

**M&A PREDICTIONS: RECONSIDERING THEIR VALUE, END-USERS, AND
METHODOLOGIES**
**ПРОГНОЗУВАННЯ ЗЛИТТІВ ТА ПОГЛИНАНЬ: МЕТОДОЛОГІЯ ОЦІНКИ
ВАРТОСТІ ТА ЕФЕКТИ ДЛЯ УЧАСНИКІВ**

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***Abstract.** The article explores market participants who may benefit from M&A predictions and how their goals may impact the requirements for M&A predictions. These participants (also called end-users of M&A predictions) are company shareholders considering selling their business, shareholders and company management considering acquiring one or a few other companies, shareholders and company management competing with potential M&A targets or buyers, and advisory firms providing investment banking services in the industries where M&A deals occur. Analyzing their goals while applying M&A predictions, the article concludes that the requirements for M&A predictions can be changed depending on these goals. These end-users may benefit from M&A predictions even if the deals they predict won't happen. These end-users have the potential to significantly influence the outcome of the M&A events they are predicting. The M&A prediction quality criterion imposed by earlier research - the M&A prediction is correct only when a predicted M&A deal happens - can be relaxed depending on the end-users of M&A predictions and their goals. An M&A prediction will be more valuable for end-users if it includes information on both potential targets and potential buyers. M&A prediction may have a more significant value for end-users if it allows for predicting multiple counterparties for a potential party to an M&A deal. The article analyses the existing theoretical basis behind the M&A predictions and concludes that these theories are insufficient to cover all possible reasons behind the deals from the buyers' and sellers' perspectives – additional reasons exist that trigger M&A deals. Also, the existing theories are not always proven by the existing research, showing that their correctness may depend on the context. The article explores the current stance of M&A prediction methodologies, such as: binary*

state prediction models based on a linear combination of independent variables, starting from the earlier works focused on prediction variables for M&A targets to later works dedicated to adding new company-specific prediction variables of the targets and reflecting the context; alternative computational techniques to predict M&A targets, like non-parametric computational techniques, including machine learning; methodologies to predict M&A buyers; methodologies to predict pairs of buyers and targets, researching the relatedness between them. The article concludes that the M&A prediction methodology shall consider and reflect additional motivations for the M&A deal for targets and buyers and shall always include the context. Predicting only targets seems like a one-sided approach. On the contrary, predicting both parties of the deal seems like a promising prediction methodology. Non-parametric computational techniques based on a broader range of prediction variables, reflecting the motivations of the M&A deal's parties and the context, look like a promising basic prediction methodology that should be further developed. Testing new M&A prediction methodologies within a specific sector for a longer time looks promising for increasing the robustness of the model's prediction ability. Finally, out-of-sample tests done over a longer time are necessary to check the models' prediction ability.

Keywords: M&A, predictions, buyers, sellers, targets, deals, takeovers, models.

Анотація. У статті досліджується учасники ринку, які можуть отримати вигоду від прогнозування злиттів та поглинань (M&A), а також вплив їх цільових очікувань на вимоги до прогнозів M&A. Ці учасники (їх також називають кінцевими користувачами прогнозів злиття та поглинання) - акціонери компанії, які розглядають можливість продажу свого бізнесу, акціонери та керівництво компанії, які розглядають можливість придбання однієї чи кількох інших компаній, акціонери та керівництво компанії, що конкурують із потенційними об'єктами злиття та поглинання чи покупцями, а також консультаційні фірми, що здійснюють інвестиційну діяльність та надають банківські послуги в галузях, де відбуваються угоди M&A. В результаті дослідження автори дійшли висновку, що вимоги до прогнозів M&A можуть бути змінені в залежності від цілей та очікувань учасників. Ці кінцеві користувачі можуть отримати вигоду від прогнозування угод злиття та поглинання, навіть якщо прогнозовані ними угоди не відбудуться. У статті аналізується існуюча теоретична база прогнозів M&A та робиться висновок, що цих теорій недостатньо для того, щоб охопити всі можливі причини угод з точки зору покупців і продавців – існують додаткові причини, які викликають угоди M&A. У статті досліджується поточна позиція методологій прогнозування M&A, таких як: двійкові моделі прогнозування стану, засновані на лінійній комбінації незалежних змінних, починаючи від попередніх робіт, зосереджених на змінних прогнозування для цілей M&A, до пізніших робіт, присвячених додаванню нових прогнозів для конкретної компанії змінні цілей і відображення контексту; альтернативні обчислювальні методи для прогнозування цілей M&A, наприклад непараметричні обчислювальні методи, включаючи машинне навчання; методології прогнозування M&A покупців; методології для прогнозування пар покупців і цілей, дослідження спорідненості між ними. Очевидно, що методологія прогнозування M&A повинна враховувати та відображати додаткові мотиви для угоди M&A, завжди включаючи контекст. Непараметричні обчислювальні методи, засновані на ширшому діапазоні прогнозних змінних, що відображають мотивацію сторін угоди M&A та контекст, виглядають як багатообіцяюча базова методологія прогнозування, яку слід розвивати далі. Тестування нових методологій прогнозування злиттів і поглинань у певному секторі протягом тривалого часу виглядає багатообіцяючим для підвищення надійності прогнозної здатності моделі.

Ключові слова: M&A, прогнози, покупці, продавці, цілі, угоди, поглинання, моделі.

Introduction. M&A deal predictions have been researched since the late 1960s. The primary purpose of that previous research was to correctly predict the future targets - the companies to be acquired

via M&A deals. Predicting the M&A target correctly and investing in its shares way before the M&A deal announcement may help an investor achieve abnormal returns. However, neither of the prediction methodologies has proven effective over time and across different contexts. According to (PWC, 2024), the annual size of M&A deals globally during the last 5 years was in the range of \$1.8tn-\$3.7tn while the annual number of deals was in the range of 50,000-65,000. Given the size of the M&A market globally and the number of firms involved, these deals have a massive impact on all market participants worldwide. That leads us to assume that M&A predictions may benefit broader market participants. Extending the range of M&A prediction end-users and understanding their goals while using M&A predictions leads to changes in requirements for M&A predictions. The existing theoretical background explaining the reasons for M&A deals does not cover all possible reasons. Additional reasons exist that trigger M&A deals. Thus, the reasons behind the M&A deals shall be researched further. The same applies to the impact of context on M&A deals. The prediction methodologies shall consider and reflect additional motivations for the M&A deal for targets and buyers, reflecting context and fixing the methodological flaws found by the existing M&A predictions research.

The purpose of this article is to elaborate on market participants who may benefit from M&A predictions, define their goals/motivations while using M&A predictions, and how these goals impact the requirements of the M&A predictions. We will also compare the existing theoretical basis of M&A predictions vis-à-vis some other motivations of market participants to proceed with M&A deals. Finally, we will analyze the current stance of M&A prediction methodologies and conclude about promising ways to develop them, considering the practical perspectives.

Recent literature review. The theoretical basis of M&A predictions was provided by (Jensen and Ruback, 1983; Manne, 1965), who suggested the market for corporate control theory, and (Shleifer, Vishny, 2003), (Dong, Hirshleifer, Richardson, Teoh, 2006) who elaborated on the misvaluation theory. The first studies on M&A prediction variables were done by (Taussig and Hayes, 1968; Vance, 1969; Monroe, R. J. and Simkowitz, M. A. 1971; Stevens, D. L. 1973; Singh, A. and Singh, T. D. 1971; Tzoannos, J. and Samuels, J. M. 1972; Kuehn, D. 1975). The remarkable work by (Palepu, 1986) fixed the methodological flaws of the previous studies but still showed it is difficult to predict M&A targets correctly and proposed a methodological approach for predictions that became mainstream. The further works of (Ambrose and Megginson, 1992a and 1992b), (Meador, Church, Rayburn, 1996), (Ouzounis, Gaganis, Zopounidis, 2009), (Espahbodi, Espahbodi 2003) and others elaborated on new company-specific characteristics (prediction variables) of the targets. (Powell, 1997), (Barnes, 2000), (Cudd and Duggal, 2000), Powell (2001) and others found how the context impacts M&A predictions of targets. (Ragothaman, Naik, Ramakrishnan, 2003), (Tsagkanos, Georgopoulos, Siriopoulos, 2007), (Pasiouras, Tanna, Zopounidis, 2007) and others proposed alternative computational techniques for M&A predictions of targets. (Pasiouras, Gaganis, 2007), (Ben Slama, Saidane, Fedhila, 2012), (Ozer, Okur, Çam, 2022) and a few others proposed methodologies to predict buyers. (Wei, Chiang, Yang, 2009, 2014), (Futagami, Fukazawa, Kapoor, Kito, 2021), (Arsini, Straccamore, Zaccaria, 2023) proposed methodologies to predict pairs of targets and buyers, researched the relatedness between them.

Presentation of the main research outcomes. The relevance and practical usage of M&A predictions. Mergers and acquisitions (M&As) are deals with a firm's stock that fit two criteria: (i) changing ownership over a firm's stock, and (ii) changing corporate control over the firm. Such a firm is also called a target.

An acquisition occurs when the acquirer (or buyer) company buys the target's stock and receives corporate control over the target. A merger occurs when two firms transfer their stock and assets to a newly formed entity. However, shareholders of both firms in the merger rarely receive equal stakes in the newly formed entity-shareholders of one of the firms usually prevail in the newly formed entity. Such a merger is de facto an acquisition, as described above.

An M&A deal develops the acquirers' businesses in various ways, such as extending their product or service offering, entering new markets, improving competitiveness, acquiring resources critical for their business, realizing synergies, and several others. For the owners of targets, an M&A deal means the possibility of exiting their business and capitalizing on it-receiving cash or other liquid assets in exchange for their shares sold.

The research on M&As is quite extensive, covering many topics. Among these are motivations for M&As, risks and outcomes from M&As for acquirers and targets, and predictions of M&A deals.

The latter research was stimulated by the fact that the M&A deal announcement significantly impacts the target's share price if the target's shares are traded on the stock exchange. (Tunyi, 2021) suggests that the target's share price gains upwards of 20% on average immediately after the announcement of the M&A deal. Thus, predicting the M&A target correctly and investing in its shares way before the M&A deal announcement may help an investor achieve abnormal returns.

That explains why most M&A deal prediction research focuses on predicting M&A targets.

Besides earning an abnormal return if the M&A target is predicted correctly and in advance, (Tunyi, 2021) suggests a few other reasons for the relevance of M&A predictions of the targets:

I. The need for managers to be aware of their firms' risk of becoming the target of a takeover bid to take action to safeguard the interests of their shareholders or extract excess managerial rent or achieve the valuation premium;

II. The potential for target prediction models to aid regulators in their bid to narrow down potential cases of insider trading ahead of takeover announcement;

III. Knowledge of the likelihood that a firm's competitors and supply chain partners will engage in M&A activity is perhaps important for the firm's long-term strategy development.

We believe that predicting M&A deals, especially in case such predictions would include not only the potential targets' but also the potential buyers' information, may have practical usefulness for the broader range of market participants (or end-users of M&A predictions) while they plan and execute their strategy:

1. Company shareholders who consider to sell their business;
2. Shareholders and company management considering to acquire one or a few other companies;
3. Shareholders and company management competing with potential M&A targets or buyers;
4. Advisory firms providing investment banking services in the industries where M&A deals occur.

Below, we elaborate on how these end-users may benefit from M&A predictions:

1. Company shareholders considering exiting the business may need to predict potential buyers for their business before deciding to start the sale process. The more buyers they could engage in the process via getting bids from them, the higher the chances they would close their sale successfully. Also, the number of potential buyers involved in the competitive sale process may help the sellers achieve a higher valuation for their company.

2. Shareholders and company management considering proceeding with the acquisition may need to predict potential targets before starting to approach them. Suppose there are no strict preferences for a particular target at the beginning. In that case, the more predicted targets are open to considering a sale to this acquirer, the higher the chances that this acquirer will close its acquisition successfully.

3. Shareholders and company management should consider their competitors' M&A plans. If an M&A occurs, it changes the market landscape for all market participants, impacting their business and future development. While predicting competitors' M&As, the company may change its strategy, including starting its own M&A process, bidding to buy its competitor, or offering its business to the bidders participating in the competitor's sale process.

4. Advisory firms that provide investment banking services may need to predict potential M&A targets and buyers in order to engage with them and help them execute their M&A deals, working either on the seller's or buyer's side.

The value of M&A predictions varies depending on the end-users and their goals. The same is true about their influence on the M&A events they try to predict.

For investors willing to earn abnormal returns by investing in the stock of a potential M&A target, the M&A prediction brings value if a predicted M&A target becomes a target of the completed M&A deal. Otherwise, investing in wrong targets would generate losses instead of abnormal returns (Palepu, 1986). Such investors usually do not impact the outcome of the M&A deals they try to predict.

Let's elaborate on the potential value of M&A predictions for each group of end-users suggested above, and how these end-users influence the M&A events they may try to predict:

1. For business sellers, the M&A prediction brings value if at least one predicted buyer bids for their business. As explained above, this value increases if a few such bidding buyers are predicted. However, obtaining bids from these buyers depends also on the sellers' actions. The outcome of the sale process - whether the sale happens and who acquires the company-also depends on the sellers' actions.

2. For shareholders and the management of an acquirer, the M&A prediction brings value if at least one predicted target would be open to considering a sale to this acquirer. Depending on the acquirer's M&A strategy, as described above, the value of such prediction may increase if a few such targets are predicted. However, the target's openness to be acquired depends on the acquirer's actions. The same is true for the outcome of the further acquisition process.

3. A prediction of a competitor's M&A deal brings value to the company's shareholders and management that made it if it helps to reveal the competitor's M&A process. For example, the company predicted that its competitor would likely exit the business. So, the company starts gathering information from the market and gets a confirmation that its competitor is for sale. In that case, the company may want to bid for it. Alternatively, the company may wish to initiate its sale process, attracting bidders already participating in the competitor's sale process. In either case, predictions about potential bidders for the competitor would help the company execute its chosen M&A strategy. Also, the company may not proceed with any of those M&A strategies, but will adjust its business strategy to prepare for the competitor's sale. The company's actions may impact the outcome of the competitor's M&A process. All the above logic applies to the situation when the company predicted a likely acquisition made by its competitor.

4. For an investment banker, the M&A prediction brings value if it helps him initiate or engage in the M&A process as an advisor on either side of the project. For example, a banker predicts that a specific company is likely to be sold. In that case, a banker may approach this company and, if his prediction about the company's intentions is correct, get engaged by the company to help it execute the sale process. Alternatively, the banker may be engaged by a potential buyer willing to buy this company. Finally, there can be a situation when there is no sale process with the company predicted as a target, but the banker still may use his prediction to persuade the party he is engaged with to start the M&A process. In all these cases, predictions of potential bidders for this company will help the banker increase its chances of getting engaged with either party. The same logic as above works regarding a prediction about an acquirer. In all these cases, the banker may impact the intentions of the party it is engaged with, and the outcome of the M&A process.

Based on this, the following changes to M&A prediction requirements shall be considered:

1. The end-users may benefit from M&A predictions even if the deals they predict won't happen;

2. The end-users may impact the outcome of the M&A events they are predicting;

3. Points 1 and 2 above mean that the M&A predictions quality criterion imposed earlier - i.e. the M&A prediction is correct only when a predicted M&A deal happens - can be relaxed depending on the end-users of M&A predictions and their goals;

4. There will be a more significant value of an M&A prediction for end-users if it includes both potential targets' and potential buyers' information;

5. M&A prediction may have a more significant value for end-users if it allows for predicting multiple counterparties for a potential party to an M&A deal. For example, a few buyers are predicted for a potential target, or a few targets are predicted for a potential buyer.

The theoretical basis for M&A predictions. (Tunyi, 2021) concludes that there are two main theoretical perspectives behind the takeover likelihood modeling, based on earlier research: the market for corporate control theory and the misvaluation theory.

The market for corporate control theory (Jensen and Ruback, 1983; Manne, 1965), or the management inefficiency theory, suggests that management teams compete to manage the firm's resources in the interest of shareholders. Thus, the management team that performs poorly for the firm's shareholders is subject to takeover bids from more efficient management teams.

(Shleifer, Vishny, 2003) and (Dong, Hirshleifer, Richardson, Teoh, 2006) used the misvaluation theory to explain the reasons for M&A deals. The buyers strive to buy the targets which they believe are undervalued, i.e., valued below their fundamental value, if the deal is done in cash, or less overvalued when compared to the buyer's own value, if the deal is done in shares (Dong, Hirshleifer, Richardson, Teoh, 2006).

We believe there could be other reasons triggering the M&A deals not covered by the theories mentioned above:

1. Owners want to sell the business at the best possible market momentum and while it performs excellently to maximize the valuation and achieve other attractive deal terms for the sellers. Example: the exits in the IT services sector globally during 2018-2021 at peak valuations when the sector has grown fast.

2. Owners want to sell the business due to longer-term threats for their business or its industry, while the business itself performs great and there are no threats on the short-term horizon. Example: specific M&A deals in the metallurgical sector in the first half of the 2010s, anticipating long-term deterioration on the market due to expected overcapacity in steel production in China and the potential end of the commodity super cycle.

3. Owners want to sell the business because of plans unrelated to the business's stance or industry per se. Examples: a PE fund needs to exit due to its expiration; the business owner wants to retire and cash out.

4. Buyers would like to buy because of the reasons not covered by the market for corporate control theory and the misvaluation theory. Examples: the acquisition of the target makes sense from the buyer's strategy point of view, achieved synergies, even if the valuation is high; the buyer's top management wants to achieve quick wins via M&A deals (Garrow, Awolowo, 2024).

Furthermore, there could be external factors impacting all buyers and sellers on the market and their decisions about M&A deals, such as:

1. Financial markets situation;
2. Macroeconomic situation;
3. Regulatory environment.

The research dedicated to M&A deals covers many of the reasons triggering M&A deals, but it has limited or no application in M&A deal prediction research.

Earlier research of predicting M&A targets - prediction variables. The first studies (Taussig and Hayes, 1968; Vance, 1969; Monroe, R. J. and Simkowitz, M. A. 1971; Stevens, D. L. 1973; Singh, A. and Singh, T. D. 1971; Tzoannos, J. and Samuels, J. M. 1972; Kuehn, D. 1975) concluded that the

M&A targets usually had different characteristics before the actual deal happened when compared to non-targets. This means that the selection of the targets is nonrandom, and the targets could be predicted using their characteristics, so-called prediction variables.

These earlier studies concluded that targets usually had lower profitability, lower return on equity, lower or unpredictable dividend pay-out, lower valuation multiples (i.e. undervalued), lower growth, and were smaller in size. Some works contradicted each other; for example (Kuehn, 1975) concluded that targets had lower liquidity levels, while (Taussig and Hayes, 1968; Stevens, 1973) concluded the opposite. These were the first signs that conclusions about the targets' characteristics could be biased by the samples of companies selected for the research purposes or the research methodology itself.

These previous studies used discriminant analysis, factor analysis, and probit models to predict targets, distinguishing them from non-targets. Scholars claimed that their models were highly predictive. However, they did not provide the theoretical framework to support the selection of prediction variables and their relationship with the likelihood of M&A deals. In contrast, they start with many prediction variables and try to find via modeling which of these variables are statistically meaningful and, thus, could be used to predict the targets, narrowing down the initial list of variables.

Palepu approach to predict M&A targets. The remarkable work made by (Palepu, 1986) found that the previous studies mentioned above had certain methodological flaws, such as the usage of non-random equal-share samples in model estimation, the usage of arbitrary cut-off points in target prediction, and the usage of equal-share samples in prediction tests. While fixing the flows mentioned above, Palepu proposed an improved approach for target prediction. He suggested defining and testing the six hypotheses to explain the selection of the prediction variables:

1. Inefficient management hypothesis. Firms with inefficient management are likely targets. Two alternative metrics for management efficiency were used: return on firm stock vs. the market and return on equity.
2. Growth resource mismatch hypothesis. Firms with a mismatch between their growth and the financial resources at their disposal are likely targets. So, there are two options for being a target: low-growth, resource-rich firms and high-growth, resource-poor firms.
3. Industry disturbance hypothesis. Firms in industries subjected to "economic disturbances" are likely acquisition targets.
4. Size hypothesis: the likelihood of acquisition decreases with the size of the firm.
5. Market-to-book hypothesis: firms with lower market values than their book value are likely acquisition targets.
6. Price-earnings hypotheses: firms with low P/E ratios are likely acquisition targets.

The modeling confirmed the first, second, and fourth hypotheses. Regarding the second hypothesis, it was found that targets are likely firms with low growth and low leverage, though liquidity has no impact.

Though not all the hypotheses were confirmed, defining and testing the hypothesis to select prediction variables has become a mainstream approach in the research over the next years.

All the Palepu prediction models, though they provide a statistically significant explanation, have low prediction power. The best model explains 12.45% (out of 100%) of the firm's acquisition probability variation. The model erroneously predicts many non-targets as targets.

Palepu concluded that it is difficult to predict targets for M&A deals using binary state prediction models based on a linear combination of independent variables.

Further works to predict targets. Several attempts were made to improve the accuracy of the target predictions. However, all the models either had low predictive ability, as claimed by their authors, or the predictive ability was undefined since the authors did not test the models out-of-sample. We provide a few examples of research works split by direction.

Adding new company-specific characteristics (prediction variables) of the targets.

(Ambrose and Megginson, 1992a and 1992b) concluded that the Palepu model has low explanatory power – none of the Palepu hypotheses were validated in the sample proposed by the authors. They concluded that the information known about targets is rather limited. This means that the existing characteristics are insufficient to separate the targets from non-targets - the new characteristics of targets should be found.

(Meador, Church, Rayburn, 1996) tested logit regression binary analysis over samples of US mergers during 1981-1985. The model for horizontal mergers (i.e., within the same industry) showed higher prediction ability, with the following target variables showing significance: long-term debt/total assets, long-term debt/market value, market value/book value, asset growth, and sales growth.

(Ouzounis, Gaganis, Zopounidis, 2009) concluded that targets had inefficient management teams, were undervalued, and less profitable, in line with previous works. However, they concluded that targets are usually larger than non-targets, which contradicted to (Palepu, 1986, Powell, 2001, 2004) but was consistent with (Powell, Yawson, 2007).

(Espahbodi, Espahbodi 2003) In addition to financial predictor variables, they tried to apply a few non-financial variables and concluded that a dummy variable defining the existence of management's golden parachutes impacts the target prediction. However, their models poorly predicted future targets.

(Ben Slama, Saidane, Fedhila, 2012) analyzed M&A activities within the banking sector in Europe during 2000-2006. Along with usual predictor variables like ROE and size, they concluded that newly introduced predictor variables characterizing banks' lines of activities are statistically meaningful for target predictions.

(Tunyi, Ntim, Danbolt, 2019) analyzed M&A deals in the UK from 1988 to 2017 and introduced new management efficiency metrics based on firms' financial indicators (i.e. ROA, ROE etc.) and stock market performance. The results suggest that the companies run by managers who focus on sustaining long-term shareholders' value, even at the expense of current profitability, are less likely to be acquisition targets. By contrast, companies run by managers who pursue profitability at the expense of long-term shareholder value creation are more likely to face acquisition.

(Ozer, Okur, Çam, 2022) analyzed M&A deals within the US insurance industry from 1990 to 2019. Along with financial predictor variables, like size and cash holdings, the newly introduced predictor variables characterizing the type of insurer activity (life, non-life) and the presence or absence of ESG (environmental, social, governance) scores were statistically meaningful for predictions.

(Xiang, Zheng, Wen, Hong, Rose, Liu, 2012) was the first work to use historical textual information from news about M&A targets and non-targets to predict future targets. The research focused on technology companies and used TechCrunch and Crunchbase web-sites to collect company news information. Though research claimed a high true positive rate between 60% to 79.8% with a false positive rate between 0% and 8.3% to predict M&A targets, no out-of-sample experiments were done to evaluate whether this approach can predict targets there.

Reflecting the context.

(Powell, 1997) concluded that the characteristics of the target change over time and that Palepu's models have a low prediction ability.

(Barnes, 2000) tried to apply industry-relative financial predictor variables for targets. However, neither of his models (industry-specific and general) can correctly predict targets out of the sample.

(Cudd and Duggal, 2000) found out that industry-specific distributional characteristics are important for modeling based on financial ratios. As a test case, the study replicates (Palepu, 1986), who employs financial ratios in logit models to investigate the usefulness of six acquisition hypotheses in predicting takeover targets. Without adjustment for industry-specific distributional characteristics, only one of six Palepu's acquisition hypotheses was confirmed by this research. After adjustment, the four of six Palepu's acquisition hypotheses were confirmed. The adjusted model produced a classification

accuracy significantly greater than chance and significantly greater than that observed for the unadjusted model.

Powell (2001) tested whether it is possible to generate abnormal returns from investing in a portfolio of targets predicted using models similar to those proposed by (Palepu, 1986). However, unlike (Palepu, 1986), the portfolios were formed using different out-of-sample cut-off probabilities, which took into account the investment objective of prediction modeling. That resulted in smaller portfolios with higher average takeover probabilities. However, the model predicted too many false targets out of the sample.

The work of (Espahbodi, Espahbodi 2003), cited earlier, concluded that a dummy variable reflecting the anti-takeover regulation showed statistical significance in target prediction.

(Tsaykanos, Georgopoulos, Siriopoulos, 2007) which analyzed M&A deals in Greece and concluded that the local targets usually boasted higher productivity, were long present on the market (i.e., have higher experience when compared to non-targets), and were larger and had good financial performance. It is interesting that these conclusions contradict the previous research we referred to earlier, meaning that the context – in this case, the geography – has a meaningful impact on the predictions.

(Ben Slama, Saidane, Fedhila, 2012) concluded that the following target's country contextual variables introduced into the model were statistically significant while predicting targets in cross-border banking M&A in the EU: the countries' level of restrictions on the banking activity, growth rate of GDP, the growth rate of population, the inflation, and the FDI size. The research concluded that banks, which were the targets in M&A deals, operating in countries with higher levels of restrictions in the banking sector, lower inflation, and lower FDI but with higher growth in GDP and population.

(Tynyi, 2019) concluded that the target size has a nonlinear but rather U-shape dependence on the deal probability. An important conclusion of this work is that acquirers tend to buy larger targets when the stock market is growing and there is ample liquidity. Thus, the environment (in this case, market momentum) impacts the likelihood of the deal and the parameters of the target (in this case, its size).

Separation of the targets depending on M&A type (friendly or hostile) and other major corporate events different from M&A deals (bankruptcy restructuring)

(Powell, 2004) assumed that the characteristics of hostile and friendly takeover targets are different since there are other motives for such takeovers. Thus (Powell, 2004) applied a multinomial model that considered the M&A bid type (friendly or hostile). However, the study reports poor model predictive ability as all models (multinomial and binomial) misclassified many non-targets as targets.

(Powell, Yawson, 2007) found out bankrupt firms had declining stock returns similar to takeover targets. That means earlier prediction hypotheses and related prediction variables did not completely capture the motives behind the takeovers.

(Danbolt, Siganos, Tunyi, 2016) suggested using the screening technique to separate potential takeover targets from distressed firms using three parameters: size, leverage, and liquidity.

Applying alternative computational techniques

While many of the works mentioned above used parametric models, such as discriminant, logit, and probit models, some of the works dedicated to M&A target predictions used alternative computational techniques.

For example (Espahbodi, Espahbodi 2003), in addition to well-known parametric models, also applied recursive partitioning for target predictions based on the prediction variables we described above. However, these alternative computational techniques did not improve the ability of the models to predict.

(Ragothaman, Naik, Ramakrishnan, 2003) applied rule induction techniques such as IXL and ID3 to predict acquisition targets and compared these techniques with a classical discriminant analysis model

and a logit model using the same data. They concluded that the prediction ability of the new techniques is comparable to classical approaches, but there is no superiority of the new techniques.

(Tzagkanos, Georgopoulos, Siriopoulos, 2007) used recursive partitioning techniques, that is, decision-tree models, with certain changes when compared to (Espahbodi, Espahbodi 2003) applying the machine learning algorithm J4.8. The results shown that J4.8 outperforms the classical regression tree, although the predictive accuracy is not promising.

(Pasiouras, Tanna, Zopounidis, 2007) applied Multicriteria Decision Aid methods such as MHDIS, PAIRCLAS, and Utilities Additives Discriminantes (UTADIS) to predict M&A targets in the EU banking industry. (Ouzounis, Gaganis, Zopounidis, 2009) used UTADIS, Artificial Neural Networks and Support Vector Machines methods along with classical discriminant analysis to predict targets.

There was limited evidence that alternative methods significantly outperform the parametric models.

(Xiang, Zheng, Wen, Hong, Rose, Liu, 2012) used a topic extraction method called latent Dirichlet allocation to analyze news about M&A targets and non-targets. The algorithm allowed to find out which topics relate to M&A targets and which do not, which is how M&A targets could be predicted using historical news information about the companies. However, there was no evidence of testing this method on out-of-sample companies and the news related to them.

Prediction of M&A buyers. The first works to find characteristics of M&A buyers that differentiate them from non-buyers were done simultaneously with the first works about the characteristics of M&A targets.

For example, (Tzoannos, Samuels, 1972) concluded that M&A buyers usually have low levels of capital and reported falling gearing (leverage) ratios, growing dividends and growing profitability. (Kuehn, 1975) concluded that M&A buyers usually were over-valued and demonstrated high growth levels but had low profitability ratios when compared to their industry average.

Similarly to M&A targets, M&A buyers' selection is nonrandom-the M&A buyers could be predicted using their characteristics. Additional buyer-specific and context variables can be applied to predict buyers.

(Pasiouras, Gaganis, 2007) analyzed the M&A deals in the banking sector. They used regression models to determine the factors that define targets and acquirers. They concluded that acquirers are usually bigger in size, have higher profitability and cost efficiency when compared to non-acquirers. It is interesting, however, that when they split their sample for two sub-periods, only one characteristic remained robust for acquirers over time – the size. This reminds us of an earlier conclusion relevant to the targets – the context impacts the prediction variables. That's relevant for the buyers' prediction variables as well.

(Ben Slama, Saidane, Fedhila, 2012) analyzing M&A deals in the banking sector concluded that buyers in the banking sector are usually universal banks. They used logit multinomial models to predict whether a specific bank is a target or a buyer.

(Ozer, Okur, Çam, 2022) used multinomial logistic regression to identify the determinants associated with becoming targets or acquirers in the US insurance industry. Insurance firms are more likely to be acquirers if they have higher profitability, higher cash flow, and higher intangibles, as well as if they are non-life and do not have ESG scores. Moreover, the likelihood of becoming an acquirer decreases in times of global financial crises (GFCs) as compared to non-GFC times

(Yan, Xiao, Li, Jin, Wang, Ke, Yang, Zha, 2016) tried to predict M&A buyers using historical information about the firms' activities as buyers in M&A deals and news from Crunchbase. More specifically they applied a mutually-exciting point process with a regression prior to quantify the investor's M&A behavior. The work was motivated by the so-called contagious 'wave-like' M&A phenomenon, which has been well-recognized by the economics and management communities. A

tailored model learning algorithm is devised that incorporates both static profile covariates and past M&A activities.

Prediction pairs of M&A buyers and targets, links between buyers and targets. While extensive research was done on predicting M&A targets and rarer works to predict M&A buyers, there were limited attempts to predict both parties of an M&A deal – a target and a buyer. These latter works can be a basis for developing models for predicting a set of buyers for a specific target or a set of targets for a particular buyer.

(Wei, Chiang, Yang, 2009, 2014) the basic idea was that in the technology sector, M&A deals happen when the target's technology profile complements the technology profile of the bidder. Thus, the prediction of the targets in this sector should be made with consideration of the technological profile of the bidder company or its compatibility with the candidate target companies' technological profiles. The M&A prediction technique that encompasses technological indicators as independent variables and accounts for the technological profiles of both bidder and candidate target companies was proposed. These technological indicators were derived from patent documents. The ensemble machine learning method was developed for the proposed technology M&A prediction technique to predict pairs of bidder and candidate target companies based on their technological profiles.

(Futagami, Fukazawa, Kapoor, Kito, 2021) assumed that buyers and targets have similar features. Thus, the future pairs of buyers/targets can be predicted based on this assumption using historical M&A deals and features of their buyers and targets. However, to train a machine learning algorithm to predict future pairs, the negative samples shall be included in its learning process. The authors proposed to generate negative samples (the pairs of companies that did not do M&A deals in the past as buyers and targets) based on the similarities between such companies, same as for positive samples (the actual pairs of buyers and targets from the historical M&A deals). This allowed learning minor differences between companies from negative and positive samples to improve the prediction ability of the algorithm. The authors evaluated their prediction model using 2000–2018 acquisition logs collected from CrunchBase. Based on the analysis of the high SHapley additive explanation (SHAP) value features, they found that the newly considered network and company relation features had high significance (10 out of 22 top key features). They also clarified how these novel features contributed to the prediction of acquisition occurrence by interpreting the SHAP value.

(Arsini, Straccamore, Zaccaria, 2023) similarly to (Wei, Chiang, and Yang, 2009, 2014) assumed that M&A deals happen more frequently between buyers and targets similar to each other from the technological perspective. The authors used patent data to compile technology profiles about the companies and predict future M&A pairs based on this information. They tested machine learning and network-based algorithms, showing that a simple angular distance with the addition of the industry sector information outperforms the other approaches

Finally (Albora, Straccamore, Zaccaria, 2024) is the third work we wanted to refer to similar to (Wei, Chiang, Yang, 2009, 2014) and (Arsini, Straccamore, Zaccaria, 2023) which used patent data to predict M&A deal pairs. The authors developed a new algorithm called MASS to calculate the similarity between companies and made predictions based on it. MASS is based on a simplification of tree-based machine learning algorithms and naturally incorporates intuitive criteria for deals. By applying MASS to the Zephyr and Crunchbase datasets, the authors showed that it outperforms LightGCN, a "black box" graph convolutional network algorithm. When similar companies have disjoint patenting activities, on the contrary, LightGCN turns out to be the most effective algorithm.

Conclusions.

1. The existing literature assumes quite a narrow value of M&A predictions for a limited number of market participants. We believe there is a broader range of market participants or end-users of M&A predictions, that can benefit from them, such as company shareholders considering selling their business, shareholders and company management considering acquiring one or a few other companies,

shareholders and company management competing with potential M&A targets or buyers, and advisory firms providing investment banking services in the industries where M&A deals occur.

All these end-users may benefit from M&A predictions while planning their M&A deals or conducting their usual business.

2. These end-users may benefit from M&A predictions even if the deals they predict won't happen.

3. These end-users, armed with M&A predictions, have the potential to significantly influence the outcome of the M&A events they are predicting.

4. The M&A predictions quality criterion imposed by earlier research - i.e. the M&A prediction is correct only when a predicted M&A deal happens - can be relaxed depending on the end-users of M&A predictions and their goals.

5. An M&A prediction will be more valuable for end-users if it includes information on both potential targets and potential buyers.

6. M&A prediction may have a more significant value for end-users if it allows for predicting multiple counterparties for a potential party to an M&A deal. For example, a few buyers are predicted for a potential target, or a few targets are predicted for a potential buyer.

7. The existing theories explaining the deals' motivations are insufficient to cover all possible reasons behind the deals from the buyers' and sellers' perspectives. The existing theories are not always proven by the existing research, showing that their correctness may depend on the context.

8. The prediction methodology shall consider and reflect additional motivations for the M&A deal for targets and buyers. One way forward is to incorporate into the M&A deal prediction methodologies the findings about M&A deal motivations suggested by broader M&A research.

9. Context shall always be a part of the prediction methodology since it directly impacts the M&A outcome.

10. From the practical standpoint, an M&A deal is impossible to accomplish if no buyer is ready to consummate it. There must be a buyer who decides to conclude the deal and has the financial capacity for that. Predicting only targets seems like a one-sided approach. On the contrary, predicting both parties of the deal seems like a promising prediction methodology.

11. This brings us to predicting pairs or even predicting potential targets for a buyer and potential buyers for a target. The latter approach (multiple potential counterparties for a selected party) may allow for the selection of the likeliest candidates for the deal based on predicted sets of targets and buyers.

12. Non-parametric computational techniques based on a broader range of prediction variables, reflecting the motivations of the M&A deal's parties and the context, look like a promising basic prediction methodology that should be further developed.

13. Testing new M&A prediction methodologies within a specific sector for a longer time looks promising for increasing the robustness of the model's prediction ability.

14. Out-of-sample tests done over a longer time are necessary to check the models' prediction ability.

References

1. Taussig, R. A. and Hayes, S. L. (1968). Cash take-overs and accounting valuations. *The Accounting Review*, 43(1):68–74.
2. Vance, J. O. (1969). Is your company a take-over target. *Harvard Business Review*, 47(3):93.
3. Monroe, R. J. and Simkowitz, M. A. (1971). Investment characteristics of conglomerate targets: a discriminant analysis. *Southern Journal of Business*, 9:1–16.
4. Stevens, D. L. (1973). Financial characteristics of merged firms: A multivariate analysis. *Journal 33 of Financial and Quantitative analysis*, pages 149–158

5. Singh, A. and Singh, T. D. (1971). Take-overs: Their Relevance to the Stock Market and the Theory of the Firm, volume 19. CUP Archive
6. Tzoannos, J. and Samuels, J. M. (1972). Mergers and takeovers: the financial characteristics of companies involved. *Journal of Business Finance*, pages 5–16.
7. Kuehn, D. (1975). Takeovers and the Theory of the Firm: an empirical analysis for the United Kingdom 1957–1969. Springer.
8. Palepu, K. G. (1986). Predicting takeover targets: A methodological and empirical analysis. *Journal of Accounting and Economics*, 8(1):3–35.
9. Ambrose, B. and Megginson, W. L. (1992a). The role of asset structure, ownership structure, and takeover defenses in determining acquisition likelihood. *Journal of Financial and Quantitative Analysis*, 27(04):575–589.
10. Ambrose, B. W. and Megginson, W. L. (1992b). The role of asset structure, ownership structure, and takeover defenses in determining acquisition likelihood. *Journal of Financial and Quantitative Analysis*, 27(4):575–589.
11. Meador, A. L., Church, P. H., & Rayburn, L. G. (1996). Development of prediction models for horizontal and vertical mergers. *Journal of financial and strategic decisions*, 9(1), 11-23.
12. Ouzounis, G., Gaganis, C., and Zopounidis, C. (2009). Prediction of acquisitions and portfolio returns. *International Journal of Banking, Accounting and Finance*, 1(4):381–406.
13. Powell, R. G. (2001). Takeover prediction and portfolio performance: A note. *Journal of Business Finance & Accounting*, 28(7-8):993–1011.
14. Powell, R. (2004). Takeover prediction models and portfolio strategies: a multinomial approach. *Multinational Finance Journal*, 8(1/2):35–72.
15. Powell, R. and Yawson, A. (2007). Are corporate restructuring events driven by common factors? implications for takeover prediction. *Journal of Business Finance & Accounting*, 34(7-8):1169–1192.
16. Espahbodi, H. and Espahbodi, P. (2003). Binary choice models and corporate takeover. *Journal of Banking & Finance*, 27(4):549–574.
17. Ben Slama, M., Saidane, D., & Fedhila, H. (2012). How to identify targets in the M&A banking operations? Case of cross-border strategies in Europe by line of activity. *Review of Quantitative Finance and Accounting*, 38, 209-240.
18. Tunyi, A. A., Ntim, C. G., & Danbolt, J. (2019) Decoupling management inefficiency: Myopia, hyperopia and takeover likelihood. *International Review of Financial Analysis*, 62, 1-20.
19. Ozer, G., Okur, N., & Çam, İ. (2022). Determinants of becoming an M&A acquirer or target: evidence from the US insurance industry. *Journal of Capital Markets Studies*, 6(2), 203-218.
20. Powell, R. G. (1997). Modelling takeover likelihood. *Journal of Business Finance & Accounting*, 24(7-8):1009–1030.
21. Barnes, P. (2000). The identification of uk takeover targets using published historical cost accounting data some empirical evidence comparing logit with linear discriminant analysis and raw financial ratios with industry-relative ratios. *International Review of Financial Analysis*, 9(2):147–162.
22. Cudd, M., & Duggal, R. (2000). Industry distributional characteristics of financial ratios: An acquisition theory application. *Financial Review*, 35(1), 105-120.
23. Tsagkanos, A., Georgopoulos, A., and Siriopoulos, C. (2007). Predicting greek mergers and acquisitions: a new approach. *International Journal of Financial Services Management*, 2(4):289–303.
24. Tunyi, A. (2019). Firm size, market conditions and takeover likelihood. *Review of Accounting and Finance*.
25. Ragothaman, S., Naik, B., & Ramakrishnan, K. (2003). Predicting corporate acquisitions: An application of uncertain reasoning using rule induction. *Information Systems Frontiers*, 5, 401-412.

26. Pasiouras, F., Tanna, S., & Zopounidis, C. (2007). The identification of acquisition targets in the EU banking industry: An application of multicriteria approaches. *International Review of Financial Analysis*, 16(3), 262-281.
27. Danbolt, J., Siganos, A., and Tunyi, A. (2016). Abnormal returns from takeover prediction modelling: challenges and suggested investment strategies. *Journal of Business Finance & Accounting*, 43(1-2):66–97.
28. Pasiouras, F., & Gaganis, C. (2007). Financial characteristics of banks involved in acquisitions: evidence from Asia. *Applied Financial Economics*, 17(4), 329-341.
29. Yan, J., Xiao, S., Li, C., Jin, B., Wang, X., Ke, B., ... & Zha, H. (2016, July). Modeling Contagious Merger and Acquisition via Point Processes with a Profile Regression Prior. In *IJCAI* (pp. 2690-2696).
30. Xiang, G., Zheng, Z., Wen, M., Hong, J., Rose, C., & Liu, C. (2012). A supervised approach to predict company acquisition with factual and topic features using profiles and news articles on techcrunch. In *Proceedings of the international AAAI conference on web and social media* (Vol. 6, No. 1, pp. 607-610).
31. Wei, C. P., Chiang, Y. S., & Yang, C. S. (2009). Patent analysis for supporting merger and acquisition (m&a) prediction: A data mining approach. In *Designing E-Business Systems. Markets, Services, and Networks: 7th Workshop on E-Business, WEB 2008, Paris, France, December 13, 2008, Revised Selected Papers 7* (pp. 187-200). Springer Berlin Heidelberg.
32. Yang, C. S., Wei, C. P., & Chiang, Y. H. (2014). Exploiting technological indicators for effective technology merger and acquisition (M&A) predictions. *Decision Sciences*, 45(1), 147-174.
33. Futagami, K., Fukazawa, Y., Kapoor, N., & Kito, T. (2021). Pairwise acquisition prediction with SHAP value interpretation. *The Journal of Finance and Data Science*, 7, 22-44.
34. Arsini, L., Straccamore, M., & Zaccaria, A. (2023). Prediction and visualization of Mergers and Acquisitions using Economic Complexity. *Plos one*, 18(4), e0283217.
35. Albora, G., Straccamore, M., & Zaccaria, A. (2024). Machine learning-based similarity measure to forecast M&A from patent data. *arXiv preprint arXiv:2404.07179*.
36. Tunyi, A. (2021). Fifty years of research on takeover target prediction: a historical perspective. *Qualitative research in financial markets*, 13(4), 482-502.
37. Manne, H. G. (1965). Mergers and the market for corporate control. *Journal of Political Economy*, 73.
38. Jensen, M. C. and Ruback, R. S. (1983). The market for corporate control: The scientific evidence. *Journal of Financial Economics*, 11(1):5–50.
39. Shleifer, A. and Vishny, R. W. (2003). Stock market driven acquisitions. *Journal of Financial Economics*, 70(3):295–311.
40. Dong, M., Hirshleifer, D., Richardson, S., and Teoh, S. H. (2006). Does investor misevaluation drive the takeover market? *The Journal of Finance*, 61(2):725–762.
41. Garrow, N., & Awolowo, I. F. (2024). Animal spirits, hubris, narcissism: Behavioural determinants of merger and acquisition outcomes. *Journal of Governance and Regulation*, 13(2, spe), 287-296.
42. PWC (2024) Mid-Year Outlook, Global M&A Industry Trends. <https://www.pwc.com/gx/en/services/deals/trends.html>