 401(k). They attribute this effect to negative upward social comparison, where, by observing that the behavior of their peers betters conforms to societal norms, people are discouraged to behave in accordance with these norms.

Mugerman et al. (2014) analyze the impact of a 2005 reform that allowed Israeli workers, rather than their employers, to decide how to invest their retirement savings. Using data from a large employer, they document that within company

departments, the choices of colleagues from the same ethnic group strongly influenced the decision to choose a particular fund.

5   Similarities Between Parents and Children

Children often exhibit similar traits to their parents and grandparents. It should not be too surprising, therefore, that empirical studies have also documented the transmission of economic outcomes (e.g., wealth, income, and education), behaviors (e.g., saving rates), and preferences (e.g., risk aversion) between generations (see Black & Devereux, 2011; Mogstad & Torsvik, 2022, for recent reviews on intergenerational mobility). However, the extent to which these similarities are genetic ("nature") or due to environmental factors ("nurture") is subject to debate. The distinction between the two is also complicated because gene expression is influenced by the environment, and genetically determined traits in turn also influence people's life experiences.

5.1   Saving Behavior

Parents can influence their children's saving behavior through several channels. It is possible that saving behavior is passed on directly if parents view thrift as a desirable trait and consequently teach their children to save. In addition, personal characteristics known to influence saving could be correlated across generations and lead to similar saving behavior. For example, risk and time preferences may be partly genetic, or parents may pass on their financial knowledge. Finally, the environment in which children grow up, which depends on the socioeconomic status of their parents, could explain differences in saving behavior later in life. For example, growing up as the child of wealthy parents may be conducive to setting long-term saving goals.

Brown and Taylor (2016) use British survey data to analyze how the saving behavior of children aged 11–15 is influenced by their parents. They show that parental allowances have a negative effect and part-time work has a positive effect on children's propensity to save and that saving at a young age predicts saving in early adulthood. Importantly, they find no significant intergenerational correlation in saving. However, their study suffers from the usage of a relatively crude saving measure, where children were only asked whether they "usually" save money, but did not provide the exact amount.

In contrast, Cronqvist and Siegel (2015) document a genetic transmission of saving behavior for a sample of Swedish twins, exploiting the fact that identical twins share 100% of their genes, while fraternal twins share only about 50%. They define the saving rate as the change in net worth, excluding changes in home value, divided by disposable income. For their main analysis, they use an adjusted saving

rate as the dependent variable, computed as the residual of a regression of the saving rate on individual and household characteristics. They decompose the variation in saving rates into a genetic, a parental, and an individual-specific component and find that genetics explain about one-third of the variation. The explanatory power of genetics is larger among children of wealthy parents, possibly due to a more supportive childhood environment. Moreover, they find that parenting strongly impacts saving behavior at a young age, but that (unlike genetics) its influence diminishes with age. Importantly, their estimates suggest that the individual-specific component is still the most important factor, explaining about two-thirds of the variation in saving rates. Finally, they show that income growth, smoking, and obesity (but not education) are significantly correlated with saving rates and argue that this is due to a genetic transmission of time preferences or self-control ability.

A study by Boar (2021) indicates that precautionary savings might be linked between generations. She analyzes survey data for the U.S. and finds that uncertainty about children's long-term income, determined mainly by the child's age and work sector, is negatively related to parental consumption. She then argues that this finding reflects parents' efforts to accumulate a buffer stock to protect their children against negative income shocks, consistent with a dynastic precautionary savings motive.

5.2 Wealth

A strong persistence of wealth across generations may be problematic since it conflicts with the notion of economic mobility. However, as Black and Devereux (2011) note, it might also be worrisome to find no correlation at all, as this would imply that inheritances or investments in children's human capital have no effect. Charles and Hurst (2003) report an age-adjusted elasticity of children's wealth with respect to parents' wealth of 0.37. However, looking at children's and parents' positions in the wealth ranking in more detail, they still find substantial mobility from one generation to the next.

Black et al. (2020) examine the effects of genetic and environmental factors on wealth and other economic outcomes, including saving rates, for a large sample of Swedish adopted children. To do so, they examine whether children's outcomes are more strongly related to their biological parents, with whom they share genetic traits, or to their adoptive parents, who raise them and shape their childhood environment. They find that adoptees' net worth, saving rates, earnings, income, consumption, equity share, and stock market participation are better explained by the characteristics of their adoptive parents, suggesting that these outcomes are mainly determined by parenting. For their main analysis, they convert children's and parents' wealth, income, earnings, equity share, consumption, and saving rates into within-cohort ranks calculated relative to their position in the distribution of children or parents. However, they show that their results for wealth do not depend on this rank transformation. They find no significant relationship between saving

rates of adoptees and their biological parents. Genetic endowments appear to be more important for human capital since children's years of schooling are better explained by those of their biological parents.

Using a similar approach, Fagereng et al. (2021) attempt to isolate the influence of childhood upbringing on wealth and portfolio risk in a sample of Korean-born children who were later adopted by Norwegian families. While they do not observe the characteristics of the biological parents, they take advantage of the fact that children were randomly assigned to adoptive parents, which allows them to control for the influence of genetics. First, they document a significant correlation between the wealth, stock market participation, and portfolio risk of children and their adoptive parents, suggesting that these outcomes are influenced by parenting. They then compare these estimates to those of children raised by their biological parents and find that the intergenerational association in wealth is twice as large if the children are also genetically related to the individuals raising them.

Barth et al. (2020) show that a polygenic score (i.e., an index of certain genetic traits), which prior research has shown to be linked to educational attainment, significantly predicts people's retirement wealth. They find that education and labor income only explain two-thirds of this relationship and argue that an association between the polygenic score and saving rates, risk tolerance, and increased ability for long-term planning may explain the remaining effect.

Boserup et al. (2018) study the wealth holdings of Danish children aged 1– 18 and find that wealth in childhood strongly predicts wealth in adulthood, after controlling for parents' wealth. Assuming realistic annual rates of return of 3– 6%, however, accumulation of childhood wealth into adulthood is insufficient to explain this strong predictive power of childhood wealth. They therefore conclude that childhood wealth seems to proxy for intergenerational correlation in savings behavior and future transfers from parents.

If after-tax bequests and gifts received from (grand-)parents represent a substantial share of people's total wealth accumulation, this may be a straightforward explanation for the perpetuation of wealth inequalities over generations.

Boserup et al. (2016) examine the role of bequests for Danish individuals aged 45–50, by comparing the wealth of persons whose last living parent died in 2010 (treatment) to the wealth of persons with exactly one living parent (control). They report a 36% difference between the two groups in the average wealth change from 2008 to 2011, relative to the control group's wealth in 2011. However, the impact of these bequests on inequality is ambiguous, as the overall variance of wealth increases, but the share of wealth held by the richest 1% decreases.

Adermon et al. (2018) extend the analysis to up to four generations and examine how much bequests contribute to wealth persistence in Sweden. They report rank correlations of 0.3–0.4 between parents and children and 0.1–0.2 between grandparents and grandchildren. They then show that bequests explain about half of the parent-child correlation, while earnings and education jointly explain only one quarter.

Black et al. (2022) rely on Norwegian data to analyze how much gifts and inheritances contribute to an individual's total inflows over a 19-year period,

calculated as the capitalized sum of net labor income, government transfers, and gifts and inheritances received. They find that gifts and inheritances only account for a relatively small share of total inflows, except if they come from very wealthy parents.

5.3   Income

Several studies have documented a substantial intergenerational persistence in income (see a recent review of the literature by Black & Devereux, 2011). If saving rates vary with long-term income, this may also explain similarity in savings across generations.

Chetty et al. (2014b) take a closer look at how intergenerational income mobility varies geographically within the U.S. and identify factors associated with greater mobility. For the entire country, they report an overall rank correlation of 0.34 between the family incomes of parents and their children. They then present a heat map of rank correlations for each commuting zone in the U.S., documenting substantial geographic variation in income mobility. While not claiming a causal relationship, they show that greater mobility is associated with lower residential segregation, lower income inequality, better primary schools, greater social capital, and greater family stability.

5.4   Time and Risk Preferences

Likewise, the transmission of time or risk preferences across generations might translate into similarities in saving behavior.

Arrondel (2013) uses French data to examine how these preferences are linked to wealth across generations. He reports a parent-child correlation in risk and time preference scores, constructed based on the answers to multiple survey questions, of about 0.25 and an elasticity of child's wealth with respect to parents' wealth of 0.22. He then shows that preferences explain 13% of this elasticity after controlling for lifetime income.

Hubler (2018) investigates heritability of time preferences using a sample of German twins. He finds that the correlation in self-reported patience is much larger between identical twins than between fraternal twins. Genetic differences explain about 23% of the total variation in patience between individuals, suggesting that people are, to some degree, born either patient or impatient.

5.5   Human Capital

Similar to wealth, strong intergenerational persistence in educational outcomes or human capital may contradict the ideal of equality of opportunity, at least to the extent that it cannot be explained by genetic transmission of innate ability (Black & Devereux, 2011).

Adermon et al. (2021) use a Swedish sample to examine the persistence of human capital across multiple generations, including members of the extended family. Measuring human capital as total years of schooling and grade point average (GPA) achieved, they show that conventional parent-child regressions underestimate the level of intergenerational persistence compared with estimates that also consider the outcomes of the dynasty.

5.6   Investment Behavior

Finally, there is a strand of the literature that analyzes how people's investment behavior is shaped by their parents. Given that risky assets usually offer more attractive returns over a long investment horizon, parent-child similarities in, for example, the share of wealth invested into equities can help explain why children of wealthy parents tend to accumulate more wealth themselves.

Black et al. (2017) compare the degree of similarity between the investment behavior of Swedish adopted children and their biological and adoptive parents to disentangle the effects of nature and nurture on children's propensity to take investment risks. They find that stock market participation is influenced by both genetic and environmental factors. In contrast, environmental factors appear to play a dominant role in risk attitudes, proxied by portfolio volatility and the share invested in equities. More generally, their findings suggest that observed investment behavior can be better explained by controlling for the respective parent-level variables.

Cronqvist and Siegel (2014) examine the relative importance of genetic, environmental, and individual-specific factors for a number of well-known investment biases. Specifically, they calculate scores to quantify under-diversification, home bias, disposition effects, excessive trading, performance chasing, and skewness preference. Using data on Swedish twins, they find that after controlling for observable characteristics, the genetic component explains about 45% of the variation in investors' propensity to engage in such irrational behavior. They also show that work experience in a finance-related field (but not education in general) can mitigate the influence of genetic endowments and that different life experiences can produce large differences in investment biases, even among genetically identical twins belonging to the same family.

6 Summary

This chapter provides a brief—and ultimately subjective—overview of recent empirical research on household saving decisions, which are central to our understanding of financial markets and the economy as a whole.

The importance of household savings is highlighted in times of crisis. Rising inflation increasingly threatens the standard of living of many middle-class households without emergency funds to fall back on. In addition, the long-term trend of an aging society will inevitably mean that individuals will have to take more personal responsibility for their retirement. However, some households may be unable or unwilling to increase their saving rates in anticipation of these challenges. While the literature generally confirms the widespread notion that poorer and less educated households are particularly at risk of under-saving, it also documents surprising variation in saving rates and retirement preparedness at the upper end of the socioeconomic spectrum. A growing body of work also shows that financial decisions are partly the result of being born into a particular family.

People may not be able to choose their parents (or their genes), but they can certainly learn to make better decisions by following the advice of experts. However, as Choi (2022) notes, many people get their financial advice not from economists but from popular financial "experts" whose advice often differs significantly from the academic consensus. Nevertheless, we believe that academic household finance can play an important role in shaping better economic policy. For example, when it comes to saving for retirement, an important insight seems to be that policy needs to consider people's limited financial knowledge and widespread inertia.

There are many open questions for future research. To name just two, we note first that many studies analyzing the saving behavior of private households are based on administrative data from Scandinavian countries. It would be interesting to see to what extent these results can be generalized using comparable data from other countries. Second, it might be worthwhile to further investigate the underlying causes (or "channels") of intergenerational similarities in saving behavior.

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