Meta analysis of business valuation solutions – are AI based methods better?

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Abstract: *Purpose of the article* – this article addresses the challenge of accurately assessing business value in today's dynamic environment, exploring the limitations of traditional valuation methods and the potential of modern, technology-driven approaches.
Research methodology – the study uses qualitative research methods, including content analysis, deductive reasoning, and comparative analysis, to review various business valuation techniques.
Findings – the research finds that traditional methods like Discounted Cash Flow and Relative Valuation are outdated, failing to capture all value factors. Modern approaches, such as simulation-based valuation, machine learning, and neural networks, combine traditional methods with advanced techniques. These methodologies utilize vast datasets and sophisticated algorithms, enhancing predictive accuracy and understanding of market dynamics. Neural networks excel in analysing complex patterns and adapting to market shifts. However, no single method can capture all nuances, necessitating diverse approaches and acknowledging the subjective nature of valuations.
Keywords: business valuation, traditional and advanced valuation methods, machine learning, neural networks, artificial intelligence
JEL classification: G12, C45, M21

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Meta analiza rešitev za vrednotenje podjetij – so metode, ki temeljijo na umetni inteligenci, boljše?

Povzetek: *Namen članka* – članek obravnava izziv natančnega ocenjevanja vrednosti podjetja v današnjem dinamičnem okolju ter raziskuje omejitve tradicionalnih metod vrednotenja in možnosti sodobnih, tehnološko zasnovanih pristopov.
Metodologija raziskave – v študiji so za pregled različnih tehnik vrednotenja podjetij uporabljene kvalitativne raziskovalne metode, vključno z analizo vsebine, deduktivnim sklepanjem in primerjalno analizo.
Ugotovitve – raziskava ugotavlja, da so tradicionalne metode, kot sta diskontirani denarni tok in relativno vrednotenje, zastarele in ne zajemajo vseh dejavnikov vrednosti. Sodobni pristopi, kot so vrednotenje na podlagi simulacij, strojno učenje in nevronske mreže, združujejo tradicionalne metode z naprednimi tehnikami. Te metodologije uporabljajo obsežne nabore podatkov in izpopolnjene algoritme, kar povečuje natančnost napovedovanja in razumevanje tržne dinamike. Zlasti nevronske mreže so odlične pri analiziranju zapletenih vzorcev in prilagajanju spremembam na trgu. Vendar nobena metoda ne more zajeti vseh nians, kar zahteva različne pristope in priznavanje subjektivne narave vrednotenja.
Ključne besede: vrednotenje podjetij, tradicionalne in sodobne metode vrednotenja, strojno učenje, nevronske mreže, umetna inteligenca

Introduction

In modern times, and in the past, the development of the economy has been dictated by companies that are constantly developing and expanding their activities. This evolution is not merely a reflection of individual business ambitions; rather, it underscores a fundamental principle of economic growth: innovation. Companies drive innovation through research, development, and implementation of new technologies, products, and services. This relentless pursuit of growth is not only a testament to the ambition of these businesses but also crucial for enhancing their business value and valuation. Companies that innovate and expand their operations are better positioned to capture market share, increase revenue streams, and ultimately drive up their valuation metrics such as earnings multiples and market capitalization.

The principle of functional business valuation, explained by Matschke et al. (2010), finds relevance in various business dealings such as acquisitions, divestitures, mergers, and demergers. In these complex scenarios, conflicting interests often arise among different parties, be it between buyers and sellers or among merging/divesting partners, all struggling to secure the most advantageous outcome. Yet, within these diverging interests, there exists a common goal of reaching a transactional agreement acceptable to all involved stakeholders.

In this context, the primary objective of business valuation is therefore to establish a reasonable estimate of the economic value of the whole or part of a company, based not only on historical data, but also on the prospects of the company, what is expected of it in the future, what the future earnings and risks will be, etc.

As already mentioned, companies evolve and change very rapidly, and their value changes therefore, which adds to the challenge of arriving at an appropriate estimate of the value of a company. Also, the valuation process is a complex process and the value itself is influenced by several factors. As a result, our final valuation will also be based on which factors have all been considered, and the method used for the valuation itself plays an important role. In this context, Kulwizira Lukanima (2023) noted an important observation: although the term valuation is widely used, its fundamental aspects may not be widely understood. Evaluation is not an absolute determination but a relative one, with analysts using different methods and considerations according to their specific purposes and contexts. This diversity of approaches results in different value or equity recommendations for the same company. The definition of value itself varies depending on the valuation approach chosen. Thus, the valuation process is inherently nuanced and subject to interpretation, underlining the importance of understanding its complexity for sound decision-making.

Given that a range of approaches are used, the purpose of this research is to review which approaches have been used over the years to assess the value of companies. We will start with an overview of traditional methods, and then turn our focus to more modern methods that combine traditional metrics with advanced models in the field of Machine Learning (ML) and Artificial Intelligence (AI). We will also look at which factors they have considered in their research and have flagged as having a significant impact on the value of the company itself. Such research is important as it can be used as a guideline by valuation analysts and other researchers to help improve decision-making processes in the business world and more accurately assess the value of companies.

In the next section, we will briefly present the methods we have used to collect data and analyse or review existing approaches to business valuation and the factors that influence this value. Qualitative approaches have been used to extract information from published

research and to compare the different approaches to business valuation, as well as the differences that have or have not arisen when specific factors have been considered.

1 Methodology

For collecting the data, we used so called using documents technique, i.e., the use of published scientific and peer-reviewed articles. The qualitative research methods used for this literature review study were content analysis, deduction, comparison, and a historical approach. The latter was employed to analyse older methods first, followed by more recent ones, allowing for a chronological understanding of how valuation techniques have evolved over time.

As a basic approach in literature review, the document analysis is one of the most common tactics. Since our main and only source of data are scientific papers and books or chapters in books, our research will begin with abovementioned. Strauss & Corbin (1998) explained that document analysis involves a methodical approach to assess or appraise various documents. Like other qualitative research methodologies, document analysis mandates a thorough scrutiny and interpretation of data to unveil significance, enhance comprehension, and construct empirical insights.

Bowen (2009) summarizes that the use of documents as a qualitative method for data collection can serve five purposes: (1) providing context, as documents provide background information and historical insight and help researchers to understand it; (2) information in documents can prompt researchers to ask new questions and observe particular situations; (3) documents provide additional research data that enrich the knowledge base; (4) by analysing different drafts of documents, researchers can track changes and developments over time; and (5) document analysis serves to verify or validate findings from other sources.

Denzin (1970) clarified that document analysis is frequently employed alongside other qualitative research techniques. Scientific term is triangulation, which means to involve a variety of methodologies to investigate the same phenomenon. Hereinafter, as part of this process other used methods are described.

Harwood & Garry (2003) explained that content analysis is a technique for analysing the content of different types of data, like visual and verbal data. In our case, we will of course focus on visual data, as we will analyse articles. This method makes it easier for researchers to understand and interpret the meaning and structures of texts or other content elements. It can be implemented at different levels, from a surface analysis to a detailed understanding of links, patterns and other concepts. The content analysis method can be used for both qualitative purposes, usually during the development phase of the research itself, and quantitative purposes, to determine the frequency of phenomena.
Theoretical frameworks guide the research process, either by deriving hypotheses from existing theories or by inducing hypotheses from observed patterns. Thus, researchers can use deductive, inductive or abductive reasoning. According to Johnson-Laird (2010), deductive reasoning is a central cognitive process that involves logically drawing conclusions from propositions. Azungah (2018) describes that a deductive approach is used in research when the analysis is based on an existing theory. Myers (2020) refers to such reasoning as a 'top-down' approach, where the researcher starts with the theory or hypotheses that they wish to test. He argues that this is a confirmatory method, as opposed to inductive reasoning, which he labels a research method.

Based on what has been described and given that we have carried out a literature review and observed the principles of evaluating businesses and the factors that influence their value, we can say that we have used a deductive approach. In our case, this means that we

already had outlined the principles of business valuation and the factors that influence it, and then we checked whether these principles and factors matched with findings that we found in the reviewed literature.

Finally, we used comparison analysis. In their paper, Onwuegbuzie et al. (2012) outlined that constant comparison technique is one of the five data analysis techniques that plays vital role in qualitative research. Glaser & Strauss (2017) are described as the originators of this approach. As per Strauss & Corbin (1998), constant comparison analysis encompasses five key characteristics: (1) theory construction rather than testing; (2) providing researchers with analytical instruments for data analysis; (3) assisting researchers to understand various meanings within data; (4) offering researchers a creative and methodical approach to data analysis; and (5) helping researchers pinpoint, develop, and perceive connections among data components while formulating a theme.
This approach delivered a systematic analysis of the lending studies and provided a critical comparison of what factors are essential for measuring the value of businesses. We also provided a comprehensive overview of different approaches that have been used for valuation and which of those approaches are most optimal for this task.

2   Results and findings

As we can retrieve from one of the chapters (Fazzini, 2018), valuing a business is far from uniform and requires a complex understanding of the complexity of businesses as well as the multifaceted contexts in which they function. Put differently, each business forms an ecosystem influenced by the dynamics of the industry, market conditions, management strategy, and internal functioning processes, explained (Basole et al., 2015). The most important distinction is made between businesses that continue to operate (Sterling, 1968) and those that have ceased to exist and were liquidated (Hudson, 1986). While running a business's value is associated with its revenue generating ability, its assets and liabilities, and prospects for future growth, a business that has been completely liquidated is worth an entirely different amount. In our paper, the focus will be primarily directed towards analysing business valuation approaches for the ongoing operations and growth of thriving businesses, known as going concerns.

Moreover, the businesses that one chooses to analyse also differ from one another. In many ways, some are simply much more regular than others – their revenues are stable, their expenses are manageable, and there is a clear future ahead of them. Others are likely going through the pains of liquidation (Dunleavy, 2009) – their assets are sold to cover the debt to creditors, contracts are renegotiated, and the business ceases to exist. It is necessary to highlight these differences because they dictate what exactly needs to be considered. The former is more focused on revenue forecasts and market position and potential competitive advantage. The latter is cantered on the valuation of assets and liabilities and what can be done to maximize returns on those assets. In this aspect, our focus will primarily be on normal operating businesses, distinct from those facing challenges and the potential process of liquidation.

Given our narrowly selected set of companies for which we will review their valuation methods, we can state that business valuers use several approaches in their analyses, ranging from the basic to the complex. Although these models may differ in their underlying assumptions, they share common features and can be grouped into broad categories, which makes it easier to understand the position of each model in the broader space, to explain the reasons for their different results and to identify examples of fundamental logical fallacies. Damodaran (2002) thus presents 3 basic approaches to the process of corporate value measurement that are used in practice.

2.1 Traditional valuation approaches

The first approach to business valuation, presented by Damodaran (2002), is Discounted Cash Flow (DCF) method that is used to determine the worth of an asset by evaluating the present value of the cash flows it's anticipated to generate in the future. This approach (Kruschwitz & Loeffler, 2006) considers the time value of money, reflecting the notion that a dollar received today is worth more than a dollar received in the future due to factors like inflation and the opportunity cost of capital. By discounting these future cash flows back to their present value, DCF valuation provides insight into the intrinsic value of an asset, assisting in investment decision-making and financial analysis. Damodaran (2002) continues, that under the DCF approach there are two main perspectives for assessing the worth of a business: equity valuation and firm valuation. Equity valuation focuses solely on determining the value of the ownership stake in the business, whereas firm valuation encompasses the entire enterprise, considering not only equity but also other stakeholders like bondholders and preferred stockholders. Although both methods involve discounting anticipated cash flows, they diverge in terms of the specific cash flows and discount rates utilized. The comparison of the two perspectives is shown in Table 1.

Table 1. Categorization of DCF for business valuation.

Discounted Cash Flow (DCF)			
Equity Valuation		Firm Valuation	
Assets	Liabilities	Assets	Liabilities
Considered cash flows are those generated from assets, accounting for debt payments and reinvestments required for future expansion.	The discount rate solely reflects the expense associated with obtaining equity financing.	Considered cash flows are those derived from assets, occurring before any debt obligations, but after the firm's reinvestment to cultivate growth assets.	The discount rate encompasses the expenses associated with raising both debt and equity financing, proportionate to their utilization within the business.
The present value represents the worth attributed solely to the equity claims on the firm.		The present value represents the total worth of the entire firm and reflects the combined value of all claims on the firm.	

Source: Extracted from Damodaran (2002).

Indeed, the DCF has established itself as one of the primary approaches to business valuation, and the evidence from the report (Nyborg & Mukhlynina, 2016) corroborates such a position. In this case, the findings benefited from the expansive work conducted in the framework of a research (Mukhlynina & Nyborg, 2016), focused on the preferences and applications of valuation practitioners. Therefore, the above-detailed study of the DCF methods proved it to be arguably one of the most used valuation tools that exemplify its recognition and overall value to the field.

Like the consensus derived from above-mentioned, the author (Fernández, 2007) of affirm what he considers as a theoretical correctness of the valuation method that depends on the discounting of cash flows, therefore describes the outlined approach. Very thoroughly presentation of DCF models (1) Cost of Capital Approach (Kulwizira Lukanima, 2023e), (2) The Adjusted Present Value approach (Kulwizira Lukanima, 2023f), and (3) Dividend Discount Models (Kulwizira Lukanima, 2023d) can be found as chapters of a book (Kulwizira Lukanima, 2023c), where author additionally discusses some concerns regarding DCF models (Kulwizira Lukanima, 2023g). DCF approach is also in the forefront of a research (Nenkov & Hristozov, 2022) which delves into the application of the DCF enterprise valuation model, focusing on key input variables that influence operating free cash flows and at the same time also

discusses fundamental problems associated with determining the value of companies in a broader context. Furthermore, an in-depth examination of the DCF valuation approach was applied in the thesis (Öhrner & Öhman, 2023), where authors analysed if this method yields accurate stock prices when conducted across a diverse sample, rather than focusing on specific sectors by comparing predicted stock prices to actual stock prices. There were also some studies which were geographically slightly more narrowly focused e.g., a critical assessment of employing the DCF method for property valuation within the South African real estate sector (Pienaar, 2015).

An exhaustive examination of the literature landscape, providing various works that employ the DCF valuation approach is offered by the author (Isik, 2010). Through thorough analysis and synthesis, the author provides a comprehensive overview, clarifying the diverse methodologies, applications, and findings derived from the utilization of DCF in business valuation across a multitude of contexts and industries. A comprehensive survey of DCF valuation models, examining the evolution and application of these models in financial literature was also presented (Damodaran, 2007).

As the second approach, Damodaran (2002) described relative valuation as a method that is utilized to assess the value of an asset by comparing it to similar assets within the same market or industry sector. This approach relies on identifying comparable assets and gauging their worth in relation to a shared metric, such as book earnings, cash flows, or the number of customers. By analysing these comparative indicators, relative valuation provides insights into the relative attractiveness and pricing of the asset in question. This technique is particularly valuable in contexts where absolute valuation methods may be challenging due to limited data availability or uncertainty in future cash flow projections.

When talking about relative valuation, some analysts compare multiples between companies, while others assess a company's current multiples against its historical performance, explained Damodaran (2002). While many relative valuations rely on comparing similar assets' pricing concurrently, some also consider fundamental factors in their assessments. In this aspect, we can roughly distinguish between two different approaches: fundamental and comparative. The first approach ties multiples to fundamental aspects of the firm, resembling discounted cash flow models in data requirements and outcomes. It shows how multiples change with shifts in firm characteristics, enabling analysis of factors like changing profit margins on price-sales ratios and the relationship between price-book value ratios and return on equity. The second approach is much more common and involves comparing a firm's valuation with that of similar firms in the market or with its own past valuations. However, finding truly comparable firms can be challenging, often requiring acceptance of some differences. In such cases, adjustments must be made to account for variations in growth, risk, and cash flow measures across firms. Methods for controlling these variables can vary from simple industry averages to complex multivariate regression models that identify and address relevant factors. Additionally, Damodaran (2002) presented two more approaches based on relative valuation: Cross-Sectional Comparisons and Comparisons across time. When comparing the price-earnings ratio of a software firm to the industry average, it's relative valuation involving cross-sectional comparisons. Conclusions depend on assumptions about the firm's similarity to industry norms. If the firm is deemed similar, a lower ratio may suggest it's undervalued; if riskier, it may warrant a lower ratio than peers. It is important to note, that fundamentals must be considered for accurate comparisons. Comparison across time is usually used in comparing a mature firm's current trading multiple to its historical multiple and can provide insights, but it relies on the assumption that the firm's fundamentals haven't changed significantly. Factors like growth rate and interest rates can influence these multiples over time. For instance, high-growth firms typically see a decline in their price-earnings ratio as they mature. Changes in interest rates and market behaviour can also affect how multiples are interpreted, with

lower interest rates and overall market growth potentially leading to higher multiples for most companies.

Relative valuation, like the DCF approach, is also one of the most used methodologies for assessing the value of a company. This is evidenced by the findings of the report and research (Mukhlynina & Nyborg, 2016; Nyborg & Mukhlynina, 2016) that additionally state that when it comes to using multiples, the ratio that compares a company's Enterprise Value (EV) to its Earnings Before Interest, Taxes, Depreciation & Amortization (EBITDA) (= EV/EBITDA) is the one that is the most used.

Regarding relative valuation, an exemplary conceptual framework was presented (Sharma & Prashar, 2013), providing a robust foundation for assessing the worth of assets within a comparative context. The authors not only offer a methodology for conducting relative valuations but also meticulously outline the inherent advantages and disadvantages associated with this approach by delineating the strengths and limitations of relative valuation. More detailed and comprehensively, the method is presented in before-mentioned book (Kulwizira Lukanima, 2023c), more specifically in its chapter (Kulwizira Lukanima, 2023b). A thorough overview is also presented by the author that has already been mentioned (Damodaran, 2007). Additionally, in his thesis (Pétursson, 2016), the author in a clear and transparent way describes the relative valuation approach for corporate valuation. Moreover, the author delves into a comparative examination of relative valuation across diverse industries. In the area of relative business valuation, we also find studies that are somewhat limited geographically, but which provide a good overview of the relative valuation framework and concept e.g., the research limited to the land of U.S. (Nissim, 2013).

Besides all the theoretical studies on the topic of relative valuation that we have mentioned, a comprehensive literature review was conducted (Isik, 2010), wherein the author not only introduced the relative valuation approach to firm valuation but also highlighted various authors and their studies or research that have utilized the relative valuation method for similar purposes.

Finally, Damodaran (2002) presented contingent claim valuation approach which is a sophisticated tactic that leans on option pricing models to assess the value of assets bearing option-like features, such as patents and reserves. These models, rooted in financial theory, are adept at quantifying the worth of assets whose value is contingent upon certain events or circumstances. Even option pricing models are categorized. The first categorization classifies options according to whether they are tied to financial assets or real assets. Financial options, such as those linked to stocks and bonds, are more common, whereas real options relate to real assets like commodities or real estate and are referred to as such. Another way to categorize options is by whether the underlying asset is actively traded. This distinction is significant because most financial assets are traded, whereas only a small portion of real assets are actively traded. Options linked to traded assets are simpler to assess as market data readily provides inputs for pricing models. Conversely, options tied to non-traded assets pose challenges in valuation due to the absence of market inputs for the underlying assets.

Contingent valuation has been around for a long time. However, throughout this period there have been several developments which have had a profound impact on the very relevance of this method, particularly in terms of its economic application (Hoyos & Mariel, 2010). This method is comprehensively described (Carson & Hanemann, 2005) by exploring the historical roots of contingent valuation, examining its origins and foundational works before delving into its development across various thematic dimensions. Following this historical context, the theoretical underpinnings of contingent valuation are introduced, with a particular

emphasis on its alignment with standard measures of economic welfare. Subsequently, attention is directed towards the consideration of existence/passive use issues, providing insights into this critical aspect of valuation methodology. Author (Venkatachalam, 2004) noted this method has been criticized, therefore, he examined the latest advancements in strategies aimed at tackling the challenges of accuracy and consistency stemming from various biases, errors, and other empirical and methodological concerns associated with the mentioned method. In the discourse surrounding critiques of the contingent valuation approach, author (Hausman, 2012) provides a nuanced perspective by selectively scrutinizing the contingent valuation literature. He concentrates on empirical findings while also shedding light on persistent challenges that endure within the methodology. Through this focused examination, the paper underscores the ongoing presence of certain long-standing issues within the field.

2.2 Advanced valuation approaches

Up until this point, we've thoroughly examined the classical methodologies commonly employed in business valuation, offering insights into their underlying concepts, structures, principles, as well as their respective merits and drawbacks. However, our exploration now pivots towards a more contemporary perspective, where we delve into concrete examples of modern approaches to business valuation as these modern methodologies encompass innovative techniques and metrics that cater to the complexities of today's markets. Moreover, in a review of corporate valuation (Torrez et al., 2018) author asserts that we require more innovative methods to discern shifts in companies' financial standings.

Leveraging advanced statistical techniques, we delve deeper into the complexities of business valuation, transcending traditional methods. Let's start by introducing a model cantered on the relative valuation of companies. In their recent work (Hu et al., 2021), a statistical factor model crucial for value investing and corporate decisions was presented. It scales a company's market value by book capital to create a cross-sectionally comparable relative value target, minimizing multicollinearity. Through regression, it links industry classification, valuation factors, and company relative value, explaining cross-sectional variation with minimal degradation. The residual identifies temporary misevaluation, offering opportunities for investors and management in timing decisions.

By leveraging vast amounts of data and complex algorithms, ML-based approaches have the potential to provide deeper insights into company worth, offering practitioners and investors a more comprehensive understanding of market dynamics and intrinsic value. The question of whether machine learning is more effective than traditional methods was addressed in a recent study (P. Koklev, 2023). The answer to this question was, of course, positive, but the author also found more: the use of machine learning outperforms even certain advanced econometric approaches such as linear regression.

Similar conclusions were presented in the study (Geertsema & Lu, 2023), where machine learning was utilized for relative valuation and peer firm selection. Authors found that their model outperformed traditional methods in accuracy across various firm types and accurately predicted fundamental values, with overvalued stocks experiencing subsequent price decreases and undervalued stocks seeing increases. Moreover, the identified determinants of valuation multiples aligned with theoretical predictions, particularly focusing on profitability, growth, and efficiency ratios.

A couple of years ago, comprehensive research was made in the field of ML models (Vayas-Ortega et al., 2020) for assessing business value. The authors aimed to enhance company valuation methods by combining traditional DCF models with ML techniques. They conducted an extensive analysis, testing 18 different ML methods, and found that incorporating both endogenous (related to value creation) and exogenous (industry/country specific) variables

improved predictive capabilities. They identified Bagging Trees, Supported Vector Machine Regression, and Gaussian Process Regression as consistently yielding the best results.

Another broad research in the realm of training various ML models was conducted (P. S. Koklev, 2022). Here, the author explored using machine learning to predict enterprise market capitalization based on financial statement data. Through empirical analysis using various ML methods, including Gradient Boosting Decision Trees, for which the study achieved an 86.7% R2 performance metric. Furthermore, the author identified key features from financial statements, highlighting the importance of Comprehensive income, and addressed model interpretability and data handling techniques. The research concluded that ML offers a more accurate and cost-effective approach to company valuation.

In addition, theses have been carried out within which the authors have focused on the valuation of companies. In one, where the author conducted a study focused on the use of ML in the context of mergers and acquisitions (Kaunisto, 2024), the author's goal was to create a regression machine learning model tailored for forecasting the revenue of privately held companies operating within the United States. The second one (Haich, 2021) included even more advanced techniques of artificial intelligence compared to ML – the author used deep learning approach with addition of Long Short-term memory model.

One of the most advanced ways to delve into an accurate prediction of company's value originates from artificial intelligence. Neural networks stand as sophisticated tools, offering unparalleled depth and nuance in assessing the worth of businesses. With their ability to analyse vast datasets, recognize complex patterns, and adapt to ever-changing market dynamics, neural networks represent a transformative approach. The usefulness of neural networks is thus widely recognized e.g., the authors (Yang et al., 2023) proposed an approach, which suggest that companies and their key members naturally form a diverse network, where each node represents a different entity (like a company or a person) and has various types of information associated with it. By analysing this network, they extracted hidden patterns called embeddings for each company, which they then used to assess its value.

The finding that advanced AI methods like neural networks perform better, was also presented in a paper (Guner & Unal, 2023), where authors looked at different methods people use for assessing business value, like financial ratios, but found that using a specific model called the NARX model might be better. They tested this model on data from various companies in certain industries over the years 2000 to 2021. They found that the NARX model was quite accurate, especially when using a certain network structure and time delay.

Among these innovative approaches, authors (Wilimowska & Krzysztoszek, 2013) delve into the concept of employing neural networks for company valuation. Expounding on this method, the scholars investigated into the factors influencing asset value, income, or both, emphasizing the mixed valuation approach, which accounts for two categories of drivers: asset-related and income-related. Additionally, they introduced a method grounded in artificial neural networks. They outline the structure and simulation of the model, exemplifying its implementation through a case study of the "Hama-Bis" company.

As already presented, business valuation often involves assessing the worth of a company's assets, earnings potential, and future cash flows. This aligns with the approach (Siddiaui & Patil, 2018) taken by the authors in evaluating stocks for long-term investment. Here, the authors developed a system for evaluating stocks based on fundamental analysis, utilizing Monte Carlo simulation and discounted cash flow analysis. The model focuses on long-term investment and is tailored for low-debt companies and at the same time aims to provide unbiased investment guidance by comparing intrinsic values with market prices, using statistical reasoning.

There is similar research that again included both, DCF and Monte Carlo simulation (Leifer & Lev, 2016). Here, business valuation was conducted using discounted cash flow, with uncertainty in parameters modelled stochastically, where Monte Carlo simulation forecasted cash flow distribution and predicted risks from uncertainty. Moreover, the approach allows for analysing and reducing uncertainty by improving sales or cost forecasts.

A challenge is also accurately assessing startup's value and for this challenge (Dhochak et al., 2022) author utilized various established strategic management theories like the resource-based view and network-based theory, along with a dataset of 757 Indian startup deals from 2012 to 2019, to create a predictive model for startup valuation using Artificial Neural Networks (ANN). They compared this ANN model with linear regression, finding that ANN can be a useful supplement or even an alternative to traditional valuation methods due to its adaptability and accuracy. What is more, this model could enhance negotiation between venture capitalists and entrepreneurs, offering a competitive edge.

It is well known that each industry has its own characteristics and specificities that have a significant impact, so it is wise to address them in the business valuation process itself. In navigating the diverse landscape of these industry-specific challenges, author (Oh, 2021) delved into the realm of Information and Communication Technology (ICT) and noted that the precise technology valuation method is urgently needed to get successful technology transfer, transaction and commercialization. In this research, the author analysed the characteristics of the high-tech ICT technology and the main factors in technology transfer or commercialization process, and proposed the precise technology valuation method that reflects the characteristics of the ICT technology through phased analysis of the existing technology valuation model.

Authors (Chen et al., 2012) delved into biotech industry in Taiwan and used Stepwise Regression and Back-Propagation Neural Network (BPNN) to analyse data, focusing on variables like operating profit margin and stock price to indicate firm value. In conclusion, BPNN improves estimation accuracy over regression methods.

Apart from sorting companies by industry, there are other ways to sort them, including those listed on stock exchanges and those not listed. In their study (Liu et al., 2020), developed a way to better figure out how much listed companies are worth. They used neural networks and described them as good for understanding complex patterns and learning on its own. Additionally, as a detailed overview of which methods and advanced models were used and which area of industry they covered, a thorough study was conducted (Holder et al., 2022) to explore the integration of AI into business valuation, revealing a shift in valuation methodologies. Traditional calculations remain unchanged, but data collection processes are evolving. The review covers prevalent machine learning algorithms and a systematic analysis of publications from 2015 to early 2021. Despite growing interest, current applications primarily favour classic methods like classification and linear regression within supervised learning.

2.3 3-dimensional demonstration of approaches in practice

As previously discussed, the landscape of companies exhibits a rich diversity. Our initial classification distinguishes between those in operation and those liquidated. Moreover, among the operational entities, attention is drawn to discerning between those functioning smoothly and those encountering formidable hurdles hinting at prospective liquidation. In the following, we present further very commonly used business divisions, which will be used to classify these approaches accordingly.

First dimension is very well known, and divides companies based on ownership structure, which varies, reflecting the distribution of ownership interests and control. First group are privately-owned companies that are held by individuals or a group, retaining autonomy but often facing limitations in capital. The second one are publicly traded companies, listed on stock exchanges, offer shares to the public, spreading ownership widely but subjecting them to regulatory requirements and shareholder demands (Hoff et al., 2002).

The second dimension will be defined as types of firms based on their life cycle. Companies undergo various stages of development, each presenting distinct challenges and opportunities and can be divided in 4 groups (Bakarich et al., 2019). Startups are in the early stage, focused on developing and validating their business model, often seeking funding and building their initial customer base. Growth-stage companies have proven their concept and are scaling operations, expanding their market reach, and increasing revenue. Mature companies have established market presence and stable revenue streams, prioritizing efficiency and innovation to sustain growth. Declining companies face challenges such as market saturation or technological obsolescence, requiring restructuring or reinvention to revitalize their business. Like the life cycle of a company, the life cycle of a sector progresses through stages of development, growth, expansion, maturity, and decline, reflecting shifts in market dynamics, innovation, and competitive forces (Strašek & Jagrič, 2008).

The last dimension will be measured in acquisitions: the level of ownership acquired by the acquiring company varies, defining the extent of control and influence (Sherman, 2010). A minority stake involves purchasing less than 50% of the target company's shares, offering some influence but not controlling interest over operations and strategic decisions. A controlling stake sees the acquiring company purchasing over 50% but less than 100% of the target company's shares, granting significant sway over operations, governance, and strategy. Similarly, a majority stake entails purchasing more than 50% of the shares, allowing substantial control. A full acquisition occurs when the acquiring company purchases 100% of the target company's shares, resulting in complete ownership and control, typically leading to the target company becoming a wholly owned subsidiary or merging into the acquiring entity, thus assuming complete responsibility for its operations and management.

Based on these classifications, we provide an overview of approaches, where we present, in which case the specific approach is suitable. The results are presented in
Table 2.

Table 2. The suitability of the approaches with respect to 3D classification.

	Privately-owned companies				Publicly traded companies			
	Startups	Growth stage	Mature	Declining	Startups	Growth stage	Mature	Declining
Minority stake	AIA	ASVA, MIA, AIA	ASVA, MIA, AIA	ASVA, MIA, AIA	AIA	ASVA, MIA, AIA	ASVA, MIA, AIA	ASVA, MIA, AIA
Controlling stake	MIA, AIA	DCF, RV, CV, ASVA, MIA, AIA	DCF, RV, CV, ASVA, MIA, AIA	RV, ASVA, MIA, AIA	MIA, AIA	DCF, RV, CV, ASVA, MIA, AIA	DCF, RV, CV, ASVA	RV, ASVA, MIA, AIA
Majority stake	CV, MLA, AIA	DCF, RV, CV, ASVA	DCF, RV, CV, ASVA	RV, ASVA, MIA, AIA	CV, MLA, AIA	DCF, RV, CV, ASVA, MIA, AIA	DCF, RV, CV, ASVA	RV, ASVA, MIA, AIA
Full acquisition	CV, MLA, AIA	DCF, RV, CV, ASVA	DCF, RV, CV, ASVA	RV, ASVA, MIA, AIA	CV, MLA, AIA	DCF, RV, CV, ASVA, MIA, AIA	DCF, RV, CV, ASVA, MIA, AIA	RV, ASVA, MIA, AIA

Certain conclusions can be drawn from the table above. The most covered types of companies, where a wide range of valuation approaches are suitable, are typically public firms in the growth-stage or mature part of their lifecycle, with the measured acquisition being a controlling stake, majority stake, or full acquisition. This is because such companies usually have a substantial amount of historical financial data available, enabling the application of both advanced and traditional valuation methodologies. Additionally, if data for private companies is accessible, this category is also well-covered, as similar financial metrics can often be applied. In these scenarios, advanced valuation approaches, including AI and machine learning methods, can complement traditional methods to provide a comprehensive analysis.

In the aspect of least optimal type of companies to assess their value are startups that pose significant challenges for valuation due to their limited operating history, uncertain future cash flows, and high risk. Consequently, startups, particularly those targeted for minority stake acquisitions, present the most problematic types of companies for valuation. Valuing startups accurately requires forecasting future performance, which is inherently uncertain, and traditional valuation methods may struggle to capture the unique characteristics of these early-stage ventures. Additionally, minority stake acquisitions in startups may lack control over strategic decisions and cash flows, further complicating the valuation process. Lastly, we can present the most valuable insight that the AI approaches cover every type of company due to its flexibility and adaptability. AI techniques, such as neural network algorithms, excel in handling large and complex datasets, making them applicable to companies across various stages of the lifecycle and ownership structures. AI can analyse diverse data sources, including financial statements, market trends, and industry dynamics, to identify patterns and relationships that may not be apparent through traditional valuation methods alone. Moreover, AI approaches can continuously learn and improve over time, allowing for more accurate and dynamic valuations in rapidly evolving business environments. Therefore, AI represents a versatile tool that can enhance valuation analysis for all types of companies.

3 Conclusion

In this review article, we look at the importance of accurate business valuation. When it comes to companies, there are constant sales or purchases, mergers between companies or divisions. In each case, there are both buyers and sellers who want the best terms for themselves, and it is therefore of the utmost importance to determine or find the optimum value of a company that will satisfy both parties. It is also well known that nowadays, due to very rapid progress and technological development, companies are changing their activities enormously. There is also a constant demand for new products and services, which is why companies are expanding. All of this leads to a constantly changing company value, which is influenced by many factors, which makes assessing the value of companies more challenging, but at the same time it is important to keep abreast of all the changes.

The review itself used qualitative research methods. We started by using the so-called document analysis technique, where our sources were peer-reviewed articles, books or book chapters and working papers. Qualitative research methods included (1) content analysis, which served to provide context and broaden our knowledge base and helped to interpret the content of the texts, (2) deductive reasoning, which was used to test existing theories, whereby the identified principles were aligned with findings from the literature, and (3) comparative analysis, which was used to systematically analyse and compare different valuation approaches, which helped to identify optimal methods of valuing companies.

We have reviewed the methods that have emerged over the years in the valuation of companies themselves, starting with an overview of traditional methods such as discounted cash flow and relative valuation methods, and then moving on to slightly more sophisticated methods that, while based on traditional methods, use a combination of other models.

Advanced approaches in business valuation encompass cutting-edge methodologies rooted from artificial intelligence field, such as machine learning and neural networks. These modern techniques transcend traditional valuation methods, offering deeper insights into market dynamics and intrinsic worth. ML-based models leverage vast datasets and complex algorithms to predict company value more accurately. These approaches integrate both endogenous and exogenous variables, enhancing predictive capabilities and providing practitioners with a comprehensive understanding of a company's financial standing.

Moreover, neural networks emerge as sophisticated tools for assessing business value. The above-mentioned studies demonstrate the superior performance of NN-based models over traditional methods like financial ratios or linear regression. Neural networks offer unparalleled depth in analysing complex patterns and adapting to market dynamics, providing investors and management with valuable insights for strategic decision-making. To further support these findings, our research (Jagrič et al., 2024) shows that advanced neural network-based methods, such as the Self-Organizing Map (SOM) model, are much more efficient and accurate for business valuation compared to traditional methods which is clearly demonstrated by the SOM model's superior performance in reducing valuation errors and achieving better prediction results.

As the landscape of business valuation evolves, the integration of AI techniques promises to revolutionize the way companies are evaluated, enabling more informed investment decisions and strategic planning.

Additionally, it was possible to see that no single traditional method can capture all the factors and complexities of a company to accurately assess its value. Thus, each method has its advantages and disadvantages, but it is also important to recognize that the assessment of a company's value depends on the valuator and on the interpretation of what the value of the company means to someone or how they interpret it.

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