



# **FINANSE i PRAWO FINANSOWE**

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## REQUIRED RATE OF RETURN ON FINANCIAL INSTRUMENTS BY AN INDIVIDUAL INVESTOR IN THE CONTEXT OF BEHAVIOURAL FINANCE

Michał Kurzawiński\*, Agata Gniadkowska-Szymańska\*\*

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### REQUIRED RATE OF RETURN ON FINANCIAL INSTRUMENTS BY AN INDIVIDUAL INVESTOR IN THE CONTEXT OF BEHAVIOURAL FINANCE

#### ABSTRACT

**The purpose of the article.** The main research objective of this work is to examine the occurrence of three heuristics among individual investors: overconfidence, loss aversion, and the disposition effect. The study aims to show the occurrence of these heuristics in a sample of investors.

**Methodology.** The study was conducted on a sample of 121 individual investors using an online survey based on scenario questions. The research method was selected based on the unique characteristics of behavioural finance. The research requires direct interaction with market participants, i.e., individual investors.

**Results of the research.** The research revealed the occurrence of two out of three examined heuristics. The analysis of the responses from the study participants led to the conclusion that emotions play a significant role in influencing decision-making processes in investor behaviour.

**Keywords:** behavioral finance, financial instruments, heuristics, perspective theory.

**JEL Class:** G1, G4, G41.

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## **Required Rate of Return on Financial Instruments by an Individual Investor in the Context of Behavioural Finance**

Behavioural finance is one of the youngest and most dynamically developing trends in the field of finance. It questions investor rationality and, as the name suggests, analyses the behaviour of entities on financial markets. The basis of behavioural finance is prospect theory by Kahneman and Tversky (1979). Academic researchers consider investor behaviour based on observed heuristics, i.e., simplified decision-making rules that often lead to cognitive errors. Heuristics in the context of behavioral finance research play a key role in understanding how people make financial decisions in situations of uncertainty. They are simplified rules of thought that help in quick decision-making, but can lead to systematic cognitive errors. Heuristics help explain market anomalies and understand why investor behavior often deviates from the rational model of Homo Economicus. Studying these mechanisms contributes to better design of investment strategies and financial products that take into account human cognitive and emotional limitations.

The main research objective of this work is to examine the occurrence of three heuristics among individual investors: overconfidence, loss aversion, and the disposition effect. The study aims to show the occurrence of these heuristics in a sample of investors.

### **Review of the Literature**

A trend in financial theory in recent years is behavioural finance. The behavioural concept of finance does not deny the validity of the classical theory of finance; rather, it questions the rationality of investor behaviour on the market. The behavioural approach to studying the behaviour of economic entities combines elements of economics and psychology. The need to develop this trend questioned the sufficiency of the economic result itself in investors' decisions, suggesting that psychological factors also determine the direction of action taken, pointing to the lack of rationality of market participants in their behaviour (Szyszka, 2009; Shanmuganathan, 2020).

The concept of behavioural finance is mainly based on Daniel Kahneman and Amos Tversky's (1979) prospect theory, which is a kind of continuation and development of the expected utility theory. Prospect theory, unlike Neumann and Morgenstern's normative theory, is descriptive, aiming to reflect and describe people's behaviour in conditions of risk. The two basic assumptions that make up prospect theory are utility and probability (Kulawik, 2023; Fishburn & Kochenberger, 1979). In the case of usability, Kahneman and Tversky (1992) replaced this concept with the concept of value. Decision-making takes place in two stages: editing and evaluation. The editing phase assigns the results to profits or losses. In the evaluation phase, the decision maker evaluates the value of each perspective and makes an appropriate decision. In the classic version of prospect theory, creators use random games in which a maximum of two non-zero outcomes are possible.

Heuristics are simplified rules for thinking or making decisions. They are a kind of mental shortcut that allows you to save time and intellectual effort in decision-making (Gigerenzer et al. 2022; Hjeij & Vilks, 2023). However, heuristics do not always lead to correct decisions because they are based on assumptions and simplifications, which can lead to errors (Khan et al., 2021).

One of the main heuristics in the field of behavioural finance is overconfidence bias, characterised by an excessive overestimation of one's knowledge, skills, and ability to predict future events. Investors influenced by this bias may be overly optimistic in assessing future events, anticipating profits from their investments despite the lack of a solid basis for such expectations. They may not consider risk when making decisions, incorrectly assess financial risk, or not understand the consequences of their actions (Kumar & Price, 2023; Ul Abdin et al., 2022; Naveed & Taib, 2021).

Excessive self-confidence can also encourage investors to frequently enter into transactions to undertake risky speculations (Kuranchie-Pong & Forson, 2022). Werner De Bondt (1998) conducted a study on a group of investors, asking them to predict the future quotations of the Dow Jones Industrial Average (DJIA) index for two- and four-week periods, providing extreme quotations representing the peak and the trough of the analysed period with a 90% probability. The results revealed that the index quotations were definitely "broader" than investors' predictions and differed, especially in the case of the four-week forecast. Consequently, he concluded that the strength of overconfidence is directly proportional to the length of the forecast period. Excessive self-confidence, particularly in one's skills and knowledge, manifests itself through incorrectly calibrating the probabilities associated with analysed events. The precision of events considered certain by the respondents is 85%, while for events considered impossible, the probability drops to 20% (Berthet, 2022).

Another implication in the area of investors' motivational tendencies is loss aversion. Loss aversion is one of the key elements of prospect theory (Merkle, 2020). It assumes that the value function is steeper for losses than for gains (Schmidt & Traub, 2002). This hypothesis was motivated by Kahneman and Tversky's discovery that the annoyance an investor experiences after suffering a loss seems to be greater than the pleasure derived from making a profit (Kahneman & Tversky, 1979).

Thaler (1980) extended the concept by suggesting that obtaining a good has a much lower valuation than losing it. He proposed loss aversion as an explanation for the holding effect, which he defined as the discrepancy between bid and loss prices (Thaler, 1980). He conducted an experiment during which he divided students into two groups. Each student in the first group received a coffee mug with the university logo, while students in the second group were left without mugs. The participants were then asked about the price of the mug – the students who owned the mug were asked about the selling price, while the other students were asked about its purchase price. There was a discrepancy between the proposed prices, as those who wanted to sell the mug proposed significantly higher prices than those who wanted to buy it (Cao et al., 2021; Goyal et al., 2023; Mamidala et al., 2023).

The disposition effect is a phenomenon that represents the tendency of investors to quickly sell rising assets and hold onto losing portfolio assets (Kaustia 2010; Shefrin & Statman, 1985). Research

based directly on data from individual investors' brokerage accounts showed the particular presence of this effect on small-cap companies (Andreu et al., 2020). From the behavioural finance perspective, this phenomenon can be explained as a consequence of the anchoring effect, that is, investors' excessive attachment to the price at which the security was purchased, as well as their excessive self-confidence and optimism, which confirms their belief in the temporary nature of an inappropriate valuation that is inconsistent with their expectations, thus preventing them from admitting their judgment was wrong (Haryanto et al., 2020; Zhang et al., 2022).

The second assumption of the disposition effect refers to the value function from the Kahneman and Tversky curve, which posits convexity in the area of losses and concavity in the area of profits. In other words, when investors have assets in their portfolio on which a profit can be made, they will be risk averse. Conversely, when the portfolio components only allow for the realisation of a loss, investors will be more inclined to take additional risks (Antony, 2020; Muralidhar and Berlik, 2017).

The three heuristics mentioned above are only a sample of what can be discussed today in the context of behavioural finance. Other beliefs and heuristics in the literature include the following:

- the availability heuristic, which assigns probability in direct proportion to its publicity, i.e. the probability is higher the more the event is known to the investor (Pachur et al., 2012; Salman et al., 2021);
- the representativeness heuristic, which involves making inferences on an insufficiently large sample (Ahmad et al., 2021; Khan et al., 2021);
- cognitive conservatism, i.e., there is insufficient consideration of the importance of new information due to a strong attachment to the previous state of knowledge (Sood et al., 2023; Hidayat and Moin, 2023).

Although classical finance theory and the behavioural approach are opposite trends, they do not have to be mutually exclusive; in fact, they can be complementary. The concept of behavioural finance can be used to predict the behaviour of investors, as a collective, in the market and to use divergent valuations to achieve their own benefits (Vasileiou, 2022).

### **Methodology and Identification of Significant Trends and Dependencies**

The purpose of the study is to understand and examine the occurrence of behaviours and cognitive biases associated with behavioural finance heuristics, such as overconfidence, loss aversion, and the disposition effect. It also aims to identify their impact on investment decisions. The study was conducted on a sample of 121 individual investors using an online survey based on scenario questions. The research method was selected based on the unique characteristics of behavioural finance. The research requires direct interaction with market participants, i.e., individual investors. This method also made it possible to reach a wider audience than if a "paper" survey had been used. Data was collected between May 27 and June 30, 2023. The survey was published in investment groups, on social media,

and sent to the academic community. Table 1 contains a summary of data regarding education broken down by gender and age of respondents.

**Table 1**

*Education by gender and age of respondents*

|        | Basic education | Secondary education | Higher education | Sum |
|--------|-----------------|---------------------|------------------|-----|
| >55    |                 |                     | 9                | 9   |
| Female |                 |                     | 3                | 3   |
| Male   |                 |                     | 6                | 6   |
| 18–25  | 3               | 18                  | 27               | 48  |
| Female | 3               | 6                   | 15               | 24  |
| Male   |                 | 12                  | 12               | 24  |
| 26–35  |                 | 6                   | 24               | 30  |
| Female |                 | 3                   | 6                | 9   |
| Male   |                 | 3                   | 18               | 21  |
| 36–45  |                 | 7                   | 15               | 22  |
| Female |                 | 3                   | 3                | 6   |
| Male   |                 | 4                   | 12               | 16  |
| 46–55  |                 | 3                   | 9                | 12  |
| Female |                 | 3                   |                  | 3   |
| Male   |                 |                     | 9                | 9   |
| Sum    | 3               | 34                  | 84               | 121 |

Source: own calculations.

The general conclusions from the survey responses show that extreme values, both extremely low and high, make up a small portion of the responses to each question. Clearer trends emerge when grouping the responses. Thus, turning to the first question, a relatively small group of respondents claim that their investments will not exceed the rate of return on the WIG index. Twenty per cent of the people in the sample had a neutral approach to beating the market. However, all those who determined the probability of exceeding the market return are seen as being confident they would exceed the benchmark return rate. Additionally, in a supplementary question, those who would assign responsibility for the failure of their investments to external factors comprise the largest group (39%). In another question regarding overconfidence, up to 60% of respondents declared that they trade in shares based only on their own analyses. Similarly, 60% of respondents expected that the rates of return on their investment would exceed the average return on the stock market.

These trends reveal the presence of the heuristics of overconfidence and investor optimism. The tendency to overestimate knowledge and skills may, in this case, lead to losses on positions in a brokerage account.

Subsequent questions analysed investors' loss aversion, which involves excessive avoidance of losses rather than achieving profits. In the first question about the probability of keeping a losing stock in the portfolio while hoping for a change in the trend, the vast majority (55%) declared that it is highly probable that they would keep losing stocks in their portfolio. Thus, they are ready to bear the risk to

avoid a loss. This insight was supplemented by another question, which revealed the largest group of respondents (47%) would realise a loss in the event of a significant decline.

In the next question, the respondents encountered a scenario in which they have a profitable share in their portfolio, but the price has recently shown significant volatility. When asked about the probability of selling the shares and realising profits in order to avoid a potential loss, a minority of investors opted to continue holding the instruments, indicating a willingness to take risks in order to make a profit. Most participants (62%) would make a profit immediately. Therefore, in the next question, the respondents were asked at what potential decline they would decide to sell shares. In this case, a drop of 1–30% would be enough for 68% of the respondents, indicating that investors are not willing to take risks.

Those questions showed the occurrence of loss aversion among the respondents, who are to be satisfied with even a small profit just to avoid a loss. In the case of potential losses, they are not willing to close losing positions in order to realise a loss, but they are ready to take risks, i.e., to continue to hold losing positions in the hope that the market trend reverses.

The last set of questions concerned the disposition effect, which is somewhat related to loss aversion and involves holding losing positions and selling profitable positions. In order to examine the occurrence of this heuristic among the sample, two hypothetical factual situations were presented to the participants. The first had two assets in the portfolio, one profitable and the other loss-making. The participants were asked to rate the likelihood of selling winning stocks and keeping losing stocks. Forty-eight per cent of the respondents stated that they would be unlikely to sell profitable shares and keep losing shares. Twenty per cent remained neutral, and 32% would take the risk to reduce losses and sell profitable shares, thus leaving losing positions in the portfolio. The participants were asked at what minimum profit they would decide to sell the profitable shares. The dominant groups were people willing to sell their shares at a profit of 21–30% (25% of respondents) and 11–20% (22% of respondents).

The remaining two questions investigated the opposite scenario, i.e., selling loss-making shares and keeping profitable shares. Forty-two per cent of people said they were likely to get rid of losing positions and keep profitable ones. When asked about the minimum loss required to sell losing shares, they were also mostly unwilling to risk more than a 30% loss in the value of their position.

The questions that examined the disposition effect did not indicate its occurrence in the study group. This may be related to the fear and greed of the investors, which explains the reduction in losing positions and keeping the profitable ones.

### **Conclusions on Individual Investors' Investment Decision-Making**

The research revealed the occurrence of two out of three examined heuristics. The analysis of the responses from the study participants led to the conclusion that emotions play a significant role in

influencing decision-making processes in investor behaviour. However, not all heuristics were noticed in every sample. This variability may be related to many factors, both external (e.g., the current macroeconomic situation) and internal (e.g., the dominance of rational investors in the sample, perhaps the dominance of specific personality types). The study confirmed the lack of rationality in certain aspects of decision-making in financial markets. In conditions of uncertainty, investors make decisions chaotically and tend to take risks to avoid losses rather than to achieve profits. They overestimate their competencies when making decisions in investment processes, exposing themselves to potential losses.

When considering financial and behavioural factors, the required rate of return for an individual investor becomes a multidimensional challenge. Traditional financial models assume that investors act rationally, minimise risk, and maximise profit. However, behavioural finance reminds us that people frequently deviate from this abstract ideal. They often act under the influence of emotions, cognitive biases, and heuristics, which influence their risk assessment and expectations regarding the return on investment (Cao et al., 2021; Iramani and Lutfi, 2021; Mamidala et al., 2023).

From this perspective, the required rate of return becomes a more flexible and individual concept. What investors expect can be shaped by their personality traits, life experiences, financial goals, and level of risk tolerance. Furthermore, the level of excessive optimism, loss aversion, and disposition effect influences the perception of risk and reward, which in turn influences the determination of the required rate of return (Zhang et al., 2022; Salman et al., 2021).

Appropriate financial advice and portfolio management that consider both financial and behavioural aspects are necessary. Individual investors should be aware of their own behaviours and susceptibility to cognitive biases to make more rational and informed financial decisions. Techniques such as financial education, financial planning, and investment advice can help manage the impact of behavioural factors on the investment process.

In the context of behavioural finance, the required rate of return is not just a mathematical number but also a reflection of the investor's psychology and emotions. Understanding these aspects is crucial to achieving investment success and achieving long-term financial goals.

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## SOCIAL ASPECTS IN NATIONAL PUBLIC PROCUREMENT

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### SOCIAL ASPECTS IN NATIONAL PUBLIC PROCUREMENT

#### ABSTRACT

**The purpose of the article.** Public procurement, which was originally aimed solely at reducing corruption, has been expanded to include additional elements that can have a broad impact on the socio-economic environment. One of these elements is social aspects, which can broaden the scale of effects obtained from the implementation of the order. The aim of the work is to quantitatively examine the changes taking place in the public procurement market in the use of social aspects, including social clauses. The study was conducted to confirm a growing interest in this element of procurement among public entities. The paper hypothesizes that in the years 2017–2023 there was a significant increase in the use of new procurement opportunities using social aspects. The research question is whether the lack of measurable incentives for contracting authorities limits the introduction of social aspects in public procurement.

**Methodology.** The paper discusses the principles of classifying social aspects of public procurement in years 2017–2023, taking into account social clauses in particular. The empirical part uses aggregated data obtained from documents published by the Public Procurement Office. In order to enable comparability of observations in individual years, an indicator analysis was used. Since data for 2024 was not available in official reports, the research was conducted on the basis of a 200-element random sample taken from all public procurements awarded by domestic entities in that year.

**Results of the research.** Analysis of published aggregated market data and data obtained from the sample taken indicate a limited increase in the use of social aspects in public procurement. Despite the even incidental use of social clauses, it can be stated that the situation in this area is gradually improving, as the average annual rate of change in the period under review showed a 16% increase in the number of such orders and a 33% increase in their value.

**Keywords:** public procurement, efficiency, offer evaluation criteria, social aspects, social clauses.

**JEL Class:** K49, G18, H12, H57.

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### **Social Aspects in National Public Procurement**

Spending public funds, and the entities that spend them, are permanently burdened with a lack of trust in the scope of conducting rational financial management. The lack of trust is observed at the level of the individual taxpayer and public institutions supervising entities that have public funds at their disposal. This phenomenon concerns all market economies, in which entities with private ownership capital carry out orders placed by public entities. In order to limit the freedom to spend public funds in a situation where free market rules do not restrict the entity placing the order, administrative mechanisms for spending public funds were introduced. Administrative rules for granting orders financed from public funds were originally intended to limit the influence of the subjective assessment of the public entity in the selection of the contractor. The original purpose of legal regulations was to limit pathological phenomena, in particular those that may have the characteristics of corruption. Additionally, regulating the rules for spending public funds was to ensure equal access for all entities legally operating on the market, enabling them to develop within the framework of fair competition. In the public interest is the effective spending of public funds understood as achieving maximum effect with minimum expenditure and supporting the private sector, which through the fiscal system feeds public finances. In addition, it provides employment to citizens, which limits public expenditure on social protection of the community, while increasing the number of payers of social contributions. Until 2009, national and community legal acts focused on achieving the primary objective of public procurement. In 2009, with the implementation of the provisions of art. 26 of Directive 2004/18/EC indicating the possibility of potentially narrowing the circle of contractors based on social and environmental considerations, it was possible to achieve an additional, secondary objective in public procurement. The possibility of defining secondary objectives in public procurement was extended in art. 70 of Directive 2014/24/EU (repealing Directive 2004/18/EC) by introducing conditions covering economic, innovation-related, environmental, social or employment-related aspects.

Administrative mechanisms for selecting a contractor, despite observing the principle of competition, almost always limit market competition through the requirement to specify the conditions for participation in the procedure. Due to the lack of possibility to specify standardized conditions for participation in the procedure, they are determined individually each time based on the subject, scope, type and method of execution of the order. In connection with the above, doubts often arise as to the correctness of their determination. The fact of limiting market competition is visible in the case law of the National Appeal Chamber. A clash of interests between contracting authorities implementing statutory instructions and contractors applying for a public contract and subjectivity in assessing the correctness of determining the conditions for participation in the procedure may always occur. In the case of introducing statutory restrictions in the form of additional subjective criteria, a dispute through appeal is pointless due to the statutory right of the contracting authority. Observing the impact on competitiveness in the area of conditions for participation in the public contract award procedure in this

respect through case law is unfeasible. Due to limitations in the public procurement monitoring system, the only possibility of observing the procurement system in terms of the use of social aspects in procurement is to refer to data aggregated by the Public Procurement Office (UZP) or to develop data based on a random sample. Using statistical tools, an attempt was made to verify the hypothesis that in the years 2017–2023 there was a significant increase in the use of new opportunities for awarding contracts using social aspects. The research question was asked whether the lack of measurable incentives for contracting authorities limits the introduction of social aspects in public procurement. Due to the lack of available data for 2024, the assessment of practice in this area was carried out on the basis of a random sample taken from all public contracts awarded by domestic entities in 2024.

### **Social Aspects in Public Procurement**

The concept of social aspects in public procurement has been in force since 2009 and is the result of the amendment to the Public Procurement Law of 2004 (Journal of Laws 2019, item 1843). The change was introduced based on the provisions of EU Directive 2004/18/EC and enabled the award of public procurement contracts that take into account important social issues.

The national legislator introduced the potential possibility for public entities to obtain secondary objectives, in addition to the primary objective of implementing the subject of the contract (Kowalewska & Szut, 2012, p. 8). The concept of green procurement emerged and the Public Procurement Office adopted a new strategy defined as a new approach to public procurement (Uljasz, 2010, p. 8). Attempts were also made to analyze the relationship between the new approach to public procurement and its effectiveness (Nowicki, 2013, p. 10). In July 2015, the Council of Ministers issued Recommendations on the application of social clauses in public procurement by the government administration (Antykorupcja, n.d.), recognizing that public institutions are not only obliged to make public expenditures in accordance with the provisions of the Public Procurement Law while maintaining the best quality-to-price ratio, but should also support the implementation of public policies, including social policy.

In the public procurement nomenclature there is a parallel concept of social aspects, social clauses and social services.

Social aspects concern broad, additional rights for the ordering party, who is even authorized to limit the circle of potential contractors, which violates the principle of equal access to the order. It is permissible to reserve the order for, e.g., a sheltered workshop or a social cooperative. Social aspects concern both the reservation of the order for a selected group of contractors and allow for the introduction of appropriate non-price criteria for the evaluation of offers, in the form of, for example, additional points for the employment of professionally excluded persons. This means that the most advantageous offer does not have to be the cheapest offer. A contractor meeting the criteria based on social aspects gains a competitive advantage over an entity that does not intend to meet these criteria.

The fundamental difference in the catalogue of possibilities of applying social aspects is that some of them, referred to as social clauses, concern the condition of participation in the procedure. Failure to meet it eliminates the contractor from the possibility of participating in the procurement procedure. In some cases, meeting this condition is not possible for the applicant for the order. This concerns, for example, the requirement to have the status of a sheltered workshop. It is also possible to establish a condition for participation in the procedure that does not unconditionally limit competition, e.g., by requiring the employment of unemployed, young, disabled persons, persons under 30 years of age and persons over 50 years of age or the requirement to employ persons involved in the execution of the order on the basis of an employment relationship. In summary, social clauses constitute a fragment of social aspects aimed at excluding from the public procurement procedure entities that do not meet the condition set by the ordering party.

In Poland, in the opinion of the Public Procurement Office, social clauses are also considered to be reserved contracts provided for under the special regime for awarding contracts for social services and other specific services, awarded on the basis of art. 361 of the Public Procurement Law (Gov.pl, n.d.). The concept of social services was introduced by the Act of 22 June 2016 (Journal of Laws, 2016, item 1020) to the then applicable Public Procurement Law of 2004. In the current legal status (year 2025), it is defined by Chapter 4 of the Public Procurement Act. The position of the Office can be disputed due to the definition of social services. Social services appear at the moment when the ordered service is included in the catalogue of services enumerated in Annex XIV of Directive 2014/24/EU of the European Parliament and of the Council and Annex XVII of Directive 2014/25/EU. The catalogue of these services is closed and includes, among others, health, religious, hotel, security, restaurant and legal services. It follows that the recognition of a service as a social service depends solely on the subject of the contract and not on the intention of the contracting authority. Such services are distinguished from other services by lower administrative rigor, giving the ordering party greater freedom in conducting the procedure. The method of order execution, conditions of participation in the order and non-price criteria of offers do not affect the definition of the service as social. It is also possible to use social aspects in the form of, for example, conditions of participation in the procedure or non-price criteria of offers in the order for social services, which may build a position excluding the inclusion of social services in the range of social aspects.

In the UZP reporting, as contracts with social aspects, there also appears an aggregated group of contracts, to which are added the so-called green contracts, innovative contracts and those in which non-price criteria for evaluating offers were used, such as quality or deadline. Due to the obligation to use non-price criteria, this group constitutes about 25% of all awarded contracts, which effectively improves the statistics of the use of social aspects in public procurement.

Legal regulations concerning the public procurement market are very often amended. The repealed Act of 2004 - Public Procurement Law was amended on average, twice a year. The repeal of EU Directive 2004/18/EC by Directive 2014/24/EU and the limited readability of the frequently

amended legal act resulted in the entry into force of the new Public Procurement Law (PZP) in force from January 1, 2021 (Journal of Laws of 2019, item 2019). The Act places particular emphasis on the use of public procurement as a tool of social policy. In chapter 3, article 21 of the PZP, the concept of the State Purchasing Policy was introduced, which should take into account, among other things, the application of social and health aspects. The obligation to comply with the state purchasing policy was imposed on government administration units. Compared to the previous legal status, selected contracting entities were obliged to conduct the public procurement procedure in a way that, by discounting the implementation of the subject of the contract, will allow for obtaining socially beneficial secondary effects. For other public and sectoral contracting entities, the use of additional elements related to social aspects in the public procurement procedure is optional. This means that the lack of activity of the contracting entity in the above topic, giving up the possibility of obtaining secondary effects of the public procurement and, as a result, limiting itself to taking only actions leading to the implementation of the primary goal, does not affect in the slightest way the assessment of the work of the persons managing the entity.

### **Public Contracting Authority in Free Market Conditions**

In the market economies of modern democracies, two fundamentally different groups of entities operate. They include both individuals and legal entities, institutions and organizations that use material and legal resources to meet their needs, within the framework of the exchange of goods on the free market.

The first, dominant in terms of the number of participants, group consists of entities with private capital of various organizational structures. It includes individuals, not necessarily conducting business activity, legal entities defined in the Commercial Companies Code or companies operating under the principles specified in the Civil Code (Journal of Laws 2024, item 1061). A common feature of these entities is the ownership structure indicating directly or indirectly specific individuals. As a result, the financial result of such an entity translates to varying degrees into the financial revenues of individuals.

A common feature of these entities is the direct link between the financial result and the finances of a specific person or group of people and, consequently, the need for effective management in order to pursue their interests. The owners, in order not to suffer the consequences of improper management, are interested in obtaining maximum income with minimum expenses. Free market mechanisms verify the way of managing the entity and improper management is verified by the market.

The second group of entities includes public finance sector entities, state organizational units without legal personality, state or local government enterprises, legal persons established for the specific purpose of meeting needs of a general nature, not having an industrial or commercial character. These entities are listed in detail in art. 4 of the Public Procurement Law. In the public procurement nomenclature, they are referred to as classic contracting entities. In addition to classic contracting

entities, the legislator defined in art. 5 of the Public Procurement Law a second subgroup, referred to as sectoral contracting entities. According to the report of the President of the Public Procurement Law (Report of the President of the Public Procurement Office, 2023) in 2023, the number of classic contracting entities was 31,472. Data on the number of sectoral contracting entities has not been published for several years, the reports of the President of the Public Procurement Law from previous years reported that their number oscillated around 500.

The common feature of this group of entities is the lack or limited need for effective management of financial resources. This results from the limited impact of market mechanisms on the financial condition of the entity. The income of employees, including management, is not dependent on the financial result of the entity. Persons managing the entity are held accountable only for the implementation of the purpose for which the entity was established, which means that the entity's orientation towards effective spending of funds is limited. In domestic conditions, a spectacular example of this were investments related to the preparation of EURO 2012. The topic was widely commented on and left a mark on the mentality of people responsible for investments (Polskie Radio, 2012). Public attention and the assessment of the management of entities ordering construction works were focused solely on the effective award of the contract and not on the most effective possible method of its implementation.

An additional common feature is the guarantee of financial resources for operations directly from public sources. This applies even to a specific group of entities, which are public hospitals. These entities, whose founding entity may be, for example, a public university or a provincial government, generally operate on the basis of free market mechanisms and compete on the market with private entities in the area of healthcare. This market competition is apparent and results solely from the fact that private healthcare services participate in part of the limited financial resources transferred by the National Health Fund. It is difficult to talk about fair market competition in a situation in which a public entity is obliged to provide healthcare services in their full scope and the refusal to provide a medical service may involve criminal liability of the management of the entity. A private entity selects from the basket of services only services that are profitable for the entity. For this reason, among others, there are no private hematology departments. In connection with the above situation, a public hospital in a situation of lack of funds, regardless of whether it results from incorrectly priced medical procedures or improper management, can count on an additional financial stream in the form of various types of funding (Dziennik Łódzki, 2025), often multi-million (Gov.pl, 2025). While supporting public hospitals with additional funds is not a negative phenomenon, it does not affect the mobilization of the management of such entities to orient the administrative services towards optimal management of their resources.

The legislator also included sectoral ordering parties in the group under discussion. Entities which, due to their quasi-monopolistic position, can transfer the costs of irrational management directly to the economic environment in the form of, for example, an increase in the prices of energy supplies or

mining or transport services. In connection with the above, sectoral and classic ordering parties are obliged under the Public Procurement Law to apply administrative principles for the acquisition of goods and services, including construction works.

Their introduction results from the reduced concentration of public entities on the way of spending financial resources, which can lead to “waste of resources” (Brzozowska, 2011, p. 20). In a situation where a contract is awarded to a contractor who did not have to prepare an offer taking into account the competition's proposals, the so-called “corruption margin” may appear (Burguet & Yeon-Koo, 2004, p. 55), inflating the price of the contract. Thanks to the broad approach to public procurement, the efficiency of spending financial resources can be perceived not only as a direct reduction in price, but as a sum of benefits resulting from all, including long-term, changes in socio-economic life, such as e.g., lower energy consumption, toxic emissions, reduced social spending through the activation of disabled people. Difficulties in estimating the efficiency of public procurement are one of the basic and difficult to solve problems even in economies with extensive experience in public procurement (European Commission, 2011).

A particular example of the benefits of secondary public procurement was a project successfully implemented by the United States government.

In 1993, at the initiative of the US Environmental Protection Agency (EPA), the US government decided that only computer equipment that met the Energy Star label requirements would be purchased (European Commission, 2005). As the world's largest single purchaser of computers, it had a huge impact on the quality of the product. IT equipment manufacturers, motivated by the possibility of losing a significant part of the market for their products, introduced appropriate design changes in their products to meet the requirements of the standard.

The environmental benefits of implementing Energy Star by the federal government are quantifiable. In the US alone, they are estimated at four trillion kWh of electricity saved between 1993 and 2019 and greenhouse gas emission reductions equivalent to more than three point five billion tons of CO<sub>2</sub>, which is equivalent to the annual emissions of 750 million cars (Energy Star, 2020). This is 23 times more than the annual energy consumption (PSE, 2023) and more than 12.5 times more than the CO<sub>2</sub> emissions (UTK, n.d.) recorded in Poland in 2023.

Not every secondary effect can be estimated, but it can be assumed that any higher costs of order fulfillment are more than compensated by the implementation of additional goals. This issue is difficult to monitor due to the impossibility of converting all social benefits into money.

### **Analysis of Contracting Authorities' Decisions Regarding the Use of Social Aspects**

Decisions regarding public procurement are based, as previously mentioned, on the administrative principles described in the Public Procurement Law, which is based on the guidelines contained in European directives. The freedom of the entity placing the order is strictly limited by the

law. It should be noted, however, that like most legal regulations, the Public Procurement Law contains descriptions of obligatory and optional activities.

Observations of the public procurement system conducted from different perspectives show a certain regularity. Contracting authorities tend to construct the procedure in a way that burdens the administrative services responsible for the order as little as possible. Practice has shown that their most important task is to effectively award the order, because in practice only this aspect of the procedure influences the assessment of the persons conducting the procedure and the management of the unit. A negative assessment in this respect may result in personnel changes, loss of bonuses or other more or less burdensome consequences. Introducing additional optional elements in the procedure automatically introduces additional possibilities that make it difficult to conduct it effectively. This may result, for example, from extending the possibility of initiating an appeal procedure for a contractor introducing actions that extend the procedure or seeking to invalidate the procedure. Such behaviour is not incidental and results from the desire to postpone the order until the contractor's implementation potential, which is engaged by another contracting authority, is released. Additionally, introducing optional elements in the procedure, such as social aspects, does not translate in any way into the assessment and remuneration of the persons responsible and preparing the documentation of the procurement procedure. To sum up, the possibility of introducing additional optional elements in the procedure may potentially burden the contracting authority without in any way compensating for the additional involvement.

The phenomenon of preferring the simplest way to award a contract has been observed practically since the very beginning of the introduction of the public procurement system. The most striking example of striving to award a contract in the simplest possible procedure, apart from the abuse of the single-source procurement procedure, is the lack of consent of contracting authorities to use non-price criteria for the evaluation of offers. An attempt was made to eliminate the lack of application of non-price criteria for the evaluation of offers by introducing a statutory requirement for their use. In response, contracting authorities use a multi-criteria evaluation model built on the basis of criteria referred to as dead or apparent (Szymański, 2015, p. 318). These are the criteria that fulfill the statutory disposition, contribute practically nothing to the procedure for the evaluation of offers, leaving only the price on the basis of which the most advantageous offer is selected. The emergence of such a market response to statutory regulations was also confirmed by the Public Procurement Office (UZZP, n.d.). It should be pointed out that through non-price criteria for the evaluation of offers, it is possible to introduce, among others, social aspects to the awarded contracts.

In the national public procurement system, monitoring of public procurement contracts is conducted to a limited extent. In the part concerning the application of social aspects of the Public Procurement Law, information on their application is obtained on the basis of annual reports on contracts awarded, which each public contracting authority sends to the office by March 1 of each year following the year to which the report relates pursuant to the provisions of art. 82 sec. 2 of the Public Procurement Law.

One of the attempts to directly examine the issue was a study conducted by the Supreme Audit Office based on a questionnaire sent to selected local government units (Supreme Audit Office, 2016, p. 59). The description of the selection of units on the basis of which information on the results of the audit was presented excludes the possibility of conducting an estimation in order to obtain information on the domestic public procurement market. The study was conducted on the basis of an audit conducted in 29 government administration units and selected local government units, and surveys submitted by local government units in the number of 1914. The conclusion resulting from the analysis of the surveys was that the scale of application of social clauses was negligible, and the conclusion from the conducted study was that the recommendations of the Council of Ministers, despite the actions taken by the Chancellery of the Prime Minister and the Public Procurement Office, did not result in an increase in the scale of their use (Supreme Audit Office, 2016, p. 11). The study did not authorize the presentation of quantitative data covering the domestic public procurement market and covered a fragment of social aspects.

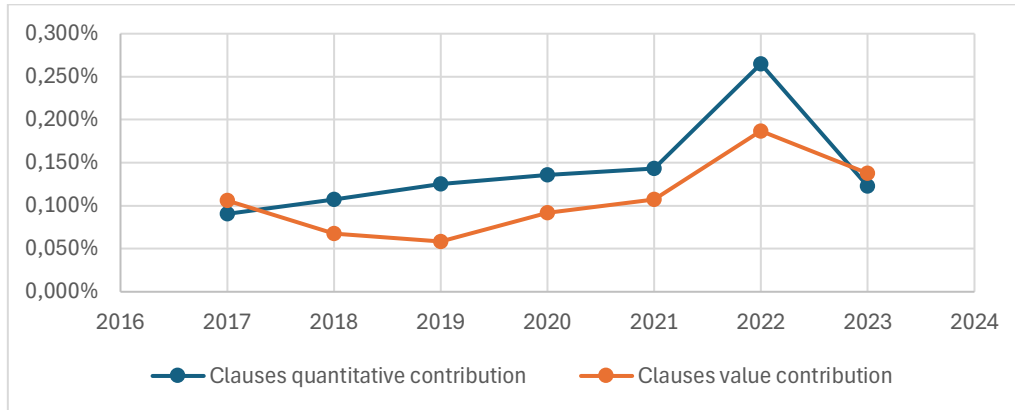
The analysis was based on available data published in annual reports on the functioning of the system. In order to fill the information gap resulting from the delay in the reporting system, the study was extended to the analysis of a random sample taken from all contracts awarded in 2024. Due to the high workload and scope of the data analyzed, the work in question was limited to taking a 200-item sample. The workload results from the need to review the contract notice, the corresponding contract award notice and often the need to verify data from the notices with the information contained in the Tender Specification (TTS). The time limitation results from difficulties in accessing the TTS of earlier procedures, which are often removed from tender platforms.

Due to the fact that the public procurement market, examined on an annual basis, oscillates both in terms of the value and the number of contracts awarded, the observation of changes taking place there through the prism of absolute values is very limited.

In order to achieve resilience to changes in the scale of the public procurement market in the period under review, structure indicators were determined for each year under review based on data obtained from the annual reports of the President of the Public Procurement Office. Access to archived data is limited due to the lack of access to data from 2017 and earlier years. Data from these periods is available only to people who previously conducted system analyses and archived the source documents on their own. Figure 1 presents the quantitative and value share of public procurements that include social clauses.

**Figure 1**

*Share of social clauses in public procurement contracts awarded in 2017–2023*

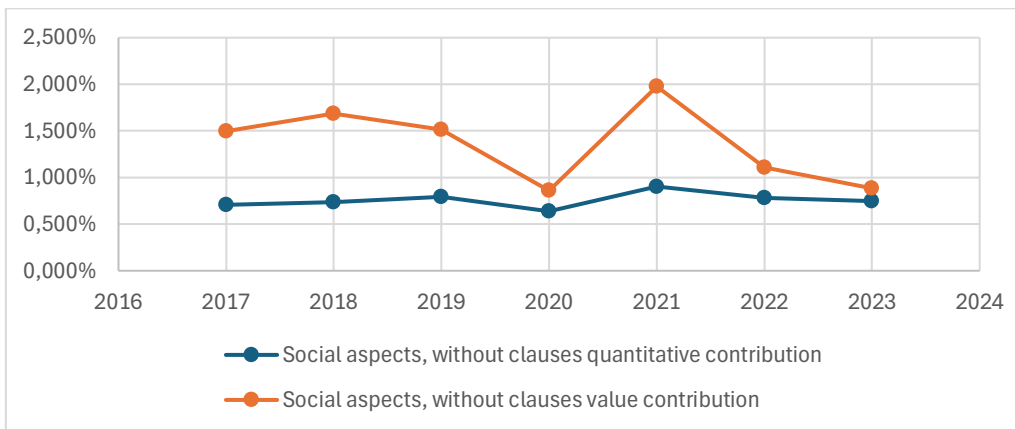


Source: own calculations based on data from the reports of the President of the Public Procurement Office on the functioning of the public procurement system in 2017–2023.

Figure 2 presents the share of contracts awarded in the years 2017–2023 containing social aspects, excluding social clauses. The indicated aspects do not apply to reserved contracts provided for under the special regime for awarding contracts for social services and other specific services, social and health services. They also do not apply to contracts, especially construction works, in which there is a reference in the description of the subject of the contract to accessibility for disabled persons. To sum up, Figure 2 presents contracts in which the basic contract is actually discounted, providing additional socially expected results, similarly to the case of social clauses. This may involve both the requirement to employ people who are professionally excluded and the stimulation of ecological behaviours that reduce the burden on the natural environment.

**Figure 2**

*Share of social aspects in public procurement contracts awarded in 2017–2023*

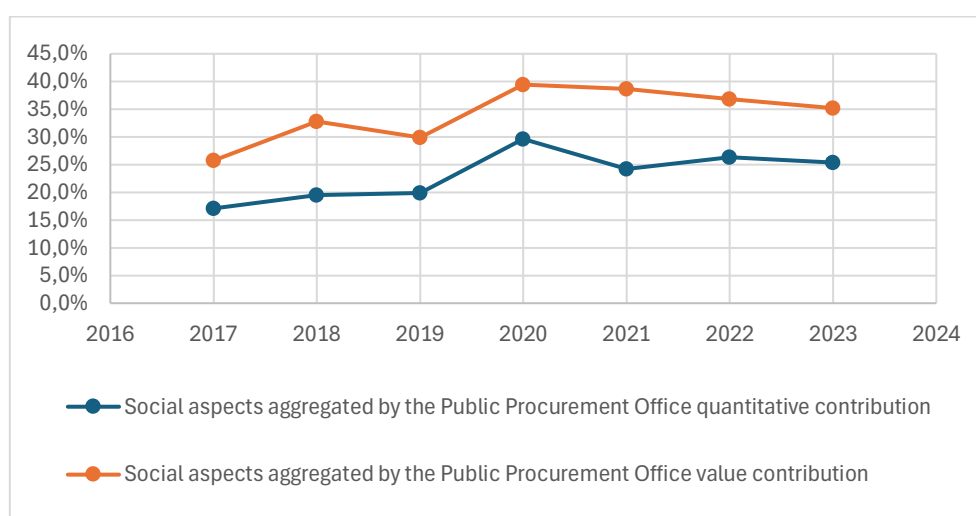


Source: own calculations based on data from the reports of the President of the Public Procurement Office on the functioning of the public procurement system in 2017–2023.

The data published by the Public Procurement Office also includes aggregated information at a very high level concerning contracts taking into account social aspects. This group, which of course contains social clauses, also includes contracts requiring the employment of the contractor's employees under an employment contract. This group includes contracts containing environmental and innovation aspects, as well as contracts taking into account accessibility requirements for disabled persons. It also included the contracts requiring a label confirming the compliance of the offered supplies, services or construction works with the required features of the contract being performed, specified in art. 104 of the Public Procurement Law. The largest part of this group are contracts awarded on the basis of art. 242 sec. 2, which specifies the types of non-price criteria for the evaluation of offers, including criteria concerning quality and technical parameters that may be defined as apparent criteria listed in art. 242 sec. 2 item 6. This group is particularly numerous due to the statutory indication in art. 246 sec. 1 of the application of non-price criteria. Without a doubt, such aggregation of orders and their treatment as orders with social aspects improves statistics in the scope of the use of social aspects. Figure 3 presents the dynamics of changes in social aspects defined by the Public Procurement Office.

**Figure 3**

*Share of public procurement contracts with social aspects aggregated by the Public Procurement Office in public procurement contracts awarded in 2017–2023*



Source: own calculations based on data from the reports of the President of the Public Procurement Office on the functioning of the public procurement system in 2017–2023.

Considering that this group of orders includes, among others, procedures in which the offer evaluation criteria include the delivery date, after-sales service, implementation time or technical parameters, the group has the right to constitute a large share of all orders awarded.

Despite the almost incidental use of social clauses, it can be stated that the situation in this area is gradually improving, because the medium-term, in this case annual, pace of change in this area

showed a 16% increase in the number of orders and a 33% increase in their value. An analysis of orders in a broader sense, in which, in addition to social clauses, we take into account additional social aspects, which are most often read into the criteria for evaluating offers, seems unsatisfactory. Despite the sporadic occurrence of such orders, a positive change can be observed, indicating that on average the number of orders increases by 3.7% year by year. Unfortunately, no change in the medium-term increase in the value of orders awarded in this way was observed.

In the scope of contracts awarded in 2024, the study was conducted based on a random sample of 200 elements. Analysis of the selected procedures showed that social aspects were used in two cases. In one procedure conducted by the public health service, additional points were awarded in the criteria for evaluating offers for employing people who were over 50 years of age. The second case concerned a penitentiary, where, similarly, additional points were awarded in the criteria for evaluating offers for employing people incarcerated in the facility. Due to the too low structure indicator, its estimation was not carried out.

The introduction of social aspects to public procurement is possible in all types of procurement, which means that it applies to all sectors of the economy. However, it most often appears in construction works and services, where it manifests itself through supporting people who are professionally excluded. The introduction of social aspects to deliveries is almost incidental and in practice is limited to limiting the choice of supplier without referring to the ordered product. The natural ordering party that would directly discount social aspects in the orders they place are local government units, which in practice avoid introducing additional elements in the procurement procedures. Being a leader in the award of orders for construction works, they could significantly increase, for example, the activation of the unemployed.

### **Conclusion**

The legislator's difficulty in improving the efficiency of public procurement is the lack of objective tools that can measure this efficiency, which is partly due to the lack of broad use of quantitative methods in the analysis of the public procurement system (Starzyńska, 2016, p. 456).

To a limited extent, it is possible to observe the direction of changes in the system based on aggregated market data. However, it is difficult to precisely calculate the financial benefits resulting from the introduction of new possibilities for awarding public procurement contracts. Certain aspects, such as improving the situation of people who, despite exclusion, have re-entered the labor market, are financially immeasurable. The return resulting from the new approach to public procurement is socially expected and may, like the American Energy Star project, bring measurable social and economic benefits on a national scale.

Conducting analyses requires access to source data, which is becoming increasingly difficult in the case of public procurement. This concerns the limited functionality of searching the European public procurement database Tender Electronic Daily (TED, n.d.), which has recently been deprived of

a statistical search module. Despite objective limitations, using data collected by the Public Procurement Office from annual reports, it is possible to assess changes in the behavior of contracting authorities in the area of using social aspects. Annual information published by the Public Procurement Office collected according to the same methodology, despite the limitations of the method, allows for insight into the public procurement system.

Analysis of data on social aspects indicated limited interest of contracting entities in this element of public procurement. From our own study conducted on a random sample, despite the lack of possibility to estimate structure indicators, information on entities using social aspects turned out to be interesting. The study predicted that contracts with social aspects would be awarded mostly by local government units, which constitute a relatively large group of contracting entities, additionally focused on social protection of residents. The sample included proceedings conducted by the public health service and a penitentiary institution, i.e., entities that do not directly have, among others, the obligation to professionally activate the unemployed, pay social benefits, i.e., funds that can be limited with the proper use of social aspects in contracts. Without introducing motivation for contracting entities, with optional elements related to social aspects for most entities, the increase in such contracts will be limited. This is related to the conservative position of the contracting entity's employees. An attempt to introduce a statutory requirement to use social aspects may be met with circumvention of the regulations, as is the case with some non-price criteria. It can be stated that this is an element that the legislator should take into account again in amendments to the Public Procurement Law. It should be analyzed whether rigid restrictions and statutory orders, which are easily circumvented by contracting authorities, should not be changed into a system of incentives. Research should also be conducted to assess the financial benefits resulting from the use of social aspects.

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## ANALYSIS OF INVESTMENT EFFECTIVENESS ON THE PAINTING MARKET – SCIENTIFIC LITERATURE REVIEW

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### ANALYSIS OF INVESTMENT EFFECTIVENESS ON THE PAINTING MARKET – SCIENTIFIC LITERATURE REVIEW

#### ABSTRACT

In response to the growing interest in the effectiveness of investing in alternative assets, the academic community offers numerous publications on investing in works of art. The purpose of this article is to conduct a critical and comparative analysis of the most significant scientific publications on investment effectiveness in the auction market for paintings and to answer the question of the risk and effectiveness of these investments compared to traditional assets, such as stocks, bonds, real estate, commodities, and others. To achieve this stated objective, a literature review was conducted, covering 35 works that form the canon of global literature in the field of art market research. The primary criterion for selecting the publications was their citation frequency in the subject literature, considered in order of their publication. A supplementary criterion was the market being the subject of the study. Consequently, the selected publications include not only major world paintings in large, mature markets but also previously unexamined paintings and emerging art markets.

No circumstances were found that would definitively allow for the formulation of a thesis presenting art as an attractive investment, particularly over a long-term horizon. The results differ depending on the period under study and the characteristics of the paintings in the research sample. Generally, rates of return are low and subject to high risk. Within a specific time and in a specific market, paintings with certain characteristics can yield higher rates of return and exhibit greater effectiveness than other assets. In mature art markets, this effectiveness was found to be lower than in financial markets but higher than in non-financial asset markets. In contrast, in emerging art markets, investment effectiveness was generally higher than that of both global financial and non-financial markets.

**Keywords:** art market, investments, effectiveness, financial markets.

**JEL Class:** G11, G12, G14.

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## Introduction

The high prices achieved by paintings at art auctions contribute to an increased demand for knowledge about the factors that determine the value of a work of art, as well as the rates of return and risks associated with investing in art. It should be noted that, although the concept of art is much broader, the term "work of art" as used in this article, refers specifically to a work of painting, and "art market" refers to the auction market for paintings.

There are many publications concerning the "art market" and "art investment." The purpose of this article is to conduct a critical and comparative analysis of the most significant scientific publications regarding investments in the art market and to answer the question of how the risk and effectiveness of investing in works of art have performed in comparison to traditional assets: securities, real estate, commodities, hedge funds, Private Equity funds, and others.

The literature review encompassed 35 items most frequently cited in the subject literature and published in scientific journals such as: *Applied Economics*, *Australian Economic Papers*, *Cambridge Journal of Economics*, *Canadian Journal of Economics*, *Eastern Economic Journal*, *Economic Inquiry*, *Emerging Markets Review*, *International Advances in Economic Research*, *Journal of Business Research*, *Journal of Cultural Economics*, *Journal of Finance*, *Journal of Political Economy*, *Management Science*, *Review of Financial Studies*, *The American Economic Review*, *The Economist*, *The Journal of Alternative Investments*, *Transformations in Business & Economics* a.o., which form the canon of world literature in the field of art market research.

The primary criterion for the selection of publications was their citation frequency in the subject literature. A supplementary criterion was the market being the subject of the study. Consequently, the selected publications feature not only great, world-renowned paintings in large, mature markets such as the American, British, or French one, but also previously unexplored paintings and emerging markets: Canadian, Belgian, South American, Venezuelan, German, Swiss, Polish, Russian, Chinese, Indian, Australian, North African, and Middle Eastern. This approach to selecting publications reflects the chronological and geographical dimensions of the present study.

A list of the articles and journals examined in this work, along with their bibliometric data, is presented in Table 1. The table excludes articles, monographs, chapters in monographs, and reports that do not possess bibliometric indicators. The articles not presented in Table 1 were published in working paper series that are not indexed in the Web of Science and Scopus databases, such as: NBER Working Paper Series, LSF Research Working Paper Series, CFS Working Paper Series, Working Paper VU University Amsterdam, John M. Olin Program in Law & Economics Working Paper. However, they are frequently cited in scientific publications concerning the art market

**Table 1***Bibliometric indicators of analyzed articles and journals*

| <b>Bibliography</b>                                                                                                                                                                              | <b>Article</b>                           | <b>Journal</b>                                                                                                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| Agnello, R. J. (2002). Investment Returns and Risk for Art: Evidence from Auctions of American Paintings 1971–1996. <i>Eastern Economic Journal</i>                                              | Scopus cited by 0 /<br>WoS cited by 0    | 2023: CiteScore 1.3 / IF – no indicator<br>Indexed: Web of Science, Scopus, SJR<br>2002: CiteScore, IF – no indicator |
| Agnello, R. J. & Pierce, R. K. (1996). Financial Returns, Price Determinants, and Genre Effects in American Art Investment. <i>Journal of Cultural Economics</i>                                 | Scopus cited by 77 /<br>WoS cited by 0   | 2023: CiteScore 5.2 / IF 1.9<br>1996: CiteScore, IF – no indicator<br>Indexed: Scopus, Web of Science                 |
| Anderson, R. C. (1974). Painting as an Investment. <i>Economic Inquiry</i>                                                                                                                       | Scopus cited by 126 /<br>WoS cited by 89 | 2023: CiteScore 3.8 / IF 2.32<br>1974: CiteScore, IF – no indicator<br>Indexed: Scopus, Web of Science                |
| Barbosa, R. L. & Campos, N. F. (2008). Paintings and Numbers: An Econometric Investigation of Sales Rates, Prices and Returns in Latin American Art Auctions. <i>IZA Discussion Paper Series</i> | Scopus cited by 34 /<br>WoS cited by 34  | 2023: CiteScore 2.2 / IF 1.0<br>2008: CiteScore – no indicator /<br>IF 0.765<br>Indexed: Scopus, Web of Science, SJR  |
| Baumol, W. (1986). Economic Issues in the Arts. Unnatural Value: or Art Investment as Floating Crap Game. <i>The American Economic Review</i>                                                    | Scopus cited by 0 /<br>WoS cited by 0    | 2023: CiteScore 18.6 / IF 10.5<br>1986: CiteScore, IF – no indicator,<br>Indexed in Scopus, Web of Science            |
| Białowąs, S., Potocki, T. & Rogozińska, A. (2018). Financial returns and cultural price determinants on the Polish art market 1991–2012. <i>Acta Oeconomica</i> , Budapest                       | Scopus cited by 2 /<br>WoS cited by 1    | 2023: CiteScore 1.4 / IF 0.7<br>2018: CiteScore 1.0 / IF 0.840<br>Indexed: Scopus, Web of Science                     |
| Buelens, N. & Ginsburgh, V. (1993). Revisiting Baumol's Art as a Floating crap game. <i>Working Paper</i> , Université Libre de Bruxelles – C.E.M.E.                                             | Scopus cited by 101 /<br>WoS cited by 81 | 2022: IF 2.8 / CiteScore 4.7<br>1993: CiteScore, IF – no indicator<br>Indexed: Scopus, Web of Science, SJR            |
| Campbell, R. A. J. (2009). Art as a Financial Investment. <i>The Journal of Alternative Investments</i>                                                                                          | Scopus cited by 72 /<br>WoS cited by 64  | 2023: CiteScore 1.2 / IF 0.4<br>2009: CiteScore, IF – no indicator<br>Indexed: Scopus, Web of Science, SJR            |
| Chanel, O., Gérard-Varet, L. & Ginsburgh, V. (1996). The relevance of hedonic price indices. The case of paintings. <i>The Journal of Cultural Economics</i>                                     | Scopus cited by 113 /<br>WoS cited by 0  | 2023: CiteScore 5.2 / IF 1.9<br>1996: CiteScore, IF – no indicator<br>Indexed: Web of Science, Scopus                 |
| Fase, M. M. G. (1996). Communications – Purchase of Art: consumption and investment. <i>The Economist</i>                                                                                        | Scopus cited by 10 /<br>WoS cited by 4   | 2023: CiteScore 2.9 / IF 2.4<br>1996: CiteScore, IF – no indicator                                                    |

|                                                                                                                                                                    |                                                 |                                                                                                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| Frey, B. S. & Pommerehne, W. W. (1988). Is Art such a Good Investment?. <i>The Public Interest</i>                                                                 | Scopus cited by 0 /<br>WoS cited by 8           | 2023: CiteScore, IF - no indicator<br>1988: CiteScore, IF - no indicator<br>Indexed in Scopus       |
| Garay, U. (2019). Determinants of Art Prices and Performance by Movements: Long-Run Evidence from an Emerging Market. <i>Journal of Business Research</i>          | Scopus cited by 12 /<br>WoS cited by 15         | 2024: CiteScore 20.3 / IF 10.5<br>2019: CiteScore 8.9 / IF 4.874<br>Indexed: Scopus, Web of Science |
| Garay, U., Vielma, G. & Villalobos, E. (2017). Art as an investment alternative: the case of Argentina. <i>Academia Revista Latinoamericana de Administración</i>  | Scopus cited by 8 /<br>WoS cited by 8           | 2023: CiteScore (Scopus) 2.6, /<br>IF (Clarivate) 1.3<br>2017: CiteScore 0.8 / IF 0.617             |
| Goetzmann, W. N. (1993). Accounting for taste: an analysis of art returns over three centuries. <i>The American Economic Review</i>                                | Scopus cited by 0                               | 2023: CiteScore 18.6 / IF 10.5<br>1993: CiteScore, IF - no indicator<br>Indexed in Scopus           |
| Higgs, H. (2010). Australian Art Market Prices during the Global Financial Crisis and two earlier decades, <i>Australian Economic Papers</i>                       | Scopus cited by 18 /<br>WoS cited by 16         | 2023: CiteScore – no indicator /<br>IF 1.2<br>2010: CiteScore - no indicator /<br>IF 0.388          |
| Hodgson, D. (2011). An analysis of pricing and returns in the market for French Canadian paintings. <i>Applied Economics</i>                                       | Scopus cited by 4 /<br>WoS cited by 4           | 2023: CiteScore 3.8 / IF 1.8<br>2011: CiteScore 0.9/ IF 0.459                                       |
| Hodgson, D. & Vorkink, K. (2004). Asset pricing theory and the valuation of Canadian paintings. <i>Canadian Journal of Economics</i>                               | Scopus cited by 47 /<br>WoS cited by 43         | 2023: CiteScore 2.2 / IF 1.3<br>2004: CiteScore - no indicator /<br>IF 0.420                        |
| Korteweg, A. G., Kräussl, R. & Verwijmeren, P. (2016). Does It Pay to Invest in Art? A Selection-Corrected Returns Perspective. <i>Review of Financial Studies</i> | Scopus cited by 56 /<br>WoS cited by 51         | 2023: CiteScore 16.0 / IF 6.8<br>2016: CiteScore 7.0 / IF 3.689                                     |
| Kräussl, R. & Logher, R. (2010). Emerging Art Markets. <i>Emerging Markets Review</i> .                                                                            | Scopus cited by 59 /<br>WoS cited by 56         | 2023: CiteScore 7.1 / IF 5.6<br>2010: CiteScore, IF - no indicator                                  |
| Lucińska, A. (2015). The Art Market in the European Union. <i>International Advances in Economic Research</i>                                                      | WoS cited by 5,<br>Scopus SNIP:<br>2015 = 0.522 | 2023: IF 1.1                                                                                        |
| Mei, J. & Moses, M. (2005). Vested interest and biased price estimates. Evidence from an auction market. <i>Journal of Finance</i>                                 | Scopus cited by 61 /<br>WoS cited by 58         | 2023: CiteScore 12.9 / IF 7.6<br>2005: CiteScore - no indicator/<br>IF 2.549                        |
| Renneboog, L. & Spaenjers, C. (2013). Buying Beauty: On Prices and Returns in the Art Market. <i>Management Science</i>                                            | Scopus cited by 196 /<br>WoS cited by 187       | 2023: CiteScore 8.8 / IF 4.6<br>2013: CiteScore 4.8 / IF 2.524                                      |

|                                                                                                                                                                                                                  |                                         |                                                                                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|------------------------------------------------------------------------------------------------|
| Renneboog, L. & Van Houtte, T. (1999).<br>The Monetary Appreciation of Paintings:<br>from Realism to Magritte. <i>Cambridge<br/>Journal of Economics</i>                                                         | Scopus cited by 47 /<br>WoS cited by 38 | 2023: CiteScore 4.3 / IF 2.0<br>1999: CiteScore, IF - no indicator,                            |
| Stein, J. P. (1977). The Monetary<br>Appreciation of Paintings. <i>Journal of<br/>Political Economy</i>                                                                                                          | Scopus cited by 0 /<br>Wos cited by 81  | 2023: CiteScore 15.2 / IF 6.9<br>2977: CiteScore, IF – no indicator<br>Indexed: Web of Science |
| Witkowska, D. (2016). Evaluation of the<br>Individual Hedonic Art. Price Indexes for<br>the Polish Painters Representing the<br>Auction Market in Poland. <i>Transformations<br/>in Business &amp; Economics</i> | Scopus cited by 2 /<br>WoS cited by 2   | 2023: CiteScore 2.4 / IF 1.8<br>2016: CiteScore 0.9 / IF 0.556<br>Indexed: Scopus              |
| Worthington, A. & Higgs, H. (2006).<br>A Note on Financial Risk, Return and<br>Asset Pricing in Australian Modern and<br>Contemporary Art. <i>Journal of Cultural<br/>Economics</i>                              | Scopus cited by 18                      | 2023: CiteScore 5.2 / IF 1,9<br>2006: CiteScore, IF – no indicator<br>Indexed: Scopus          |

Source: own elaboration.

The measures of risk and effectiveness in the analyzed publications include the standard deviation of rates of return, the risk-adjusted return (RAR), the beta coefficient ( $\beta$ ), and the Sharpe and Treynor ratios. The effectiveness ratios were treated as techniques that combine the rate of return and risk into a single measure (Tarczyński, 1997, p. 155).

### Review of world literature

Measures of risk and effectiveness were determined using market rates of return from global or national stock indices, depending on the characteristics of the research samples and the objectives of the studies. Most frequently, these were the following indices: MSCI World Portfolio, MSCI World Equity Index, MSCI Canadian Equity Index, Global Equity Index MSCI World, DAX30, S&P500, and TSX/S&P Composite Index. The excess return on investment over the risk-free rate was typically determined using the annual rates of return on short-term treasury bills, such as the 3M US T-bill rate, 3M German Treasury Bills, and the Bank of Canada Bank Rate. A comparison of the rates of return and the basic measures of risk and effectiveness for investments in the painting market and other assets is presented in Table 2.

**Table 2**

*A Summary of Comparative Research Findings on Rates of Return, Risk, and Effectiveness in the Global Art and Traditional Asset Markets*

| Author          | Characteristics of the research sample: type of painting, sales period, number of transactions/ additional information | Average annual rate of return, <sup>1</sup> risk and effectiveness measures: standard deviation <sup>2</sup> / Sharpe ratio / Sharpe-Israelsen ratio / Treynor ratio / RAR/ $\beta$ / minimum and maximum values of the rates of return, the standard deviation, Sharpe ratio, $\beta$ , RAR, Treynor ratio <sup>3</sup> |                           |
|-----------------|------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
|                 |                                                                                                                        | Art market                                                                                                                                                                                                                                                                                                               | Traditional asset markets |
|                 |                                                                                                                        | single-base price index                                                                                                                                                                                                                                                                                                  |                           |
| Rush (1961)     | global painting markets                                                                                                |                                                                                                                                                                                                                                                                                                                          |                           |
|                 | 1. 1925                                                                                                                | 1. 100%                                                                                                                                                                                                                                                                                                                  |                           |
|                 | 2. 1925-1929                                                                                                           | 2. 165%                                                                                                                                                                                                                                                                                                                  |                           |
|                 | 3. 1925-1930                                                                                                           | 3. 100%                                                                                                                                                                                                                                                                                                                  |                           |
|                 | 4. 1925-1933                                                                                                           | 4. 50%                                                                                                                                                                                                                                                                                                                   |                           |
|                 | 5. 1925-1935                                                                                                           | 5. 71%                                                                                                                                                                                                                                                                                                                   | -                         |
|                 | 6. 1925-1940                                                                                                           | 6. 81%                                                                                                                                                                                                                                                                                                                   |                           |
|                 | 7. 1925-1945                                                                                                           | 7. 102%                                                                                                                                                                                                                                                                                                                  |                           |
|                 | 8. 1925-1950                                                                                                           | 8. 150%                                                                                                                                                                                                                                                                                                                  |                           |
|                 | 9. 1925-1955                                                                                                           | 9. 290%                                                                                                                                                                                                                                                                                                                  |                           |
|                 | 10. 1925-1960                                                                                                          | 10. 981%                                                                                                                                                                                                                                                                                                                 |                           |
| Anderson (1974) | global painting markets, sales in years:                                                                               |                                                                                                                                                                                                                                                                                                                          |                           |
|                 | 1. 1800-1970 >13,000 lots                                                                                              |                                                                                                                                                                                                                                                                                                                          |                           |
|                 | 2. 1653-1970 1,730 lots                                                                                                | 1. RN = 3.3%                                                                                                                                                                                                                                                                                                             | 1. RN = 6.6%              |
|                 | 3. 1780-1970 1,693 lots                                                                                                | 2. RN = 4.9%                                                                                                                                                                                                                                                                                                             | 7.                        |
|                 | 4. <i>Old Masters</i> 1780-1970, 643 lots                                                                              | SD = 56.0%                                                                                                                                                                                                                                                                                                               | 1949-1955:                |
|                 | 5. British paintings of the 18th and 19th centuries 1825-1970, 707 lots                                                | 3. RN = 3.7%                                                                                                                                                                                                                                                                                                             | RN = 21.7%                |
|                 | 6. Impressionists 1900-1970, 166 lots                                                                                  | 4. RN = 4.1%                                                                                                                                                                                                                                                                                                             | SD = 11.6%                |
|                 | 7. 20th-century painting 1950-1970, 49 lots                                                                            | 5. RN = 3.6%                                                                                                                                                                                                                                                                                                             | 1956-1962:                |
|                 |                                                                                                                        | 6. RN = 11.0%                                                                                                                                                                                                                                                                                                            | RN = 6.8%                 |
|                 |                                                                                                                        | 7. RN = 22.9%                                                                                                                                                                                                                                                                                                            | SD = 12.6%                |

<sup>1</sup> Nominal average annual rate of return – RN, real annual rate of return – RR.

<sup>2</sup> Standard deviation of rates of return – SD.

<sup>3</sup> Respectively - RR<sub>MIN;MAX</sub> or RN<sub>MIN;MAX</sub>, SD<sub>MIN;MAX</sub>, Sharpe<sub>MIN;MAX</sub>,  $\beta$ <sub>MIN;MAX</sub>, RAR<sub>MIN;MAX</sub>, Treynor<sub>MIN;MAX</sub>.

|                                                 |                                                                                          |                                                            |                                                                                                                                                                                                                              |
|-------------------------------------------------|------------------------------------------------------------------------------------------|------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Stein (1977)                                    | 1. American market:<br>1946-1968,<br>8,950 transactions                                  | 1. RN = 10.5%                                              | 1. RN = 14.3%                                                                                                                                                                                                                |
|                                                 | 2. British market:<br>1946-1968,<br>35,823 transactions<br><i>boom</i> in the art market | $\beta = 0.82$<br>2. RN = 13.1%                            |                                                                                                                                                                                                                              |
| Baumol (1986)                                   | global painting markets,<br>1652-1961,<br>640 lots                                       | RR = 0.55%<br>RR <sub>MIN;MAX</sub> :<br>[-19.0%; 27.0%]   | RR = 2.5%                                                                                                                                                                                                                    |
| Frey,<br>Pommerehne<br>(1988)                   | global painting markets,<br>1,198 transactions                                           | 1. RR = 1.5%<br>2. RR = 1.5%                               | 1. RR = 3.0%<br>2. RR = 3.3%<br>3. RR = 2.5%                                                                                                                                                                                 |
|                                                 | 1. 1635-1987                                                                             | RR <sub>MIN;MAX</sub> :<br>[-16.0%; 26.0%]                 |                                                                                                                                                                                                                              |
|                                                 | 2. 1635-1949<br>3. 1950-1987<br>renowned painters                                        | 3. RR = 1.6%<br>RR <sub>MIN;MAX</sub> :<br>[-19.0%; 16.0%] |                                                                                                                                                                                                                              |
| Goetzmann<br>(1993)                             | British market,<br>2,809 transactions                                                    | 1. RN = 3.2%                                               | 1. RN <sub>MIN;MAX</sub> : [1.5%; 4.3%]                                                                                                                                                                                      |
|                                                 | 1. 1716-1986<br>2. 1900-1986                                                             | 2. RN = 5.2%                                               | 2. RN <sub>MIN;MAX</sub> : [0.8%; 5.7%]                                                                                                                                                                                      |
| Buelens,<br>Ginsburgh<br>(1993)                 | global painting markets,<br>5,900 transactions                                           |                                                            | 1. RR = 2.5%                                                                                                                                                                                                                 |
|                                                 | 1. 1700-1961                                                                             | 1. RR = 0.91%                                              |                                                                                                                                                                                                                              |
|                                                 | including:                                                                               | 2. RR = 1.09%                                              |                                                                                                                                                                                                                              |
|                                                 | 2. 1700-1869                                                                             | 3. RR = 3.49%                                              |                                                                                                                                                                                                                              |
|                                                 | 3. 1870-1913                                                                             | 4. RR = -4.19%                                             |                                                                                                                                                                                                                              |
|                                                 | 4. 1914-1949                                                                             | 5. RR = 9.63%                                              |                                                                                                                                                                                                                              |
| Chanel,<br>Gérard-Varet,<br>Ginsburgh<br>(1996) | 5. 1950-1961                                                                             | 6. RR = 2.5%                                               | -                                                                                                                                                                                                                            |
|                                                 | 6. 1700-1961<br>except years 1914-1949                                                   |                                                            |                                                                                                                                                                                                                              |
|                                                 | global painting markets,<br>impressionism,<br>postimpressionism                          |                                                            |                                                                                                                                                                                                                              |
|                                                 | 245-1,972 transactions                                                                   | 1. RR = 4.9%                                               |                                                                                                                                                                                                                              |
|                                                 | 1. 1855-1969                                                                             | 2. RR = 6.0%                                               |                                                                                                                                                                                                                              |
|                                                 | including:                                                                               | 3. RR = -3.7%                                              |                                                                                                                                                                                                                              |
| Fase (1996)                                     | 2. 1855-1914                                                                             | 4. RR = 23.8%                                              | 1. RN <sub>MIN;MAX</sub> : [1.8%; 6.7%]<br>CPI <sup>4</sup> : 3.5% <i>p.a.</i><br>2. RN <sub>MIN;MAX</sub> :<br>[11.2%; 14.8%]<br>CPI: 9.5% <i>p.a.</i><br>3. RN <sub>MIN;MAX</sub> : [0.5%; 19.2%]<br>CPI: 5.7% <i>p.a.</i> |
|                                                 | 3. 1915-1949                                                                             | 5. RR = 4.3%                                               |                                                                                                                                                                                                                              |
|                                                 | 4. 1950-1960                                                                             |                                                            |                                                                                                                                                                                                                              |
|                                                 | 5. 1961-1969                                                                             |                                                            |                                                                                                                                                                                                                              |
|                                                 | 19th-century European<br>painting,                                                       | 1. RN = 11.0%                                              |                                                                                                                                                                                                                              |
|                                                 | 1. 1946-1966                                                                             | 2. RN = 10.6%                                              |                                                                                                                                                                                                                              |
|                                                 | 2. 1972-1992                                                                             | 3. RN = 8.6%                                               |                                                                                                                                                                                                                              |
|                                                 | 3. 1982-1992                                                                             |                                                            |                                                                                                                                                                                                                              |

<sup>4</sup> CPI - Consumer Price Index.

|                                    |                                                                             |                                            |                                                                                                                                                                                                                                                                                |
|------------------------------------|-----------------------------------------------------------------------------|--------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Agnello,<br>Pierce (1996)          | American market,<br>15,216 transactions,<br>renowned painters<br>1971-1992  | RN = 9.3%                                  | RN <sub>MIN;MAX</sub> : [7.4%; 13.1%]                                                                                                                                                                                                                                          |
|                                    | including monothematic:                                                     | 1. RN = 12.6%                              |                                                                                                                                                                                                                                                                                |
|                                    | 1. avant-garde<br>painting                                                  | 2. RN = 0.2%                               |                                                                                                                                                                                                                                                                                |
|                                    | 2. landscape                                                                | 3. RN = 6.2%                               |                                                                                                                                                                                                                                                                                |
|                                    | multi-topic:                                                                | 4. RN = 11.3%                              |                                                                                                                                                                                                                                                                                |
| Landes (1999)                      | 3. a.o. seascape                                                            |                                            | 1. RR <sub>MIN;MAX</sub> : [3.66%; 7.68%]<br>2. RR <sub>MIN;MAX</sub> :<br>[5.39%; 10.11%]<br>3. RR <sub>MIN;MAX</sub> :<br>[7.81%; 10.85%]                                                                                                                                    |
|                                    | 4. a.o. still life                                                          |                                            |                                                                                                                                                                                                                                                                                |
|                                    | Ganz collection,<br>86 transactions                                         | 1. RR = 20.67%                             |                                                                                                                                                                                                                                                                                |
|                                    | 1. 1948-1986                                                                | 2. RR = 14.29%                             |                                                                                                                                                                                                                                                                                |
|                                    | 2. 1948-1989                                                                | 3. RR = 11.74%                             |                                                                                                                                                                                                                                                                                |
| Renneboog,<br>Van Houtte<br>(1999) | 3. 1948-1997                                                                |                                            | 1. RN = 5.6%<br>SD = 19.4%<br>Sharpe = 0.122<br>2. RN = 7.6%<br>SD = 30.1%<br>Sharpe = 0.227<br>3. RN = 6.9%<br>SD = 27.5%<br>Sharpe = 0.185<br>4. RN = 1.9%<br>SD = 52.8%<br>Sharpe = 0.137<br>5. RN = 3.5%<br>6. RN = 8.4%<br>7. RN = 10.2%<br>8. RN = 11.3%<br>9. RN = 3.2% |
|                                    | Belgian market,<br>10,598 transactions,<br>renowned painters                |                                            |                                                                                                                                                                                                                                                                                |
|                                    | 1. 1970-1997                                                                |                                            |                                                                                                                                                                                                                                                                                |
|                                    | including:                                                                  |                                            |                                                                                                                                                                                                                                                                                |
|                                    | 2. oil technique                                                            |                                            |                                                                                                                                                                                                                                                                                |
|                                    | 3. expressionism                                                            |                                            |                                                                                                                                                                                                                                                                                |
|                                    | 4. surrealism                                                               |                                            |                                                                                                                                                                                                                                                                                |
|                                    | 5. impressionism                                                            |                                            |                                                                                                                                                                                                                                                                                |
|                                    | 6. 1970-1989                                                                |                                            |                                                                                                                                                                                                                                                                                |
|                                    | including:                                                                  |                                            |                                                                                                                                                                                                                                                                                |
|                                    | 7. oil technique                                                            |                                            |                                                                                                                                                                                                                                                                                |
|                                    | 8. luminism                                                                 |                                            |                                                                                                                                                                                                                                                                                |
|                                    | 9. surrealism                                                               |                                            |                                                                                                                                                                                                                                                                                |
|                                    |                                                                             |                                            |                                                                                                                                                                                                                                                                                |
|                                    |                                                                             |                                            |                                                                                                                                                                                                                                                                                |
|                                    |                                                                             |                                            |                                                                                                                                                                                                                                                                                |
| Agnello (2002)                     | American market,<br>1971-1996,<br>25,217 transactions                       | 1. RN = 4.2%<br>SD = 23.1%                 | RN <sub>MIN;MAX</sub> : [7.1%; 11.6%]<br>SD <sub>MIN;MAX</sub> : [2.0%; 12.1%]                                                                                                                                                                                                 |
|                                    | 1. Total including<br>a.o.:                                                 | 2. RN = 9.9%<br>SD = 18.0%                 |                                                                                                                                                                                                                                                                                |
|                                    | 2. high-end <sup>5</sup>                                                    | 3. RN = 7.3%<br>SD = 25.8%                 |                                                                                                                                                                                                                                                                                |
|                                    | 3. high-end portraits                                                       | 4. RN = 2.0%<br>SD = 18.4%                 |                                                                                                                                                                                                                                                                                |
|                                    | 4. low-end <sup>6</sup> portraits                                           | 5. RN = 8.3%<br>SD = 40.2%                 |                                                                                                                                                                                                                                                                                |
|                                    | 5. genre painting<br>high-end                                               | 6. RN = 2.0%<br>SD = 28.1%                 |                                                                                                                                                                                                                                                                                |
|                                    | 6. landscapes                                                               |                                            |                                                                                                                                                                                                                                                                                |
| Hodgson,<br>Vorkink (2004)         | Canadian market,<br>1968-2001,<br>12,821 transactions,<br>renowned painters | RR = 8.5%<br>SD = 17.3%<br>$\beta$ = 0.359 | RR <sub>MIN;MAX</sub> : [8.6%; 15.5%]<br>SD <sub>MIN;MAX</sub> : [0.3%; 23.7%]                                                                                                                                                                                                 |

<sup>5</sup> High-end – high-class painting, the most valuable.<sup>6</sup> Low-end – mediocre, low-value painting.

|                                 |                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                         |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Edwards (2004)                  | South American market,<br>1981-2001,<br>12,690 transactions,<br>renowned painters<br>1. Total including:<br>2. born before 1900<br>3. born after 1920<br>4. women's painting<br>(except Frida<br>Kahlo)                          | 1. RR = 9.00%<br>SD = 12.6%<br>$\beta$ = 0.108<br>2. RR = 3.90%<br>SD = 20.71%<br>3. RR = 5.54%<br>SD = 18.26%<br>4. RR = 32.05%<br>SD = 140.00%                                                                                                                               | RR <sub>MIN;MAX</sub> : [3.8%; 7.3%]<br>SD <sub>MIN;MAX</sub> : [41.0%; 57.3%]                                                                                                                                                                                                                          |
| Mei, Moses<br>(2005)            | American market,<br>4,896 transactions<br>1. 1950-2000<br>2. 1900-2000<br>3. 1875-2000                                                                                                                                           | 1. RR = 8.2%<br>SD = 21.3%<br>2. RR = 5.2%<br>SD = 35.5%<br>3. RR = 4.9%<br>SD = 42.8%<br>$\beta$ = 0.718                                                                                                                                                                      | 1. RR <sub>MIN;MAX</sub> : [1.3%; 9.1%]<br>SD <sub>MIN;MAX</sub> : [2.3%; 16.2%]<br>2. RR <sub>MIN;MAX</sub> : [1.1%; 7.4%]<br>SD <sub>MIN;MAX</sub> : [4.9%; 22.2%]<br>3. RR <sub>MIN;MAX</sub> : [1.8%; 7.4%]<br>SD <sub>MIN;MAX</sub> : [4.8%; 20.8%]<br>$\beta$ <sub>MIN;MAX</sub> : [0.114; 1.160] |
| Worthington,<br>Higgs (2006)    | global painting markets,<br>1976-2001,<br>211,927 transactions<br>1. Total including:<br>2. surrealism<br>3. contemporary<br>painting<br>4. <i>Old Masters</i><br>5. British painting of<br>the 20th century<br>6. impressionism | 1. RN = 2.54%<br>SD = 10.12%<br>RAR = 0.29<br>2. RN = 1.25%<br>SD = 11.31%<br>RAR = 0.16<br>3. RN = 3.72%<br>SD = 10.47%<br>RAR = 0.40<br>4. RN = 2.02%<br>SD = 8.26%<br>RAR = 0.28<br>5. RN = 2.85%<br>SD = 7.24%<br>RAR = 0.42<br>6. RN = 2.29%<br>SD = 13.86%<br>RAR = 0.24 | RN <sub>MIN;MAX</sub> :<br>[6.49%; 16.82%]<br>SD <sub>MIN;MAX</sub> :<br>[2.62%; 15.29%]<br>RAR <sub>MIN;MAX</sub> : [0.83; 2.49]                                                                                                                                                                       |
| Kräussl,<br>Schellart<br>(2007) | German market,<br>1986 – 2006,<br>“great” painters,<br>1,950 transactions                                                                                                                                                        | RN = 1.6%<br>RR = -0.5%<br>SD = 35.2%<br>RAR = 0.18<br>Sharpe = 0.031<br>Treynor = 1.116                                                                                                                                                                                       | RR <sub>MIN;MAX</sub> : [2.0%; 8.7%]<br>SD <sub>MIN;MAX</sub> : [1.5%; 29.0%]<br>RAR <sub>MIN;MAX</sub> : [0.213; 3.8383]<br>Sharpe <sub>MIN;MAX</sub> : [-0.465; 0.946]<br>Treynor <sub>MIN;MAX</sub> :<br>[-9.971; 7.892]                                                                             |
| Barbosa,<br>Campos (2008)       | South American market,<br>1995-2002, <i>dot-com bubble</i> ,<br>Sotheby's,<br>1,663 transactions                                                                                                                                 | RN = 5.23%                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                         |
| Kräussl, Elsland<br>(2008)      | German market,<br>1985-2007,<br>61,135 transactions                                                                                                                                                                              | RN = 3.8%<br>SD = 17.9%<br>Sharpe = 0.0322<br>$\beta$ = 0.248<br><i>downside</i> $\beta$ = -0.0924                                                                                                                                                                             | RN <sub>MIN;MAX</sub> : [7.5%; 10.1%]<br>Sharpe <sub>MIN;MAX</sub> :<br>[0.2071; 1.1970]<br>$\beta$ <sub>MIN;MAX</sub> : [-0.031; 1.558]                                                                                                                                                                |

|                           |                                                                                                          |                                                                   |                                                                                                                                                                                         |
|---------------------------|----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Campbell<br>(2009)        | global painting markets,<br>1980-2006                                                                    | 1. RN = 6.56%<br>SD = 8.08%<br>RAR=0.81                           | RN <sub>MIN;MAX</sub> : [8.36%; 14.91%]<br>SD <sub>MIN;MAX</sub> : [8.57%; 22.72%]<br>RAR <sub>MIN;MAX</sub> : [0.48; 1.28]                                                             |
|                           | 1. “giants”,<br>109,000<br>transactions                                                                  | 2. RN = 5.52%<br>SD = 7.09%<br>RAR = 0.78                         |                                                                                                                                                                                         |
|                           | 2. <i>Old Masters</i> ,<br>25,000 transactions                                                           | 3. RN = 6.30%<br>SD = 13.12%<br>RAR = 0.48                        |                                                                                                                                                                                         |
|                           | 3. impressionism,<br>22,000 transactions                                                                 | 4. RN = 7.55%<br>SD = 7.38%<br>RAR = 1.02                         |                                                                                                                                                                                         |
|                           | 4. modernism,<br>63,000 transactions                                                                     | 5. RN = 9.00%<br>SD = 9.90%<br>RAR = 0.91                         |                                                                                                                                                                                         |
|                           | 5. contemporary<br>painting,<br>21,000 transactions                                                      |                                                                   |                                                                                                                                                                                         |
| Dürr (2010)               | Swiss market,<br>1993–2009,<br>5,231 transactions,<br>Christie’s, Sotheby’s                              | RN = 3.58%<br>SD = 16.43%                                         | RN <sub>MIN;MAX</sub> : [2.01%; 3.99%]<br>SD <sub>MIN;MAX</sub> : [7.99%; 21.35%]                                                                                                       |
| Kräussl, Logher<br>(2010) |                                                                                                          | 1. RR = 10.00%<br>SD = 26.5%<br>Sharpe = 0.32<br>$\beta$ = 0.6526 | 1. Russian stock market:<br>RR = 25.77%<br>SD = 69.61%<br>Sharpe = 0.62                                                                                                                 |
|                           | 1. Russian market,<br>1985–2008,<br>25,524 transactions                                                  | 2. RR = 5.7% SD<br>= 21.1%<br>Sharpe = 0.16<br>$\beta$ = -0.2166  | 2. Chinese stock market:<br>RR = 21.73%<br>SD = 117.8%<br>Sharpe = 0.62                                                                                                                 |
|                           | 2. Chinese market,<br>1990–2008,<br>7,172 transactions                                                   | 3. RR = 42.2%<br>SD = 36.9%<br>Sharpe = 1.14<br>$\beta$ = -0.027  | 3. Indian stock market:<br>RR = 33.08%<br>SD = 27.16%<br>Sharpe = 1.15                                                                                                                  |
|                           | 3. Indian market,<br>2002–2008,<br>2,858 transactions                                                    |                                                                   |                                                                                                                                                                                         |
|                           |                                                                                                          |                                                                   |                                                                                                                                                                                         |
|                           |                                                                                                          |                                                                   |                                                                                                                                                                                         |
| Higgs (2010)              | Australian market,<br>1. 1986–2009<br>2. 2008-2009,<br>Global Financial Crisis                           | 1. RN = 1.17%<br>SD = 17.35%<br>2. RN = -5.85%<br>SD = 20.87%     | 1. RN <sub>MIN;MAX</sub> :<br>[1.54%; 1.86%]<br>SD <sub>MIN;MAX</sub> :<br>[2.19%; 9.78%]<br>2. RN <sub>MIN;MAX</sub> :<br>[-3.95%; 1.08%]<br>SD <sub>MIN;MAX</sub> :<br>[3.0%; 17.01%] |
|                           | 64,203 transactions,<br>renowned painters,<br>quarterly measures                                         |                                                                   |                                                                                                                                                                                         |
|                           |                                                                                                          |                                                                   |                                                                                                                                                                                         |
| Hodgson (2011)            | Canadian market,<br>1968-2005,<br>“great” <i>French Canadian</i> ,<br>4,135 transactions,<br>oil/acrylic | RR = 4.34%<br>SD = 15.49%<br>$\beta$ = 0.335                      | RR <sub>MIN;MAX</sub> : [2.79%; 5.69%]<br>SD <sub>MIN;MAX</sub> : [3.22%; 16.55%]                                                                                                       |

|                                                |                                                                                                                                           |                                                                                                                                                                                      |                                                                                                                                                                                                                               |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Renneboog,<br>Spaenjers<br>(2013)              | global painting markets,<br>1,088,709 transactions,<br>oil paintings,<br>renowned painters<br>1. 1957-2007<br>2. 1982-2007                | 1. RR = 4.04%<br>SD = 19.05%<br>Sharpe = 0.2000                                                                                                                                      | 1. RR <sub>MIN;MAX</sub> :<br>[1.06%; 6.63%]<br>SD <sub>MIN;MAX</sub> :<br>[2.11%; 24.19%]<br>Sharpe <sub>MIN;MAX</sub> :<br>[-0.0548; 0.4106]                                                                                |
|                                                |                                                                                                                                           | 2. RR = 4.55%<br>SD = 18.04%<br>Sharpe = 0.2725                                                                                                                                      | 2. RR <sub>MIN;MAX</sub> :<br>[-0.89%; 9.33%]<br>SD <sub>MIN;MAX</sub> :<br>[7.53%; 16.76%]<br>Sharpe <sub>MIN;MAX</sub> :<br>[-0.1171; 0.7256]                                                                               |
| Kräussl (2014)                                 | Turkish, Middle Eastern and<br>North African market,<br>3,544 transactions,<br>2000-2012,<br>renowned auction houses                      | RN = 8.9%<br>SD = 31.5%<br>Sharpe = 2.387<br>$\beta$ = 1.103<br>Treynor = 0.428                                                                                                      | RN <sub>MIN;MAX</sub> : [-2.0%; 9.5%]<br>SD <sub>MIN;MAX</sub> : [6.8%; 43.3%]<br>Sharpe <sub>MIN;MAX</sub> : [0.527; 3.934]<br>$\beta$ <sub>MIN;MAX</sub> : [0.815; 1.140]<br>Treynor <sub>MIN;MAX</sub> :<br>[0.257; 0.394] |
| Dimson,<br>Spaenjers<br>(2014)                 | British market,<br>world paintings,<br>1900-2012,<br>renowned painters                                                                    | RR = 2.4%<br>SD = 12.4%                                                                                                                                                              | RR <sub>MIN;MAX</sub> : [0.9%; 5.2%]<br>SD <sub>MIN;MAX</sub> : [6.3%; 19.8%]                                                                                                                                                 |
| Lucińska (2015)                                | Global Financial Crisis,<br>2007-2012<br>1. Polish market,<br>1,708 transactions<br>2. British market<br>3. French market                 | quarterly rates of return                                                                                                                                                            |                                                                                                                                                                                                                               |
|                                                |                                                                                                                                           | 1. RN <sub>MIN;MAX</sub> :<br>[-56.0%; 121.2%]<br>SD = 83.7%<br>2. RN <sub>MIN;MAX</sub> :<br>[-6.1%; 3.8%] SD<br>= 6.0%<br>3. RN <sub>MIN;MAX</sub> :<br>[-4.5%; 2.2%]<br>SD = 3.3% | -                                                                                                                                                                                                                             |
| Witkowska<br>(2016)                            | Polish market, 2008-2013,<br>17 most liquid painters,<br>1,710 transactions                                                               | RN = -7.62%                                                                                                                                                                          | RN <sub>MIN;MAX</sub> :<br>[-18.86%; 28.10%]                                                                                                                                                                                  |
| Korteweg,<br>Kräussl,<br>Verwijmeren<br>(2016) | global painting markets,<br>1960-2013,<br>69,103 transactions<br>1. Total<br>2. Old Masters<br>3. American painting<br>4. Top 100 Artists | 1. RN = 6.29%<br>SD = 11.5%<br>Sharpe = 0.11                                                                                                                                         | 1.<br>RN <sub>MIN;MAX</sub> : [4.33%; 11.25%]<br>SD <sub>MIN;MAX</sub> : [3.19%; 23.27%]<br>Sharpe <sub>MIN;MAX</sub> :<br>[-0.118; 0.415]                                                                                    |
|                                                |                                                                                                                                           | 2. RN = 4.56%<br>SD = 13.8%<br>Sharpe = -0.033<br>3. RN = 6.83%<br>SD = 10.3%<br>Sharpe = 0.176<br>4. RN = 9.50%<br>SD = 13.9%<br>Sharpe = 0.323                                     |                                                                                                                                                                                                                               |
| Garay, Vielma,<br>Villalobos<br>(2017)         | Argentine market,<br>1981-2014,<br>71 liquid painters,<br>5,069 transactions                                                              | RN = 6.81%<br>SD = 29.85%                                                                                                                                                            | RN <sub>MIN;MAX</sub> : [8.50%; 29.81%]<br>SD <sub>MIN;MAX</sub> : [10.45%; 88.15%]                                                                                                                                           |

|                                               |                         |                    |                                          |
|-----------------------------------------------|-------------------------|--------------------|------------------------------------------|
| Białowas,<br>Potocki,<br>Rogozińska<br>(2018) | Polish market,          | 1. RN = 8,7%       |                                          |
|                                               | 1. 1991-2012            | SD = 15.6%         | 1. RN <sub>MIN;MAX</sub> : [2.1%; 16.6%] |
|                                               | 2. 1995-2000            | 2. RN = 25.9%      | SD <sub>MIN;MAX</sub> : [5.8%; 33.8%]    |
|                                               | 3. 2000-2003            | 3. RN = -6.2%      | 2. RN <sub>MIN;MAX</sub> : [4.0%; 18.1%] |
| Garay (2019)                                  | 4. 2008-2012            | 4. RN = -3.5%      |                                          |
|                                               | Venezuelan market,      | RR = 0.95          | RR <sub>MIN;MAX</sub> : [0.8%; 13.5%]    |
|                                               | 1970-2014,              | SD = 31.6%         | SD <sub>MIN;MAX</sub> : [2.2%; 77.7%]    |
|                                               | 5,961 transactions,     | Sharpe = 0.01      | Sharpe <sub>MIN;MAX</sub> : [0.00; 0.40] |
| Lucińska (2021)                               | 69 painters             |                    |                                          |
|                                               | Polish market,          | RN = 1.92%         | RN <sub>MIN;MAX</sub> : [-0.05%; 4.02%]  |
|                                               | 2008-2017,              | SD = 9.6%          | SD <sub>MIN;MAX</sub> : [1.5%; 25.2%]    |
|                                               | 4,647 transactions,     | Sharpe-Israelson = | Sharpe-Israelson <sub>MIN;MAX</sub> :    |
|                                               | 30 most liquid painters | -0.0020            | [-0.0102; -0.0010]                       |

Source: own elaboration.

Rush (1961) presented the dynamics of painting price indices for the years 1925–1960. After these indices rose to 165% in 1929, a decline to 50% was observed in 1933, during the Great Depression, and they remained below the 1925 baseline level throughout the years of World War II. The years between 1950–1960 were a period of enormous increases in the indices, which reached a level of 981%.

Anderson (1974) calculated the average annual rates of return for global painting for the periods 1653–1970, 1780–1970, and 1800–1970, finding them to be 4.9%, 3.7%, and 3.3%, respectively. These were significantly lower than the returns on financial assets, for which the average annual rates of return, for example, during the 1800–1970 period, exceeded 6%. Rates of return similar to those for global painting were achieved across different schools and other sales periods; for example, Old Masters<sup>7</sup> paintings sold in the years 1780–1970 and 18th- and 19th-century British paintings sold between 1825 and 1970 were characterized by average annual rates of return of 4.1% and 3.6%, respectively. However, Anderson also noted the existence of periods and schools of painting for which returns were significantly higher than the long-term average. For instance, Impressionist paintings sold between 1900 and 1970 yielded a return of 11.0%, while 20th-century paintings from 1950 to 1970 achieved a return of nearly 23%, surpassing the returns on stocks of American NYSE companies. He concluded that certain movements (e.g., contemporary paintings) could be competitive with financial assets during periods of prosperity in the art market.

Stein (1977) examined the market for American and British paintings for the period 1946–1968. He noted that during the post-war period of prosperity in the art market, the average nominal annual rate of return was approximately 10.5% for American paintings and 13.1% for British paintings, which was not an attractive proposition when compared to the 14.3% return on the British Financial Times Index stocks. He calculated the beta coefficient ( $\beta$ ) for the American market to be 0.82, which indicated that an investment in paintings was defensive in nature and less risky than an investment in stocks from the Fisher Index.

<sup>7</sup> Old Masters – European painters active between c. 1300 and 1800.

Baumol (1986) examined the prices of paintings sold in art markets between 1652 and 1961. He published the results of his research with a great sense of timing. In the late 1980s, when the art market was booming, potential investors were informed that over a 300-year period, the average annual real rate of return was 0.55%, lower than the interest rate on British government bonds, which averaged approximately 2.5% per year. Furthermore, the rates of return were highly volatile, ranging from –19% to +27% annually, with 40% of transactions generating an absolute loss and 60% generating a small positive rate of return, lower than the interest rate on government securities. Shortening the investment horizon to 50 years offered a chance for large profits but also posed the threat of large losses. Beyond this period, profitability approached zero.

The research by Frey and Pommerehne (1988) focused on paintings by world-renowned artists. Between 1635 and 1987, the average annual return on investment in painting was approximately 1.5% p.a., while for British government bonds, it reached over 3%. Dividing the study period into two parts, 1635–1949 and 1950–1987, yielded similar results. Not only were the rates of return surprisingly low, but their volatility was also considerable; from 1635 to 1949, they ranged from –16% to 26%, and from 1950 to 1987, from –19% to 16%, exceeding the risk of financial markets.

Goetzmann (1993) examined sales transactions in the British market. In the period 1716–1986, the annual rate of return was 3.2%, exceeding the 1.5% return on British LSE stocks but not matching the 4.3% return on British government perpetual bonds. Between 1900 and 1986, this rate averaged 5.2%, approaching the 5.7% return of the S&P 500 index stocks and surpassing the average annual return on US Treasury bonds, which was 0.8% during this period. The final conclusion concerned the relationship between the investment horizon and the rates of return: over the long term, they achieve lower values. He also noted that the art market, similarly to financial markets, is characterized by business cycles.

The research by Buelens and Ginsburgh (1993) concerned the global painting markets in the years 1700–1961 and in specific sub-periods. Confirming the earlier negative conclusions regarding rates of return (e.g., Baumol (1986); Frey and Pommerehne (1988); Goetzmann (1993); Anderson (1974)), they noted strong fluctuations across various subgroups, such as different movements in painting and sub-periods. Thus, for the entire period studied, the average annual rate of return was 0.91%, with the rate for British painting being 0.57% and for the Impressionists (from 1870 onwards) reaching 2.96%. Between 1700 and 1869, the average annual rate of return was 1.09%, ranging from a 1.03% return for 17th-century Dutch painting to a 2.12% return for British painting. The years 1870–1913 were characterized by an average annual rate of return of 3.49%, with fluctuations ranging from 2.24% for British paintings to 6.26% for the Impressionists. The period of crises and wars, 1914–1949, showed a negative average annual rate of return of –4.19%, ranging from –4.59% for British paintings to –1.59% for 15th-century Italian paintings. The final interval studied, i.e., the years 1950–1961, was a period of prosperity in the art market, when the average annual rate of return was very high at 9.63%, ranging from 0.16% for 15th-century Italian paintings to 23.76% for the Impressionists. In this way,

movements in painting (e.g., Impressionism) and certain periods (e.g., 1950–1961) were identified when higher profitability was achieved. Excluding the crisis years of 1914–1949, it was found that over the entire period studied, the average annual rates of return stood at a level of 2.5%, similar to the average annual interest rate on government bonds.

The annual rates of return determined by Chanel et al. (1996) for Impressionist and Post-Impressionist paintings at global auction houses from the years 1855–1969 varied depending on the sub-periods studied and the size of the research samples. Thus, for the entire period studied, the annual rate of return was 4.9%; for the years 1855–1914, the average rate of return was 6.0%; the period 1915–1949 saw the rate of return take on an average value of –3.7%, confirming the results of earlier research by Buelens and Ginsburgh (1993). In the years 1950–1960, i.e., the art market boom, the average annual rate of return reached a high level of 23.8%, while in the years 1961–1969, it was 4.3%.

Fase (1996) determined the rates of return on 19th-century European paintings. He noted that in the years 1946–1966, the return on investment in paintings, at 11%, offered a significant advantage over the return from the stock market (6.7%) and gold (1.8%). The periods 1972–1992 and 1982–1992 were characterized by nominal annual returns on investment in paintings of 10.6% and 8.6%, respectively. These were lower than the returns on British bonds (11.2% and 16%, respectively), stocks (14.8% and 19.2%), gold (12.9% and 0.5%), and real estate (11.8% and 8.2%). This means that during the art market boom, investing in paintings yielded greater returns than the markets for other assets. In other periods, such a relationship did not hold true. In each of the periods studied, the rates of return on the art market were found to have surpassed inflation.

Agnello and Pierce (1996) determined the rates of return in the market for renowned American paintings for transactions in the years 1971–1992, i.e., during a period of economic growth. The nominal average annual rate of return was 9.3%, while inflation during this period was over 6% p.a. The average annual return on the market for large-cap stocks reached 13.1%, the return on US government bonds was 9.7%, and on T-bills, 7.4%. This means that the research sample included works that yielded a negative real rate of return, as well as those whose rate of return was positive but did not match that of the aforementioned securities. It was noted that the subject matter of the paintings strongly influences the achieved rates of return; certain subjects (e.g., avant-garde paintings, still lifes) are conducive to higher returns, while others (e.g., landscapes) are not.

The factors of investor knowledge and the ability to select paintings with high price-growth potential are the reasons behind the success of the Ganz family collection, a point highlighted by Landes (1999). He determined the average annual rates of return for the periods 1948–1986, 1948–1989, and 1948–1997. In the first period, the rate of return on the Ganz's paintings was 20.67%, whereas S&P 500 large-cap stocks had a return of 3.66% and small-cap NYSE stocks a return of 7.68%. In the second period, the return on the paintings was 14.29%, while the returns on the two stock categories were 5.39% and 10.11%, respectively. In the third period, the return on the paintings stood at 11.74%, while the

respective stock returns were 7.81% and 10.85%. This indicates a significant outperformance of the investment in paintings compared to stocks in all the periods studied.

Renneboog and Van Houtte (1999) studied the Belgian painting market for the periods 1970–1997 and 1970–1989. For the first period, they calculated the measures of return, risk, and effectiveness to be 5.6% (nominal), 19.4%, and 0.122, respectively. During the same period in the capital market, returns ranged from 8.3% for S&P 500 stocks to 9.2% for the European Stock Index, and were thus higher. In the stock markets, the standard deviation ranged from 16.0% to 20.6%. During this period, Expressionist, Surrealist, and Impressionist paintings, as well as oil paintings, also yielded rates of return lower than the securities market, i.e., ranging from 1.9% for Surrealism to 7.6% for oil paintings. Similarly, the Sharpe ratio was lower for the painting market at 0.122, whereas for the stock markets it was within the range of 0.285–0.302. In the shorter period, i.e., 1970–1989, the average annual rate of return on the painting market was 8.4%, which fell within the range of returns in the capital market [7.3%; 9.9%]. Particularly high rates of return during this time were yielded by oil paintings (10.2%) and those representing the Luminist movement (11.3%). Ultimately, it was concluded that, with certain exceptions, return and effectiveness are lower than in the stock market, while the risk is higher.

Agnello (2002) determined the rates of return in the American painting market for the years 1971–1996, focusing on paintings by popular artists that achieve high prices at auction. The average nominal rate of return was 4.2% p.a. and was markedly lower than the rates of return on the S&P 500 stock market (11.6%), 10-year US government bonds (8.5%), 6-month T-bills (7.1%), and the CPI inflation rate (5.4%). Disaggregation of the research sample according to various criteria yields more varied results. For instance, high-end works yield a return of 9.9%, outpacing debt securities. The rates of return for high-end portraits and high-end genre painting are 7.3% and 8.3%, respectively, surpassing US T-bills but not matching S&P 500 stocks and US government bonds. The risk in the market for all paintings studied is high, with an average standard deviation of 23.1%, significantly exceeding the risk indicators for S&P 500 stocks (12.1%) and for long-term (2.0%) and short-term (2.6%) government bonds.

Hodgson and Vorkink (2004) examined the rates of return on paintings by recognized Canadian artists for the period 1968–2001. The average annual real rate of return was 8.5%, which was lower than both the return on Canadian MSCI stocks (15.5%) and on Canadian government bonds (8.6%). The risk in the art market, with a standard deviation of 17.3%, was lower than in the stock market (23.7%) and significantly higher than in the government bond market (0.3%). The positive and weak risk relationship between the painting market and the stock market was confirmed by the beta coefficient ( $\beta$ ) value of 0.359. The return and risk in the Canadian art market show values similar to the parameters of the American market determined by Mei and Moses (2005) and differ significantly from those of the British art market as determined by Goetzmann (1993).

Edwards (2004) examined auction records from 1981–2001 in South American countries. The average annual real rate of return for the entire research sample was 9%, whereas the rates of return for

the stock markets ranged from 3.8% in Argentina to 7.3% in Chile and Brazil. The high rate of return may have been influenced by paintings by female artists, which had a rate of return of 32.05%. The standard deviation was 12.6%, which was lower than in the stock markets (ranging from 41.0% in Chile to 57.3% in Argentina). An exceptionally high risk, with a standard deviation of 140%, was associated with paintings by female artists. The beta coefficient ( $\beta$ ) of 0.108 indicated a weak response to changes in the rates of return in the capital market.

Mei and Moses (2005) constructed repeat-sales indices for paintings by American artists sold at the Sotheby's and Christie's global auction houses for three periods: 1950–2000, 1900–2000, and 1875–2000. In the first period, the average annual real rate of return was 8.2%, compared to 8.9% for the S&P 500 index, 9.1% for the Dow Jones index, 1.9% for US government bonds, 2.2% for American corporate bonds, and 1.3% for US T-bills. In the second period, the 5.2% return on paintings also fell within the range of 1.1% for the debt securities market to 7.4% for Dow Jones stocks. This was similar to the third period, when the return was 4.9% and fell within the range of 1.8% for T-bills to 7.4% for the stock markets. The risk in the art market was significantly higher. The standard deviation for art was 21.3% compared to a range of 2.3% for T-bills to 16.2% for Dow Jones stocks (1950–2000); 35.5% compared to a range of 4.9% for T-bills to 22.2% for Dow Jones stocks (1900–2000); and 42.8% compared to a range of 4.8% for US government bonds to 20.8% for Dow Jones stocks (1875–2000). The  $\beta$  (beta) coefficient was 0.718, indicating a risk lower than that of the market. These relationships were characterized by returns in the painting market that were higher than those in the debt securities market, but lower than those in the stock market, and were associated with higher risk.

Worthington and Higgs (2006) examined global art markets for the period 1976–2001, disaggregated by artistic movement. The average annual rates of return for art ranged from 1.25% for Surrealism to 3.72% for contemporary painting and were lower than in the financial markets, where returns fell within the range of 6.49% for US T-bills to 16.82% for US small-cap stocks. Standard deviation for art ranged from 7.24% for 20th-century English paintings to 13.86% for French Impressionism. This indicated that in general the risk was higher than for T-bills (2.62%), while in other cases, it was lower than for long-term US corporate bonds (10.51%) and US government bonds (11.68%). However, it was always lower than the risk of the US small-cap stock market (15.29%). The risk-adjusted return (RAR) indicators for art ranged from 0.16 for Surrealism to 0.42 for 20th-century English painting, and were lower than in the financial markets, where they assumed values from 0.83 for long-term government bonds to 2.49 for US T-bills. This is another study demonstrating the outperformance of traditional financial markets over the art market, and at the same time, showing varied risk relationships, where painting is characterized by a higher risk than T-bills but a lower risk than equity and long-term debt securities.

Kräussl and Schellart (2007) studied the market for the most important German painters for the period 1986–2006. They determined the average annual geometric rates of return to be 1.6% (nominal) and –0.5% (real), which was a weaker result than in the markets for other assets, where rates of return

ranged from 2.0% for GSCI gold to 8.7% for the S&P 500 stock market. The volatility of rates of return in the art market was 35.2% and was higher than in other markets, which ranged from a standard deviation of 1.5% for 10-year German government bonds to 29.0% for DAX 30 index stocks. The Sharpe ratio was 0.031, whereas in the financial markets, it ranged from -0.465 for CSFB/Tremont Hedge funds to 0.946 for 10-year US government bonds. The Treynor ratio of 1.116 was higher than that for 10-year UK government bonds (-9.971) and lower than that for 10-year US government bonds (7.892). The investment effectiveness of painting places it between hedge funds, US T-bills, and GSCI gold on one hand, and the European Real Estate Price Index, US, UK, and German government bonds, and stocks on the other.

Barbosa and Campos (2008) examined the rates of return on South American painting during the years of the dot-com bubble, 1995–2002. The research sample comprised paintings by the most recognized artists sold at auctions in New York. The average annual rate of return was 5.23%, which for obvious reasons was lower than the returns on the stock market; however, some caution is advised in interpreting these results due to the short time period covered by the study.

Kräussl and Elsland (2008), based on hedonic indices, determined the rates of return for German paintings from 1985 to the first half of 2007. The average annual rate of return was 3.8% and was subject to a high risk (standard deviation) of 17.9%. During this time, financial assets yielded annual returns in the range of [7.5% for Private Equity (LPX50); 10.1% for CC/Tremont Hedge funds]. The Sharpe ratio was less favorable for the painting market, at 0.0322, compared to 0.2071 for Private Equity funds and 1.1970 for US corporate bonds. The lower value of the beta coefficient ( $\beta$ ) at 0.248, compared to the  $\beta$  for Private Equity (1.558), indicates a lower systematic risk in the art market than in the financial market. The negative value of the downside beta ( $\beta$ ) indicator, i.e., -0.0924, points to the potential for achieving better rates of return in the painting market when financial markets experience a downturn.

Campbell (2009) studied the market for the “giants” of painting (i.e., the 100 most important painters from various countries and artistic movements) for the period 1980–2006. The average annual nominal rates of return for art ranged from 5.52% for Old Masters to 9.00% for contemporary painting, whereas in the financial markets, returns were in the range of 8.36% for 10-year US government bonds to 14.91% for US corporate bonds. The standard deviations of rates of return in the art market were in the range of [7.09% for Old Masters; 13.12% for European Impressionism], while in the financial markets, this range was formed by values from [8.57% for British 10-year government bonds; 22.72% for US corporate bonds]. This research indicates a lower rate of return in the art market than in the financial markets and reveals more varied risk relationships.

Dürr (2010) determined the average annual rate of return on Swiss painting for the period 1993–2009. It amounted to 3.58% and was lower than the return on HFRI FOF hedge funds (3.62%) and JPM GBI global bonds (3.99%), while surpassing the return on the MSCI World stock market (2.01%). The risk of rates of return in the painting market (16.43%) fell within the range of [7.99% for bonds; 21.35%

for stocks]. This indicates lower returns and higher risk in the painting market compared to the hedge fund and bond markets, and higher returns and lower risk compared to the stock market.

Kräussl and Logher (2010) studied the painting markets: the Russian market from 1985 to 2008, the Chinese market from 1990 to 2008, and the Indian market for the period 2002–2008. In the periods studied, the average rate of return in the art market in Russia was 10.00% versus 25.77% in the Russian RTS stock market; in China, it was 5.70% versus 21.73% in the Chinese SSE stock market; and in India, it was 42.20% versus 33.08% in the Indian BBE100 stock market. The returns in the art markets of Russia and India surpassed the returns obtainable during that time on global financial markets, where they ranged from 4.30% for 10-year US government bonds to 11.09% for CS/Tremont hedge funds. The volatility of rates of return in the art market was 26.5%, 21.1%, and 36.9% respectively, while the risk in the respective stock markets was 69.61%, 117.80%, and 27.16%. The Russian art market is characterized by a positive beta ( $\beta$ ) coefficient of 0.6526. In the Chinese and Indian markets, the beta ( $\beta$ ) coefficients are  $-0.2166$  and  $-0.027$ , respectively, which means that the rates of return are inversely correlated with the rates in the capital markets of those countries.

Higgs (2010) determined the average quarterly rates of return in the Australian art market for the period 1986–2009. The average quarterly return for well-known painters was 1.17%, compared to 1.54% in the Australian stock market and 1.86% in the real estate market. The volatility in the art market (17.35%) significantly exceeded the volatility in the stock market (9.78%) and the real estate market (2.19%). During the global financial crisis of 2008–2009, the level of returns was very low: in the art market, it was  $-5.85\%$ ; in the stock market,  $-3.95\%$ ; while only the real estate market recorded a positive quarterly rate of return of 1.08%. During this time, the return in the Australian paintings market decreased by 7.02 percentage points (p.p.) quarterly, compared to a decrease of 5.49 p.p. in the stock market and 0.78 p.p. in the real estate market. Risk increased unequally, rising to a level of 20.87% in the art market, 17.01% in the stock market, and 3% in the real estate market.

Hodgson (2011) studied the rates of return on oil and acrylic paintings by recognized French-Canadian artists from the period 1968–2005. He determined the average annual rate of return to be 4.34%. This was lower than the return on stocks on the Canadian TSX/S&P exchange (5.69%) and higher than the Canadian interest rate during that time (2.79%). The risk in the art market, with a standard deviation of 15.49%, was similar to the risk in the stock market (16.55%). The beta ( $\beta$ ) coefficient was 0.335, which signifies a weak relationship between the rates of return on the paintings market and the Canadian stock market.

Renneboog and Spaenjers (2013) studied the market for renowned global artists for the periods 1957–2007 and 1982–2007. In the first period, the return in the painting market was 4.04%. This did not match the rates of return from the S&P 500 (6.63%) and Global Stocks (6.34%) markets, but it surpassed the returns on the Shiller U.S. real estate market (1.06%), gold (2.35%), T-bills (1.39%), and others. The Sharpe ratio of 0.2000 proved to be lower than in the S&P 500 and Global Stocks markets, where it was 0.4106 and 0.3953, respectively. It was higher than in the real estate market ( $-0.0548$ ), the

CRB commodities market (0.1780), and the gold market (0.1285). In the years 1982–2007, a real rate of return of 4.55% was recorded, compared to rates of return from the range of [5.77% for DJ US government bonds; 9.33% for the S&P 500]. It was higher than in the markets for gold (−0.89%), commodities (2.06%), and real estate (2.41%). Similarly to the first study period, the Sharpe ratio of 0.2725 was lower than in the markets for global stocks (0.5039), S&P 500 stocks (0.5707), government bonds (0.4503), and corporate bonds (0.7256), but higher than in the markets for gold (−0.1171), commodities (0.0511), and real estate (0.0902). Both the rates of return and the effectiveness in the art market are lower than in the financial asset markets, but more favorable than in the markets for non-financial assets (commodities, gold, real estate).

Kräussl (2014) studied the paintings markets for the period 2000–2012. The analysis covered paintings sold at major auction houses and painted by renowned artists from Turkey, the Middle East, and North Africa (MENA). An average annual rate of return of 8.9% was determined. This was higher than the returns in the markets for Datastream World real estate (−2.0%), MSCI World stocks (2.7%), PE LPX50 funds (4.8%), GSCI commodities (5%), ML corporate bonds (7.6%), and DJ CS hedge funds (8.4%), but lower than the rate of return on Citigroup World WGBI government bonds (9.5%). The risk in the painting market (31.5%) was significantly greater than the risk in the corporate bond market (6.8%) and lower than the volatility in the PE funds market (43.3%). The value of the beta ( $\beta$ ) coefficient (1.103) was higher than in the markets for commodities (0.815) and corporate bonds (1.083), and lower than in the government bond market (1.140). The Treynor ratio was 0.428 and was higher than the values in all compared markets, where it ranged from 0.257 for stocks to 0.394 for the real estate market. The Sharpe ratio was 2.387 and was higher than in the markets for PE (0.527), commodities (0.582), real estate (0.907), and stocks (0.645), but lower than in the markets for hedge funds (2.727) and government bonds (3.934).

Dimson and Spaenjers (2014) compared the return and risk of investing in paintings and other collectible assets, such as stamps. They determined the average annual real rates of return in the British paintings market for the period 1900–2012. It achieved 2.4%, surpassing the returns on T-bills (0.9%), World Gold Council gold (1.1%) and bonds (1.5%), but not matching the rates of return in the philatelic market at 2.8% (Dimson and Spaenjers, 2011) or for global CSR stocks at 5.2%. The standard deviation of returns on paintings was 12.4%, exceeding the risk of the US T-bills market (6.3%) but not matching the risk for gold (16.6%) and stocks (19.8%).

Lucińska (2015) compared the quarterly rates of return in the Polish, British, and French painting markets for the years 2007–2012, i.e., the period preceding the global financial crisis and immediately following it. In the Polish market, they ranged from [−56.0%; 121.2%], compared to the much smaller range of returns in the British market [−6.1%; 3.8%] and the French market [−4.5%; 2.2%]. This is consistent with the high value of the standard deviation in the Polish market (83.7%) compared to the corresponding values in the British (6.0%) and French (3.3%) markets. The stable rates of return in Great Britain and France contrast with the highly volatile Polish market. The returns in the British

and French art markets move in parallel with the course of the global financial crisis. Returns in the Polish art market remain unstable and highly volatile, reacting to the crisis with a one-year delay.

Witkowska (2016) determined the average annual rate of return for the years 2008–2013 for the most liquid painters in the Polish auction market. For the artists selected for the research sample, the result was negative; during this period, investing in paintings yielded losses at a level of  $-7.62\%$ . This was a better result than the WIG stock market ( $-18.86\%$ ) but worse than the market for Polish treasury bonds ( $28.10\%$ ).

Korteweg et al. (2016) determined the rates of return in the global auction market, i.e., across 350 auction houses, for the period 1960–2013. The average annual rate of return for the entire sample was  $6.29\%$ , the standard deviation was  $11.5\%$ , and the Sharpe ratio was  $0.11$ . When disaggregated by category, the rates of return ranged from  $4.56\%$  for Old Masters to  $9.50\%$  for the Top 100 Artists. During this time, Global Equities yielded a return of  $11.25\%$ , DJ corporate bonds  $8.72\%$ , WBG Commodities  $8.63\%$ , Shiller U.S. real estate  $4.33\%$ , and T-bills  $5.02\%$ . The risk for art was in the range of [ $10.3\%$  for American paintings;  $13.9\%$  for the Top 100 Artists], compared to a wider variation in the financial markets: [ $3.19\%$  for the T-bills market;  $23.27\%$  for the commodities market]. The Sharpe ratio for art ranged from  $-0.033$  for Old Masters to  $0.323$  for the Top 100 Artists, compared to values from  $-0.118$  in the real estate market to  $0.415$  in the corporate bond market. The group of the most expensive painters, the Top 100 Artists, stands out with a higher return than financial markets (with the exception of the global stock market) and greater effectiveness than the real estate and commodities markets.

Garay et al. (2017) studied the market for paintings by recognized Argentine artists for the period 1981–2014. They determined an average annual rate of return of  $6.81\%$  and a standard deviation of rates of return at  $29.85\%$ , a high level typical for emerging markets. While Total S&P 500 Argentina stocks were much more profitable ( $29.81\%$ ) than both the Argentine art market and the American stock market, their risk stood at an astronomically high level of  $88.15\%$ . During this period, the US financial markets were characterized by a different relationship between rates of return and risk, i.e., lower returns and lower risk. The return on 10Y US Treasury Bonds was  $8.50\%$  with a volatility of  $10.45\%$ , and the rates of return in the Total S&P 500 US stock market stood at  $12.66\%$  with a volatility of  $16.86\%$ .

Białowas et al. (2018) studied the Polish art market. They determined the aggregate rates of return for sales transactions of paintings ( $74.3\%$  of transactions), drawings ( $25.5\%$ ), and collages ( $0.3\%$ ) for the years 1991–2012. The average annual arithmetic rate of return in the art market was  $8.7\%$ , surpassing the return on Forex PLN/USD ( $2.1\%$ ) and the interest rate on annual deposits ( $7.9\%$ ), but not matching the returns on Polish WIG stocks ( $16.6\%$ ), Mennica Polska gold ( $11.3\%$ ), and 52-week treasury bills ( $9.8\%$ ). In the category of risk, the art market (with a standard deviation of returns of  $15.6\%$ ) shows similarity to gold ( $14.2\%$ ), exceeds the risk of the Forex market ( $13.1\%$ ), treasury bills ( $6.5\%$ ), and deposit interest rates ( $5.8\%$ ), but does not match the risk of WIG stocks ( $33.8\%$ ). The Sharpe effectiveness ratio has a negative value in the art market. The analysis of returns by sub-periods indicates that only the years 1995–2000 brought the art market an advantage over other assets, with a rate of return

of 25.9% compared to the other rates, which were in the range of [4.0%; 18.1%]. In the other's sub-periods, the rates of return are at the lowest level among all assets: -6.2% in 2000–2003 and -3.5% in 2008–2012.

The Venezuelan painting market for the period 1970–2014 was studied by Garay (2019). The return achieved an average level of 0.95%, surpassing the rates of return on US T-bills (0.8%) but not matching the returns on US government bonds (3.4%), crude oil (6.3%), American S&P 500 stocks (7.6%), and Venezuelan stocks from the Caracas Stock Exchange (13.5%). The high risk (31.6%) exceeded the volatility of rates of return for T-bills (2.2%), US bonds (9.9%), US stocks (17.1%), and crude oil (25.4%), while not matching the risk of Venezuelan stocks (77.7%). The Sharpe ratio placed the effectiveness of the Venezuelan art market (0.01) behind Venezuelan stocks (0.16), crude oil (0.22), US government bonds (0.27), and US stocks (0.40), but ahead of T-bills (0.00).

Lucińska (2021) studied the Polish market for the most liquid painters for the period 2008–2017. The average annual rate of return was 1.92%, placing it in second place, behind 5-year State Treasury bonds (4.02%) but ahead of the NBP (National Bank of Poland) returns on the real estate market (0.5%) and WIG20 stocks (-0.05%). The risk in the art market was 9.6% and was second only to WIG20 stocks (25.2%), surpassing the real estate market (2.9%) and treasury bonds (1.45%). The Sharpe-Israelsen ratio was negative with the value of -0.0020, behind real estate (0.0010) but ahead of WIG20 stocks (-0.0102).

### **Summary of Research on the Global Art Market**

Factors conducive to higher returns in the art market than in financial markets have been identified. These pertained to the period covered by the study, selected characteristics of the purchased paintings, the assets used as a benchmark, and the specific nature of the art market.

The results of art market research indicate that long-term investment in paintings is less profitable than short-term investment, although better results can be obtained by investing in works of art representing a specific country or movement in painting (Sawicki and Borowski, 2018, p. 99–100). This conclusion is very general and requires further specification. Generally, long-term investments in the paintings market are characterized by average annual rates of return that are lower than those in securities markets, and especially in stock markets. Investment effectiveness is also unfavorable for the art market, as demonstrated by the majority of the discussed studies (e.g., Anderson (1974), Stein (1977), Baumol (1986), Frey and Pommerehne (1988), Renneboog and Spaenjers (2013), Worthington and Higgs (2006), Kräussl and Elsländ (2008), Kräussl and Logher (2010), Renneboog and Spaenjers (2013), Korteweg et. al. (2016)).

Within a specific timeframe, paintings possessing certain characteristics can yield a rate of return higher than that of other assets. The most common period covered by the samples is several decades, though studies have also been described that concern a few years (Witkowska (2016)), over

a decade (e.g., Buelens and Ginsburg (1993), Chanel et al. (1996), Fase (1996), Kräussl (2014)), or several hundred years (e.g., Anderson (1974), Baumol (1986), Frey and Pommerehne (1988), Goetzmann (1993)). Over the long term, upward and downward trends occur cyclically in the art market (Goetzmann (1993)). Studies covering a period of several hundred years (Baumol (1986)) indicated that the investment effectiveness of paintings was close to zero. This is not surprising when considering the history of the world, and of Europe in particular, which is full of wars, economic crises, and other tragedies that inevitably disrupted the art world and the art market (Chanel et al. (1996)).

In shorter periods (e.g., several decades), both strongly positive and negative rates of return were possible (Baumol (1986), Frey and Pommerehne (1988)). During periods of growth in the art market (e.g., in the years 1950–1961), the return in the painting market was higher than or equal to that of securities markets and other assets (e.g., Rush (1961), Anderson (1974), Goetzmann (1993), Buelens and Ginsburgh (1993), Chanel et al. (1996), Fase (1996)). The rate of return in the paintings market reached a level similar to that achieved in securities markets (primarily in the government bond or T-bills markets) when years such as 1914–1949 were excluded from the research sample (Buelens and Ginsburg (1993), Chanel et al. (1996)). Crises in financial markets caused a greater decline in effectiveness in the art market than in the stock (Rush (1961)) and real estate markets (Higgs (2010)).

It was noted that selected thematic groups, movements, and periods in painting, as well as the quality of the paintings, can positively influence the profitability of an investment. For example, the rates of return on avant-garde painting and still life were, in a specific period, higher than the returns on debt securities (Agnello and Pierce (1996)). Investments in Belgian oil and Luminist paintings had higher rates of return than stocks (Renneboog and van Houtte (1999)). The high-end portraits and genre painting yielded higher rates of return than US T-bills (Agnello (2002)). The investments in contemporary painting by the 'giants' of world painting were more profitable than US government debt securities (Campbell (2009)) and the stocks of American companies (Anderson (1974)). In cases of exceptionally high-quality painting, the rates of return were extraordinarily high, as exemplified by the history of the Ganz collection (Landes (1999)).

Stocks are more profitable than paintings, especially during periods of rapid asset price growth in the capital markets, such as the dot-com bubble of 1995–2001 (Barbosa and Campos (2008)). In selected periods and for selected research samples (e.g., particular movements in painting, the Top 100 Artists, MENA painters), the outperformance of painting's returns was noted over investments in T-bills (Mei and Moses (2005)); bonds and hedge funds (Dürr (2010)); gold (Fase (1996), Kräussl and Schellart (2007), Renneboog and Spaenjers (2013), Dimson and Spaenjers (2014)); commodities (Renneboog and Spaenjers (2014)); and real estate (Fase (1996), Higgs (2010), Renneboog and Spaenjers (2013), Korteweg et al. (2016)). An inverse relationship between the returns on painting and bonds was also observed (Baumol (1986)). The outperformance of art market returns over the inflation rate and interest rates (e.g., Fase (1996)) was stated, which allows for the use of artworks as a hedge against inflation.

The specific nature of emerging art markets is that extraordinarily high rates of return can be achieved on them, higher than those obtainable in global financial markets. This has been the case, for example, in the art markets of South America (Edwards (2004)); Russia, China, and India (Kräussl and Logher (2010)); Poland (Lucińska (2015)); and the MENA countries, where even during the years of the global financial crisis, only price increases were observed (Kräussl (2014)). This conclusion does not apply to the Polish market before 2017 (Witkowska (2016), Lucińska (2021)).

Risk in the art markets is varied. Generally, the standard deviations of rates of return in the painting markets are greater than the standard deviations in the securities markets (Frey and Pommerehne (1988), Mei and Moses (2005), Agnello (2002), Worthington and Higgs (2006), Kräussl and Schellart (2007), Campbell (2009), Higgs (2010), Renneboog and Spaenjers (2013)). This observation pertains to mature global painting markets and renowned auction houses (e.g., Sotheby's or Christie's). However, this relationship depends on the type of security used as a benchmark. Thus, the volatility of rates of return in the Canadian painting market was lower than the volatility in the Canadian stock markets (e.g., Hodgson and Vorkink (2004), Hodgson (2011)), but higher than in the S&P 500 stock market (Renneboog and Van Houtte (1999)), interest rates (Hodgson (2011)), bonds (e.g., Hodgson and Vorkink (2004), Dürr (2010)), T-bills (e.g., Dimson and Spaenjers (2014), Korteweg et al. (2016)), gold (Dimson and Spaenjers (2014)), and commodities (Korteweg et al. (2016)). These relationships were shaped differently in emerging markets, e.g., in Poland (Lucińska (2015)), in Russia and China (Kräussl and Logher (2010)), and in the countries of the Middle East and North Africa (Kräussl (2014)), where the risk in the art markets was lower than the risk of securities. Periods of financial crises involve a greater increase in risk in the art market than in financial markets (Higgs (2010)).

The relationships of the Sharpe ratio in the art market and other asset markets were varied. The values of this indicator in mature art markets were lower than in the markets for stocks (Renneboog and Van Houtte (1999), Kräussl and Elsland (2008), Renneboog and Spaenjers (2013)), US government bonds (Kräussl and Schellart (2007), Kräussl (2014)), and hedge funds (Kräussl (2014)), but higher than in the markets for non-financial assets, e.g., commodities (Renneboog and Spaenjers (2013)), gold, real estate (Kräussl and Schellart (2007)), and others. In the emerging art markets of MENA, investment effectiveness was more favorable than in the global markets for stocks, PE funds, commodities, and real estate (Kräussl (2014)).

Most often, the beta ( $\beta$ ) coefficient fell within the range of (0, 1), indicating a lower risk in the art market than in financial markets and the defensive nature of art as an investment. Exceptions apply to the emerging MENA markets, with a beta ( $\beta$ ) coefficient  $> 1$ , indicating the potential for a strong reaction to changes occurring in financial markets and the aggressive nature of investment in painting (Kräussl (2014)).

## Conclusions

Based on the research presented, final and exhaustive answers to the questions about painting as an investment asset have not been formulated. No strong evidence has been found to support the thesis of art as an attractive investment, particularly over a long-term horizon. The results differ from one another depending on the methodology adopted for determining rates of return, the period, and the paintings included in the research sample. Generally, the rates of return are modest and are subject to high risk.

However, a detailed analysis of the discussed studies has made it possible to identify factors that are conducive to higher returns in the art market than in financial markets. Within a specific time and in a specific market, paintings possessing certain characteristics have yielded a rate of return higher than that of other assets. The effectiveness of investing in paintings was varied; in mature art markets, it was lower than in financial markets but higher than in the markets for non-financial assets. In emerging art markets, investment effectiveness was more favorable than in the global financial, commodity, and real estate markets.

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## TOWARDS THE EU CAPITAL MARKET: IMPACT OF THE 'FASTER' DIRECTIVE

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### TOWARDS THE EU CAPITAL MARKET: IMPACT OF THE 'FASTER' DIRECTIVE

#### ABSTRACT

**The purpose of the article.** This article aims to analyse the 'FASTER' Directive and to examine the relevance of its measures, as well as the possible consequences of their implementation.

**Methodology.** Reports from the European institutions, specifically from the European Parliament, the proposal for a Council Directive and the Directive 2025/50 were consulted. National and international literature on the subject was also analysed in order to better understand the doctrine's perspectives on the subject.

**Results of the research.** This study revealed that the adoption of a Directive is the best solution for resolving the issues of double taxation and complicated and costly procedures for refunding of withholding tax. This will enable a joint response to the phenomena of tax fraud and abuse, which have caused Member States to lose huge amounts of revenue. The introduction of the new measures will enable an increase in cross-border investment, benefiting the single market and preventing the cases of cum-cum and cum-ex.

**Keywords:** free movement of capital, withholding taxes, Capital Markets Union, Directive.

**JEL Class:** K34.

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### **The importance of using a Directive in tax matters**

The Directive in analysis falls under the European Union Tax Law. In fact, this branch of law intends to regulate European taxes and to fight against tax abuse and fraud. The latter is one of the primary concerns of European Tax Law (Sérgio Ribeiro, 2021, p. 14). The former, although it is a goal to strive for, harmonisation in terms of tax abuse has not yet been achieved (Dibout & Offermanns, 1998, p. 93).

The European Union has only residual and limited powers in tax matters. In this area, the European Union aims to influence or rectify the tax systems of the Member States, guaranteeing cohesion with European legal and economic policies. This is also the case in policies against tax abuse of fraud, with the aim of enabling the internal market to function (Pistone, 2017, p. 73). We can therefore say that tax sovereignty belongs primarily to the Member States (Easson, 1993, p. 3).

For this reason, the European Union has essentially used the Directive as its main act of choice to achieve further coordination in tax matters, in accordance to Article 115 of the Treaty on the Functioning of the European Union (TFEU). As a result, the 'FASTER' Directive (Council Directive (EU) 2025/50 of December 10, 2024, whose effects started on January 30<sup>th</sup>, 2025) follows a special legislative procedure, in which the Council of the European Union is the primary lawmaker and unanimity of the Council is in principle required to approve the Directive, except if the reinforced mechanism applies.

#### **Before the 'FASTER' Directive**

In the European legal system, some efforts have been made to combat tax abuse and fraud.

In fact, a proposal for a Directive was presented in 1989, providing for the withholding tax at source of capital income paid to other Member States (Dourado, 2018, p. 336).

Later, the Savings Directive (Directive 2003/48/EC) emerged as the first step towards providing for an automatic exchange of information and the taxation of savings income in the form of interest in the EU. Member States, such as Austria, Belgium and Luxembourg, chose the withholding tax system on a transitional basis and the provision of information was limited to interest income that had been paid by a paying agent to another entity of a Member State (Dourado & Reigada Pereira, 2006, p. 253).

Posteriorly, Directive 2011/16/EU imposed an automatic exchange of information between Member States for certain categories of income and capital. This Directive is mainly concerned with financial income that taxpayers obtained in Member States (different from the State of residence) and provides for an automatic exchange of information in stages, later extending to other categories of income and capital.

## The 'FASTER' Directive: Justification

Recently, in 2020, the Commission publicized a legislative initiative about withholding tax and refund procedures. In June of 2023, the Commission presented the proposal for a Council Directive on reducing excess withholding tax, introducing more efficient withholding tax and refund procedures and offering also Member States the necessary tools to fight tax fraud and abuse (Frescurato & Bortolameazzi, 2023). In addition, the Directive's main objective is to support the proper functioning of the Capital Markets Union by facilitating cross-border investment, according to the Proposal for a Council Directive on Faster and Safer Relief of Excess Withholding Taxes (COM/2023/324).

The aim was to change the current paradigm, since cross-border investments, whether in the form of dividends or interest, are taxed in the Member State of source, through the withholding tax technique, and are taxed again in the investor's State of residence (Van Seggern & Elsenburg, 2024, p. 34). A problem of double taxation arises, which is attempted to be resolved with the signing of Double Taxation Conventions, in which states reciprocally balance the tax benefits and costs by establishing a lower rate of withholding tax or an exemption from taxation (Vogel et al., 2006, p. 295).

Even so, these refund procedures are characterised by their length and costliness. Furthermore, the withholding tax procedures applied by the Member States also differ significantly.

In addition, the free movement of capital, combined with banking secrecy, has allowed tax evasion to flourish. Several cases of 'cum-cum' or 'cum-ex' have therefore emerged. These are sales negotiation strategies that allow investors to exploit loopholes in dividend taxes (DWT) (Casi et al., 2021).

These phenomena are not new; in fact, they date back to 1990, when the existence of a loophole in the tax treatment of capital gains derived from share dividends was first detected (Doerfer, 2022). In 2007, Germany's banking association also warned of the dangers and risks of double tax reimbursements. However, it wasn't until 2019 that the authorities and the courts began to repress these phenomena. On July 28, 2021, the German Federal Court of Justice (*Bundesgerichtshof*) confirmed that 'cum-ex' transactions should be considered as criminal act of tax evasion by the German tax authorities. Later, on April 6, 2022, the Court reiterated that 'cum-ex' transactions are illegal in Germany.

In June 2023, the European Parliament adopted the Resolution C/2024/492 in which it stressed that these two phenomena were the biggest tax fraud scandals in the history of the European Union, causing EU Member States to lose around 140 billion Euros<sup>1</sup>

These scandals, as stated by the European Parliament, have justified the need for harmonised withholding taxes procedures within the European Union to prevent tax fraud, double taxation and double non-taxation. To this end, the Directive aims to remove obstacles to cross-border investments, make withholding tax procedures more efficient and at the same time combat tax fraud and tax abuse, according to Recital 1.

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<sup>1</sup> In October 2018, a team of investigative journalists published 'the cum-ex files', revealing large-scale tax fraud schemes.

This is, therefore, the framework that makes the emergence of the ‘FASTER’ Directive urgent and necessary.

### ***The ‘cum-ex’ cases***

The term ‘cum’ refers to dividend rights being connected to shares and ‘ex’ refers to no dividend rights connected to shares (Doobay & Ruchelman, 2022).

In cases of ‘cum-ex’, dividends from a commercial company are subject to withholding tax in the company's jurisdiction. To avoid double taxation of dividends, the foreign shareholder can request a refund of the part of the tax withheld at source in the country where the company is resident, as well as requesting relief from withholding tax in their state of residence.

In practice, taxpayers who practised ‘cum-ex’ traded the same shares for a short period between the ex-date and the date of registration of the dividends, which subsequently allowed all the people who temporarily held the shares to claim reimbursement, falsely claiming to be shareholders entitled to reimbursement (Hoke, 2023).

### ***The ‘cum-cum’ cases***

While ‘cum-ex’ cases aim to obtain reimbursements of undue taxes, ‘cum-cum’ cases aim to reduce or minimize the tax burden on dividends. In fact, taxpayers, who are not entitled to a lower withholding tax rate, take part in transactions with entities eligible to benefit from a reduced withholding tax rate as if they were the owners of the security, in order to split the savings among themselves (Banham & Hodge, 2020).

## **The Directive's innovations**

### **The digital certificate of tax residence in a Member State**

The Directive establishes the rules for the digital tax residence certificate (eTRC) and requires them to be applied in all Member States. This certificate aims to bring speed, simplicity and security to the administrative process.

It is intended for this digital certificate to have an extensive scope of application, being used for withholding tax procedures, as well as for proving tax residence for tax purposes. The aim is for all taxpayers in the European Union to have access to adequate, equal and effective proof of their tax residence, according to Recital 7. These certificates must be issued within 14 days of the application being submitted, in accordance with Article 4(2). In the event of a delay, the Member States must inform the entity requesting the eTRC the reasons for the delay and the additional time required, under the terms of the Article 4(4).

In accordance with paragraph 2 of this article, certain information must be included. If it is a natural person, under paragraph 2 under the point (a), the eTRC must include name, surname, date of birth and VAT number, or an equivalent number for tax purposes. In accordance with point (b), if it is a legal person, it must contain the name, tax identification number or equivalent, and if available, the unique European identifier (EUID) or legal entity identifier (LEI) or other legal entity registration number that is valid for the entire period covered.

It must also contain the taxpayer's address, the date of issue of the certificate, the period covered (which must cover a maximum period of one year or the tax year), the tax authority issuing the eTRC, the applicable double taxation conventions, depending on the taxpayer's residence, and, finally, any other additional information required to prove the taxpayer's tax residence.

We defend that the information on the eTRC should be available in different languages to ensure efficiency in reimbursements.

Through the residence certificate, taxpayers will be able to submit their withholding tax refund requests digitally, during the calendar year in which the request is granted, bringing greater speed and simplicity to the refund processes, and making it possible to prevent the double taxation of income, in clear contrast to the paper-based procedures, which required the submission of physical documents and physical interaction (European Parliament, 2024, p. 4).

It will therefore be a harmonised digital residence certificate, recognised throughout the whole EU territory. To this end, the European Commission will establish computerised forms for issuing the certificates, including the language regime, security standards and technical protocols, in accordance with Article 4(8) of the Directive.

### **Obligation to register on the European Portal of Certified Financial Intermediaries**

It is in Chapter III, Section 1 that the Directive regulates the obligation to register certified financial intermediaries. This obligation to create a national register only applies to Member States that grant relief from excess withholding tax on dividend or interest income to residents of another Member State, under the terms of Articles 5(1) and 5(2).

Under the terms of Article 5(3), Member States are also obliged to designate a competent body to maintain and update this national register.

It should be noted that checking the national register is extremely important, since once registered, certified financial intermediaries are bound to fulfil certain obligations, such as communicating information on dividend or interest payments for which they are responsible. This information will be used to reconstitute the payment chain, preventing the risk of tax fraud or abusive tax practices, which are magnified by the 'cum-cum' and 'cum-ex' phenomena.

To this extent, and in accordance with Article 7, Member States must require national registration for all large financial institutions that process dividend or interest payments on securities,

as well as for central securities depositories that are responsible for withholding tax on such payments. These applications must be submitted through the European Portal of Certified Financial Intermediaries and must be approved within three months by the Member State following their submission.

The registers will therefore be available on the European Portal of Certified Financial Intermediaries, which the Commission will develop using its own resources or those of a third party, according to Article 6.

It is important to note that, for the purposes of the Directive, a financial intermediary refers to an entity that is part of the securities payment chain between the issuer and the registered owner who receives payment for the securities. This entity can take on the guise of a central securities depository, as provided for in Article 2(1) of Regulation 909/2014 of the European Parliament and of the Council, a credit institution, in accordance with Article 4(1) of Regulation 575/2013, an investment firm, a branch of the entities under points (a), (b) or (c) or a legal person from a third country that is authorised to provide services similar to those of the aforementioned entities. Once the financial intermediary has been nationally registered, it becomes a certified financial intermediary.

According to Article 8, financial intermediaries must fulfil certain requirements, such as: being a tax resident in a Member State or in the jurisdiction of a third country, as mentioned in point (a) of the Regulation; having an authorisation from the competent authority carrying out a custody activity in relation to financial intermediaries or in relation to a central securities depository; and having a declaration of compliance with the provisions of Directive 2015/849 or with the comparable rules of the third country jurisdiction not included in Annex I of the Council Conclusions (C/2024/6322) on the Revised EU List of Non-Cooperative Jurisdictions for Tax Purposes or in Table I of the Annex to Regulation 2016/1675.

The national register should include information such as the name of the certified financial intermediary, the date of registration, the contact details and any existing websites of the intermediary, the EUID or LEI, or any legal entity registration number issued by the State of residence.

The Member States may reject the request for registration. The refusal of the registration request can be based alternatively on the commission of one or more offences or violations of the national rules of the Member State or other jurisdiction, should they result in a loss of withholding tax revenue, or if an investigation is opened into possible tax fraud or abusive tax practices by a Member State or other jurisdiction that could result in a loss of withholding tax revenue.

Nonetheless, another application for registration can be submitted if the circumstances that caused the rejection have been remedied, in accordance with Article 8(6) of the Directive.

Finally, a financial intermediary's national registration can be withdrawn if it requests its withdrawal, or if it no longer fulfils the requirements set out in Article 8. However, Article 9(2) elaborates on the grounds for withdrawing the registration. Without prejudice, paragraph 4 allows the financial intermediary to be re-registered if the circumstances are corrected.

## **Reporting obligations for certified financial intermediaries**

In the traditional procedures, the reporting obligations are assigned to the withholding agents who interact with the final beneficiaries of the income and the entire chain of intermediaries is not required to submit additional declarations to the tax authorities, neither the authorities of the other EU Member States. The Directive aims to create a system of trusted intermediaries, who are obliged to communicate information relating to the part of the transaction that is individually visible to each one, which will allow the recipients of the full communication - the tax authority or the withholding agent – to scrutinise the entire chain of transactions.

Certified financial intermediaries will have to fulfil various obligations, including reporting information on income, which can be direct or indirect.

The communication is said to be direct when the certified financial intermediaries communicate the information directly to the competent authority of the source Member State. On the other hand, it is indirect when the certified financial intermediaries communicate the information along the chain of payment of the securities and in a sequential manner. This information then reaches the withholding agent or a specific certified financial intermediary who communicates the information to the competent authority of the source Member State.

To this end, they must communicate the investments made by their clients, the holding period of the securities and the financial agreements on the securities under which a tax reduction is claimed. The purpose of communicating information on the holding period is to find out whether the securities were acquired within two days of the ex-dividend date to avoid new abusive schemes known as cum-ex. Regarding financial agreements, the main purpose is to obtain information on financial agreements with securities that have not been settled or have expired, as a way to detect the cum-cum phenomenon.

Article 10 of the Directive establishes the obligation to communicate information. This communication must be made by the end of the second month following the month of the payment date.

According to Article 10(7), the documentation that corroborates the information communicated must be kept by the certified financial intermediaries with national registration for a period of ten years after reporting.

### ***Relief systems***

Directive 2025/50 regulates two accelerated procedures that are intended to be a complement to the normal procedure for refunding of withholding tax. The goal is to harmonise these procedures within the European Union and to speed them up. The system of relief at source is provided for in Article 13 and the accelerated refund system is regulated by Article 14, which can be adopted cumulatively by a Member State.

Article 11 states that applications must be made by certified financial intermediaries who are responsible for maintaining the source of investment of a registered owner who has received dividends or interest paid by a resident of the source Member State.

Nonetheless, they must fulfil certain cumulative conditions set out in points (a) and (b) of the Article 11(1). Firstly, the registered owner must have authorised the financial intermediary to claim the relief on his/her behalf. Secondly, the certified financial intermediary has verified and confirmed the registered owner's eligibility for the relief.

### ***Relief-at-source system***

Article 13 of the Directive allows Member States to set up this system, authorising certified financial intermediaries responsible for maintaining the investment account to apply for relief from withholding tax on behalf of a registered owner. To this end, they must provide the withholding agent with a set of information on the tax residence of the registered owner, or the information contained in the documentation deemed appropriate by the source Member State, in accordance with Article 12(2), under the point (b), and, finally, the withholding tax rate applicable to the payment, in accordance with national rules or double taxation treaties.

For this system to be applied, the registered owner must also be the person entitled to relief from withholding tax under the national rules of the source Member State or under the rules of a double taxation treaty.

However, it may happen that the registered owner and the person entitled to relief do not coincide, the provisions on indirect investments should apply instead.

### ***Quick refund system***

The quick refund system, as set out in Article 14 of the Directive, concerns a system that authorises certified financial intermediaries responsible for maintaining the investment account of a registered owner to request accelerated repayment of excess withholding tax on behalf of the registered owner.

To this end, certified financial intermediaries must provide the information set out in paragraph 3 of the same regulation, namely: identification of the registered owner, identification of the dividend or interest payment, the applicable withholding tax rate, the total amount of excess withholding tax to be refunded, the tax residence of the registered owner, the eTRC verification code, or the information from the documentation pursuant to Article 12(2), under the point (b) and the declaration of the registered owner pursuant to Article 12.

According to Article 14(2), Member States must process refund claims within 60 days of the expiry of the deadline for applying for an accelerated refund. In the event of late repayment of excess withholding taxes on dividends or interest, interest may be charged on the refund for each day of delay,

if provided for in national law. The implementation of default interest is a penalty to motivate Member States to process procedures more quickly (Van Seggern & Elsenburg, 2024, p. 37).

### ***Grounds for refusal***

Member States can refuse a refund request if they consider there is a risk of tax fraud or abusive tax practices. There may therefore grant a refusal when the request does not fulfil the requirements of Article 14(4), Article 11 and Article 12; when it is not possible to reconstitute the payment chain, or when the Member State decides to initiate a tax verification or audit procedure in a case identified as likely to represent a risk of tax fraud or abusive tax practices.

### ***Standard refund system***

Under Article 17 of the Directive, Member States must ensure that there is a normal system for reimbursing requests for relief when the procedures of Articles 13 and 14 do not apply because the conditions for their application have not been met. This system is an alternative to the procedures enshrined in the Directive (Radcliffe & Devisscher, 2023, p. 326).

### **The liability of certified financial intermediaries in the event of total or partial non-compliance with the main obligations of the Directive**

The 'FASTER' Directive establishes the personal liability of certified financial intermediaries for improper tax relief, with the possibility of withdrawing their national registration and imposing penalties.

Regarding the possibility of imposing sanctions, under the terms of Article 19, the Directive does not regulate the establishment of sanctions for total or partial non-compliance and leaves this task up to the Member States.

The establishment of sanctions is intended to serve as a prevention for non-compliance with the obligations set out in the Directive. However, it should be noted that these sanctions must be effective and proportional.

It is essential that there are national rules that impose certain sanctions in the event of non-compliance by certified financial intermediaries, since they play an important role in communicating the information that will serve as the basis for relief from withholding tax or for a refund, and in the event of total or partial non-compliance with this obligation, the total or partial loss of withholding tax revenue is possible.

These national rules should regulate the liability of certified financial intermediaries, including those agents who do not act as certified financial intermediaries, as well as registered owners and investors who submit incomplete and inaccurate information to certified financial intermediaries.

## **Obligation to transpose the Directive**

Article 25 of the Directive stipulates that it must be transposed into the national legal order of the Member States by December 31, 2028, with the provisions applying from January 1, 2030.

It is understandable that this three-year deadline was set to give Member States the needed period to transpose the measures correctly and adequately. However, it is urgent that these measures enter into force in legal systems, as this is a powerful and harmonised weapon to combat tax fraud and abusive tax practices and to fully implement the free movement of capital in the EU.

### **The ECJ and the fight against tax abuse to guarantee the free movement of capital**

The ECJ has played an important role in the field of European tax law, in clarifying the concept of tax abuse (Feria, 2008, p. 214), which the Court calls a ‘wholly artificial arrangement’ (Vanistendael, 2006, p. 194). The legitimacy of its intervention derives precisely from the fact that a national law may restrict a fundamental freedom by giving a discriminatory treatment (Saldanha Sanches, 2006, p. 266). To this extent, the ECJ has been analysing the compatibility of national tax provisions of the Member States with European Union law (Nicoleta Ionescu, 2012, p. 317), even though it recognises the tax competence of the Member States in matters of direct taxation (Case C-374/04, C-379/05, C-540/07, C-487/08, C-284/09).

The Court has therefore made several contributions to the fundamental principle of the free movement of capital enshrined in Article 63 of the TFEU. Cases such as C-387/11 and C-312/22 stand out, where the Court reiterates the prohibition of discrimination against taxpayers, whether they are residents or non-residents of a Member State.

In case C-387/11, the Court considered that Belgian tax legislation gave unfavourable tax treatment to income from capital and securities received by non-resident investment companies that did not have a permanent establishment in Belgium compared to income received by resident companies or with a permanent establishment in Belgium. In fact, Belgian legislation established a tax exemption for income from capital and securities only for companies established in Belgium. It was therefore considered that there was discriminatory treatment, in breach of the obligations arising from Article 49 of the TFEU.

More recently, in case C-312/22, the question was whether the Article 22, 71 and 101 of the Portuguese Income Tax Code were compatible with Article 56 of the TFEU. It turned out that the national legislation in question subjected interest income from bonds and debt securities issued in Portugal, which were paid in that Member State and which were earned by a natural person resident in Portugal, to a rate of 20%. On the other hand, when this income derived from another Member State or from a third country, it was included with the individual's income from other categories and it was applicable a progressive tax rate of up to 40 per cent. There was a distinction between taxpayers depending on where they were resident or the Member State where they invested their capital.

In conclusion, in exercising their tax sovereignty, Member States must follow European Union law, ensuring that their national tax rules are compatible with it. However, the Court recognises that a rule restricting fundamental freedoms may exist, but for it to be considered valid, there must be overriding reasons in the general interest, it must be appropriate to guarantee the achievement of the objective it pursues and it must not go beyond what is necessary.

### **Conclusions**

This European Commission's legislative initiative comes in to enhance the free movement of capital in the EU, but faced with countless cases of fraud and abuse and the risk of their perpetuation and with tax administrations facing a significant loss of public revenue, we believe that this initiative is the best way to solve the problems mentioned above, while also resolving the issues of double taxation and excessively complicated and costly procedures. The Directive allows the harmonisation of specific procedure legislation and a concerted fight against fraud and abuse that would not be achieved through the individual initiatives of each Member State.

It seems to us that this Directive will benefit investors residing in the European Union, with diversified portfolios, encouraging cross-border investment in the EU and benefiting therefore the single market.

To this end, the Directive imposes relevant and important measures, including the introduction of an electronic tax residency certificate, the obligation for financial intermediaries to register on the European Portal of Certified Financial Intermediaries and the obligation for them to report transactions that are individually visible to each one, allowing the entire transmission chain to be reconstructed. It seems to us that these measures will successfully achieve the objectives in question.

Finally, we also believe that establishing sanctions for possible non-compliance with the obligations imposed in the Directive is necessary to ensure that non-compliant behaviour is discouraged. It is also understandable that the provision of sanctions should be left to the Member States, adjusting measures to better fit each State's national reality, with the only limit being that those sanctions should be effective, reasonable and proportional.

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## NEUROBIOLOGIA A PARADYGMAT FINANSÓW NA PRZEŁOMIE XX I XXI WIEKU

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### NEUROBIOLOGY AND THE FINANCIAL PARADIGM AT THE TURN OF THE 21ST CENTURY

#### ABSTRACT

**The purpose of the article.** The paper aimed to investigate how the brain functions established through the process of evolution influences decisions regarding the activities of entities on the financial market and how this affects changes in the behavior of these entities on the market. Additionally, it aimed to understand the definitions of basic concepts and thus contribute to changing the financial paradigm.

**Methodology.** The research uses a method based on a review of literature from fields dealing with the issues raised in the topic, such as behavioral economics, finance, and neurobiology.

**Results of the research.** It was pointed out that the turn of the 20th and 21st centuries was a period of intensification of phenomena that fostered the emergence of anomalies, thus signaling symptoms of chaos in the financial world. Phenomena such as the information and digital revolution, increasing financialization, and chrematistics were identified, which are, among other things, the result of the implementation of the growth dogma, obligatory for homo oeconomicus for thousands of years. The fact of the progressive departure from ethical and moral values in all types of activities was emphasized. In these conditions, the decisions/actions of entities operating on the financial market cause changes in the understanding of basic concepts to be observed and, consequently, tendencies to change the definitions of these concepts, leading to a departure from the current financial paradigm.

**Keywords:** Financial Market, Neurobiology, Growth Dogma.

**JEL Class:** A20, E44, G15.

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## Wstęp

System gospodarczy w trzeciej dekadzie XXI wieku znajduje się w fazie rozwoju określanej jako gospodarka postindustrialna. Procesy globalizacji, wspierane osiągnięciami nauki i techniki, w istotny sposób wpływają na rozwój społeczno-gospodarczy, a tempo i dynamika zmian zmuszają do sięgania po nowe osiągnięcia wiedzy w celu doskonalenia stosowanych rozwiązań technicznych i organizacyjnych, tworzenia warunków administracyjno-prawnych i instytucjonalnych sprzyjających wdrażaniu innowacji, będących m.in. efektem rewolucji informacyjnej i cyfrowej oraz rozwoju nauki i przedsiębiorczości. Jednocześnie obserwujemy nasilenie zjawisk, które wyraźnie sygnalizują, iż w świecie finansów można zaobserwować objawy chaosu zwłaszcza, że ciągle dominuje model wolnorynkowej gospodarki neoliberalnej, w której tzw. fundamentalizm rynkowy (wiara w nieomyślność i niezawodność wolnego rynku) jest podstawą wszelkiej działalności i niejako programowo małą uwagę zwraca się na kwestie społeczne i etyczno-moralne, co ma istotny wpływ na funkcjonowanie sektora finansowego. Wypada ten fakt podkreślić ze względu na niepokojące, choć stanowiące przez długi okres temat tabu, negatywne zjawiska nasilenia hazardu moralnego oraz coraz bardziej wyrafinowanych oszustw, dla których wspomniany okres przełomu wieków XX i XXI oraz pierwsze dekady XXI wieku okazał się okresem wyjątkowo owocnych żniw (Akerlof i Shiller, 2017). Jednocześnie na rynku pracy opanowanym przez pokolenie BB (Baby boomers), pokolenie X tzw. cyfrowych imigrantów, mamy już pokolenie Y tzw. cyfrowych tubylców oraz wkracza pokolenie Z tzw. cyfrowych nomadów<sup>1</sup>. W określaniu kolejnych pokoleń specjalnie podkreśla się ich stosunek do informatyzacji oraz narzędzi i technik cyfrowego przetwarzania danych.

Na ile efekt synergii związany z wymianą pokoleń oraz postępem nauki i techniki wpływa na wysoką dynamikę zmian, a zarazem przyczynił się do głębokości tych zmian? Czy zmiany związane z szerokim wykorzystaniem cyfrowych technik przetwarzania danych w takich obszarach, jak działalność informacyjna, edukacyjna, polityczna, gospodarcza i techniczna oraz ekologiczna można określić mianem zmian o charakterze rewolucyjnym mając na uwadze ich wpływ na zachowania podmiotów, definicje pojęć, a tym samym zmiany paradygmatów? Rozwinięta działalność naukowa, która szeroko wykorzystywała narzędzia cyfrowej techniki przetwarzania danych oraz techniki informatyczne w procedurach badawczych stanowiła fundament tych zmian. Decyzje podejmowane we wspomnianych obszarach działalności w zglobalizowanym świecie rzutują w sposób istotny na rozumienie i pojmowanie takich pojęć, jak ryzyko i niepewność nieodłącznie związanych z działaniem i podejmowaniem decyzji. Dotyczy to decyzji/działań związanych z funkcjonowaniem i zachowaniem zbiorowości (społeczeństw, wspólnot, narodów) oraz jednostek w dynamicznie zmieniającym się zglobalizowanym świecie, zarówno jeśli chodzi o sferę społeczno-polityczną i gospodarczą, jak i etyczną oraz moralną. Szczególnie odnosimy te uwagi do ostatnich dwóch dekad XXI wieku kiedy to

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<sup>1</sup> BB (baby boomers) – urodzeni w latach 1946–1964; pokolenie X – urodzeni w latach 1965–1980; pokolenie Y – urodzeni w latach 1981–1996; pokolenie Z – urodzeni w latach 1997–2012.

mamy do czynienia zarówno z rewolucyjnymi zmianami będącymi wynikiem aplikacji osiągnięć nauki do praktyki, jak i ekstremalnymi zjawiskami społeczno-gospodarczymi, politycznymi, przyrodniczymi takimi, jak kryzysy i chaos na rynku finansowym, migracje ludności, epidemie i pandemie, konflikty zbrojne (wojny), czy też coraz bardziej realnie zagrażająca planecie katastrofa ekologiczna. Problemy związane z tymi zjawiskami wpisują się w procedurę, którą zwykło się określać jako *Risk Management* tzn. zarządzanie w warunkach ryzyka. Analizując przyczyny i skutki rewolucyjnych zmian przełomu XX i XXI wieku, należy zwrócić uwagę na uwarunkowania i motywy postępowania człowieka wprowadzającego i korzystającego z tych zmian zarówno od strony praktycznej, jak i moralnej oraz etycznej. Czy przy ich wprowadzaniu i wykorzystywaniu dominuje krytyczny pragmatyzm tzn. czy dominuje świadomość i umiar, czy też bierze górę chęć dominacji, uczucie satysfakcji oraz bieżące zaspakajanie wciąż rosnących, nie zawsze uzasadnionych potrzeb, bez szerszej refleksji dotyczącej konsekwencji jakie niosą te zmiany dla życia przyszłych pokoleń gatunku homo sapiens na planecie Ziemia? W efekcie podejmowanych decyzji/działań człowiek uruchamia proces ryzyka – wkracza w obszary ryzyka. Czy ma tego świadomość i zdaje sobie sprawę z konsekwencji jakie niesie ze sobą uruchomienie tego procesu tzn. wejście w fazę realizacji ryzyka oraz skutków tej realizacji, dotyczy to całego spektrum działań człowieka, a zwłaszcza tych działań, które skutkują ryzykiem z winy człowieka w tym m.in. ryzyka antropogenicznego?

Poszukując merytorycznych rozwiązań tego typu problemów realizujemy cel jakim jest próba wskazania możliwych strategii (kierunków i obszarów działania) na każdym etapie procedury *Risk Management*, przede wszystkim na etapie identyfikacji oraz kontroli ryzyka, mając na uwadze specyfikę trzeciej dekady XXI wieku (okres rewolucji cyfrowej, informacyjnej, biotechnologicznej, oraz zagrożenia katastrofą ekologiczną). Sięgamy przy tym po osiągnięcia różnych dziedzin wiedzy, bowiem zagadnienie okazuje się na tyle złożone i skomplikowane, że wymaga szerokiego spektrum narzędzi będących wynikiem osiągnięć różnych dyscyplin naukowych. Przełom wieku XX i XXI charakteryzuje się poszerzeniem horyzontu badawczego procedury *Risk Management* dzięki wykorzystaniu osiągnięć różnych dziedzin wiedzy. Problemy jakie pojawiły się, okazały się na tyle złożone i skomplikowane, że wymagały szerokiego spektrum narzędzi będących wynikiem osiągnięć różnych dyscyplin naukowych. Ciekawe wnioski jesteśmy w stanie formułować w oparciu o wyniki badań prowadzonych na przełomie XX i XXI wieku przez neurobiologów w wielu znanych ośrodkach naukowych. Podejście deterministyczne ekonomii klasycznej wsparte osiągnięciami ekonomii behawioralnej oraz wynikami badań neurobiologów z przełomu XX i XXI wieku znakomicie poszerzają horyzonty badawcze, a tym samym możliwości zrozumienia i wyjaśniania zjawisk oraz rozwiązywania pojawiających się problemów. Zwracamy uwagę na badania neurobiologów w aspekcie teorii ewolucji oraz utrwalonej przez wieki zasady działania gatunku homo sapiens jaką jest dogmat wzrostu. Jednym z celów pracy jest wskazanie, na podstawie wyników badań neurobiologów, w jaki sposób utrwalone w procesie ewolucji funkcje mózgu wpływają na decyzje dotyczące działalności podmiotów na rynku finansowym oraz jaki ma to wpływ na zachowania podmiotów na tym rynku, jednocześnie na

rozumienie definicji podstawowych pojęć, a tym samym na zmianę paradygmatu finansów. W Tabeli 1 wymieniono te ośrodki, autorów i tematykę badań neurobiologów, które przyczyniły się do szerszego spojrzenia na rozumienie pojęć ryzyko i niepewność – nieodłącznych elementów wszelkiej działalności człowieka, a tym samym zachowania człowieka w skomplikowanym świecie finansów w trzeciej dekadzie XXI wieku.

**Tabela 1**

*Ośrodki, autorzy oraz tematy badań neurobiologów*

| Ośrodek                           | Autorzy                                    | Tematyka badań                                                                                 |
|-----------------------------------|--------------------------------------------|------------------------------------------------------------------------------------------------|
| Uniwersytet Mc Gilla<br>Montreal  | Olds i Milner<br>(1954)                    | Układ nagrody                                                                                  |
| Uniwersytet Colombia<br>Nowy York | Schneider i in.<br>(2007)                  | Skorelowanie rangi społecznej danej osoby<br>z ilością receptorów dopaminergicznych<br>w mózgu |
| Uniwersytet<br>Oxford             | Croxson i in.<br>(2011)                    | Aktywność neuronów po zbilansowaniu strat<br>w stosunku do zysków                              |
| Uniwersytet<br>Stanforda          | Mischel i in.<br>(1989),<br>Mischel (1973) | Zjawisko dewaluacji odroczonej<br>gratyfikacji                                                 |
| Uniwersytet<br>Princeton          | McClure i in.<br>(2004)                    | Świadomość a prądkowie, układ nagrody,<br>odroczone gratyfikacja                               |
| New York University               | Kandel (2020)                              | Psychiatria – co mózgi mówią o nas<br>samych                                                   |

Źródło: opracowanie własne.

W artykule odwoływano się do wspomnianych wyników mając na uwadze interpretację i praktyczne aplikacje tych wyników w naukach ekonomicznych, a zwłaszcza w odniesieniu do popularyzowanej w ostatnich dziesięcioleciach XXI wieku idei zrównoważonego rozwoju gospodarczego, przy znanych wynikach badań neurobiologów dotyczących teorii ewolucji oraz dogmatu wzrostu.

### Neurobiologia a nauki ekonomiczne

Osiągnięcia mówiące o rewolucyjnych zmianach oraz możliwe scenariusze praktycznego ich wykorzystania są efektem rozwoju niezwyklego narządu jakim jest mózg człowieka: „*najbardziej niewiarygodny cud techniki jaki kiedykolwiek powstał, udoskonalał się przez tysiące lat za pomocą starannie dobranej zestawu genów, umożliwiającego znalezienie odpowiedzi na coraz to nowe wyzwania środowiskowe*” (Bohler, 2020, s. 31;40).

Interpretując zachowania podmiotów funkcjonujących w świecie realnym, gdzie decyduje człowiek, a nie maszyna, za mało uwagi poświęcamy wynikom badań dotyczącym ewolucji i zasadom funkcjonowania mózgu prowadzonym przez neurobiologów na przełomie wieków XX i XXI. Podkreślić należy, że inteligentne maszyny, w tym AI, są konstruowane i programowane przez człowieka, który przez tysiące lat wykorzystywał mózg konstruując narzędzia, maszyny i urządzenia mając na uwadze najprościej rozumianą optymalizację (maksimum szeroko pojętego efektu przy minimalizacji nakładu). Warto pochylić się nad wnioskami płynącymi z badań neurobiologów, pamiętając o definicji Bohlera (2020), mając na uwadze tak ważny obszar działalności jakim jest teoria ryzyka w odniesieniu do gospodarki w powszechnie panującym modelu globalnej gospodarki rynkowej. Pamiętamy jednocześnie, że mózg to złożona konstrukcja w której na procesy decyzyjne istotny wpływ mają m.in. takie elementy, jak prążkowie (regulator i główny motywator działań) oraz kora mózgowa (odpowiedzialna m.in. za rozumowanie, zdolność mówienia, planowania i organizacji, jak również abstrakcyjne myślenie oraz pamięć).

**Prążkowie** to część mózgu, która odpowiada za motywowanie do działania. Wchodzi w skład tzw. układu nagrody, decyduje o sposobie użycia kory mózgowej i innych elementów mózgu oraz o realizację priorytetowych celów (tzw. pięciu podstawowych wzmocnień pierwotnych (Bohler, 2020)):

1. Znaleźć pożywienie.
2. Znaleźć partnerów seksualnych.
3. Podnieść pozycję społeczną.
4. Poszerzyć terytorium i zdobyć informacje zwiększające szanse przeżycia.
5. Realizować powyższe cele przy najmniejszym wydatku energii.

Neurony prążkowie obdzielają dopaminą – enzymem będącym jednocześnie bodźcem i nagrodą za działanie<sup>2</sup> oraz przekaźnikiem przyjemności, wywołującym m.in. uczucie satysfakcji z działania, samozadowolenie itp. w odpowiedzi na osiągnięcie celu. Jak wykazują badania, w aspekcie tzw. „metod ujarzmiania prążkowie”, neurony prążkowie odgrywają również istotną rolę w procesie uczenia.

Dopamina wyzwala uczucie przyjemności i wzmacnia motywację do działań, które przyczyniają się do realizacji priorytetowych celów prążkowie.

Każdy z wymienionych celów prążkowie wiąże się z decyzją, działaniem, tzn. realizacją tych celów wymaga narzędzi, opracowania strategii oraz planu działania. Realizacja celów prążkowie jest równoznaczna z wejściem w obszar ryzyka. Piąte podstawowe wzmocnienie pierwotne stanowiące wytyczną działania prążkowie, przy realizacji pozostałych wzmocnień, spełnia postulat programu optymalizacji – maksimum efektu przy minimalnym nakładzie środków. Analizując historię rozwoju gatunku homo sapiens można zauważyć, że prążkowie na przestrzeni tysięcy lat okazuje się konsekwentnym i skutecznym realizatorem programów optymalizacyjnych nie zważając na kryteria etyczne i moralne. Realizuje te programy poczynając od czasów eliminacji neandertalczyka oraz innych

<sup>2</sup> Funkcjonowanie dopaminy sprowadza się do koniunkcji dwóch istotnych dla decyzji/działania elementów: bodziec i nagroda.

gatunków człekopodobnych, przez okres przejścia homo sapiens od zbieractwa i łowiectwa do wspólnot agrarnych, aż do czasów gospodarki rolnej i rzemiosła, po czasy współczesne, tzn. przejścia przez rewolucję przemysłową do wspomnianych rewolucji biotechnologicznej oraz technologii informatycznej i cyfrowej. Jeśli chodzi o programy optymalizacyjne, metody i dobór środków – tu pojawia się drugi istotny z punktu widzenia naszych rozważań element mózgu jakim jest kora mózgowa.

**Kora mózgowa** to zewnętrzna struktura mózgu charakteryzująca się budową warstwową (6 warstw). Jest to najważniejsza część składowa mózgu zaangażowana w odbiór i przetwarzanie informacji zmysłowych, planowanie i wykonywanie ruchów, procesy poznawcze oraz procesy związane z emocjami i motywacją. Kora mózgowa jest swego rodzaju narzędziem, które pozwala na wypracowanie coraz bardziej złożonych strategii, działań indywidualnych oraz koordynację współdziałania w grupach liczących wiele podmiotów. Jak wykazuje teoria ewolucji obserwowany rozwój kory mózgowej przyczyniał się do tego, że człowiek tworzył i tworzy coraz bardziej zaawansowane technologie, które wykorzystuje w realizowanych projektach. Jednocześnie należy podkreślić, że kora mózgowa jest to narzędzie, o którego użyciu decyduje prądkowie zaprogramowane na motywowanie do działania maksymalizującego zaspakajanie celów priorytetowych prądkowia. Są to działania dążące do tego, aby ich realizację przynosiły większe korzyści od już zapamiętanych, zaś związany z prądkowiem tzw. układ nagrody sprawiał, że odczuwamy przyjemność (satisfakcję), gdy uzyskamy rezultat lepszy od przewidywanego (Bohler, 2020, s. 146–152). Szczególne skonfigurowanie mózgu człowieka (dominacja prądkowia nad korą mózgową) sprawia, że nawet wtedy, gdy potrzeby są zaspokojone wciąż otrzymujemy bodźce by żądać więcej. Krótko mówiąc prądkowie zagarnia wszystko i nakłania do tego aby zdobywać (osiągać) „więcej” wykorzystując do tego możliwości jakie stwarza kora mózgowa. Efekt obserwujemy do dnia dzisiejszego – podstawowym dogmatem działalności homo sapiens od czasów prehistorycznych stał się wzrost, w którym funkcja celu prądkowia (zaspakajanie celów priorytetowych) jest optymalizowana przy wykorzystaniu coraz bardziej skomplikowanych i zaawansowanych technologii tworzonych i wprowadzanych dzięki pracy kory mózgowej. Stało się to siłą napędową ewolucji kory mózgowej, a jednocześnie gatunku homo sapiens. Generalną zasadą rządzącą połączeniami neuronalnymi w mózgu człowieka jest zasada „*kora proponuje, prądkowie decyduje*” (Bohler, 2020, s. 185–187).

### **Dogmat wzrostu**

Omawiając funkcjonowanie wyróżnionych elementów struktury mózgu otrzymujemy wyjaśnienie istoty ewolucyjnie utrwalonej i obowiązującej od tysięcy lat w działalności człowieka niezależnie od epoki, przyjmowanych narracji i modelu działalności gospodarczej zasady rzutującej na działalność człowieka, którą jest dogmat wzrostu. Dogmat ten doprowadził w trzeciej dekadzie XXI wieku zglobalizowaną gospodarkę rynkową na skraj katastrofy ekologicznej, m.in. w wyniku skutków realizacji ryzyka z różnych obszarów działalności związanych z bezrefleksyjną realizacją tego dogmatu.

Człowiek od tysięcy lat wykorzystując w swojej działalności mózg oraz wszelkie dostępne dobra planety Ziemia poddawał się dyktatowi prądkowia, działając zgodnie z dogmatem wzrostu. Działania te będące efektem reakcji prądkowia na warunki i bodźce otoczenia stanowiły swoiste potwierdzenie praw ekonomii behawioralnej. Wspomniane kolejne etapy rozwoju tzn. przejście od zbieractwa, łowiectwa do wspólnot agrarnych, rozwój rolnictwa, rzemiosła i usług, rewolucję przemysłową aż po rewolucję biotechnologiczną, informatyczną i cyfrową przełomu wieków XX i XXI, opierały się na dogmacie wzrostu. Oznaczało to, że mimo dostrzegalnych, wielkich osiągnięć, niezaspokojone prądkowie żądało więcej odwołując się do wzmocnień pierwotnych zwłaszcza tych, które dotyczyły warunków życia, a w szczególności dóbr materialnych (era konsumpcjonizmu). Dzięki pracy kory mózgowej powstawały narzędzia, udoskonalano metody oraz narracje, które umożliwiały realizację tego żądania. Ten proces opisujący relacje prądkowie – kora mózgowa to w wielkim skrócie opis procesu ewolucji mózgu homo sapiens od strony dogmatu wzrostu.

Przełom XX i XXI wieku to okres kiedy zaczynają pojawiać się sygnały płynące z obszarów świadomości szukające sposobów tzw. „ujarzmiania prądkowia”, a w konsekwencji refleksji dotyczącej ryzyka kontynuacji dogmatu wzrostu w gospodarce globalnej, mając na uwadze potrzeby i rozwój ludzkości oraz przyszłość planety. Pojawiają się pytania dotyczące *stricte* dogmatu wzrostu tzn. działalności społeczno-gospodarczej odwołujące się do tego dogmatu od strony neurobiologii (roli składowych mózgu w tej działalności). Postulat zrównoważonego rozwoju zakładający iż: *„potrzeby obecnego pokolenia mogą być zaspokojone bez umniejszania szans przyszłych pokoleń na ich zaspokojenie”* (Raport Brundtland, 1987) wydaje się być dość czytelny jeśli chodzi o intencje, gorzej jeśli chodzi o działanie tzn. wypełnienie go treścią. Szczególnie, gdy mamy na uwadze fakt koincydencji zachłanności prądkowia z dogmatem wzrostu. Świadczą o tym zjawiska charakteryzujące od lat zachowania i funkcjonowanie sfery realnej gospodarki. Charakterystyczne dla tej sfery jest lekceważenie sygnałów wysyłanych przez planetę (wzrost częstotliwości zjawisk ekstremalnych związanych ze zmianami klimatycznymi będącymi konsekwencją działalności gospodarczej) oraz brak odpowiedniej reakcji na zjawiska anomalii w finansach (globalizacja, chrematystyka na rynkach finansowych przy nasilającym się zjawisku hazardu moralnego oraz pogłębiającym się zróżnicowaniu majątkowym i dochodowym podmiotów). Z należytą powagą, nie są traktowane towarzyszące działalności gospodarczej, niepokojące zjawiska społeczne (ksenofobia, migracje ludności, starzenie się społeczeństw). Wydaje się, że sfera realna robi to z pełną świadomością, bowiem głównymi wskaźnikami wykorzystywanymi w procesie oceny jakości funkcjonowania podmiotów sfery realnej są wskaźniki obrazujące rozwój mierzony wzrostem (zysk, PKB, bogactwo, itp.). Do tego typu wskaźników odwołujemy się w raportach, ocenach i analizach, pomijając wskaźniki efektywności, a zwłaszcza wskaźniki wskazujące na negatywne konsekwencje, tak ocenianego, rozwoju np. emisja gazów cieplarnianych, zanieczyszczenie środowiska naturalnego, zróżnicowanie majątkowe i dochodowe itp. Jak ujarzmić prądkowie, a tym samym osłabić dogmat wzrostu i ratować planetę dla przyszłych pokoleń? Jak pogodzić postulat zrównoważonego rozwoju, stojący niejako w opozycji do motywacji

prądkowia, jeśli spojrzeć na ten problem przez pryzmat wartości etycznych i moralnych, mając na uwadze zarówno wspomniane patologie sfery finansowej, jak i widmo katastrofy ekologicznej?

### Paradygmat finansów

W globalnej gospodarce rynkowej kolejnych dekad XXI wieku postawione pytania stają się coraz bardziej aktualne, a odpowiedzi na te pytania niezbędne, z uwagi na decyzje/działania człowieka. Dowodem na powagę sprawy jest sytuacja jaką obserwujemy obecnie w różnych obszarach działalności gospodarczej, gdzie podejmowane są kontrowersyjne decyzje/działania na granicy prawa, które często nie przystają do powszechnie przyjętych norm etycznych. Parafrazując stwierdzenie Thomasa Huxleya, Davida Hume, Thomasa Paine, głoszących iż: „*Mamy moralny obowiązek odróżniania sensu od non-sensu*” (Pigliucci, 2019, s. 7–12), tego typu działania są działaniami wbrew temu moralnemu obowiązkowi. Niestety przełom XX i XXI wieku oraz kolejne dekady XXI wieku charakteryzują się tym, iż człowiek (motywowany działaniem m.in. prądkowia) podejmuje i to dość chętnie decyzje/działania odbiegające od przyjętych norm prawnych i etycznych, mając na uwadze dogmat wzrostu. Tym samym otwiera tzw. nowe obszary ryzyka i stwarza zagrożenia zarówno dla tych, którzy funkcjonują wraz z nim w danej zbiorowości, jak i dla przyszłych pokoleń. W przypadku decyzji dotyczących środowiska naturalnego powinniśmy zdawać sobie sprawę, że stwarzając zagrożenie dla środowiska naturalnego przyczyniamy się do zmian klimatycznych, których konsekwencje ponosić będą przyszłe pokolenia. Nasze pokolenie<sup>3</sup> jest tylko czasowym gospodarzem, a zarazem lokatorem planety Ziemia. Musimy pamiętać, że: „*wynajmujemy dom od naszych dzieci i wnuków*”, a nasze dzieci i wnuki nie wybaczą nam zniszczenia planety oraz tego, że byliśmy wraz ze swoimi dziadkami i rodzicami współsprawcami zagrożenia wyginięcia gatunku homo sapiens na planecie Ziemia (Michalski, 2023). Jeśli chodzi o sferę finansów tu decyzje/działania podejmowane na granicy prawa, wbrew moralnemu obowiązkowi odróżniania sensu od nonsensu są coraz bardziej popularne, jak wspomniano we wstępie powołując się na pozycje Akerlof i Shiller (2017) i prowadzą na skraj przestępstw. Kryzys finansowy z jakim mieliśmy do czynienia od 2007 r. jest potwierdzeniem tezy głoszącej, iż na przełomie XX i XXI wieku w świecie finansów, a zwłaszcza na rynkach finansowych, obok pozytywnych objawów ewolucji, występują z coraz większym nasileniem objawy chaosu. W dobie globalnej gospodarki neoliberalnej prezentującej fundamentalizm rynkowy, marginalizującej kwestie społeczne oraz rolę państwa w gospodarce, jednocześnie „produkowano” i bagatelizowano zagrożenia wynikające z działania sił na rzecz rozwarstwienia (nierównowaga finansowa, zróżnicowanie dochodowe między krajami oraz dochodów wewnątrz krajów). Odbiło się to na rynku finansowym, zarówno w obszarze produktów, jak i regulacji dotyczących instytucji finansowych. Pojawiły się rozwiązania, które można uznać za zaskakujące w aspekcie przyjętych i utrwalonych zasad funkcjonowania rynku finansowego. Analiza zachowań podmiotów działających w poszczególnych sektorach tego rynku tzn. sektora bankowego,

<sup>3</sup> Pojęcie oznaczające decydentów odpowiedzialnych za decyzje dotyczące najważniejszych sfer życia społeczno-politycznego i gospodarczego w trzeciej dekadzie XXI wieku.

ubezpieczeniowego i kapitałowego, wynikających ze zmian w otoczeniu, które były konsekwencją rozwoju technologii teleinformatycznych, liberalizacji i umiędzynarodowienia, postępującego procesu globalizacji w okresie poprzedzającym kryzys oraz w czasie jego trwania może prowadzić do refleksji i zastanowienia się nad tym, czy przypadkiem nie mamy do czynienia z modyfikacją, czy też z postępującym procesem zmian zasad funkcjonowania rynku finansowego, a w efekcie nawet zmiany paradygmatu finansów. Czy misja finansów, główne zasady organizacyjne podmiotów tego obszaru działalności gospodarczej oraz zbiór pojęć, a w konsekwencji teorii tworzących podstawę nauki o finansach, jest ciągle twórcza poznawczo i spełnia wymogi dobrego paradygmatu?

Skoncentrujemy uwagę na specyficznym obszarze, jakim jest rynek finansowy, gdzie w rozważanym okresie przełomu XX i XXI wieku można było zidentyfikować wiele anomalii, wymagających rozwiązania. Wypada podkreślić, iż cały ten okres obejmuje zarówno lata poprzedzające kryzys finansowy, jak i czas kryzysu. W okresie tym na rynku finansowym zaczęły pojawiać się instrumenty pochodne, opcje oraz wszelkiego typu produkty, których powiązania z realną sferą gospodarki były trudno dostrzegalne, a nawet produkty oderwane od realnej sfery gospodarki. Zachowania podmiotów funkcjonujących na tym rynku udowodniły, że zmienia się znaczenie takich pojęć, jak: „zasada powiernictwa”, „zasada służebności”, „zasada dobrego włodarza” oraz „funkcja pośrednika”. Terminy te są obecnie inaczej rozumiane niż w klasycznych finansach lub wręcz tracą rację bytu na rynku finansowym. Przestaje się liczyć i nie odgrywa znaczącej roli etyka w finansach, zaś regulacje prawne nie nadążają za niepokojącym zjawiskiem narastającej intensywności występowania hazardu moralnego. Okazało się, że zanikają podstawowe zasady, jakimi powinien kierować się każdy podmiot świadczący usługi na rynku finansowym, w gestii którego leży zarządzanie środkami finansowymi powierzonymi przez klienta. Dotyczy to także zasady powiernictwa – pomocy klientowi w rozwiązywaniu problemów, realizacji zleceń i zaspokajaniu potrzeb (odpowiedzialność i zaufanie). Zapomniano również o sformułowanej w obowiązującym paradygmacie misji finansów: *„Misją instytucji finansowych jest pośrednictwo polegające na kojarzeniu tych, którzy posiadają kapitał, z tymi, którzy potrzebują kapitału, przy czym pośrednictwo to ma kierować się interesem klienta, mając na uwadze wzrost gospodarczy, tzn. działanie w myśl zasady – wszyscy odnoszą korzyści, koncentrując uwagę na kliencie”* (Taft, 2012).

W takich działaniach pojawia się konieczność odwołania się do zasady powiernictwa (ochrony interesów dużej grupy niedoinformowanych klientów o niskiej świadomości finansowej). Gdy instytucje finansowe przestają pełnić funkcję pośrednika działającego na rzecz klienta i zaczynają występować w charakterze mocodawcy własnych interesów, mamy do czynienia z odejściem od zasady powiernictwa. Podobnie rzecz się ma z zasadami służebności i odpowiedzialności, a tym samym zachowaniami etycznymi. Już w okresie poprzedzającym kryzys, instytucje finansowe zaczęły uważać, że zasady te, oparte na takich cechach, jak: celowość, pokora, przewidywanie, uczciwość w działaniu, nie mogą być przyjmowane jako główne wytyczne działania.

W całej gospodarce obserwujemy przerost sektora finansowego (finansyzacja gospodarki), w którym spekulacja (preferowanie niestabilności) bierze górę nad przedsiębiorczością (opieranie się na stabilności – długoterminowe programy inwestycyjne). Śmiało można stwierdzić, że obserwujemy dominację chrematystyki, która dopuszcza wszelką działalność prowadzącą do zarobku i zysku (fetysz pomnażania pieniądza). W efekcie, celem działalności instytucji finansowych, tak jak w przypadku wielu innych podmiotów funkcjonujących w sferze gospodarczej najważniejszy stał się własny zysk. Interes klienta i wzrost gospodarczy, które stanowiły główne wytyczne działalności w obowiązującym dotychczas paradygmacie, zeszły na dalszy plan, egoizm zapanował nad odpowiedzialnością. Gospodarka została zdominowana przez sektor finansowy, który miały tylko przyczynić się do rozwoju sfery realnej, tymczasem zaczął decydować o jej sytuacji, tzn. „*sluga stał się panem*” (Mączyńska, 2011). Co najgorsze, wraz z rozwojem i dominacją wolnorynkowego neoliberalizmu zdystansowano się od walorów etycznych, które uwypuklano w dotychczas obowiązującej klasycznej teorii finansów i zwracano uwagę na ich przestrzeganie w praktyce.

Wbrew wytycznym obowiązującego paradygmatu w działalności instytucji finansowych z każdego sektora rynku finansowego można zauważyć, że: „*chciwość zwyciężyła służebność*”, co m.in. przyczyniło się do wypaczenia idei finansów, a w konsekwencji powierniczej misji instytucji finansowych. Podmioty te zaczęły działać, kierując się nową filozofią, według której: „*klient przestał być traktowany podmiotowo, stał się jedynie dostawcą niezbędnych środków. Zadaniem instytucji stało się wydobyć za wszelką cenę środki od klienta, bazując, z jednej strony, na systemie, którego podstawę stanowi zaufanie do instytucji finansowych, z drugiej - niska świadomość finansowa i ekonomiczna przeciętnego klienta (brak wiedzy o mechanizmach działających na rynku finansowym oraz trudnej do rozszyfrowania dla przeciętnego klienta specyfice nowych produktów finansowych)*”. (Michalski i Śliwiński, 2015).

Przyjęto strategię mnożenia różnorodnych produktów, w tym takich, których konstrukcja zakładała zysk instytucji przy stracie klienta. Dodatkowo pojawił się problem tzw. toksycznych aktywów, czy zbyt zuchwałych spekulacji w obszarze instrumentów pochodnych. Wymyślano coraz bardziej skomplikowane instrumenty finansowe oraz dało się zauważyć preferowanie krótkoterminowego, spekulacyjnego inwestowania obciążonego dużym ryzykiem, którego konsekwencje ponosili właściciele środków, zwykle drobni ciułacze. Te zjawiska były obserwowalne już przed 2007 r., który uznano za początek obecnego kryzysu finansowego. Można przypuszczać, że ta filozofia funkcjonowania instytucji finansowych, wsparta równie ważną, z punktu widzenia paradygmatu, koncepcją zacierania granic międzysektorowych na rynku finansowym, w której gubi się z pola widzenia, czy też przesuwają na dalszy plan takie problemy, jak specyfika ryzyka w poszczególnych sektorach rynku finansowego, cechy charakterystyczne oraz różne zasady działalności podmiotów funkcjonujących w tych sektorach, istotne oznaki wypaczeń, jakie można było zaobserwować od lat na rynku finansowym to główne czynniki sprawcze tego kryzysu, które miały decydujący wpływ na jego zasięg i głębokość.

Należy dodatkowo uwzględnić fakt, iż wszystko odbywa się w dynamicznie zmieniającym się otoczeniu (rozwój technologii teleinformatycznych, liberalizacja, globalizacja) tzn., mamy do czynienia z ewolucją rynku finansowego. Wypada podkreślić, że przyczyniła się ona do rozwoju tego rynku i nie można negatywnie oceniać wszystkich jej efektów. Niestety w okresie nasilenia niepokojących zjawisk, gdy nie narzędzia, lecz sposób ich wykorzystania przez instytucje finansowe wzbudza wątpliwości, reakcja podmiotów odpowiedzialnych za sprawne funkcjonowanie rynku finansowego nie była odpowiednia do zagrożeń. Instytucje nadzoru nie reagowały z należytą starannością, aby przeciwdziałać wszystkim zjawiskom noszącym znamiona anomalii, których rozwiązanie na gruncie obowiązującego paradygmatu okazuje się trudne, a być może wręcz niemożliwe.

Nadzór (regulator) skoncentrował uwagę na problematyce usystematyzowania przepisów prawnych w zakresie funkcjonowania instytucji finansowych, czego przejawem są np. takie regulacje (dyrektywy) w Unii Europejskiej, jak Solvency II, MiFID II, MiFIR<sup>4</sup>. Poza tym powstała dodatkowo ustawa Dodd-Franka (USA). Okazało się, że rynek jako niezawodny super-regulator zawiodł, zwłaszcza jeśli chodzi o sytuację na rynku finansowym, z którą mamy do czynienia od 2007 r., a której pierwsze sygnały dało się zaobserwować już wcześniej, bo w latach dziewięćdziesiątych XX wieku. Można mnożyć przykłady potwierdzające słuszność tego stwierdzenia. Dobitym dowodem z rynku finansowego niech będzie fakt, iż przy funkcjonujących systemach nadzoru dokonano oszustwa podczas konstrukcji i wypuszczania na rynek obligacji zabezpieczonych długiem, czy sprawa zawieszenia/umarzania udziałów Reserve Primary Fund.

Interesującym, a zarazem niepokojącym zjawiskiem jest to, że obecnie działalność instytucji finansowych jest ukierunkowana w dużej mierze na konstruowanie produktów, które pozwalają pomnażać, zgodnie z przepisami prawa, zysk instytucji finansowych, działając na szkodę klienta. Tym samym mamy potwierdzenie tego, że na rynku finansowym *„chciwość zwyciężyła służebność”*. Obrazuje tę przemianę branża funduszy inwestycyjnych, która z biznesu *„sprzedajemy to, co wytwarzamy”* zmieniła się w dziedzinę *„wytwarzamy to, co będziemy sprzedawać”*. Obecna sytuacja na rynku finansowym (działania instytucji finansowych) wygląda tak, że utrwalają się sygnalizowane negatywne zmiany, a tym samym wypaczenia w rozumieniu misji finansów. Praktyka potwierdza postawę polegającą na dystansowaniu się w działalności od wartości etycznych. Należy wyraźnie podkreślić, że wszystko odbywa się zgodnie z prawem.

### **Zakończenie**

Szczególne skonfigurowanie mózgu ludzkiego będące efektem ewolucyjnych zmian spowodowało, że mózg zaprogramowany jest tak, aby sprzyjać i nie kwestionować ideologii wzrostu. Jak pogodzić uzasadniony postulat „zrównoważonego rozwoju” z panującą od wieków zasadą przyjętą przez człowieka tysiące lat temu jaką jest „dogmat wzrostu” realizowany we wszystkich sferach

<sup>4</sup> Ustawy regulujące działalność rynków finansowych oraz system wypłacalności dla zakładów ubezpieczeń.

działalności i forsowany przez karłowatą strukturę żądną władzy, seksu, jedzenia, lenistwa i dowartościowania ego, tzn. genetycznie ukształtowane prążkowie! Badania neurobiologów stają się bardzo przydatne w odpowiedzi na tak postawione pytanie.

Obok niepokojącego zjawiska obniżenia świadomości ekonomicznej i finansowej społeczeństw, będącego konsekwencją zaniedbań systemów edukacji obserwujemy niepokojące zjawisko zanikania podstawowych zasad etycznych, jakimi powinien kierować się każdy podmiot działający zarówno w sferze gospodarki realnej, jak i świadczący usługi na rynku finansowym. Przełom wieków XX i XXI charakteryzuje się tym, że na rynku finansowym mamy do czynienia z anomaliami wpływającymi na jego funkcjonowanie w szerokim rozumieniu, dotyczy to każdego sektora rynku finansowego (bankowość, ubezpieczenia, rynek kapitałowy), a tym samym instytucji finansowych oraz klientów. Te anomalie powodują, że obserwujemy odejście od paradygmatu finansów na rynku finansowym w każdym sektorze. Wpływ podlegającego ewolucji prążkowie, odwołującego się do narzędzi i dostępnych technik rewolucji technologicznej, informacyjnej i cyfrowej na decyzje dotyczące realizacji dogmatu wzrostu w sektorze finansowym spowodował, że w instytucjach finansowych „chciwość zwyciężyła służebność”. Zaobserwować można także zmiany w rozumieniu podstawowych pojęć, a tym samym zmiany definicji tych pojęć tzn. odejście od paradygmatu finansów. Czy damy radę rozwiązać ten problem w ramach obowiązującego paradygmatu wykorzystując wyniki badań neurobiologów, pamiętając o roli jaką w procesach decyzyjnych podmiotu odgrywa prążkowie i o tym, jak wpływa na zjawisko dewaluacji odroczonej nagrody (Mischel, 1958), na zanik postaw etycznych instytucji finansowych w aspekcie problematyki kształtowania paradygmatu finansów? Warto skorzystać z wyników prac prezentowanych przez neurobiologów.

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## NEUROBIOLOGIA A PARADYGMAT FINANSÓW NA PRZEŁOMIE XX I XXI WIEKU

### STRESZCZENIE

**Cel artykułu.** Celem pracy było wskazanie, w jaki sposób utrwalone w procesie ewolucji funkcje mózgu wpływają na decyzje dotyczące działalności podmiotów na rynku finansowym, jak to rzutuje na zmiany zachowania podmiotów na tym rynku oraz rozumienie definicji podstawowych pojęć, a tym samym zmianę paradygmatu finansów.

**Metodologia.** W pracy wykorzystano metodę bazującą na przeglądzie literatury z dziedzin zajmujących się problematyką poruszoną w temacie, takich jak ekonomia behawioralna, finanse oraz neurobiologia.

**Wyniki badania.** Wskazano, iż przełom XX i XXI wieku to okres nasilenia zjawisk sprzyjających pojawianiu się anomalii, a tym samym sygnalizujących objawy chaosu w świecie finansów. Wyróżniono takie zjawiska, jak rewolucja informacyjna i cyfrowa, nasilająca się finansyzacja oraz chrematystyka, będące m.in. efektem realizacji obligatoryjnego od tysięcy lat dla homo oeconomicus dogmatu wzrostu. Podkreślono fakt postępującego odejścia od wartości etycznych i moralnych we wszelkiego typu działalności. W tych warunkach decyzje/działania podmiotów funkcjonujących na rynku finansowym powodują, iż można zaobserwować zmiany jeśli chodzi o rozumienie podstawowych pojęć, a w konsekwencji tendencje do zmian definicji tych pojęć, co prowadzi do odejścia od obowiązującego paradygmatu finansów.

**Słowa kluczowe:** rynek finansowy, neurobiologia, dogmat wzrostu.

**JEL Class:** A20, E44, G15.

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## FINANCING BUSINESS ENTITIES THROUGH CROWDFUNDING AS AN ALTERNATIVE TO FINANCING WITH BANK PRODUCTS IN 2020–2023

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### FINANCING BUSINESS ENTITIES THROUGH CROWDFUNDING AS AN ALTERNATIVE TO FINANCING WITH BANK PRODUCTS IN 2020-2023

#### ABSTRACT

**The purpose of the article.** This article is based on a study which aimed to determine whether crowdfunding had become a viable alternative to banking products for Polish companies between 2020 and 2023. It was important to verify the awareness of, and knowledge about, alternative forms of financing among organisations operating in Poland. The article therefore examines whether crowdfunding became an alternative to traditional sources of financing for small and medium-sized enterprises (SMEs) in Poland between 2020 and 2023. The following hypotheses were therefore put forward:

H1: Start-ups were the entities that most frequently used crowdfunding between 2020 and 2023.

H2: Entities that did not receive financing from a banking institution during this period considered crowdfunding to be an alternative way of raising capital.

**Methodology.** The article presents the results of an empirical study aimed at determining the use of crowdfunding in Poland as a means of financing small and medium-sized enterprises between 2020 and 2023. It was also important to verify the methods used by the study participants to finance investments and current operations. The article uses a research methodology that includes the critical analysis of secondary sources, as well as methods such as analysis, synthesis, description, deduction, induction and reduction. Additionally, both Polish and foreign literature on corporate finance were analysed. Laws, resolutions, regulations, the scientific works of other organisations and reports were also examined to provide valuable information on crowdfunding in the 2020–2023 period. The generalising-synthesising method (deduction, reduction and induction) was employed to formulate recommendations. The inductive method was used to analyse the importance and characteristics of various sources of crowdfunding for enterprises. Conversely, the deductive method was employed to analyse the issue by starting from the macroeconomic situation in Poland and delving into the situations of enterprises and changes in the way they finance their activities. A reduction technique was used to perform a critical analysis of the literature and verify the formulated hypotheses

**Results of the research.** A quantitative survey of 150 businesses showed that, between 2020 and 2023, a small percentage of respondents used crowdfunding. This figure was around 10%. Entities that have opted for this method of financing are primarily start-ups, which are defined as companies that have innovative technologies and/or business models and are striving for significant growth in terms of both employees and sales (Kollmann et al., 2015, p. 15). The study showed that, between 2020 and 2023, crowdfunding in Poland was mainly used by

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organisations from the IT, medical, cosmetics, and culture and arts industries. It is also important to note that awareness of this form of financing was relatively low during the analysed period. Only 20% of the entities surveyed found it interesting, while 24% had no opinion on the subject and 56% were unaware of it. The survey results showed that Polish entrepreneurs mainly identify the following forms of business financing: bank credit, own funds and capital borrowed from family or related parties.

**Keywords:** crowdfunding, funding sources, external capital, enterprise financing.

**JEL Class:** G5, G1.

## Introduction

The period of 2020–2023 was characterised by dynamic changes in the macroeconomic and social environment. The operation of many industries was challenged by the effects of the COVID-19 pandemic, as well as by the increase in the price of energy carriers, which led to increased costs and decreased profitability for organisations. Consequently, many companies have sought alternative ways to raise capital for investment or ongoing operations. Rising interest rates made it difficult to obtain financing from banking institutions. Consequently, companies were forced to seek alternative sources of foreign capital.

This article aims to verify whether crowdfunding has become an alternative to bank products for raising funds between 2020 and 2023. The study poses the following hypotheses:

H1: Between 2020 and 2023, entities that primarily used crowdfunding were start-ups.

H2: Entities that did not receive financing from a banking institution between 2020 and 2023 considered crowdfunding as an alternative form of raising capital.

To achieve the stated goal, a quantitative survey based on a questionnaire was conducted. The survey results were supplemented by in-depth interviews (IDIs). When formulating recommendations, the generalisation-synthesis method (deduction, reduction and induction) was employed. The inductive method was used to analyse the importance of crowdfunding, starting with specific phenomena and moving towards the general. Conversely, the deductive method was used to analyse the problem by examining the ways in which business entities engaged in crowdfunding between 2020 and 2023. Based on the results of the research and critical analysis of the literature, it was possible to verify the previously stated hypotheses through reduction.

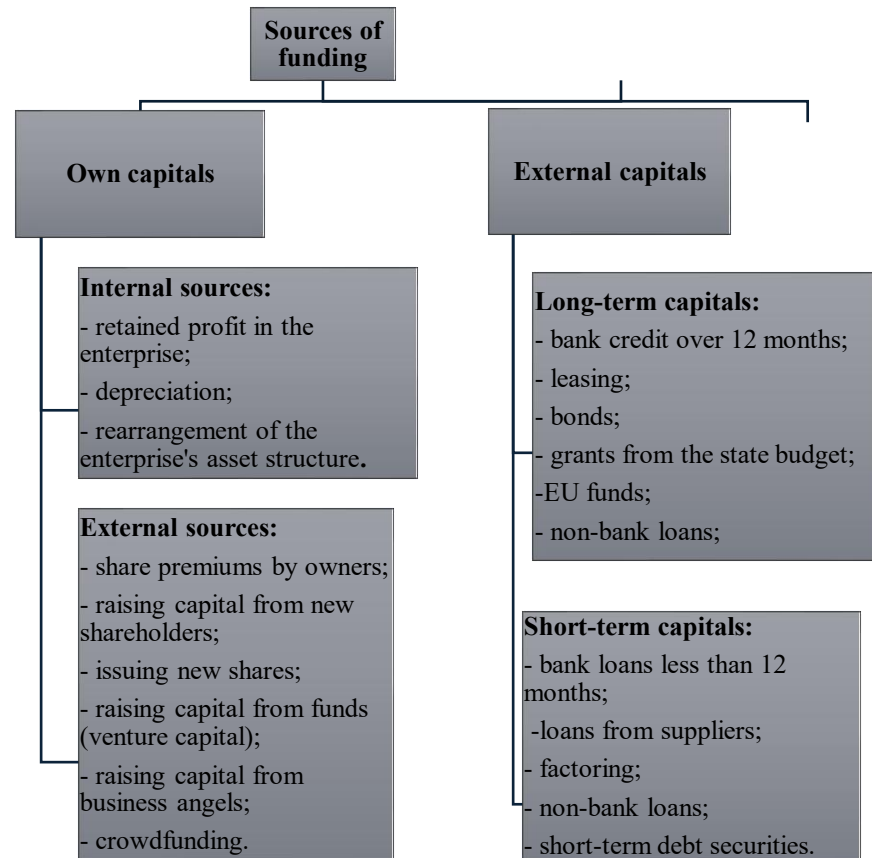
## Sources of Corporate Finance - Importance and Types – Literature Review

To ensure liquidity and continuity of operations, it is necessary to obtain appropriate financing sources for the entity's needs. These are the financial resources required to carry out core and investment activities. Money is fundamental to the functioning of any enterprise; all management decisions made within enterprises are reflected in monetary terms. Therefore, an enterprise's functioning and financial performance depend on decisions regarding the accumulation and spending of the monetary resources at its disposal.

The financial needs of an organisation can be met from a variety of sources. Figure 1 shows a breakdown of these sources.

**Figure 1**

*Division of sources of enterprise financing*



Source: own compilation based on Enz et al. (2015, p. 5) and Brealey et al. (2008, p. 529).

Taking ownership as a criterion, the sources of financing for entities can be divided into equity capital and foreign capital (debt). Equity capital is the funds contributed to an enterprise during its activities, forming the basis of its economic and financial independence. It has three functions: founding, guaranteeing, and financing the entity's activities (Bednarz & Gostomski, 2018). Therefore, equity capital forms the basis of enterprise financing. It can come from both internal and external sources. Foreign capital, on the other hand, is the sum of funds placed at the enterprise's disposal by external parties. Unlike equity, this capital remains at the disposal of the enterprise for a certain period of time, after which it must be returned, usually with interest. Foreign capital enables a company to broaden its financing base and thus increase the size of its business operations.

Another criterion for categorising financing sources is the origin of the capital. In this case, we distinguish between internal and external sources. Internal sources are developed by the enterprise itself, while external sources are mainly obtained on the financial market. Internal sources can come from

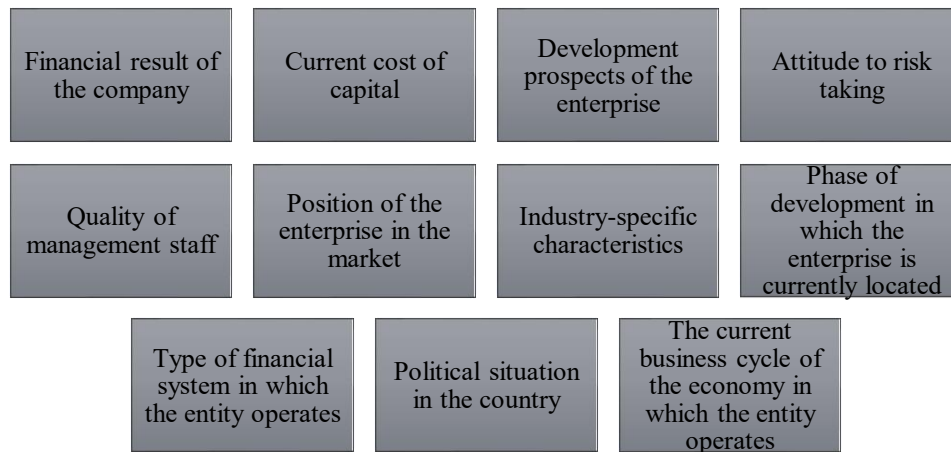
owners (e.g., stocks, shares and initial capital), while external sources can come from creditors (e.g., loans, credits, factoring and leasing). When the enterprise is first established, all capital comes from external sources in the form of funds committed by the owners and funds made available in the form of loans and credits. During the operation and development of the organisation, however, external financing supplements internal financing. This type of financing guarantees further development and is based on earned profit, depreciation and amortisation, as well as raising funds by transforming the asset structure and releasing established reserves.

The third criterion for categorising sources of financing for an enterprise's activities is the length of time that funds are made available for. In this case, we distinguish between short-term and long-term financing. Sources of financing can also be categorised by their purpose, i.e., whether they are used to finance current or investment activities. All divisions of financing sources are interrelated and dependent on one another. One example of these relationships is hybrid financing, which combines features of both equity and debt capital.

Theories of capital structure are constantly being modified (Agarwal, 2018) to take into account an increasingly broad set of factors influencing a company's choice of financing sources. Figure 2 illustrates the factors influencing an organisation's decision on its capital structure

**Figure 2**

*Factors influencing a company's financing structure decisions*



Source: own compilation based Glen (2013, p. 128).

Fama and French (2005) argue that it is useful to draw on all available theoretical streams, selecting the elements that best explain the motives behind companies' decisions regarding their financing structure. However, it is also important to remember that modern business entities operate in a dynamic and ever-changing environment.

### **Meaning and Functions of Crowdfunding - Literature Review**

Crowdfunding is a method of investing and raising capital that has become increasingly popular. Rubinton (2011) defined crowdfunding as a process whereby one party announces a need for funding and receives small contributions from many entities in exchange for some form of value. Steinberg (2012), in turn, defined it as a way of asking the general public for a start-up capital for a new venture. Crowdfunding occurs when a large number of people (the crowd) provide financial support for a project in the form of relatively small amounts of money, either in exchange for a donation or for participation in the venture (Wick, 2013). R. Wash points out that crowdfunding is the activity of attempting to obtain resources from a large group of market participants through an open application for the implementation of a new idea.

Hossain and Oparocha (2015) provide a comprehensive definition of the concept, indicating that crowdfunding is an internet-based financing method aimed at realising an initiative through micro-sponsorship in the form of small monetary contributions made online by many people within a limited timeframe. These initiatives can be the funding of tasks, ideas or projects, and are realised through an open invitation to participate in a fundraiser, mainly via the Internet. This allows funders to donate, pre-purchase products, borrow or invest, guided by their belief in the offer, the promise of the initiator and/or the expectation of a return on capital. The above definitions combine three elements:

- an online community of investors,
- the ultimate beneficiaries of these funds, i.e., the borrowers,
- service intermediaries that facilitate business relationships through online platforms.

Within crowdfunding, a number of funding models can be distinguished. The most important of these are listed by Shneor (2020) and Chunsheng et al. (2025):

1. Equity model: based on the acquisition of shares in a company.
2. Lending model: based on the provision of interest-bearing loans.
3. The donation model is based on charitable funding and is most commonly seen as collections of small amounts from the community.
4. Reward model – based on the non-financial reward of funders.
5. The invoice trading model is based on the sale of invoices through online platforms.

Equity crowdfunding offers many advantages to both investors and the entities that receive financial support in exchange for shares. The main advantage for investors is that they can participate in a venture despite having limited financial resources. A clear benefit of this is the correspondingly low financial risk. Unlike other investment models, this type of crowdfunding is essentially about providing financial support. A peculiar relationship is formed between the seller of shares or stocks and the investor, who may also become a customer of the entity in which they invested in order to profit from it. Conversely, customers and investors can actively participate in co-creating a sustainable value by engaging in environmentally sustainable investments, for example, which many regard as a future

paradigm for value extraction (Malhotra & Uslay, 2018; Wang et al., 2024). This alternative financing method is particularly important for small and medium-sized enterprises (SMEs), which often have limited financial resources (Lelo de Larrea et al., 2019).

In the continental model of the financial market, banks are at the centre of corporate financing, providing loans for current and development activities (Danilov & Pivovarov, 2024). However, in an era of dynamic environmental change and evolving conditions of bank financing for enterprises, alternative sources of organisational activity financing are also emerging in the market

### **Research Methods**

The primary objective of the survey was to identify changes in how small and medium-sized businesses in Poland acquire financing. The questionnaire included 21 questions on the financing methods used by respondents, their financial needs and obstacles to raising external capital.

The nationwide survey was conducted in August 2024. A sample of 150 small and medium-sized enterprises was surveyed. One of the non-probabilistic (non-random) sampling techniques, purposive selection, was used for the survey. This technique was based on the knowledge that the respondents had used or were using external capital to finance their operations. The survey was conducted using a questionnaire. It contained both single-choice and multiple-choice questions.

In addition, a qualitative study in the form of an interview was conducted with representatives of this group. To supplement the information received from the quantitative survey, an in-depth interview (IDI) was also conducted. Fifteen respondents (representatives of small and medium-sized businesses) attended. First, questions were prepared for the IDI interview. This was followed by sample selection. The selection of interview participants was purposive. The sample was selected based on enterprise size and financing method. In the third stage, the survey was conducted. The interviewees were asked the following questions:

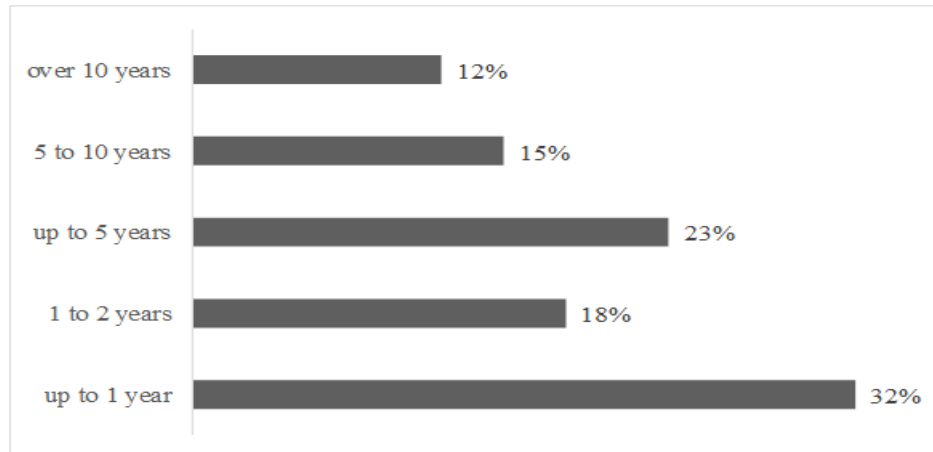
1. To what extent do you feel that there are obstacles to raising external capital from a banking institution between 2021 and 2023?
2. What prompted the need to look for ways to finance the business other than a bank loan?
3. How would you assess the availability of alternative forms of business financing, other than credit offerings from banks?
4. In 2021–2023, what was important to you when raising capital for your business?
5. How do you view crowdfunding for your business?

The qualitative IDI survey aimed to obtain data and supplement the information received from company representatives in the quantitative survey. During the one-to-one interviews, the focus was on the respondents' opinions, views and personal experiences. The aim was to ascertain the attitudes, impressions and motives that guided the actions of the participants.

The quantitative survey included 150 entities operating in Poland. Respondents declared different periods of operation, as shown in Figure 3.

**Figure 3**

*Respondents' period in business*

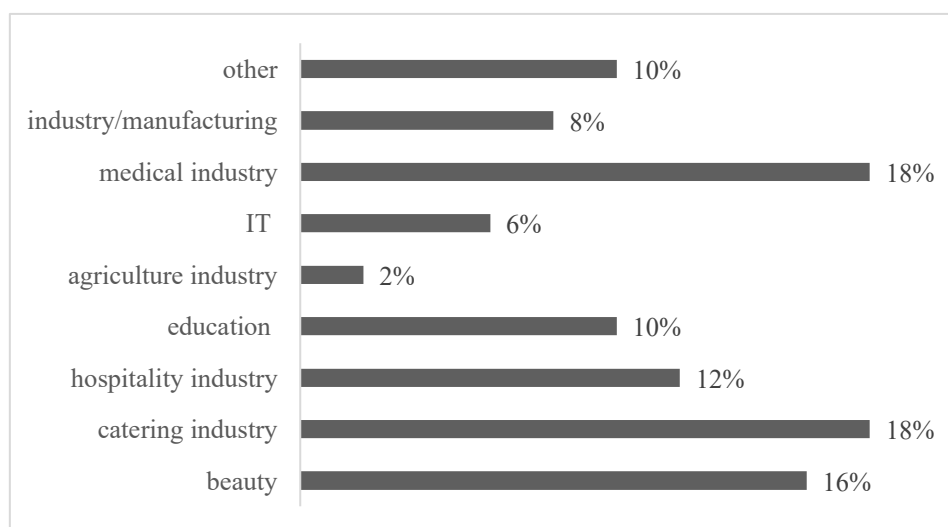


Source: own compilation.

Almost half of the respondents were businesses that had been operating in the market for up to two years. The survey also covered startups, which are defined as companies with high growth potential driven by technology, based on innovative products or services resulting from the practical application of knowledge (Blank & Dorf, 2013). The smallest percentage consisted of businesses that had been operating for more than 10 years. The vast majority of respondents were service organisations (62%). Figure 4 shows the breakdown of survey respondents by industry.

**Figure 4**

*Respondents to the survey by industry*



Source: own compilation.

The respondents included groups representing industries such as beauty, catering, hospitality, health, medical services and education. A small minority were organisations from the agricultural industry. The 'other' category included companies from the financial and logistics industries, as well as those operating in real estate.

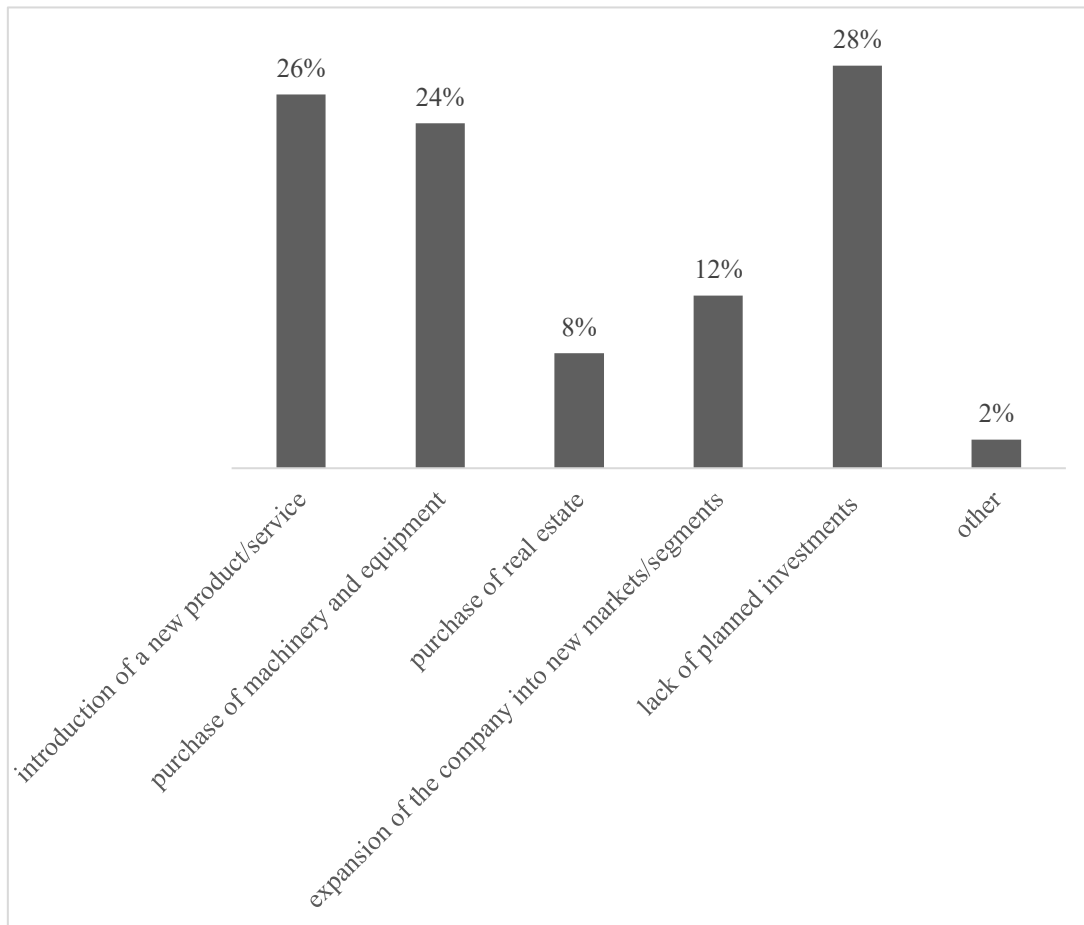
### **Crowdfunding as an Alternative Way of Business Financing in 2021-2023** – Results of Own Research

In the quantitative self-reporting survey, respondents were asked to indicate what financial obligations their company had. Almost 60% of respondents indicated that their company had a loan or credit facility. By contrast, 40% said they had a working capital loan and 12% had a credit card. The vast majority of entities also had a leasing agreement, with only 4% having a factoring agreement. Fourteen per cent of the surveyed entities also had a bank or insurance guarantee.

Companies were also asked about investments made between 2021 and 2023, and the results are presented in Figure 5.

**Figure 5**

*Investments made by the entities surveyed in 2021–2023*



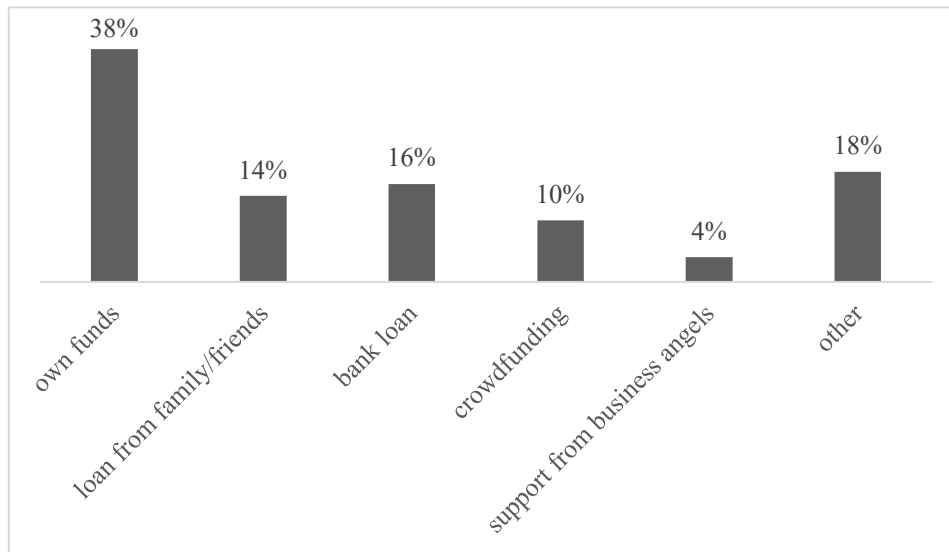
Source: own compilation.

Almost half of the companies surveyed introduced a new product or service, or decided to purchase equipment or hardware, as part of their investment plans for 2021–2023.

As part of the ongoing investment framework, the survey asked those who undertook projects in 2021–2023 to specify the sources of financing for these projects, as shown in Figure 6.

**Figure 6**

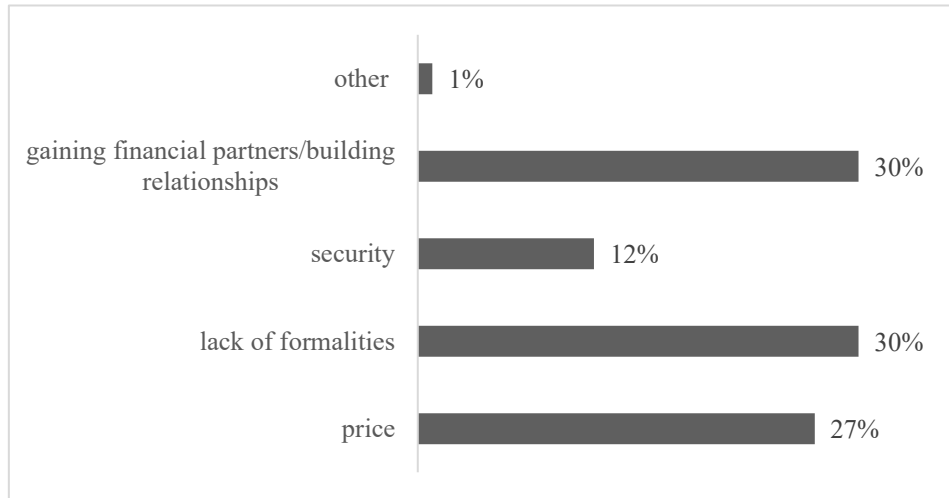
*Sources of investment funding by surveyed subjects in 2021-2023*



Source: own compilation.

The vast majority of people who took out a bank loan said they did so because they were afraid of other alternatives and knew nothing about them. Those who received support from family or friends most often indicated that they had to choose this method because financial institutions did not offer them anything suitable, or because they did not have the right collateral. Those who opted for solutions such as crowdfunding or support from business angels most often cited a lack of offers from other institutions and attractive price conditions as the reasons for their choice. The other category included leasing, financial support from affiliates or partner companies, and government grants.

In the second part of the survey, respondents were asked if they were familiar with crowdfunding. Of those asked, more than half (56%) indicated that they were not familiar with crowdfunding and had not used it. 24% said they had no opinion on this form of financing. In contrast, 20% said that it was an interesting form of financing. The companies in this group were asked about the key advantages of crowdfunding, and the results are shown in Figure 7.

**Figure 7***Advantages of crowdfunding according to surveyed companies*

Source: own compilation.

In-depth interviews with entities that used crowdfunding revealed that it was mainly small, local businesses that were inclined to do so. Among other things, they offered investors some discounts on the purchase of company products or services, or even additional products.

A significant number of entities indicated in the in-depth interviews that accessing financing from banks was difficult between 2021 and 2023. They pointed to pandemic-related problems and bank concerns first, and then to rising inflation, which significantly increased financing costs. Table 1 shows the statements made by respondents taking part in the in-depth interviews.

**Table 1***Respondents' statements on obstacles to obtaining financing from banks*

| Respondent   | Statement                                                                                                                                                                                         |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Respondent 1 | "Our company no longer has the capacity in light of the deteriorating economy during the Covid - 19 period"                                                                                       |
| Respondent 2 | " We applied for the loan in 2022, the offer presented was too expensive for the company"                                                                                                         |
| Respondent 3 | "The rising costs of energy carriers and fuels significantly increased the costs of our company and this ultimately worsened the company's performance. We knew that we would not receive a loan" |
| Respondent 4 | "In 2020 we started operations, the pandemic hit, banks took a very cautious approach towards new entrants, so we had to look for other sources of financing"                                     |

Source: own compilation.

Based on the statements of respondents who participated in in-depth interviews, it can be observed that, between 2021 and 2023, entities had problems obtaining financing from banks, especially due to stricter procedures for evaluating borrowers' ability to repay loans, worse financial performance

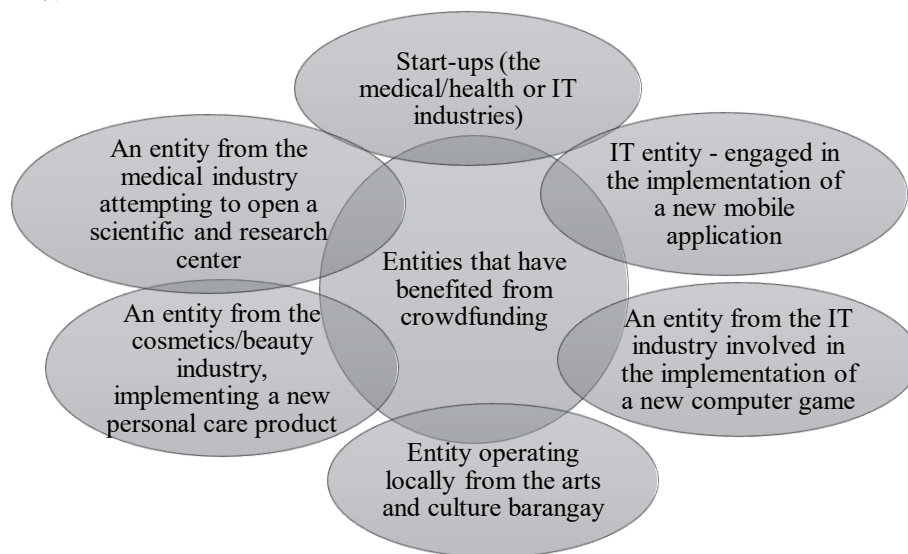
and an economic downturn. Some entities also indicated that they were start-ups without a history of creditworthiness or historical performance to indicate their financial health. Nor did they have assets to provide collateral for financing.

Entities in industries such as hospitality, catering, beauty and agriculture experienced the biggest problems financing their operations in 2021. Conversely, entities in industries such as medicine and IT indicated that they had the opportunity to use foreign capital offered by external investors (who are not financial institutions) in 2020–2021. In contrast, limited access to external funding was mainly indicated by entities in the logistics industry or those involved in real estate in 2022–2023. For the surveyed entities, elements such as the speed of access to additional money, low costs and the security of transactions were important when it came to raising foreign capital needed to make investments or maintain liquidity.

As shown in Figure 8, the main users of crowdfunding from 2020 to 2023 were start-ups operating in the medical/health or IT industries.

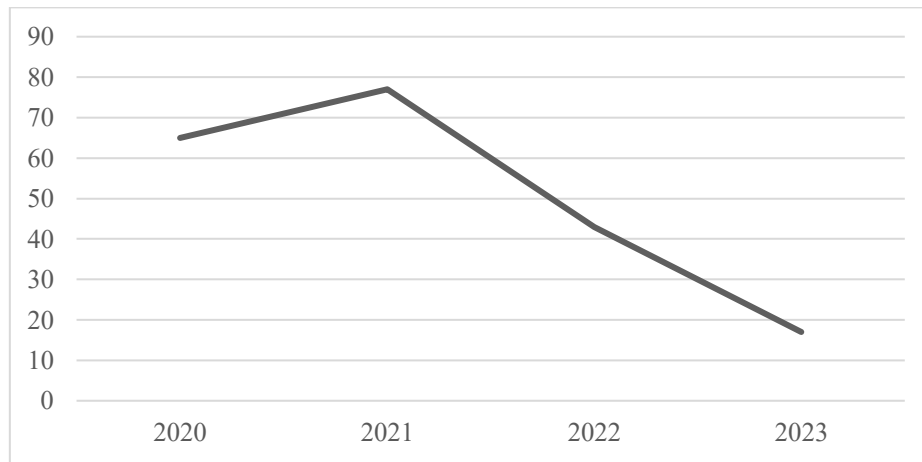
**Figure 8**

*Surveyed entities that benefited from crowdfunding between 2020 and 2023 (broken down by industry and type of activity)*



Source: own compilation based on empirical survey.

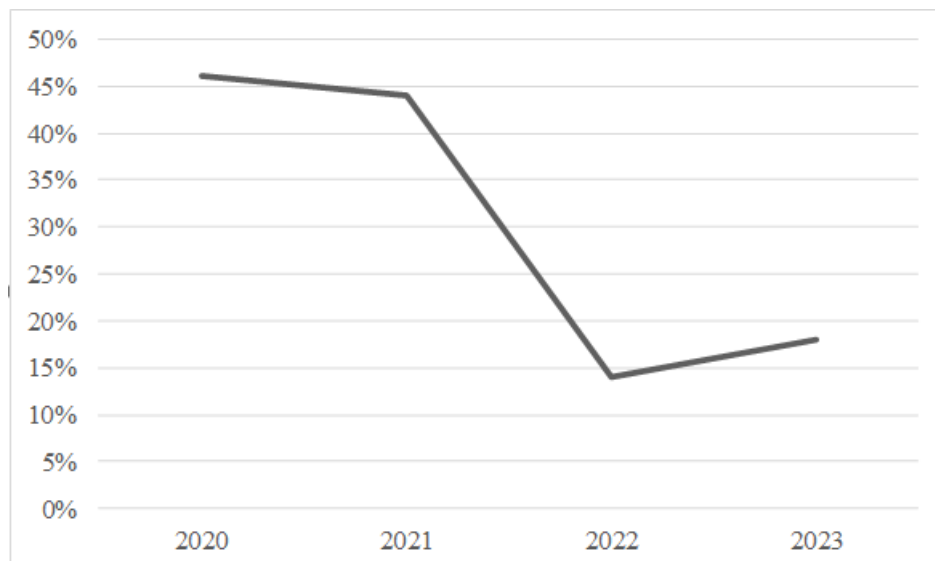
Crowdfunding has existed in Poland since 2012, but it did not become popular until 2020–2021. Figure 9 shows the number of crowdfunding issues in Poland from 2020 to 2023.

**Figure 9***Number of crowdfunding issues between 2020 and 2023*

Source: Komarnicki (2024).

The number of issues increased in 2020–2021, reflecting the growing interest of companies in raising capital through equity crowdfunding. The highest number of completed equity crowdfunding campaigns (77) was recorded in 2021. In subsequent years, however, there was a significant decrease in the number of crowdfunding issues. There was a decline of almost half in 2022 compared to 2021, and this downward trend continued, with the number of issues falling to just 17 in 2023 (Figure 9).

For each crowdfunding issue, the entity raising funds sets a target amount they want to achieve. The target is considered successfully achieved when the full target amount is raised (Figure 10).

**Figure 10***Number of successful crowdfunding issues in 2020-2023 in Poland*

Source: Komarnicki (2024).

Between 2020 and 2021, almost 45% of issues were completely successful, with entities raising the full amount. In 2022, however, there was a decline in the number of successful fundraisers compared to 2020–2021. The situation improved slightly in 2023, with 18% of issues ending in full achievement of the target (Figure 10).

During the pandemic, short-term collections were successful. However, from 2022 onwards, a period of rapid inflation and rising interest rates followed, dampening investors' enthusiasm for this type of investment. The majority of surveyed entities (70%) did not find this form attractive. Only 10% of those surveyed attempted to use this type of financing between 2021 and 2023. Of those using this type of financing, 30% indicated that fundraising through crowdfunding was successful for them.

### **Conclusions and Discussion**

Based on our own research, we can refute the hypothesis that crowdfunding was an alternative form of business financing between 2021 and 2023. As the research shows, only a small proportion of the surveyed entities used this form of financing (only 10%). This enables us to reject hypothesis 2.

Also, the hypothesis that startup entities mainly supported themselves through this method of raising funds (hypothesis 1) was not confirmed. Of the entities that indicated they use this form of financing, only 44% were start-up organisations. The remaining companies, which were classified as start-ups for the purposes of the analysis, relied on their own funds or financing from related companies.

Moreover, data presented by the Startup Poland Foundation also shows that, in 2021, 73% of existing Polish start-ups used their own funds (Michalczyk, 2022). Venture capital came second and business angels came third. Fewer than 5% of the companies participating in the survey indicated forms of financing such as crowdfunding and bank loans (Dziewit, 2021).

Siemieniuk (2023) also demonstrates in his analysis of financing sources for start-up activities that the primary source of financing for start-ups in Poland in 2023 was equity (86%). This was followed by bank loans, then subsidies. Venture capital, crowdfunding and business angels were the least popular sources of financing. The above studies also allow us to reject hypothesis 1, as do the results of our research.

However, other companies with a short operating history indicated that they had raised capital through support from family/friends, owners' funds or dedicated bank financing for new entities. The global capital shortage exacerbated by the pandemic has forced many financial institutions to reduce lending to mitigate risk (Rahman et al., 2020). Consequently, entities seeking capital are increasingly turning to alternative sources of funding, such as crowdfunding, to sustain their growth and operations (Leboeuf & Schwienbacher, 2018; Walthoff-Borm et al., 2018).

Some studies suggest that equity crowdfunding campaigns form part of a company's financing strategy. These studies claim that, in order to minimise equity dilution and maintain the highest possible level of autonomy, entrepreneurs prefer this method to other forms of entrepreneurial financing (Brown

et al., 2018). Nevertheless, Troise and Tani (2021) note that entrepreneurial traits such as vigilance and self-efficacy influence motivations to use crowdfunding. Entrepreneurs see crowdfunding as an opportunity to gain market/strategy information, co-create products and promote them.

However, other authors recognise that crowdfunding may be an inappropriate solution for funding start-ups with complex requirements, high information sensitivity (i.e., information that cannot be disclosed to the crowd), or a long economic period requiring subsequent funding (Ley & Weaven, 2011). This also enables us to reject hypothesis 1.

On the other hand, Stevenson et al. (2022) distinguish two types of entrepreneurs in the context of equity crowdfunding: necessity fund seekers and strategic fund seekers. According to these authors' analysis, entrepreneurs choose crowdfunding for a variety of reasons. These include retaining power and strategic control in the company (transactional value); greater efficiency (less time-consuming); extracting value from investors (e.g., mass referrals and lists of potential customers, providing complementary value on the demand side); creating value through the fundraising process (e.g., market validation information); and solving external stakeholder problems.

On the one hand, Walthoff-Borm et al. (2018) argue that companies turn to crowdfunding as a last resort. In line with the theory of the hierarchy of funding preferences (Myers & Majluf, 1984), they present empirical evidence showing that companies with limited internal funds (often unprofitable) and debt capacity are more likely to seek equity crowdfunding. The authors also observe a relatively higher failure rate among organisations funded by crowdfunding compared to those that did not use this method. Furthermore, the authors found that companies with unsuccessful crowdfunding campaigns had significantly higher failure rates than those with successful campaigns, supporting the thesis that companies use equity crowdfunding as a last resort.

Blaseg et al. (2021) also studied the hypothesis that companies with the highest risk, who have fewer financing alternatives, are more likely to seek financing through crowdfunding. Their study confirmed that start-ups are indeed more likely to use equity crowdfunding because they struggle to establish relationships with banks and do not have access to other sources of equity financing.

Other authors have developed models to inform the choice between reward and equity crowdfunding. In the context of information asymmetry, these models predict that, when initial capital requirements are low and projects demonstrate high quality, entrepreneurs will prefer the rewards model (Belleflamme et al., 2014; Miglo & Miglo, 2019). However, if entrepreneurs exhibit overconfidence, crowdfunding becomes the preferred option, as they can gain valuable information by selling shares before making critical production decisions (Miglo, 2021).

Other authors addressing the topic of crowdfunding note that, for those seeking funds out of necessity, equity crowdfunding was the only available option for raising funds in the research studies conducted (Hallen and Eisenhardt, 2012; Williams and Shepherd, 2016). This suggests that alternative equity funding options were unavailable to some entities at their current stage of operation. This finding

corroborates the results of our own research, in which some respondents who used crowdfunding indicated that they opted for this method due to the unavailability of alternative sources of funding.

Regarding entrepreneurs' awareness of crowdfunding, the vast majority of entities do not recognise this method of raising external capital, as revealed by the company's own survey. The continental model is still associated with financing from banking institutions. When asked about sources of investment financing for the period 2021–2023, respondents mainly identified their own funds and bank loans. Thus, this is the most common form of raising funds. Although respondents indicated problems in obtaining bank financing in 2021–2023, it was the first opportunity for some of them to obtain additional funds.

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## FINANSOWANIE PODMIOTÓW GOSPODARCZYCH POPRZEC CROWDFUNDING JAKO ALTERNATYWNY SPOSÓB DLA FINANSOWANIA PRODUKTAMI BANKOWYMI W LATACH 2020–2023

### STRESZCZENIE

**Cel artykułu.** Badanie miało na celu ustalenie, czy w latach 2020–2023 finansowanie społecznościowe stało się realną alternatywą dla produktów bankowych. Ważne było również zweryfikowanie świadomości i wiedzy przedsiębiorstw na temat alternatywnych form finansowania ich działalności. W badaniu postawiono następujące hipotezy:

H1: W latach 2020–2023 z finansowania społecznościowego korzystały głównie start-upy.

H2: Podmioty, które w latach 2020–2023 nie otrzymały finansowania od instytucji bankowej, uznały finansowanie społecznościowe za alternatywny sposób pozyskiwania kapitału.

**Metody badawcze.** W artykule przedstawiono wyniki badania empirycznego mającego na celu zidentyfikowanie wykorzystania finansowania społecznościowego jako sposobu finansowania przedsiębiorstw przez organizacje w latach 2020–2023. Ponadto ważne było zweryfikowanie sposobów finansowania inwestycji i bieżącej działalności przez uczestników badania. W artykule zastosowano metodologię badawczą obejmującą krytyczną analizę źródeł wtórnych, a także metody takie jak analiza, synteza, opis, dedukcja, indukcja i redukcja. Przeanalizowano polską i zagraniczną literaturę dotyczącą finansów przedsiębiorstw. Przeanalizowano również ustawy, uchwały, rozporządzenia, prace naukowe innych organizacji oraz raporty, które stanowiły cenne źródło

informacji na temat finansowania społecznościowego w latach 2020-2023. Do sformułowania zaleceń wykorzystano metodę uogólniająco-syntetyzującą (dedukcja, redukcja, indukcja). Metoda indukcyjna pomogła w analizie znaczenia i charakterystyki różnych źródeł finansowania społecznościowego dla przedsiębiorstwa. Z kolei metoda dedukcyjna została wykorzystana do analizy zagadnienia, zaczynając od sytuacji makroekonomicznej w Polsce, a następnie zagłębiając się w sytuację przedsiębiorstw i zmiany w sposobie finansowania ich działalności. Przeprowadzając krytyczną analizę literatury, zastosowano technikę redukcji, weryfikując w ten sposób sformułowane hipotezy.

**Wnioski.** Badanie ilościowe przeprowadzone na grupie 150 przedsiębiorstw wykazało, że w latach 2020–2023 niewielki odsetek respondentów korzystał z finansowania społecznościowego. Było to około 10% respondentów. Podmioty, które zdecydowały się na tę metodę finansowania, to przede wszystkim start-upy, rozumiane jako przedsiębiorstwo funkcjonujące krócej niż 10 lat, posiadające innowacyjne technologie i/lub model biznesowy, dążące do znacznego wzrostu liczby pracowników i/lub sprzedaży (Kollmann i in., 2015, s. 15). Badanie ukazało, że z crowdfunding w Polsce w latach 2020–2023 korzystały głównie organizacje z branży IT, medycznej, kosmetycznej oraz kultury i sztuki. Warto również zauważyć, że świadomość tej formy finansowania w analizowanym okresie była stosunkowo niska. Tylko 20% ankietowanych podmiotów wskazało tę formę jako interesującą, podczas gdy 24% nie miało zdania na ten temat, a aż 56% nie miało wiedzy na temat tego rozwiązania. Wyniki badania wykazały, że przedsiębiorcy w Polsce identyfikują głównie takie formy finansowania działalności gospodarczej, jak kredyt bankowy, środki własne, kapitał pożyczony od rodziny/podmiotów powiązanych.

**Słowa kluczowe:** crowdfunding, funding sources, external capital, enterprise financing.

**JEL Class:** G5, G1.

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## WYKORZYSTANIE BIOMETRII BEHAWIORALNEJ W KONTEKŚCIE CYBERBEZPIECZEŃSTWA POLSKIEGO SEKTORA BANKOWEGO (2019–2024)

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### USING BEHAVIORAL BIOMETRICS IN THE CONTEXT OF CYBERSECURITY OF POLISH BANKING SECTOR (2019-2024)

#### ABSTRACT

**The purpose of the article.** The purpose of the article is verification of the hypothesis that behavioral biometrics may become a solution which will reduce the extent of financial fraud in Poland. The problem in question is notable due to the negative impact of changes on cybersecurity in the environment of banking sector, after the COVID-19 pandemic. Only over the years 2019–2024 there was a tenfold increase in the value of fraud. The risk of financial crime in cyberspace is becoming the major challenge faced by the financial sector. Such high dynamism, as well as the extent of the loss experienced by customers, made supervisory authorities interested in the problem, which resulted in issuing to banks a number of directives concerning educating customers and minimizing the risk of fraud at a system level. One of the directives recommended in this matter to payment service providers is using systems based on behavioural biometrics. This modern technological solution allows to verify in real time whether the person logging in to a bank account and performing financial operations is actually the owner of the account. This paper contains strategic diagnosis of this technology by means of a SWOT analysis. This method allowed to identify and assess key internal factors (strengths and weaknesses) and external ones (opportunities and threats), as well as determining the dominant strategy of development on the financial market in Poland. As a result, the authors formed strategic recommendations both for financial institutions and regulators, which may enhance the effectiveness of behavioural biometrics in reducing financial fraud.

**Methodology.** In the article the qualitative research approach was implemented. The main method of the analysis is the case study of Polish banking sector over the years 2019–2024. Descriptive analysis was used to present the evolution of cyber threats, the extent of financial frauds, as well as regulatory frameworks. The key tool in the research is the SWOT analysis, which allowed to identify strengths and weaknesses of behavioural biometrics, as well as market opportunities and threats. It led to formulating recommendations.

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Complementarily, secondary data analysis was used. The data derived from reports, publications and statements by the market regulators.

**The results of the research.** From the perspective of financial institutions, behavioural verification may constitute the key factor in eliminating the most common financial frauds. The most effective approach adopted by banks should be proactive use of internal assets of behavioural biometrics to maximize the benefits from external market opportunities. The biggest challenge and the blocker of the development of this technology is a low level of customer acceptance, and the external threat in the form of restrictive legal and regulatory barriers. In this case, a solution should be changing the present process of obtaining a customer's consent. Connecting the consent with the benefits of convenient using e-banking may considerably increase the index of acceptance, and as a result, eliminate the biggest barrier in the development. It will enable to use the full potential of the solution supported by the development of the sector platform. Although behavioural biometrics plays a lesser role in preventing non-authorised transactions by customers manipulated by criminals, it is an important part of a proactive cybersecurity strategy, especially in the context of the principle of the refund D+1. It is essential in the context of the pressure by regulators which increases the responsibility of banks for fraud transactions.

**Practical implications.** Behavioural biometrics may become a key tool limiting the extent of financial frauds. If implemented, it increases the level of customer protection, and as a result, allows to reduce the extent of financial frauds, especially those related to taking over a bank account. The biggest benefit connected with this technology is constant, non-invasive verification of a customer's identity in the background. It is an excellent supplement to presently existing anti-fraud systems and solutions. Using sector platform may contribute to a better and faster acceptance, and increasing the efficiency of the security measures used. It will allow banks for a better reaction to incidents, and meeting the regulators' increasing demands concerning protecting customers. However, the success of implementing and using behavioural biometrics depends on solving the problem of legal barriers, market and customers education, without which the technology will remain only a niche solution.

**Keywords:** cybersecurity, financial fraud, behavioural biometrics, e-banking.

**JEL Class:** G21, G23, G29.

## Wstęp

Rozwój współczesnej bankowości cyfrowej odbywa się w otoczeniu szybko rosnącego ryzyka cyberprzestępczości. Przestępstwa finansowe stały się zjawiskiem systemowym w skali globalnej i mają wpływ nie tylko na bezpieczeństwo pojedynczych użytkowników i firm, ale również na stabilność i zaufanie do całego sektora finansowego. Istnieje uzasadniona obawa, że w przyszłości cyberprzestępczość skierowana na usługi finansowe będzie zagrażała nawet rozwojowi państw, zwłaszcza rozwijających się, które nie mają tylu środków, żeby przeciwdziałać skutkom takich przestępstw. Zgodnie z danymi Narodowego Banku Polskiego w latach 2019–2024 wartość oszustw z wykorzystaniem polecenia przelewu w Polsce wzrosła aż dziesięciokrotnie. Wskazuje to na dynamikę tego problemu wynikającą ze skoncentrowania się przestępców na klientach indywidualnych, którzy powszechnie w łańcuchu bezpieczeństwa uznawani są za najsłabsze ogniwo.

W tym kontekście istotną rolę może odegrać biometria behawioralna. Rozwiązanie to umożliwia bieżącą analizę charakterystycznych wzorców zachowań użytkowników podczas korzystania z bankowości elektronicznej. Identyfikacja odstępstw od zarejestrowanego wcześniej profilu umożliwia wykrycie próby nieautoryzowanego dostępu i przejęcia konta. W ten sposób dostarcza bankom dodatkową warstwę zabezpieczeń, działającą równolegle do dotychczasowych metod uwierzytelnienia. Ciągłe monitorowanie sesji uniemożliwia jej przejęcie, a dodatkową i bardzo cenioną zaletą jest też jej nieinwazyjny charakter, który nie wpływa na doświadczenie klienta w korzystaniu z bankowości elektronicznej. Wdrożenie weryfikacji behawioralnej napotyka na istotne bariery prawne i społeczne. Kluczowym wyzwaniem jest konieczność uzyskania świadomej i dobrowolnej zgody klienta na przetwarzanie danych biometrycznych. Zgodnie z Rozporządzeniem o Ochronie Danych Osobowych (RODO) są to dane szczególnej kategorii (Unia Europejska, 2016). Stanowisko Urzędu Ochrony Danych Osobowych jednoznacznie ogranicza możliwość wykorzystania biometrii behawioralnej bez uprzedniej zgody klienta (Lidke, 2024b). Ma to negatywny wpływ na tempo upowszechnienia się tego rozwiązania w rodzimym sektorze bankowym.

### Oszustwa finansowe jako systemowe zagrożenie sektora bankowego

Rozwój nowoczesnych usług bankowości elektronicznej w połączeniu z szybkim napływem mniej doświadczonych klientów, który miał miejsce w wyniku pandemii COVID-19, przyczynił się do zwiększenia liczby negatywnych zjawisk. Wśród nich największe znaczenie miał duży wzrost cyberprzestępczości. Większa liczba użytkowników i zdalnych transakcji doprowadziła do gwałtownego wzrostu liczby przestępstw i ataków na użytkowników bankowości cyfrowej. Działania te nasiliły się szczególnie w okresie pandemii COVID-19, czyli od początku 2020 r. Wpływ na to miała również łatwość transferu skradzionych pieniędzy poza granice Polski, wraz z ich wykorzystaniem. Z danych Komendy Głównej Policji wynika, że w 2021 r. stwierdzono 18,3 tys. przestępstw dotyczących kategorii e-bankowości i phishingu (art. 287 Kodeksu karnego). Dla porównania w 2020 r.

było ich 10 tys., czyli nastąpił wzrost o 80%. Jeszcze w 2019 r. policja notowała 9,1 tys. takich przestępstw, w 2018 r. 5,8 tys., a w 2017 r. 4,3 tys. Negatywny trend, który pojawił się w okresie pandemicznym utrwalił się i był widoczny w kolejnych latach. W 2022 r. liczba przestępstw wzrosła do 25,2 tys. I chociaż rok później liczba spadła do ponad 19 tys. (KGP, 2025), to spadek ten mógł jednak wynikać z braku chęci zgłaszania stosunkowo niewielkich strat finansowych oraz z obaw o to, że służby nie będą potrafiły rozwiązać problemu (Cyberdefence24.pl, 2024). Taką sytuację może potwierdzać liczba unikalnych incydentów cyberbezpieczeństwa, rejestrowanych przez CERT Polska. W 2021 r. zarejestrowano łącznie 29,5 tysiąca incydentów, co stanowiło wzrost o 182% w stosunku do roku poprzedniego, kiedy zanotowano ich 10,4 tys. (CERT.PL, 2022). Jeszcze w 2019 r. takich incydentów było niecałe 6,5 tys. Dynamika kolejnych lat wskazuje na narastający problem. W 2022 r. było ich 39,6 tys., w 2023 r. 80,2 tys., a w 2024 r. liczba ta przekroczyła 100 tys. (Bankier.pl, 2025; CERT.PL, 2025). Udostępnione przez policję dane dotyczą zaś jedynie informacji o przestępstwach stwierdzonych, bez uwzględnienia tych, które są jeszcze w toku. Nie wszystkie przypadki są też obligatoryjnie opisywane w katalogach w ramach kategorii e-bankowość czy phishing (Komenda Powiatowa Policji w Kołbucku, 2025). Na rosnącą liczbę przestępstw dotyczących kradzieży środków z rachunków bankowych w powiązaniu z pandemią COVID-19 wskazywał również Rzecznik Finansowy, podkreślając równocześnie, że jest to najczęstsza przyczyna skarg klientów podmiotów rynku finansowego z zakresu naruszeń Ustawy z dnia 19 sierpnia 2011 r. o usługach płatniczych (Rzecznik Finansowy, 2021). Sam temat dotyczący nieautoryzowanych transakcji pojawiał się bardzo często w podejmowanych interwencjach Rzecznika w latach 2020–2022. Wskazywał on m.in. na nowe rodzaje ataku, w tym również problem okradzionych klientów z wykorzystaniem tzw. „kredytów na klik” (Rzecznik Finansowy, 2022). O ile do niedawna przestępcy koncentrowali się na atakowaniu klientów mających większe środki na rachunku, to coraz częściej, dzięki szybkiemu postępowi technologicznemu, okradani są również klienci, którzy posiadają zdolność kredytową. Przez internet lub aplikację mobilną w sposób w zasadzie automatyczny klient lub podszywający się pod niego złodziej w ciągu zaledwie kilku minut może zaciągnąć nawet kilkudziesięciotysięczny kredyt. Następnie pieniądze są szybko transferowane na zewnątrz banku. Liczba przestępstw – zarówno takich, jak i omawianych wcześniej – zaczęła rosnąć lawinowo w latach 2021–2022, na co wskazują również dane Narodowego Banku Polskiego z tego okresu. Wynika z nich również, że większość nie jest zgłaszana na policję czy do Rzecznika Finansowego. Ze statystyk NBP, opracowywanych na podstawie danych zbieranych z banków, wynika, że w czwartym kwartale 2019 r. miało miejsce 3007 operacji oszukańczego polecenia przelewu. Dwa lata później liczba takich operacji wzrosła aż czterokrotnie, do 12 069. Na koniec tego samego kwartału 2024 r. było ich blisko 17 tys. Podobnie, jak w przypadku liczby transakcji oszukańczych, NBP raportował również duży wzrost wartości takich operacji – porównując czwarty kwartał 2019 r. i ten sam okres 2024 r. wartość ta wzrosła z 12 aż do 135 mln zł. W latach 2019–2024 wartość oszustw z wykorzystaniem polecenia przelewu wzrosła zatem aż dziesięciokrotnie. Dane te nie uwzględniają transakcji oszukańczych kartami płatniczymi, których liczba jest znacznie wyższa – w 2024 r. średnio

90 tys. operacji kwartalnie (NBP, 2025). Co ciekawe w samej pandemii liczba oszukańczych operacji kartami spadła (NBP, 2022). Wszystkie te straty to efekt wzmożonego działania przestępców. Z raportu zespołu CSIRT działającego przy Komisji Nadzoru Finansowego wynika, że w latach 2019–2024 liczba notowanych incydentów wzrosła w tempie wykładniczym, aż 16-krotnie, z 6 484 do 103 449 (KNF, 2024). Tylko pomiędzy rokiem 2020 a 2021 nastąpił wzrost o ponad 180%. Podobnie było z liczbą blokowanych domen. O ile w 2019 r. zablokowano ich zaledwie 2600, w 2020 r. już 4300, to rok później liczba phishingowych domen wzrosła do 11,5 tys. W 2024 r. zgłoszono do blokady ponad 51 tys. domen. W tym czasie zmienił się również tzw. wektor ataków z podszywania się pod banki na oferowanie fałszywych inwestycji.

### **Zmiana paradygmatu cyberprzestępczości. Socjotechnika jako kluczowe narzędzie oszustw finansowych**

Transformacja cyfrowa instytucji finansowych, która przyspieszyła po pandemii COVID-19, w połączeniu z regulacjami wzmacniającymi bezpieczeństwo systemowe banków spowodowała znaczące polepszenie rozwiązań operacyjnych i technologicznych po stronie banków i innych dostawców usług płatniczych. Ataki na banki są trudne do przeprowadzenia i wymagają ogromnego doświadczenia oraz środków finansowych.

Zwiększenie cyberbezpieczeństwa klientów, które miało miejsce po powszechnym wprowadzeniu dodatkowych metod autoryzacji i identyfikacji, było efektem zastosowania w 2015 r. dyrektywy w sprawie usług płatniczych w ramach rynku wewnętrznego UE, powszechnie określaną jako PSD2 (Unia Europejska, 2015). Dyrektywa została stworzona między innymi w celu lepszego zabezpieczenia danych i pieniędzy klientów, tak żeby mogli bez obaw przeprowadzać transakcje w internecie. W bankowości i płatnościach elektronicznych wprowadzono wymóg stosowania silnego uwierzytelniania klientów, z nielicznymi i jasno wskazanymi wyjątkami od tej reguły. Ta najbardziej odczuwalna i początkowo krytykowana zmiana polegała na podwyższeniu poziomu weryfikacji tożsamości klienta. W praktyce znacząco wydłużało to proces logowania do serwisów bankowości internetowej oraz procesy płatności dokonywanych na przykład kartami płatniczymi (SEON, 2025; Clever Advice, 2019). Silne uwierzytelnianie klienta (SCA – *Strong Customer Authentication*) to kluczowy mechanizm bezpieczeństwa, który ma na celu redukcję ryzyka oszustw w transakcjach elektronicznych. Jest to proces uwierzytelniania klienta oparty na co najmniej dwóch niezależnych elementach z kategorii: wiedzy, posiadania i cech klienta. Mechanizmy te podlegają wymogom technicznym, które wprowadziły obowiązek dynamicznego powiązania kodu autoryzacyjnego z parametrami konkretnej transakcji. Mechanizm wprowadza wymagania co do tego, żeby klient otrzymał informację o kwocie i odbiorcy przed autoryzacją, a sam kod autoryzacyjny był unikalny dla danej transakcji oraz by jakakolwiek modyfikacja parametrów transakcji unieważniała kod (Unia

Europejska, 2018). Ogromną zmianą było wprowadzenie praktyki stosowania co najmniej dwóch elementów należących do wspomnianych wcześniej kategorii:

- wiedza – coś, co wie wyłącznie użytkownik (ciągi znaków używane jako ustalone hasło),
- posiadanie – coś, co posiada wyłącznie użytkownik (używane w połączeniu z hasłami jednorazowymi przekazywanymi za pośrednictwem telefonu lub aplikacji mobilnej, np. karta płatnicza, token, ale również komputer lub telefon),
- cechy klienta – coś, co jest charakterystyczne wyłącznie dla użytkownika (np. biometria, odcisk palca).

Celem stosowania się do tych wymogów przez wydawców instrumentów płatniczych oraz podmiotów świadczących usługi *acquiringu* było podwyższenie poziomu bezpieczeństwa w transakcjach elektronicznych (Tomczyk, 2023). Wzmocnienie zabezpieczeń skłoniło przestępców do rozwoju innych sposobów kradzieży i przeprowadzania oszustw. W konsekwencji na całym świecie można zaobserwować znaczący wzrost oszukańczych transakcji wykorzystujących manipulację i różnego rodzaju narzędzia socjotechniki skierowane w szczególności do osób fizycznych, określanych mianem najsłabszego ogniwa w łańcuchu bezpieczeństwa (Barrett, 2003). Na rozwój takich oszustw miała też wpływ pandemia COVID-19, w czasie której część osób, wcześniej wykluczonych z korzystania z bezgotówkowych instrumentów płatniczych, w szczególności starszych i mniej obeznanych z rozwiązaniami cyfrowymi, zaczęła masowo korzystać z zakupów online, bankowości elektronicznej i płatności cyfrowych. Osoby te, posiadając mniejszą wiedzę o ryzykach i zagrożeniach związanych ze stosowaniem instrumentów płatniczych, nie rozpoznają prawidłowo prób przestępczych. Tacy klienci korzystają często z komputerów i urządzeń słabiej zabezpieczonych przed atakami przestępców, którzy sugestywnie zachęcają ich do instalowania złośliwego oprogramowania (np. przez SMS lub e-mail) czy złośliwego pulpitu na komputerze posiadacza rachunku. Tego rodzaju ataki można podzielić na trzy podstawowe grupy oszustw:

1. Przestępstwa polegające na przejęciu dostępu do rachunku płatniczego. Może to mieć miejsce w wyniku kradzieży lub przywłaszczenia danych, na przykład w skutek pozyskania takich informacji w wyniku manipulacji i zastosowania technik socjotechnicznych lub też w wyniku wycieku wrażliwych informacji dotyczących konta. Przestępca wykorzystuje te informacje w celu wyprowadzenia środków finansowych z tak przejętego rachunku. Tego rodzaju ataki są dużo trudniejsze do przeprowadzenia od czasu wdrożenia zaleceń dyrektywy PSD2. Z tego też względu obecnie funkcjonują w połączeniu z innymi działaniami, mającymi na celu wyłudzenie narzędzia autoryzacyjnego lub skłonienie do akceptacji zmanipulowanego użytkownika.
2. Przestępstwa polegające na zmanipulowaniu użytkownika i zachęceniu go do zainstalowania oprogramowania umożliwiającego dostęp do rachunku płatniczego z wykorzystaniem tzw. zdalnego pulpitu na urządzeniu posiadacza rachunku oraz wyprowadzeniu środków

pieniężnych. Również w takim przypadku wymagana jest interakcja przestępcy z nieświadomym takiego działania klientem instytucji finansowej.

3. Przestępstwa polegające na zmanipulowaniu posiadacza rachunku przez przestępcę podszywającego się np. za pracownika instytucji finansowej lub policji i skłonieniu go do niekorzystnego rozporządzenia swoim majątkiem. W takim przypadku to sam klient dokonuje samodzielnie autoryzacji transakcji, np. przelewu środków pieniężnych na wskazany rachunek płatniczy, podaje kod BLIK i autoryzuje transakcję czy wpłaca we wpłatomacie pieniądze na rachunek przestępcy. W każdym takim przypadku zmanipulowany płatnik uważa, że przelew jest dokonywany na rachunek uprawnionego odbiorcy.

Oszustwa wykorzystujące socjotechnikę cały czas ewoluują. Po wstępnym zainteresowaniu ofiary, przestępcy kontaktują się bezpośrednio – czy to przez telefon, czy komunikator – nakłaniając do bardziej skomplikowanych działań, które ostatecznie mają na celu wyłudzenie i kradzież pieniędzy. Coraz częściej zmanipulowane ofiary same przelewają środki na wskazane konta i rachunki, do samego końca nie mając świadomości oszustwa. Skalę tego zjawiska potwierdzają dane publikowane przez NBP (NBP, 2025). Zmieniając od 2024 r. metodologię agregowanych danych, uwzględniono szerszy zakres rodzajów transakcji oszukańczych, w tym przede wszystkim oszustwa powstałe w wyniku zmanipulowania płatnika. W przypadku fraudów z wykorzystaniem polecenia przelewu w 2024 r. banki zaraportowały straty na poziomie 557,5 mln zł (140 mln USD). Jak się okazuje, oszustwa wynikające z manipulacji płatnikiem odpowiadały za zdecydowaną większość, bo średnio 70% wartości wszystkich zaraportowanych oszustw (62% w I, 67% w II, 75% w III i 77% w IV kwartale 2024 r.). Uwzględniając transakcje oszukańcze na kartach płatniczych, łączne straty w 2024 r. wynosiły w Polsce 654 mln zł, z czego 394 mln zł (60%) wynikały z manipulacji płatnikiem. Dla porównania w Wielkiej Brytanii w tym samym okresie było to ok. 38% (Harley-McKeown, 2025). Dane te wskazują jednoznacznie, że największym wyzwaniem sektora bankowego w Polsce są przede wszystkim oszustwa dokonywane przez samych klientów, zmanipulowanych i wprowadzonych w błąd przez przestępców.

### **Zalecenia nadzorcze jako odpowiedź na rosnące zagrożenia cyberprzestępczości**

Rosnąca liczba przestępstw i wartość utraconych środków, które znacząco zwiększyły się wraz z wykorzystaniem przez przestępców nowych metod manipulacji socjotechnicznej użytkowników, wzbudziły duże zainteresowanie administracji państwowej, w tym przede wszystkim Urzędu Komisji Nadzoru Finansowego oraz Urzędu Ochrony Konkurencji i Konsumentów. W lutym 2021 r. przewodniczący KNF w liście skierowanym do sektora bankowego podkreślił, że dostawcy usług finansowych powinni konsekwentnie stosować paradygmat określany jako *security first*. W praktyce miało to oznaczać stawianie kwestii bezpieczeństwa na pierwszym miejscu. Wdrażając nowe usługi, banki i pozostałe instytucje finansowe powinny brać pod uwagę istniejące i nowe trendy ataków,

sposoby działania cyberprzestępców, a także ryzyka wynikające z planowanych przez dostawcę działań, nie tylko wobec swoich klientów, ale również w kontekście potencjalnego wpływu tych działań na cały sektor usług (Jastrzębski, 2021). Pismo przewodniczącego KNF jest przykładem tzw. miękkiej rekomendacji. Chociaż nie miało wiążącego charakteru dla banków, jak wydawane przez Urząd rekomendacje, to w praktyce ma podobne znaczenie. Sam ten fakt dowodzi, jak ogromne znaczenie Komisja kładzie na zagadnienie cyberbezpieczeństwa i edukacji. Większość instytucji na bieżąco reaguje na nowe formy ataków, informując o tym swoich użytkowników poprzez zamieszczanie na swoich stronach internetowych odpowiednich komunikatów i alertów. W opinii KNF działania te są jednak niewystarczające i nie przynoszą spodziewanych efektów, o czym świadczy skala skutecznych ataków na użytkowników usług bankowych i związany z tym poziom fraudów. Według Urzędu banki nie powinny się też koncentrować wyłącznie na swoich klientach, ale prowadzić szeroką kampanię dotyczącą cyberbezpieczeństwa (Forsal.pl, 2021). Również w 2021 r. prezes Urzędu Ochrony Konkurencji i Konsumentów wszczął postępowanie wyjaśniające, w ramach którego Urząd miał sprawdzić, jak banki rozpatrują reklamacje konsumentów związane z kradzieżą pieniędzy z konta oraz jakie stosują mechanizmy uwierzytelniania transakcji. Wezwania do przedstawienia wyjaśnień i przekazania dokumentów w tych sprawach zostały wysłane do osiemnastu banków (UOKiK, 2021). Powodem takiego działania była rosnąca liczba skarg od konsumentów dotyczących kradzieży pieniędzy z konta lub zaciągnięcia zobowiązania na ich dane. Klienci zgłaszali do UOKiK problem utraty oszczędności oraz nieuznawania reklamacji przez banki. Same zgłoszenia dotyczyły między innymi podszywania się przez oszustów pod pracownika infolinii banku, wykorzystywania fałszywej strony internetowej banku czy oprogramowania szpiegującego w celu wyłudzenia danych. Postępowaniem wyjaśniającym objęto w zasadzie wszystkie największe banki komercyjne w Polsce. Zebrany w ciągu roku materiał dowodowy pozwolił postawić pierwszym bankom zarzuty naruszania zbiorowych interesów konsumentów. W toku postępowania wyjaśniającego, prezes UOKiK ustalił również, że banki mogły wprowadzać w błąd w odpowiedziach na reklamacje dotyczące nieautoryzowanych transakcji. Jest to o tyle istotne, ponieważ za naruszenie zbiorowych interesów konsumentów bankom grożą kary nawet do 10% obrotu (UOKiK, 2024). UOKiK nakazał również, by banki zwróciły klientom pieniądze z tytułu nieautoryzowanych transakcji w terminie D+1, czyli do końca następnego dnia roboczego po zgłoszeniu nieautoryzowanej transakcji. Urząd powołał się na art. 46 Ustawy o usługach płatniczych (Dziennik Ustaw, 2011) będącej implementacją przepisów unijnych. Obowiązek ten został potwierdzony w oficjalnych komunikatach UOKiK, m.in. w 2022 r. i 2024 r., kiedy zostały wszczęte postępowania wobec kilku banków za bezprawną odmowę zwrotu środków w wymaganym przez Urząd terminie (UOKiK, 2022b; UOKiK, 2024). Wyjątki od tej zasady dotyczą jedynie sytuacji, kiedy zgłoszenie nastąpiło później niż 13 miesięcy po transakcji lub istnieje uzasadnione podejrzenie oszustwa ze strony klienta. W takim przypadku, jeśli bank ma takie podejrzenie, musi obowiązkowo zawiadomić organy ścigania. Podobne podejście do zwrotu środków w terminie D+1 zaprezentował Rzecznik Finansowy (2023). Również UKNF co do zasady przychylił

się do takiego podejścia, zwracając jednak uwagę na konieczność walki z przestępczością w obszarze płatności elektronicznych. Komisja wskazała na potrzebę zrównoważenia ochrony konsumentów, z jednoczesnym rozwijaniem przez sektor bankowy mechanizmów prewencyjnych.

Celem szeregu zaleceń opracowanych dla banków przez UOKiK jest zwiększenie skuteczności walki ze zjawiskiem nieautoryzowanych transakcji płatniczych. Szczególne znaczenie ma przy tym wykorzystanie nowoczesnych technologii, w tym stosowanie systemów opartych na sztucznej inteligencji lub biometrii behawioralnej, która może być skutecznym narzędziem zwiększającym bezpieczeństwo transakcji oraz elementem wieloskładnikowego uwierzytelnienia klienta. Biometrię behawioralną, zdaniem Urzędu, można stosować nie tylko przy logowaniu, ale również przy skracaniu okresu tzw. funkcji *cooling period*, czyli opóźnienia wykonania transakcji od złożenia dyspozycji w systemie przez klienta do czasu jej wykonania przez dostawcę. Jest ona rekomendowana ze względu na maksymalne ograniczenie ryzyka ingerencji osoby trzeciej. Podobne zastosowanie biometrii behawioralnej zalecane jest przy okazji aktywacji w bankowości mobilnej lub internetowej funkcji uprzednio niedostępnej lub samodzielnie zablokowanej przez konsumenta.

### **Charakterystyka i zasada działania biometrii behawioralnej**

W kontekście wymienionych zagrożeń rozwiązaniem, które pozwala na skuteczną, a przy tym nieinwazyjną ochronę klienta, jest biometria behawioralna. Biometria to nauka rozpoznawania jednostek na podstawie ich fizycznych lub behawioralnych cech (Jain i in., 2006). Wykorzystując technologię cyfrową można identyfikować i weryfikować osoby na podstawie ich cech fizycznych lub behawioralnych.

Przystępując do analizy zastosowania biometrii w systemach bankowych, należy doprecyzować pojęcie identyfikacji i uwierzytelnienia, ponieważ ich definicje różnią się w zależności od dziedziny. W obszarze bezpieczeństwa informatycznego proces identyfikacji polega na przedstawieniu przez użytkownika deklaracji swojej tożsamości. Najczęściej dzieje się to poprzez podanie unikalnego identyfikatora jakim jest na przykład login. Uwierzytelnienie jest w tym przypadku weryfikacją i potwierdzeniem, że użytkownik jest tym, za kogo się podaje. W literaturze przedmiotu dotyczącej biometrii behawioralnej pojęcia te funkcjonują w nieco innym znaczeniu. Identyfikacja biometryczna oznacza porównanie próbki z całą bazą danych wzorców w celu ustalenia tożsamości nieznanej osoby, a weryfikacja oznacza z kolei porównanie próbki z jednym, konkretnym wzorcem biometrycznym przypisanym do konkretnej tożsamości (Kałużny i Stolarski, 2019). Dla zachowania przejrzystości i spójności artykułu, przyjęto konwencję stosowaną w praktyce cyberbezpieczeństwa systemów IT. W takim przypadku biometria behawioralna pełni funkcję narzędzia uwierzytelnienia. Oznacza to, że w procesie klient najpierw dokonuje identyfikacji w momencie podania loginu, a następnie przechodzi proces uwierzytelnienia podając hasło. Biometria jest w tym przypadku dodatkową, działającą w tle

warstwą zabezpieczeń, która w sposób ciągły weryfikuje użytkownika. Służy do potwierdzenia, że osoba zalogowana jest prawowitym właścicielem rachunku.

Tradycyjna biometria opiera się na niezmiennych cechach fizycznych użytkownika i jest stosowana głównie do jednorazowej identyfikacji lub weryfikacji. Biometria behawioralna analizuje i profiluje zachowania użytkowników, takie jak sposób korzystania z urządzeń np. telefonu, tempa pisania na klawiaturze czy charakterystycznych ruchów myszą (Karnan i in., 2011). Liczba indywidualnych cech jest znacznie szersza i wraz z rozwojem technologii oraz urządzeń cały czas rośnie. W ramach analizy behawioralnej może być badanych łącznie nawet kilkaset różnych czynników.

Istotną cechą zastosowania biometrii behawioralnej jest fakt, że ocena zgodności zebranych danych z przechowywanym wzorcem nie musi być zawsze taka sama i jednoznaczna. Dzieje się tak nie tylko zarówno w przypadku pojedynczego zalogowania, ale również w czasie trwania dłuższej sesji, w czasie której zgodność ta może ulegać zmianom. Dynamika korzystania z klawiatury komputera i ruchu myszki, czy korzystania ze smartfonu, może się różnić w zależności od pory dnia pomiędzy różnymi dniami w dłuższym okresie, a także może być uzależniona od wielu różnych czynników zewnętrznych. Przykładowo może to być korzystanie z telefonu w autobusie, złamana ręka, zmieniona myszka komputerowa etc. Pomimo takiej zmienności nowoczesne systemy biometryczne dostosowują się do nowych warunków, a także wykazują zgodność w sposób powtarzalny w większości badanych przypadków. Potencjalne zmiany zachowania, po przednim potwierdzeniu dodatkową autoryzacją, rozbudowują profil użytkownika, dając również wsad do ogólnego wzorca zmian.

### **Zastosowanie biometrii behawioralnej w przeciwdziałaniu fraudom i przejęciom kont**

Stosując biometrię behawioralną, bank ma możliwość wykrycia różnic w zachowaniu użytkownika oraz odróżnić zachowania przestępcy od zachowania posiadacza rachunku, którego wzorzec dla celów porównawczych wcześniej pozyskał. Pozwala mu to na podjęcie odpowiedniej reakcji, czy to blokady dostępu do rachunku czy konkretnej transakcji, do czasu uzyskania dodatkowego uwierzytelnienia. Istotną zaletą takiego rozwiązania jest również działanie w tle, które nie wpływa na codzienne korzystanie z kanałów zdalnych, a także ochrona wszystkich klientów, również takich, którzy cechują się mniejszym poziomem świadomości zagrożeń i w konsekwencji utraty dostępu do rachunku. Biometria może być jednocześnie wykorzystywana równolegle razem z innymi rozwiązaniami zabezpieczającymi dostęp do bankowości elektronicznej, takimi jak silne uwierzytelnienie klienta, *device fingerprinting*, analiza ryzyka transakcji etc.

W stosunku do innych rodzajów zabezpieczeń biometria behawioralna z punktu widzenia sektora finansowego posiada niewątpliwe zalety. Należą do nich:

1. Ciągła weryfikacja tożsamości użytkownika. W przeciwieństwie do standardowych metod uwierzytelniania, w tym klasycznej biometrii, weryfikujących tożsamość w momencie logowania lub autoryzacji transakcji, biometria behawioralna umożliwia stałe

- monitorowanie zachowania użytkownika podczas całej sesji (PingIdentity.com, n.d.), natychmiastowe wykrywanie ewentualnych anomalii wskazujących na nieautoryzowane przejście dostępu (Ghiciuc, 2024) oraz działanie w tle bez ingerencji w doświadczenie użytkownika. Znacząco zwiększa to bezpieczeństwo, eliminując lub ograniczając ataki polegające na przejęciu sesji, czy oszustwa zdalnego dostępu. W takim przypadku system wykryje nagłe anomalie, czego nie są w stanie tak dobrze zatrzymać czy wysledzić inne stosowane przez banki metody, takie jak *device fingerprinting* czy silna identyfikacja klienta.
2. Skuteczność w wykrywaniu zaawansowanych oszustw. Biometria behawioralna jest szczególnie skuteczna w wykrywaniu ataku typu *Account Takeover Fraud*, w którym oszust przejmuje konto ofiary, posiadając prawidłowe dane do logowania (Mórawski, 2023). W połączeniu z innymi danymi analiza biometryczna może też przyczynić się do identyfikacji manipulacji socjotechnicznych. Ofiara ataku działa pod wpływem manipulacji, a jej zachowanie w stresie różni się od standardowego wzorca (Lidke, 2024a). Wykorzystując żyroskop aplikacji mobilnej banku, wymaganej do autoryzacji przelewu lub dzięki współpracy z telekomami, bank może sprawdzić, czy klient podczas korzystania z bankowości elektronicznej prowadzi równolegle rozmowę telefoniczną. Pomaga to wytypować podejrzaną transakcję. Mimo licznych fałszywych sygnałów, tzw. *false positive*, klienci, którzy wyrazili zgodę na wykorzystanie analizy behawioralnej, padają wielokrotnie rzadziej ofiarą oszustów niż pozostali (Baglajewski, 2024).
  3. Skuteczny i samouczący się mechanizm działania. Biometria behawioralna działa efektywnie ze względu na jej zaawansowane mechanizmy samo uczenia, oparte na uczeniu maszynowym. Systemy te tworzą indywidualny profil zachowania każdego, pojedynczego użytkownika. Pozwala to stworzyć charakterystyczne wzorce interakcji użytkownika z urządzeniem, a także analizy mikrozachowań, takich jak: dynamika korzystania z klawiatury, sposób trzymania telefonu, tempo pisanie, etc. Wzory te dostosowują się do zmieniającego się wieku, miejsca korzystania z urządzenia, etc. W połączeniu z automatycznymi reakcjami na anomalie, takimi jak możliwość zablokowania lub spowolnienia wykonania podejrzaną transakcji, daje to czas na dodatkowe uwierzytelnienie użytkownika oraz ewentualną aktualizację jego profilu. Ten sposób pozwala lepiej zweryfikować klientów w sytuacji, w której mogą dobrze nie działać inne zabezpieczenia, takie jak *device fingerprinting*. Niezależnie czy klient loguje się na danym urządzeniu pierwszy raz, korzysta z VPN, czy czyści ciasteczka w przeglądarce, jego indywidualny profil behawioralny umożliwia bankowi łatwiejszą identyfikację użytkownika, a tym samym zwiększa skuteczność stosowanych zabezpieczeń.
  4. Możliwość sektorowego współdzielenia informacji pomiędzy uczestnikami centralnej platformy technologicznej. Biometria behawioralna umożliwia szybką i skuteczną wymianę informacji pomiędzy bankami w celu wykrywania nieautoryzowanych transakcji. Model taki

pozwała na wymianę informacji o wzorcach zachowań pomiędzy wszystkimi użytkownikami oraz zwiększa skuteczność wykrywania fraudów. Oszust, przejmujący konto w jednym banku, jest łatwo i automatycznie identyfikowany w drugim – nie tylko w kontekście logowania danymi klienta, ale również w przypadku podszywania się pod niego, na przykład w celu wyłudzenia kredytu czy założenia rachunku bankowego (Uryniuk, 2024a).

Ważną cechą biometrii behawioralnej jest fakt, że ocena zgodności zebranych danych z przechowywanym wzorcem nie jest zawsze taka sama i jednoznaczna. System przy każdym logowaniu klienta porównuje zebraną próbkę z posiadanym uprzednio wzorcem. W ten sposób za każdym logowaniem, bazując na stopniu prawdopodobieństwa, wyliczany jest poziom zgodności. Może on za każdym razem nieco się różnić. Chcąc zwiększyć poziom bezpieczeństwa bank może wymagać wysokiego poziomu zgodności próbki z wzorcem. Występująca zmienność tego parametru może w takim przypadku prowadzić do zbyt częstego, niezamierzonego blokowania klientów (*False Rejection Rate*). Niższy wskaźnik akceptacji prowadzi z kolei do zwiększenia ryzyka nieautoryzowanego dostępu, czyli wpuszczenia do systemu bankowego oszusta (*False Acceptance Rate*). To znany od początku bankowości elektronicznej dylemat, jakim jest znalezienie odpowiedniego balansu pomiędzy skuteczną ochroną przed cyberprzestępcami, a wygodą klienta. Zbyt restrykcyjne podejście prowadzi do wymogu częstego, dodatkowego potwierdzania wykonywanych operacji lub wręcz do blokowania kanałów dostępu. Biometria behawioralna bardzo dobrze sprawdza się jako dodatkowy, ale nie jedyny element systemu zabezpieczeń. Stosowane w niej rozwiązania pozwalają procentowo określić, czy w danej chwili z systemu korzysta właściwy użytkownik, czy też ktoś, kogo wzorce zachowań znacząco różnią się od stworzonego wcześniej indywidulanego profilu behawioralnego. W przypadku rozwiązania sektorowego możliwe jest dodatkowo łatwiejsze wykrycie przestępcy, który przejąwszy tożsamość ofiary wykorzystuje jej dane do rozpoczęcia relacji, czyli założenia konta bankowego lub zaciągnięcia kredytu przez internet. Wykorzystanie biometrii behawioralnej pozwala bankom na elastyczność i znalezienie punktu przecięcia (*Equal Error Rate*) w zależności od zbieranych w sposób ciągły danych i kontekstu transakcji. Rozwiązanie to dostarcza cały czas procentowy wskaźnik zgodności, który w praktyce można interpretować w trzystopniowej skali: wysokiego, średniego i niskiego zaufania. Pozwala to na optymalizację procesu doświadczenia klienta, przy zachowaniu wysokiego poziomu cyberbezpieczeństwa. Systemy antyfraudowe mogą w ten sposób być bardziej restrykcyjne w przypadku przelewów wysokokwotowych lub odbiegających od reguły i odpowiednio mniej, jeśli klient dokonuje typowe operacje. Zwiększa to ergonomię korzystania z systemów bankowości elektronicznej, bez zmniejszania ochrony przed przestępcami.

Skuteczność zabezpieczania klienta rośnie wraz z połączeniem biometrii behawioralnej z innymi, równolegle funkcjonującymi rozwiązaniami. Dodatkowe i niezależne od innych reguł dane, zwiększają skuteczność systemów antyfraudowych. Przykładem takiego rozwiązania jest powszechnie stosowany od czasów wdrożenia PSD2 rozwiązanie *device fingerprintingu*, czyli tzw. zaufanego

urządzenia. Ta technologia identyfikacji i śledzenia urządzenia bazuje na kombinacji atrybutów urządzenia i przeglądarki, z której korzysta klient. W połączeniu z tradycyjnymi atrybutami, takimi jak pliki cookies czy adresacja IP, tworzy indywidualny cyfrowy identyfikator urządzenia. W ten sposób system może wykryć, czy logowanie następuje z tego samego komputera co zazwyczaj czy z innego lub zidentyfikować nietypowy wzorzec dostępu. Wszystko to, w połączeniu z zebranymi przez system biometrii behawioralnej informacjami, ułatwia wykrycie potencjalnego, nieautoryzowanego dostępu do rachunku. W takim przypadku może nastąpić zablokowanie dostępu do bankowości elektronicznej lub wymuszenie dodatkowej weryfikacji klienta. Dzięki utworzonemu w ten sposób mikrowi technologicznemu bank chroni swoich klientów przed przejęciem konta, a tym samym przed transakcjami oszukańczymi. Tego typu mechanizm można implementować również w innych rozwiązaniach, na przykład do ochrony płatności kartą w internecie. Obecnie w Unii Europejskiej wymagana jest dodatkowa autoryzacja z wykorzystaniem standardu 3-D Secure, czyli dodatkowego narzędzia autoryzacji dostarczonego przez bank. Zaimplementowanie biometrii behawioralnej może stanowić ważny system zabezpieczeń, wskazujący na użycie karty przez osobę nieuprawnioną.

### **Bariery upowszechnienia biometrii behawioralnej i perspektywy rozwoju**

Biometria behawioralna w sposób istotny jest w stanie zwiększyć bezpieczeństwo klienta i banku oraz skutecznie przeciwdziałać oszustwom, nie zakłócając przy tym doświadczenia użytkownika (UX). Pierwsze wdrożenie biometrii behawioralnej w formie testów w polskim sektorze bankowym miało miejsce na przełomie 2018 r. i 2019 r. Projekt został zrealizowany przez mBank we współpracy z Centrum Bezpieczeństwa Cyfrowego S.A., spółką z portfela funduszu mAkcelerator (mBank, 2018). Na początku 2020 r. z tego samego rozwiązania zaczął korzystać ING Bank Śląski (Ostrowska, 2020), nieco później, w 2023 r., takie rozwiązanie wdrożył BNP Paribas, rok później Velo Bank, PKO Bank Polski oraz SKOK Stefczyka, a w 2025 r. – Credit Agricol Polska. Poza ostatnim bankiem, wszystkie instytucje korzystają z rozwiązania firmy Digital Fingerprint, która w 2022 r. została przejęta przez Biuro Informacji Kredytowej (Mamstartup.pl, 2022; BANK.pl, 2022). Pierwsze wdrożenia biometrii behawioralnej w mBank i ING Bank Śląski były realizowane w formie pilotażowej. Korzystać z takiego rozwiązania mogli jedynie klienci, którzy wcześniej przystąpili do pilotażu. Taki model współpracy pozwalał na bezpieczne przetestowanie nowej technologii na środowisku produkcyjnym, przy większym obciążeniu. W kontrolowany sposób można było dostosować wszystkie systemy antyfraudowe i reguły bezpieczeństwa. W komunikacie informującym o wdrożeniu, mBank podkreślał etyczność wprowadzonego rozwiązania. Klienci zainteresowani usługą, przed przystąpieniem do korzystania, musieli wyrazić zgodę na udział w pilotażu. Bank nie obejmował nią osób, które tego nie chciały. Jak informowano, w ramach biometrii behawioralnej oferowanej przez Digital Fingerprints, system miał analizować wyłącznie sposób interakcji klientów z urządzeniami podczas korzystania z usług bankowości elektronicznej mBanku. Nie pobierano danych na temat

korzystania z innych stron czy narzędzi. W komunikacji podkreślano jednocześnie, że rozwiązanie sprawdza, jak użytkownik korzysta z serwisu banku, a nie to, co w nim robi, a także fakt, że dane zbierane na potrzeby budowy profili behawioralnych nie zawierają żadnych wrażliwych informacji. Same profile były przechowywane w formie modeli matematycznych, które uniemożliwiają przechowywającej je spółce oraz innym podmiotom identyfikację konkretnej osoby. Samemu użytkownikowi usługi przysługiwało prawo do zapomnienia, czyli usunięcia jego danych (Palczewski, 2018). Tego typu podejście do oferowania biometrii behawioralnej jest typowe dla większości banków wprowadzających tę usługę. Klient jest zachęcany do aktywacji usługi, która wymaga wyrażenia jednoznacznej zgody, w tym akceptacji regulaminu.

Mimo niewątpliwych zalet wynikających z korzystania z biometrii behawioralnej, odsetek klientów objętych tym rozwiązaniem w bankach, które go wprowadziły, jest stosunkowo niski. W ING Banku Śląskim po 3 latach od wdrożenia wynosił on 27% (CCNews, 2024). mBank, który jako pierwszy wprowadził takie rozwiązanie nie informował publicznie o liczbie klientów objętych taką usługą, jednak z zagregowanych informacji o całym rynku, które były prezentowane na Konferencji Antyfraudowej BIK 2024 wynikało, że procent ten był znacznie niższy niż w ING Banku Śląskim (Wójciecki, 2024). Analiza danych wykazała również, że taką usługę włączały przede wszystkim osoby, które już wcześniej były bardziej świadome zagrożeń w sieci. Tacy klienci stanowili przy tym minimalny odsetek wśród wszystkich oszukanych klientów ING Banku Śląskiego – było to mniej niż 4%, a w niektórych miesiącach ich udział spadał poniżej %. W rezultacie takiej sytuacji użytkownicy, którzy nie korzystają z rozwiązania biometrii behawioralnej, to jednocześnie klienci, którzy ze względu na poziom wiedzy i doświadczenia w korzystaniu z usług cyfrowych są bardziej narażeni na działania przestępców. Na włączenie nowej usługi decydują się dopiero w momencie, kiedy zostaną oszukani (Uryniuk, 2023).

Wśród wyzwań związanych z wdrożeniem i funkcjonowaniem biometrii behawioralnej, za najważniejsze uważa się niechęć klientów do udzielenia zgody na korzystanie z takiego rozwiązania. Innym wyzwaniem jest duża liczba sesji klienckich bez pozyskania danych, na przykład w sytuacji logowania się na konto z nowego telefonu. Budowa profilu biometrycznego klienta wymaga co najmniej kilku logowań. Dopiero wówczas pozyskane dane stanowią dobrą podstawę do prawidłowej weryfikacji tożsamości. Technologia zastosowana w bankowości mobilnej różni się dodatkowo od tej, która jest wykorzystywana na komputerze. Jest to o tyle duże wyzwanie, że coraz większa część klientów to tzw. klienci *mobile only*, którzy tylko w wyjątkowych sytuacjach korzystają z bankowości internetowej, a nawet jeśli już, to korzystają z niej na telefonie komórkowym, a nie na komputerze stacjonarnym. Systemy mają również problem w sytuacji współdzielenia loginu do rachunków, na przykład przez współmałżonków. Taka sytuacja powoduje, że generowana jest duża liczba fałszywych alarmów, kiedy prawowity użytkownik konta jest weryfikowany negatywnie. Wszystkie te elementy powodują, że pomimo teoretycznie wysokiej skuteczności biometrii behawioralnej, w praktyce jedynie ograniczona liczba klientów jest objęta taką ochroną – znacznie niższa niż sama liczba pozyskiwanych zgód. Wynika to z jednej strony z długotrwałego procesu budowania profilu, z drugiej strony z wielu sytuacji, które

wywołują fałszywe alarmy. W takim przypadku brak dodatkowego, skutecznego i taniego sposobu potwierdzania tożsamości klienta tworzy ogromne wyzwania przy zastosowaniu biometrii behawioralnej jako masowej, silnej metody weryfikacji. W konsekwencji rozwiązanie to staje się niszowe. Wymaga zgody klienta, a później stosunkowo długiego okresu budowania jego profilu. Okres ten może trwać nawet do kilku miesięcy i jest uzależniony od częstotliwości logowania się klientów do serwisu bankowości internetowej.

Biorąc pod uwagę wszystkie te elementy oraz koszty związane z wdrożeniem, utrzymaniem oraz promocją wśród klientów takiego rozwiązania, należy dojść do wniosku, że pomimo niewątpliwych zalet biometrii behawioralnej w codziennym jej zastosowaniu, wydaje się ona mało skuteczna i nieefektywna. Główną barierą w jej wykorzystaniu jest przede wszystkim wymóg pozyskania dobrowolnej i świadomej zgody od klienta. Wynika to z faktu, że korzystanie z takiej technologii stanowi głęboką ingerencję w prawo do prywatności osób fizycznych, które jest zagwarantowane w art. 8 ust. 1 Karty Praw Podstawowych Unii Europejskiej (Unia Europejska, 2012), art. 47 i art. 51 Konstytucji RP (Zgromadzenie Narodowe, 1997) oraz w Rozporządzeniu Parlamentu Europejskiego i Rady Unii Europejskiej 2016/679 z dnia 27 kwietnia 2016 r. (Unia Europejska, 2016). w sprawie ochrony osób fizycznych w związku z przetwarzaniem danych osobowych i w sprawie swobodnego przepływu takich danych. Dane biometryczne traktowane są jako dane szczególnej kategorii w rozumieniu art. 9 ust. 1 RODO w zw. z art. 6 RODO. Zgodnie z definicją danych biometrycznych, zawartą w art. 4 pkt 14 RODO, pojęcie „dane biometryczne” oznacza dane, które wynikają ze specjalnego przetwarzania technicznego, dotyczą cech fizycznych, fizjologicznych lub behawioralnych osoby fizycznej oraz umożliwiają lub potwierdzają jednoznaczną identyfikację tej osoby. To zaś oznacza, że poza odstępstwem związanym z ważnym interesem publicznym, użytkownik musi być w pełni poinformowany i wyrazić zgodę na przetwarzanie takich danych. Taka zgoda musi wyraźnie odróżniać się od pozostałych kwestii poruszanych w umowie z klientem, a osoba, której dane dotyczą, musi wyraźnie ją zaakceptować. Nie może to być zatem zgoda domniemana, a odmowa nie powinna wpływać niekorzystnie na sytuację klienta. Takie stanowisko polskiego Urzędu Ochrony Danych Osobowych z marca 2024 r. w zasadzie zamyka drogę do upowszechnienia biometrii bez zgody klienta, tak jak chciały to banki, bazując na podstawie art. 10 Ustawy o usługach płatniczych (Uryniuk, 2024b). Wskazuje on, że dostawcy, organizacje płatnicze i podmioty prowadzące systemy płatności przetwarzają dane osobowe w zakresie niezbędnym do zapobiegania oszustwom związanym z wykonywanymi usługami płatniczymi, prowadzeniem schematu płatniczego lub prowadzeniem systemu płatności oraz dochodzenia i wykrywania tego rodzaju oszustw przez właściwe organy. UODO stwierdzając, że dane behawioralne to dane biometryczne potwierdził, że banki nie mogą ich wykorzystywać bez zgody klienta (Lidke, 2024b).

Mając na uwadze jednoznaczne sformułowania RODO, banki oraz oferujące rozwiązanie Biuro Informacji Kredytowej zrezygnowały z korzystania z dotychczasowej i upowszechnionej nazwy biometria behawioralna, a zaczęły korzystać z alternatywnej – weryfikacja lub analiza behawioralna.

Jednym z argumentów był fakt, iż pojęcie biometrii budzi zastrzeżenia wśród klientów banków, dlatego warto posługiwać się precyzyjnymi pojęciami, biorąc pod uwagę istotne prawnie różnice pomiędzy metodami biometrycznymi, a analizą behawioralną (Mórawski, 2023). Ogromne znaczenie nabiera również edukacja klientów w zakresie bezpieczeństwa, zwłaszcza że większość użytkowników odczuwa obawy dotyczące przetwarzania ich danych. Wskazywaną alternatywą jest też zmiana sposobu pozyskiwania zgody klientów, czego przykładem może być PKO Bank Polski, który przełamał barierę braku wyrażania przez klientów zgody, łącząc ją z korzyściami UX i bezpieczeństwa. Bank zrezygnował przy logowaniu do bankowości internetowej z nowo wprowadzonej każdorazowej, dwuetapowej weryfikacji klientów, którzy wyrazili taką zgodę. Mogą oni również ustawić znacznie wyższy maksymalny dzienny limit przelewów przez internet. Klienci z mobilną autoryzacją, ale bez zgody na biometrię mogą przelać maksymalnie 200 tys. złotych, podczas gdy dla klientów ze zgodą maksymalny limit wynosi 300 tys. Działania te spowodowały, że bank w niecały rok od wdrożenia rozwiązania pozyskał ponad 60% zgód od aktywnych klientów bankowości internetowej (Lidke, 2025). Bank zdecydował się również na wejście w rozwiązanie sektorowe Biura Informacji Kredytowej, co zwiększy skuteczność całej platformy dla innych uczestników (Uryniuk, 2024a). Chociaż takie rozwiązanie okazało się skuteczne, to instytucja ta nie ustrzegła się od negatywnych opinii w mediach, w których zwracano uwagę na zastosowany schemat pozyskiwania zgód. Chociaż tego typu artykułów czy komentarzy nie było dużo, to wskazywały na negatywne podejście części klientów.

### **Analiza SWOT biometrii behawioralnej w bankowości**

W celu znalezienia odpowiedzi na pytanie, czy biometria behawioralna może stanowić ważny element w redukcji najczęściej występujących oszustw finansowych w Polsce, przeprowadzono analizę SWOT. Zaproponowana metoda jest jedną z technik diagnozy strategicznej. W swojej istocie służy poszukiwaniu, gromadzeniu i porządkowaniu danych o czynnikach determinujących i wpływających na organizację, system lub rozwiązanie, przedstawionych w przejrzystej i czytelnej formie. Zaproponowana w badaniu analiza może pomóc określić najlepszy kierunek rozwoju biometrii behawioralnej w kontekście wpływu zarówno czynników zewnętrznych, jak i wewnętrznych. Analiza rozpoczyna się od identyfikacji mocnych i słabych stron biometrii behawioralnej stosowanej przez polskie banki, ale także rozpoznania pojawiających się szans i zagrożeń z otoczenia – podejście powszechnie znane jako analiza SWOT (Strengths, Weaknesses, Opportunities, Threats). Zidentyfikowane czynniki wpływające na skuteczność wykorzystania biometrii behawioralnej podzielono na zbiory i przypisano im wagi, tworząc macierz składającą się z czterech pól S/W/O/T. Poziomy wag zostały określone zgodnie z wiedzą autorów na temat potencjalnego wpływu poszczególnych czynników, co przedstawia Tabela 1.

**Tabela 1***Czynniki analizy SWOT wykorzystania biometrii behawioralnej w bankowości*

| Czynniki wewnętrzne<br>S-Strengths                                                                                                                                                                                                                                                                                                                               | Waga | Czynniki wewnętrzne<br>W-Weaknesses                                                                                                                                                                                                                                                                                                                                                                   | Waga |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>S1 - Ciągła i nieinwazyjna weryfikacja:</b> biometria behawioralna działa w tle, monitorując użytkownika przez cały czas trwania sesji, wychytując odstępstwa od profilu, bez wpływu na jego doświadczenie (UX).                                                                                                                                              | 0,3  | <b>W1 – Niski poziom akceptacji wśród klientów:</b> wymóg uzyskania świadomej i dobrowolnej zgody klienta na przetwarzanie danych biometrycznych jest kluczową barierą umasowienia tej technologii                                                                                                                                                                                                    | 0,4  |
| <b>S2 – Wykrywanie zaawansowanych zagrożeń:</b> technologia pozwala na identyfikację oszustw typu <i>Account Takeover Fraud</i> (przejęcie konta), nawet kiedy przestępca dysponuje danymi do logowania lub wykorzystuje oprogramowanie do zdalnego dostępu do komputera. Może wykrywać anomalie w zachowaniu wskazujące na manipulację socjotechniczną klienta. | 0,4  | <b>W2 – Długi proces budowania profilu:</b> system potrzebuje co najmniej kilku logowań do stworzenia profilu behawioralnego klienta. W przypadku rzadko logujących się klientów może to trwać kilka miesięcy.                                                                                                                                                                                        | 0,15 |
| <b>S3 – Samouczący się mechanizm:</b> system oparty na uczeniu maszynowym tworzy unikalne, dynamiczne profile dla każdego użytkownika, adaptując je do naturalnych zmian w zachowaniu klienta.                                                                                                                                                                   | 0,15 | <b>W3 – Wysokie ryzyko fałszywych alarmów:</b> nietypowe, chociaż normalne działania klienta takie jak zmiana nawyków, czy inne urządzenie mogą być błędnie interpretowane przez system jako atak. Przy zbyt rygorystycznym podejściu może to powodować niepotrzebne blokady lub alerty, obniżając wygodę korzystania. Niższy poziom zgodności zwiększa prawdopodobieństwo nieautoryzowanego dostępu. | 0,15 |
| <b>S4 – Wzmocnienie systemów antyfraudowych:</b> Biometria behawioralna jest ważnym uzupełnieniem innych zabezpieczeń, takich jak zaufane urządzenie, czy silne uwierzytelnienie, wspierając wielowarstwowy system ochrony.                                                                                                                                      | 0,15 | <b>W4 – Ograniczona skuteczność przy oszustwach opartych na socjotechnice:</b> biometria behawioralna nie jest dostatecznie skuteczna przy transakcjach płatniczych dokonywanych przez klientów zmanipulowanych przez przestępców.                                                                                                                                                                    | 0,3  |
| Czynniki zewnętrzne<br>O-Opportunities                                                                                                                                                                                                                                                                                                                           |      | Czynniki zewnętrzne<br>T-Threats                                                                                                                                                                                                                                                                                                                                                                      |      |
| <b>O1 – Rosnąca skala fraudów:</b> Wzrost wartości oszustw finansowych (blisko dziesięciokrotny w latach 2019–2024) tworzy pilną potrzebę wdrażania nowych, skutecznych sposobów zabezpieczenia bankowości elektronicznej.                                                                                                                                       | 0,3  | <b>T1 – Bariery prawne i regulacyjne:</b> restrykcyjna interpretacja RODO przez Urząd Ochrony Danych Osobowych klasyfikuje dane behawioralne jako dane biometryczne szczególnej kategorii. Banki muszą pozyskiwać dobrowolną zgodę od klienta, co uniemożliwia szybkie objęcie ochroną większej grupy użytkowników.                                                                                   | 0,4  |
| <b>O2 – Możliwość budowy rozwiązania sektorowego:</b> współdzielenie informacji                                                                                                                                                                                                                                                                                  |      |                                                                                                                                                                                                                                                                                                                                                                                                       |      |

|                                                                                                                                                                                                                                                                                                                                                  |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| o wzorcach zachowań klientów pomiędzy bankami (np. w ramach platformy BIK) pozwala na szybszą identyfikację oszusta.                                                                                                                                                                                                                             | 0,2  | <b>T2 – Obawy o prywatność:</b> klienci obawiają się o prywatność i niechętnie wyrażają zgody pozwalające analizować ich zachowanie w sieci, co utrudnia masowe wykorzystanie technologii.                                                                                                                                                                                                                                                                             | 0,2 |
| <b>O3 – Rozwój technologiczny:</b> postęp w dziedzinie AI i uczenia maszynowego zwiększa skuteczność i szybkość weryfikacji behawioralnej. Sztuczna inteligencja może ułatwić wykrywanie subtelnych anomalii w czasie rzeczywistym i sprzyjać lepszemu dostosowaniu do nowych metod ataków.                                                      | 0,1  | <b>T3 – Rozwój nowych metod ataków:</b> masowe wykorzystanie <i>deepfake</i> 'ów i narzędzi AI tworzy zupełnie nowe zagrożenia i może ułatwiać jeszcze lepszą manipulację większej grupy klientów. Nowe mechanizmy mogą również skuteczniej odtwarzać zachowania klienta lub omijać stosowane zabezpieczenia.                                                                                                                                                          | 0,1 |
| <b>O4 – Zgodność z zaleceniami regulatorów:</b> urzędy takie jak UKNF i UOKiK bezpośrednio wskazują biometrię behawioralną jako narzędzie do walki z fraudami.                                                                                                                                                                                   | 0,25 | <b>T4 – Ryzyko nadużyć mechanizmu zwrotu środków w D+1:</b> UOKiK interpretuje przepisy w taki sposób, że banki mają obowiązek zwracania klientom pieniądze z tytułu nieautoryzowanych transakcji w terminie D+1, czyli do końca następnego dnia roboczego po zgłoszeniu nieautoryzowanej transakcji. Tworzy to nowe ryzyko finansowe dla banków, ponieważ przestępcy mogą masowo składać fałszywe reklamacje i wykorzystywać asymetrię czasową do wyłudzenia środków. | 0,2 |
| <b>O5 – Nowe sposoby pozyskiwania zgód:</b> banki mogą wykorzystać UX i stosować zachęty, takie jak uproszczone logowanie (bez konieczności każdorazowej autoryzacji dwuetapowej) czy wyższe limity transakcyjne do łatwiejszej aktywacji usługi. Zgoda na biometrię behawioralną może pojawiać się cyklicznie przy każdym logowaniu do serwisu. | 0,15 | <b>T5 – Zwiększenie praw klienta po wdrożeniu PSD3/PSR:</b> planowane przepisy poszerzają katalog sytuacji uprawniających do zwrotu środków (np. błędne transakcje), co oznacza, że banki będą musiały zwracać klientom znacznie więcej pieniędzy i w szerszym zakresie niż dzieje się to obecnie.                                                                                                                                                                     | 0,1 |

Źródło: opracowanie własne.

Kolejnym krokiem była identyfikacja interakcji pomiędzy czynnikami zaklasyfikowanymi do poszczególnych kategorii, co zostało przedstawione w Tabeli 2. Zaprezentowana jest tam macierz zidentyfikowanych interakcji. Wartość 1 oznacza istnienie merytorycznie uzasadnionego powiązania między czynnikiem wewnętrznym, a czynnikiem zewnętrznym. Wartość 0 oznacza brak takiego powiązania.

**Tabela 2***Macierz Interakcji Strategicznych SWOT*

|    | O1 | O2 | O3 | O4 | O5 | T1 | T2 | T3 | T4 | T5 |
|----|----|----|----|----|----|----|----|----|----|----|
| S1 | 1  | 1  | 1  | 1  | 1  | 0  | 0  | 1  | 1  | 1  |
| S2 | 1  | 1  | 1  | 1  | 0  | 0  | 0  | 1  | 1  | 1  |
| S3 | 1  | 1  | 1  | 0  | 0  | 0  | 0  | 1  | 0  | 0  |
| S4 | 1  | 1  | 1  | 1  | 0  | 0  | 0  | 1  | 1  | 1  |
| W1 | 1  | 1  | 0  | 1  | 0  | 0  | 0  | 1  | 1  | 1  |
| W2 | 1  | 1  | 1  | 1  | 0  | 0  | 0  | 1  | 1  | 1  |
| W3 | 1  | 1  | 0  | 0  | 1  | 0  | 1  | 0  | 0  | 0  |
| W4 | 1  | 0  | 0  | 1  | 0  | 0  | 0  | 1  | 1  | 1  |

Źródło: opracowanie własne.

Analizę SWOT kończy podsumowanie wyników (w tym liczba i ważona liczba interakcji, będąca sumą powiązań) przedstawione w Tabeli 3. Zastosowano następujący zestaw pytań testowych:

1. Dla interakcji mocna strona – szansa (S–O): Czy dana mocna strona pozwala wykorzystać nadarzającą się okazję?
2. Dla interakcji mocna strona – zagrożenie (S–T): Czy dana mocna strona pomoże złagodzić dane zagrożenie?
3. Dla interakcji słaba strona – szansa (W–O): Czy konkretna słabość ogranicza możliwości wykorzystania danej okazji?
4. Dla interakcji słaba strona – zagrożenie (W–T): Czy określony słaby punkt zwiększa ryzyko związane z danym zagrożeniem?

Podsumowanie zawiera interpretację wyników, wskazującą jeden z czterech podstawowych typów strategii, która jest najbardziej odpowiednia dla biometrii behawioralnej w Polsce.

**Tabela 3***Zbiórce wyniki analizy SWOT*

| Strategia                       | Suma interakcji | Ważona suma interakcji |
|---------------------------------|-----------------|------------------------|
| S/O (maxi–maxi) – agresywna     | 16              | 4,15                   |
| S/T (maxi–mini) – konserwatywna | 10              | 2,7                    |
| W/O (mini–maxi) – konkurencyjna | 12              | 2,85                   |
| W/T (mini–mini) – defensywna    | 10              | 2,7                    |

Źródło: opracowanie własne.

Analiza kombinacji S/O wskazuje na duży potencjał wykorzystania biometrii behawioralnej przez polskie banki. Odpowiada to strategii silnej ekspansji i dynamicznego rozwoju. Jest to też strategia

o największym potencjale sukcesu. Strategia agresywna (maxi–maxi), z ważonym wynikiem 4,15, wskazuje na dominujący typ strategii. Znacząco przewyższa pozostałe opcje. Wskazuje to, że najbardziej efektywnym podejściem dla banków powinno być proaktywne wykorzystanie wewnętrznych atutów biometrii behawioralnej w celu maksymalizacji korzyści płynących z zewnętrznych szans rynkowych. Pozostałe wyniki należy interpretować w kontekście tej dominującej strategii. Strategia konkurencyjna na poziomie 2,85 wskazuje, że istnieje możliwość wykorzystania sprzyjających warunków rynkowych do przewyciężenia wewnętrznych słabości technologii. Niższe wyniki strategii konserwatywnej i defensywnej na poziomie 2,7 wskazują, że chociaż zagrożenia i ich interakcje ze słabościami muszą być zarządzane, to należy je mitygować, koncentrując wysiłek na działaniach ekspansywnych.

Największym wyzwaniem i barierą w rozwoju biometrii behawioralnej jest niski poziom akceptacji wśród klientów oraz zewnętrzne zagrożenie w postaci restrykcyjnych barier prawnych i regulacyjnych. Bez skutecznego rozwiązania tych dwóch elementów nie będzie możliwe wykorzystanie mocnych stron technologii. Wydaje się, że najłatwiej dokonać tego poprzez zmianę procesu pozyskiwania zgody klienta. Z przeszkody prawnej, jaką jest wymóg uzyskania świadomej i dobrowolnej zgody klienta na przetwarzanie danych biometrycznych, banki powinny stworzyć propozycję wartości dodanej. Powiązanie zgody na analizę behawioralną z korzyściami wygodnego korzystania z serwisów bankowości elektronicznej może znacząco zwiększyć wskaźnik akceptacji, a tym samym wyeliminować główną barierę rozwoju. W ten sposób będzie można wykorzystać pełny potencjał rozwiązania, wspartego rozwojem platformy sektorowej. Presja ze strony regulatorów zwiększa odpowiedzialność banków w kontekście transakcji nieautoryzowanych. Biometria może stanowić w takim przypadku ważny element proaktywnej strategii cyberbezpieczeństwa, zwłaszcza w kontekście zasady zwrotu środków w terminie D+1.

### **Zakończenie**

Biometria behawioralna stanowi skuteczne narzędzie zwiększające poziom bezpieczeństwa w bankowości elektronicznej, a także może się stać rozwiązaniem, które umożliwi redukcję skali oszustw finansowych w Polsce. Ciągła i nieinwazyjna weryfikacja klienta pozwala na identyfikowanie nieautoryzowanych prób dostępu do rachunku, a także wykrycie anomalii w zachowaniu użytkownika umożliwia to natychmiastową reakcję, zablokowanie dostępu do rachunku lub zastosowanie dodatkowej weryfikacji użytkownika.

W toku badań zweryfikowano hipotezę „biometria behawioralna może stać się rozwiązaniem, które umożliwi redukcję skali oszustw finansowych w Polsce”. Wyniki przeprowadzonej analizy SWOT wskazują, że dominującą strategią polskich banków dla rozwoju tej technologii powinna być strategia agresywna (maxi–maxi). Polega ona na proaktywnym wykorzystaniu unikalnych mocnych stron w odpowiedzi na szybko rosnącą skalę oszustw. Takie podejście wsparte jest pozytywnymi

rekomendacjami nadzorców. Potencjał ten jest jednak mocno hamowany przez kluczowe bariery, którymi są restrykcyjna interpretacja przepisów RODO i wynikający z niej niski poziom akceptacji rozwiązania wśród klientów. Bez przezwyciężenia tych dwóch wyzwań, biometria behawioralna pozostanie rozwiązaniem niszowym, z ograniczonym wpływem na cyberbezpieczeństwo. Na podstawie przeprowadzonej w artykule diagnozy strategicznej, sformułowano rekomendacje dla kluczowych interesariuszy.

Sektor bankowy powinien skupić się na powiązaniu aktywacji analizy behawioralnej z korzyściami w zakresie doświadczenia użytkownika. Może to być łatwiejsze logowanie do konta i wyższe limity transakcyjne. Zbieranie zgody powinno być powtarzalnym elementem każdego logowania do serwisu. Jest to obecnie najskuteczniejszy sposób na przełamanie bariery niskiej akceptacji. Instytucje finansowe powinny również aktywnie uczestniczyć w rozwoju jednej sektorowej platformy wymiany informacji. Zwiększy to skuteczność wykrywania oszustw w całym systemie, a także skróci proces budowania profilu dla nowych klientów, o ile nie nastąpi fragmentaryzacja całego rynku, poprzez wdrażanie rozwiązań różnych dostawców. Takie podejście niweluje jedną z technicznych słabości technologii. Biometria behawioralna nie powinna być też traktowana jako samodzielne rozwiązanie, ale jako kluczowy element wielowarstwowej strategii cyberbezpieczeństwa. Dane pozyskiwane w ten sposób powinny wzmocniać istniejące systemy antyfraudowe, zwłaszcza w kontekście rosnącej odpowiedzialności finansowej banków wynikającej z zasady zwrotu środków w terminie D+1. Pozwoli to również na łatwiejsze znalezienie odpowiedniego balansu pomiędzy skuteczną ochroną przed cyberprzestępcami, a wygodą klienta. Pozwala to ograniczyć fałszywe alarmy, które powodują ryzyko zablokowania klienta i zmniejszają jego zadowolenie z korzystania z bankowości elektronicznej.

Opierając się o diagnozę strategiczną, sformułowano również rekomendacje dla nadzoru i administracji publicznej. Oszustwa finansowe są problemem społecznym, który nie dotyczy tylko sektora bankowego. Mimo, że ochrona danych osobowych jest priorytetem, to Urząd Ochrony Danych Osobowych powinien dążyć do znalezienia równowagi pomiędzy prywatnością, a bezpieczeństwem finansowym obywateli. W interesie wszystkich klientów banków jest stworzenie takich ram prawnych, które wspierałyby nowe technologie antyfraudowe. Nadzorcy powinni również wspierać ogólnopolskie kampanie edukacyjne na temat zagrożeń i sposobów ochrony w internecie. Powinno to obejmować zwłaszcza techniki socjotechniczne, w wyniku których przestępcy manipulują płatnikiem. Autorytet administracji państwowej może pomóc w przełamaniu barier mentalnych i obaw o prywatność przy wykorzystywaniu biometrii behawioralnej. Ważnym zadaniem administracji jest również ograniczenie zjawiska fałszywych reklam i linków, dzięki którym przestępcy łatwo nawiązują kontakt ze swoimi ofiarami.

Reasumując, chociaż biometria nie jest rozwiązaniem uniwersalnym i wolnym od ograniczeń, to posiada potencjał, żeby stać się jednym z kluczowych filarów cyberbezpieczeństwa w polskich bankach. W sytuacji szybko rosnącej liczby przestępstw, technologia ta powinna stać się ważnym

narzędziem ograniczającym skutki działania cyberprzestępców. Świadomość potencjału musi być powszechniejsza nie tylko w sektorze finansowym, ale również w administracji państwowej oraz wśród regulatorów. Skuteczność działania biometrii behawioralnej jest bowiem zdeterminowana nie tyle przez samą technologię, a przez synergię działań biznesowych, regulacyjnych i edukacyjnych.

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## WYKORZYSTANIE BIOMETRII BEHAVIORALNEJ W KONTEKŚCIE CYBERBEZPIECZEŃSTWA POLSKIEGO SEKTORA BANKOWEGO (2019-2024)

### STRESZCZENIE

**Cel artykułu.** Celem artykułu jest weryfikacja hipotezy wskazującej, że biometria behawioralna może stać się rozwiązaniem, które umożliwi redukcję skali oszustw finansowych w Polsce. Zagadnienie to jest istotne ze względu na negatywny wpływ zmian na cyberbezpieczeństwo w otoczeniu sektora bankowego po pandemii COVID-19. Tylko w latach 2019–2024 nastąpił dziesięciokrotny wzrost wartości fraudów. Ryzyko przestępstw finansowych

w cyberprzestrzeni staje się głównym wyzwaniem stojącym przed sektorem finansowym. Tak duża dynamika i skala ponoszonych przez klientów strat spowodowała zainteresowanie urzędów nadzorczych, które skierowały do banków liczne zalecenia dotyczące edukacji klientów oraz minimalizacji ryzyka oszustw na poziomie systemowym. Jednym ze wskazywanych w tym kontekście zaleceń dla dostawców usług płatniczych jest stosowanie systemów opartych na biometrii behawioralnej. To nowoczesne rozwiązanie techniczne pozwala na bieżące weryfikowanie, czy osoba logująca się do konta bankowego i przeprowadzająca operacje finansowe jest właścicielem rachunku. W pracy przeprowadzono diagnozę strategiczną tej technologii przy użyciu analizy SWOT. Metodologia ta pozwoliła na identyfikację i ocenę kluczowych czynników wewnętrznych (mocnych i słabych stron) oraz zewnętrznych (szans i zagrożeń), a także na określenie dominującej strategii rozwoju na polskim rynku finansowym. W konsekwencji autorzy sformułowali rekomendacje strategiczne zarówno dla instytucji

finansowych, jak i regulatorów, które mogą pomóc w zwiększeniu skuteczności biometrii behawioralnej w redukcji oszustw finansowych.

**Metodologia.** W artykule zastosowano jakościowe podejście badawcze. Główną metodą analizy jest studium przypadku polskiego sektora bankowego w latach 2019–2024. Do przedstawienia ewolucji zagrożeń cybernetycznych, skali oszustw finansowych oraz ram regulacyjnych wykorzystano analizę deskryptywną. Kluczowym narzędziem badawczym jest analiza strategiczna SWOT, za pomocą której zostały zidentyfikowane mocne i słabe strony biometrii behawioralnej, a także szanse i zagrożenia rynkowe. Pozwoliło to na sformułowanie rekomendacji. Uzupełniającą zastosowano analizę danych wtórnych, pochodzących z raportów, publikacji i komunikatów regulatorów rynku.

**Wyniki badania.** Z punktu widzenia instytucji finansowych weryfikacja behawioralna może stanowić kluczowy element redukcji najczęściej występujących oszustw finansowych. Najbardziej efektywnym podejściem dla banków powinno być proaktywne wykorzystanie wewnętrznych atutów biometrii behawioralnej w celu maksymalizacji korzyści płynących z zewnętrznych szans rynkowych. Największym wyzwaniem i blokerem w rozwoju tej technologii jest niski poziom akceptacji wśród klientów oraz zewnętrzne zagrożenie w postaci restrykcyjnych barier prawnych i regulacyjnych. Rozwiązaniem w tym przypadku powinna być zmiana istniejącego procesu pozyskiwania zgody klienta. Powiązanie jej z korzyściami wygodnego korzystania z serwisów bankowości elektronicznej może znacząco zwiększyć wskaźnik akceptacji, a tym samym wyeliminować główną barierę rozwoju. Umożliwi to wykorzystanie pełnego potencjału rozwiązania, wspartego rozwojem platformy sektorowej. Chociaż biometria behawioralna ma mniejsze znaczenie przy zapobieganiu nieautoryzowanym transakcjom klientów zmanipulowanych przez przestępców, to stanowi ważny element proaktywnej strategii cyberbezpieczeństwa, zwłaszcza w kontekście zasady zwrotu środków w terminie D+1. Jest to istotne w kontekście presji ze strony regulatorów, która zwiększa odpowiedzialność banków za transakcje oszukańcze.

**Praktyczne implikacje.** Biometria behawioralna może stać się kluczowym narzędziem ograniczającym skalę oszustw finansowych. Wdrożenie jej zwiększa poziom ochrony klientów, a tym samym pozwala na ograniczenie skali oszustw finansowych, zwłaszcza związanych z przejęciem rachunku. Największą wartością tej technologii jest ciągła i nieinwazyjna weryfikacja tożsamości klienta w tle. Jest to bardzo dobre uzupełnienie istniejących rozwiązań i systemów antyfraudowych. Wykorzystanie platformy sektorowej może przyczynić się do szybszej akceptacji oraz zwiększenia skuteczności zastosowanych zabezpieczeń. Umożliwi to bankom lepszą reakcję na incydenty, przy spełnieniu rosnących wymagań regulatorów w zakresie ochrony klientów. Powodzenie wdrożenia i wykorzystania biometrii behawioralnej zależy jednak od rozwiązania barier prawnych oraz edukacji rynku i klientów, bez czego technologia ta pozostanie jedynie rozwiązaniem niszowym.

**Słowa kluczowe:** cyberbezpieczeństwo, oszustwa finansowe, biometria behawioralna, bankowość elektroniczna.

**JEL Class:** G21, G23, G29.

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## GPT MODELS OR ECONOMETRIC MODELS: A COMPARATIVE ANALYSIS OF GOLD PRICE DETERMINANTS

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### GPT MODELS OR ECONOMETRIC MODELS: A COMPARATIVE ANALYSIS OF GOLD PRICE DETERMINANTS

#### ABSTRACT

**The purpose of the article.** The main objective of this article is to compare the results of data analysis regarding gold prices and their determinants using two approaches: a classical econometric model and Microsoft Copilot, which integrates advanced artificial intelligence technologies, including the GPT-4 language model (Generative Pre-trained Transformer 4). The secondary objective is to identify, based on the existing literature, the main factors influencing fluctuations in gold prices. These include: the price of crude oil, the USD/EUR exchange rate, the S&P 500 index, and the Consumer Price Index (CPI) in the United States.

**Methodology.** The empirical study involves determining the descriptive statistics of the analyzed variables, the correlation matrix, and estimating the structural parameters of the model explaining the gold price.

**Results of the research.** The best results were obtained for the logarithmic returns of the analyzed variables. In line with the stated hypotheses, there is a negative relationship between the gold price and changes in the S&P 500 index, a negative relationship between the gold price and changes in the US\$/EUR exchange rate, and a positive relationship between the gold price and the CPI. The study shows that, during the analyzed period (02.2004 –11.2023), changes in crude oil prices did not have a statistically significant impact on gold price changes. To obtain data analysis results using Microsoft Copilot, a "chat" session was conducted. The responses provided the following information: proposed determinants of gold prices, a list of scientific articles, and R code to perform the auto.arima procedure. A comparison was made between the model incorporating economic theory-based factors and the model from the auto.arima procedure suggested by Microsoft Copilot. Based on the conducted study, it can be concluded that the model incorporating both autoregressive factors and other gold price determinants better explains the analyzed variable.

**Keywords:** gold price, econometric model, gold price determinants, GPT.

**JEL Class:** C53, C58.

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## Introduction

In the 1930s, econometric models began to be used for the quantitative analysis of economic phenomena. Econometrics is a field of social science that combines statistics, mathematics, and economics. The 20th and 21st centuries have seen a dynamic development of econometric methods and a growing interest among economists in quantitative analyses. The use of appropriate tools for modeling economic variables significantly reduces forecasting errors, and estimating the structural parameters of economic models answers the question of how economies actually function. Additionally, statistical tests help economists assess whether there is a statistically significant relationship between the analyzed variables. Econometric models are now widely used for analyses in both businesses and corporations, as well as in government administrative units. They are applied in both microeconomic and macroeconomic analyses (e.g., to study the impact of government policy on the economy).

The 21st century has also seen the development of tools in the field of artificial intelligence, which utilize advanced machine learning methods, leading to significant changes in the global economy. Artificial intelligence (AI) and machine learning are now key technologies influencing changes across many sectors of the economy, from finance to manufacturing, retail, healthcare, and many others. New opportunities are opening up for businesses to improve operations, mainly through cost reduction and minimizing human error.

The purpose of this paper is twofold. First, it aims to compare the results of data analysis related to gold prices and their determinants using two approaches: classical econometric modeling and Microsoft Copilot, a tool that incorporates artificial intelligence technologies including the GPT-4 language model developed by OpenAI. The second objective is to identify, based on a review of the literature, the key economic factors influencing gold price fluctuations. These include the price of crude oil, the USD/EUR exchange rate, the S&P 500 index, and the Consumer Price Index (CPI) in the United States.

## Importance of Gold in the Economy

Gold is a precious metal that can be distinguished by three main macroeconomic functions:

- monetary function,
- industrial function,
- investment function.

### Monetary Function

The monetary function of gold occurs when it is used as a medium of exchange, a unit of account, or a store of value. The gold standard is a system in which the value of currency is directly linked to gold. In practice, this means that for each unit of currency, a specified amount of gold can be obtained. This system was popular at the turn of the 19th and 20th centuries until World War I. One of

the main advantages of the gold standard was its stability. Prices did not change too drastically, providing market participants with a sense of certainty. This system was based on three fundamental principles: the government setting the gold parity, the convertibility of currency into gold, and the strict link between the issuance of money and gold reserves. However, the system also had its drawbacks. Due to the fixed exchange rate, it hindered adjustments to changes in the competitiveness of individual countries. Additionally, the gold standard exacerbated the effects of the Great Depression. Countries that abandoned the gold standard and devalued their currencies recovered from the depression more quickly.

### **Industrial Function**

In electronics, gold is an excellent conductor and resistant to corrosion, making it valuable in the production of devices. In dentistry, gold is durable and biocompatible, making it an effective material for dental crowns and bridges. In the space industry, gold is used in spacecraft to protect against infrared radiation and stabilize temperatures. In art and jewelry, gold is prized for its color and malleability, often used for jewelry making and gilding in art. Therefore, changes in gold prices impact production costs and the aggregate level of GDP in the economy.

### **Investment Function**

Gold plays an important role as an investment instrument. Its attractiveness to investors stems from several characteristics. First, gold is a very effective tool for diversifying an investment portfolio. This means that when other instruments (such as stocks or bonds) are not yielding profits, the value of gold can offset losses. Second, gold is perceived as a hedge against inflation. In times of currency devaluation, the price of gold typically rises as investors seek to protect their assets. Gold is also attractive in times of economic uncertainty. During recessions, the price of gold usually increases. During the global financial crisis of 2007–2008, the value of the S&P 500 index fell by more than 50%, while the price of gold rose by several dozen percent (see Figure 1, daily data). However, gold does not always gain value immediately following the outbreak of an unexpected global threat, as market participants may be determined to sell gold for cash. In the initial phase of the COVID-19 pandemic, in March 2020, a sharp decline in gold prices was recorded. When comparing prices from March 2020 to May 2022, it increased by nearly 20% (see Figure 2, daily data). Ongoing military conflicts, such as the Russia–Ukraine war and instability in the Middle East, also lead to significant increases in gold prices. Although on February 24, 2022, when Russia invaded Ukraine, the price of gold slightly declined, a few days later, after sanctions were imposed on Russia (e.g., the exclusion of certain important officials from the SWIFT system), gold spectacularly gained value (see Figure 3, daily data). Therefore, investing in gold requires a thorough analysis of the factors that influence its price.

**Figure 1**

*Gold price (per troy ounce, USD) from 2007 to 2008*



Source: Bankier.pl.

**Figure 2**

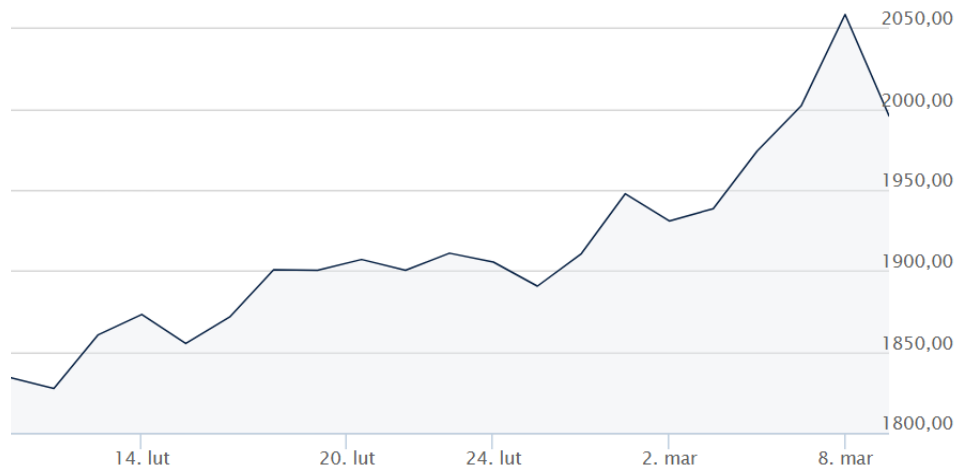
*Gold price (per troy ounce, USD) during the approximate duration of the COVID-19 pandemic*



Source: Bankier.pl.

**Figure 3**

*Gold price (per troy ounce, USD) during the initial days of the Ukraine war*



Source: Bankier.pl.

Thus, gold fulfills fundamental macroeconomic functions. The sharp fluctuations in the price of gold are most often related to extreme geopolitical or catastrophic events.

### Modeling and Determinants of Gold Price

In the literature, three main approaches can be distinguished for modeling and forecasting gold prices. First, the impact of macroeconomic factors on gold prices can be described using causal econometric models. Bukowski (2016) identified the main determinants of gold prices, which include: the price of crude oil, the US\$/EUR exchange rate, the S&P 500 index, and the yield on 10-year U.S. Treasury bonds. In empirical analyses, the first differences of the logarithmic variables were used. The following conclusions were formulated in this study:

- the relationship between the price of gold and the US\$/EUR exchange rate is negative,
- the relationship between the price of gold and the price of Brent crude oil is positive,
- the relationship between the price of gold and changes in the S&P 500 index is negative,
- the relationship between the price of gold and the yield on 10-year U.S. Treasury bonds is negative.

The depreciation of the dollar makes gold cheaper for investors outside the USA, which increases demand for gold and raises its price in US dollars (Levin & Wright, 2006). Crude oil has replaced diesel as an energy source for heating during gold mining. Consequently, an increase in oil prices leads to higher extraction costs, resulting in a higher price of gold (Polyus). Conversely, during economically unstable periods, investors may prefer gold (a safe asset) over stocks, which are associated with higher risk (Puci et al., 2022).

The impact of other independent variables on gold prices has also been studied. Choong et al. (2012) included the price of silver among the determinants of gold. They found a positive relationship between the variables, which contradicted their hypothesis that silver is a substitute for gold. The study also confirmed, in line with the hypothesis, a positive relationship between the price of gold and the Consumer Price Index (CPI), which measures inflation and affects consumer behavior.

Second, a popular method for predicting the price of gold is ARIMA models. Guha and Bandyopadhyay (2016) demonstrated that for a monthly sample from 2003 to 2014, among six different time series model forms, the ARIMA(1,1,1) model proved to be the best. They also noted the inefficiency of ARIMA models in the case of sudden, sharp changes in economic conditions. Yang (2019) selected ARIMA(3,2,1) as the best model based on empirical results. Setyowibowo et al. (2021) used a hybrid ARIMA-GARCH model, which is particularly effective for high-frequency data.

Third, rapid advancements in artificial intelligence have enabled quantitative analyses of gold prices using machine learning methods. Makalala and Li (2021) showed that the Support Vector Machine (SVM) method is more effective than ARIMA models. Zhang and Ci (2020) applied Deep Belief Network (DBN) models, comparing them with ARIMA models, traditional BP neural networks, and genetic algorithms for optimizing BP neural networks. The DBN model proved to be the best, achieving the lowest Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE), and Mean Absolute Error (MAE).

ARIMA models and machine learning models require the use of advanced econometric methods and tools, and thus, are not applied in this study. This paper attempts to identify the determinants of gold prices using causal econometric models.

Based on the presented literature, the following model will be analyzed in the empirical part:

$$Gold\_price = f(Crude\_oil\_price, S\&P500, US\$/EUR, CPI)$$

where: *Gold\_price* – the price of gold (per troy ounce, which corresponds to a weight of 31.1035 grams); *Crude\_oil\_price* – the price of crude oil (per barrel, USD, averaged from Brent, WTI, and Dubai); *S&P500* – the S&P 500 index; *US\$/EUR* – the US Dollar to Euro exchange rate; *CPI* – the Consumer Price Index (CPI).

According to the literature and economic theory, the aim of the first part of the study is to verify the following research hypotheses:

1. An increase in the US\$/EUR exchange rate causes a decrease in the price of gold.
2. An increase in the S&P 500 index causes a decrease in the price of gold.
3. An increase in the Consumer Price Index (CPI) causes an increase in the price of gold.
4. An increase in the price of crude oil causes an increase in the price of gold.

## Methodology

The most common method for estimating econometric models is the method of least squares (OLS). Let's consider a linear regression model as follows (Maddala, 2001):

$$Y_t = \beta_0 + \beta_1 x_{1,t} + \beta_2 x_{2,t} + \dots + \beta_k x_{k,t} + \varepsilon_t \quad (1)$$

where:  $Y_t$  – the dependent variable;  $x_1, x_2, \dots, x_k$  – the independent variables;  $\beta_0$  – the intercept;  $\beta_1, \beta_2, \dots, \beta_k$  – the regression coefficients, the structural parameters of the model;  $\varepsilon$  – the error term.

The Ordinary Least Squares (OLS) method for linear regression involves finding the values of coefficients  $\beta$  that minimize the sum of the squared differences between the actual values of the dependent variable and the values predicted by the model. The estimator of the Ordinary Least Squares (OLS) method is defined by the formula (Maddala, 2001):

$$\hat{\beta} = (X^T X)^{-1} X^T Y \quad (2)$$

The estimator given by equation (2) is BLUE (Best Linear Unbiased Estimator), which means that it is consistent, unbiased, and the most efficient among the class of linear estimators for the vector  $\beta$  – Gauss-Markov Theorem (Greene, 2002). According to the assumptions of the linear regression model, the error term should have the following properties:

1. The expected value of the error term is 0.
2. The variance of the error term is identical for all observations –homoskedasticity.
3. The covariance between two error terms from different periods is 0 – there is no autocorrelation.
4. The error term has a normal distribution.

Failure to meet the above assumptions can lead to non-spherical error terms. In such cases, the OLS estimator ceases to be BLUE. Therefore, any estimation of econometric model parameters requires verification of the stochastic properties of the error term. For this purpose, the following statistical tests can be used (Verbeek, 2012):

### – Test for normality of residuals

The Doornik-Hansen test is used to verify the normality of the random component distribution. The set of hypotheses is as follows:

$H_0$ : the random component follows a normal distribution,

$H_1$ : the random component does not follow a normal distribution.

Its statistic is defined by the formula:

$$DH = z_1^2 + z_2^2 \quad (3)$$

where:  $z_1$  – the transformed skewness coefficient;  $z_2$  – the transformed kurtosis coefficient.

The statistic (3) follows a chi-squared  $\chi^2$ . If the DH statistic is less than or equal to the critical value, we do not have grounds to reject the null hypothesis.

– **Lagrange multiplier test (LM test)**

The LM test is a method for checking the presence of autocorrelation, which involves correlating current values of the random component with past values. In the first stage, the parameters of model (1) are estimated, and then a model is estimated where the residual component from model (1) is the dependent variable. As explanatory variables, the lagged residuals up to order P are additionally included:

$$\varepsilon_t = \beta_0 + \beta_1 x_{1,t} + \beta_2 x_{2,t} + \dots + \beta_k x_{k,t} + \beta_{k+1} \varepsilon_{t-1} + \dots + \beta_{k+P} \varepsilon_{t-P} + \eta_t \quad (4)$$

The null hypothesis of the LM test is the absence of autocorrelation up to order P:

$$H_0: \beta_{k+1} = \dots = \beta_{k+P} = 0 \quad (5)$$

The test statistic is:

$$LM = nR^2 \quad (6)$$

where:  $n$  – the sample size in model (4);  $R^2$  – the coefficient of determination of model (4).

The LM statistic follows a chi-squared  $\chi^2$  distribution with  $P$  degrees of freedom. If the LM value is less than or equal to the critical value from the  $\chi^2$ , we do not have grounds to reject the null hypothesis.

– **White's test**

White's test for heteroskedasticity is a method for checking the presence of heteroskedasticity in the error term. The dependent variable is the squared residuals from model (1):

$$\begin{aligned} \varepsilon_i^2 = & \beta_0 + \beta_1 x_{1,i} + \dots + \beta_k x_{k,i} + \beta_{k+1} x_{1,i}^2 + \dots + \beta_{k+k} x_{k,i}^2 + \beta_{k+k+1} x_{1,i} x_{2,i} + \\ & \dots + \beta_{k+k+S} x_{k-1,i} x_{k,i} + \eta_i \end{aligned} \quad (7)$$

The null hypothesis of White's test is the homoskedasticity of the error term:

$$H_0: \sigma_i^2 = \sigma^2 \quad (8)$$

and the test statistic is defined by the formula:

$$LM = nR^2 \quad (9)$$

The statistic (9) follows a chi-squared  $\chi^2$  with  $M$  degrees of freedom (the number of all independent variables in the test regression). If the  $LM$  value is less than or equal to the critical value from the  $\chi^2$  distribution, we do not have grounds to reject the null hypothesis.

The statistical tests discussed above are a basic set of econometric tools used to assess the properties of the error term in the estimated model. Good stochastic properties of the model therefore imply no autocorrelation, homoskedasticity, and a normal distribution of the error term.

The next step in the substantive and statistical evaluation of the model is to examine the significance of the explanatory variables' impact on the dependent variable and to assess the fit to the empirical data. We conduct the significance test separately for each parameter according to the following scheme:

$H_0: \beta_k = 0$  – the explanatory variable  $x_k$  does not significantly affect the dependent variable  $Y$  (10)

$H_1: \beta_k \neq 0$  – the explanatory variable  $x_k$  significantly affects the dependent variable  $Y$  (11)

The null hypothesis is typically tested at a significance level of 0.05 with a two-tailed rejection region (which follows from the form of the alternative hypothesis). The test statistic in this test is given by:

$$t_{\hat{\beta}_k} = \frac{\hat{\beta}_k}{S_{\hat{\beta}_k}} \quad (12)$$

where:  $\hat{\beta}_k$  – the estimated regression coefficient for the  $k$ -th variable;  $S_{\hat{\beta}_k}$  – the standard error of the estimator  $\beta_k$ .

The statistic (12) follows a Student's  $t$ -distribution with  $n - k$  degrees of freedom, where  $n$  – the number of observations,  $k$  – the number of estimated parameters.

The coefficient of determination ( $R^2$ ) indicates the proportion of the variability in the dependent variable that is explained by the variability in the explanatory variable (Chudy-Hyski, 2006). The  $R^2$  value ranges from 0 to 1. The closer  $R^2$  is to 1, the greater the proportion of variability in the dependent variable explained by the model (Borkowski et al., 2007). The coefficient of determination allows for the assessment of which of the analyzed models has the best fit to the empirical data.

## Empirical Results

### Data

The analyzed sample includes monthly data for the period from February 2004 to November 2023. All figures were generated using Gretl. The data sources for the respective variables in the model are as follows:

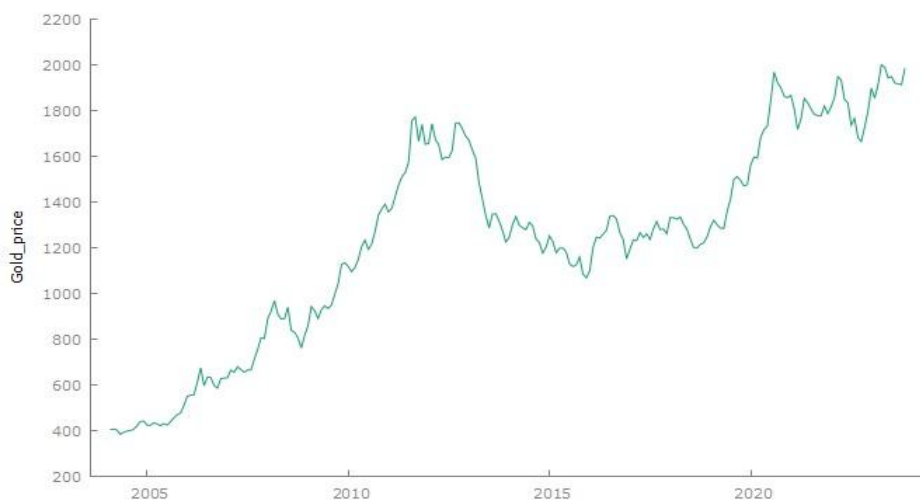
- gold prices (per troy ounce, equivalent to 31.1035 grams) – World Gold Council database (see Figure 4),

- crude oil prices (per barrel, USD, average of Brent, WTI, and Dubai) – World Bank database (see Figure 5),
- S&P 500 Index – Stooq database (see Figure 6),
- US\$/EUR exchange rate - Investing.com database (see Figure 7),
- CPI (Consumer Price Index) in the United States, 1982–1984=1 – Federal Reserve Bank of St. Louis database (see Figure 8).

The descriptive statistics of the variables are provided in the appendix.

**Figure 4**

*Gold price (per troy ounce, USD)*



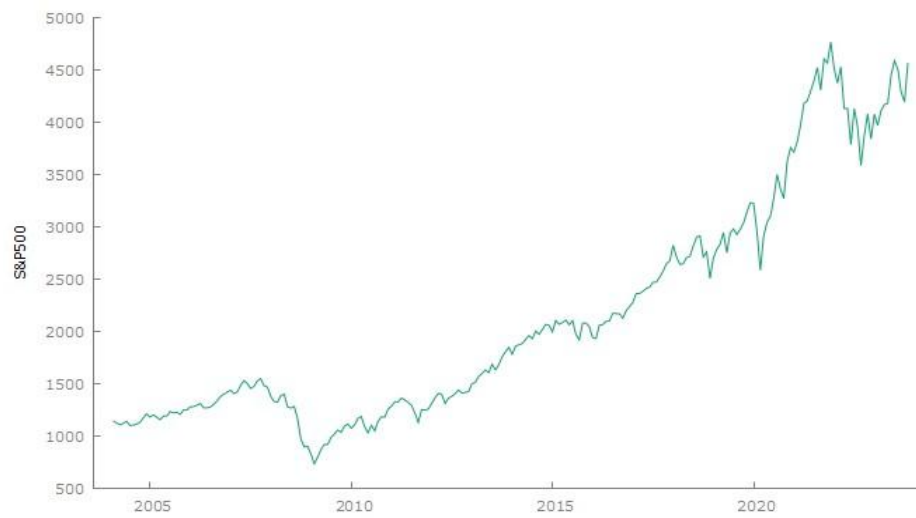
Source: Gretl software.

**Figure 5**

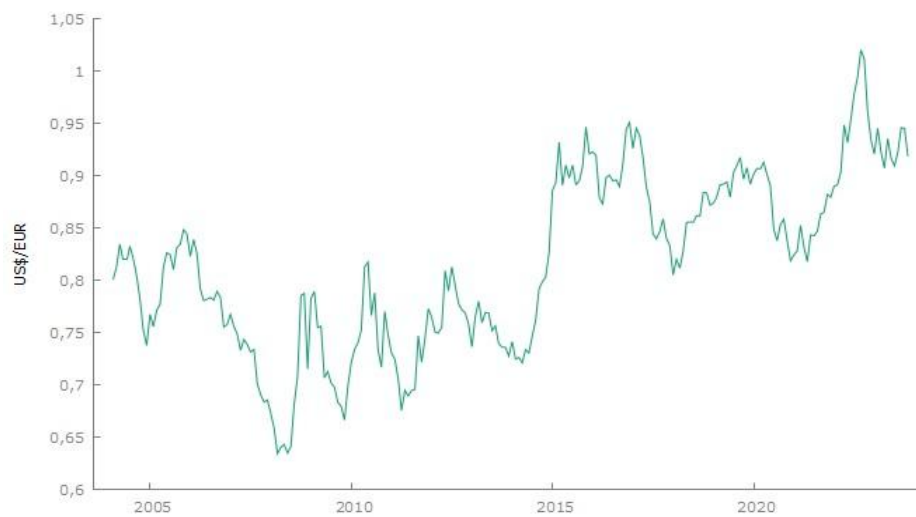
*Crude oil price (per barrel, USD, average of Brent, WTI, and Dubai)*



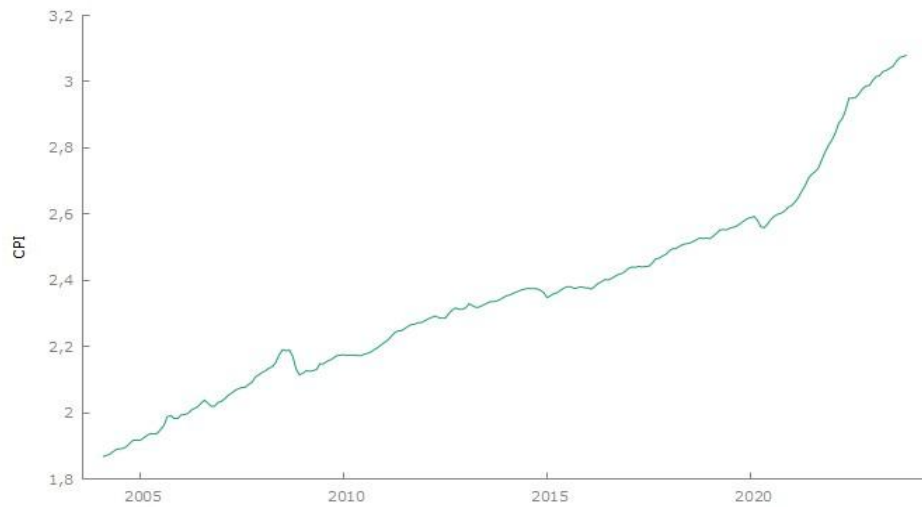
Source: Gretl software.

**Figure 6***S&P500 Index*

Source: Gretl software.

**Figure 7***US\$/EUR exchange rate*

Source: Gretl software

**Figure 8***CPI*

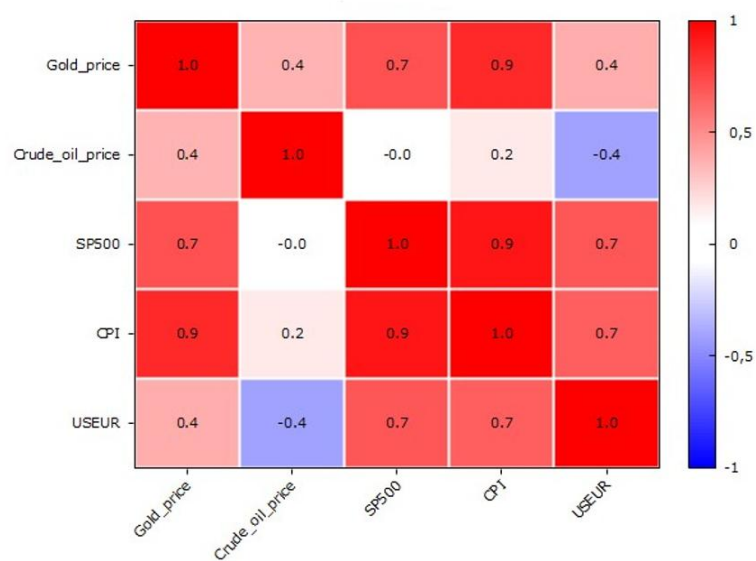
Source: Gretl software.

### Correlation Matrix

The graphs below present correlation matrices (see Matrix 1, Matrix 2) – matrices where the elements represent the correlation coefficients for the respective pairs of variables. Matrices were generated using Gretl.

#### Matrix 1

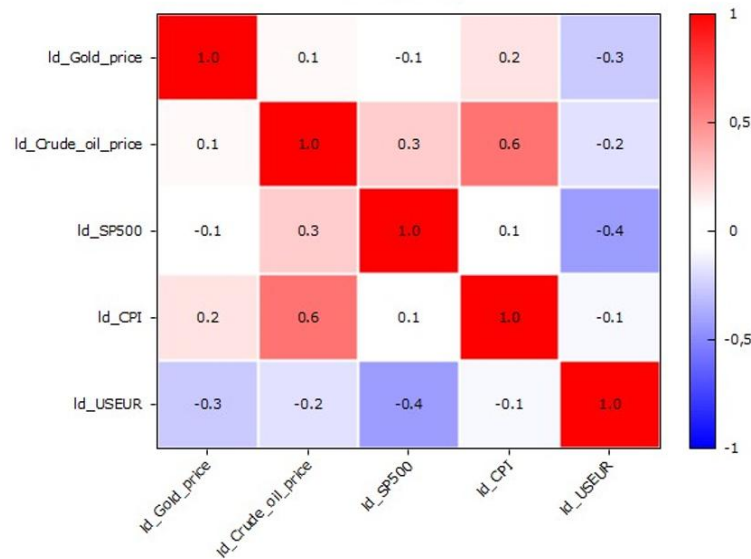
*Correlation matrix for variable levels*



Source: Gretl software.

## Matrix 2

*Correlation matrix for logarithmic increments of variables*



Source: Gretl software.

For the levels of variables, the highest correlation is observed between the gold price and the CPI index, while the weakest correlations are between the gold price and the oil price, as well as between the gold price and the US\$/EUR exchange rate. For the logarithmic increments of variables (see Matrix 2), the signs of the relationships between the gold price and other variables are consistent with the research hypotheses (oil price and CPI index positively impact the gold price, while the S&P 500 index and US\$/EUR exchange rate negatively impact it). The weakest correlations are between the gold price and the S&P 500 index, as well as between the gold price and the oil price.

## Gold Price Model

In the first step of the empirical section, the structural parameters of the model were estimated:

$$\ln Gold\_price_t = \beta_0 + \beta_1 \ln Crude\_oil\_price_t + \beta_2 \ln S\&P500_t + \beta_3 \ln US\$/EUR_t + \beta_4 \ln CPI_t + \varepsilon_t \quad (13)$$

Based on the estimation results (see Table 1), it can be observed that the oil price does not have a statistically significant impact on the gold price ( $|t - Statistic| \leq 2$ ), which contradicts the research hypothesis. For the remaining explanatory variables – the CPI index, US\$/EUR exchange rate, and S&P 500 index – the results are consistent with the hypothesized relationships, and there is a statistically significant impact on the dependent variable. The CPI index has a positive effect on the gold price, while the S&P 500 index and the US\$/EUR exchange rate have a negative impact on the gold price. An increase in the U.S. Consumer Price Index (1983=100) by 1% leads to a 6% increase in the gold price, ceteris paribus, whereas a 1% increase in the US\$/EUR exchange rate results in a decrease in the gold

price by approximately 1.2%, and a 1% rise in the S&P 500 index causes a 0.5% decrease in the gold price, *ceteris paribus*.

**Table 1**

*OLS estimation results, observations used: 2004:02–2023:11 (N = 238)*

| <b>Dependent variable (Y): l_Gold_price</b> |                    |                       |                    |                |
|---------------------------------------------|--------------------|-----------------------|--------------------|----------------|
|                                             | <b>Coefficient</b> | <b>Standard error</b> | <b>t-Statistic</b> | <b>p-value</b> |
| <b>Const</b>                                | 5.,93119           | 0.390155              | 15.20              | < 0.0001       |
| <b>l_CPI</b>                                | 5.46213            | 0.270593              | 20.19              | < 0.0001       |
| <b>l_Crude_oil_price</b>                    | −0.0314360         | 0.0481458             | −0.6529            | 0.5144         |
| <b>l_USEUR</b>                              | −1.18899           | 0.202854              | −5.861             | < 0.0001       |
| <b>l_SP500</b>                              | −0.484438          | 0.0652202             | −7.428             | < 0.0001       |

Source: Gretl software

**Table 2**

*Selected fit measures and statistics for model (13)*

|                                        |          |                                                 |          |
|----------------------------------------|----------|-------------------------------------------------|----------|
| <b>Mean of dependent variable</b>      | 7.037260 | <b>Standard deviation of dependent variable</b> | 0.445108 |
| <b>Sum of squared residuals</b>        | 7.373719 | <b>Standard error of residuals</b>              | 0.177896 |
| <b>R-squared</b>                       | 0.842961 | <b>Adjusted R-squared</b>                       | 0.840265 |
| <b>Residual autocorrelation – rho1</b> | 0.981882 | <b>Durbin-Watson statistic</b>                  | 0.052570 |

Source: Gretl software.

To examine the stochastic properties of the error term, the following tests were conducted: White's test for heteroskedasticity, the LM test for autocorrelation of the error term, and the Doornik-Hansen test for normality of the error term distribution (see Table 3).

**Table 3***Testing the stochastic properties of the model*

| Test                                           | Null hypothesis                    | Test statistic | p-value      |
|------------------------------------------------|------------------------------------|----------------|--------------|
| <b>White's test</b>                            | No heteroskedasticity in residuals | 168.058        | 1.68951e-28  |
| <b>Doornik-Hansen test</b>                     | Error term is normally distributed | 8.98924        | 0.0111689    |
| <b>LM test for 12-th order autocorrelation</b> | No autocorrelation in error term   | 372.356        | 3.09014e-139 |

Source: Gretl software.

**Figure 9***Residual plot of the error term for model (13)*

Source: Gretl software.

The error term exhibits heteroskedasticity ( $p - value \leq 0.05$ , so there is a reason to reject the null hypothesis,  $H_0$ ). The distribution of the error term is not normal ( $p - value \leq 0.05$ , so we reject  $H_0$  in favor of the alternative hypothesis). There is autocorrelation in the error term ( $p - value \leq 0.05$ , so there is a reason to reject  $H_0$ ). The empirical residuals do not constitute white noise (see Figure 9).

To eliminate the presence of autocorrelation, a lagged dependent variable was introduced as an explanatory variable:

$$\ln Gold\_price_t = \beta_0 + \beta_1 \ln Crude\_oil\_price_t + \beta_2 \ln S\&P500_t + \beta_3 \ln US\$/EUR_t + \beta_4 \ln CPI_t + \beta_5 \ln Gold\_price_{t-1} + \varepsilon_t \quad (14)$$

The results of the estimation for the structural parameters of model (14) are presented in Table 4.

**Table 4**

*OLS estimation results for model (14), observations used: 2004:03–2023:11 (N = 237)*

| <b>Dependent variable (Y): I_Gold_price</b> |                    |                       |                    |                |
|---------------------------------------------|--------------------|-----------------------|--------------------|----------------|
|                                             | <b>Coefficient</b> | <b>Standard error</b> | <b>t-Statistic</b> | <b>p-value</b> |
| <b>Const</b>                                | 0.313256           | 0.110129              | 2.844              | 0.0048         |
| <b>I_CPI</b>                                | 0.262414           | 0.0895438             | 2.931              | 0.0037         |
| <b>I_Crude_oil_price</b>                    | −0.0293083         | 0.00980851            | −2.988             | 0.0031         |
| <b>I_USEUR</b>                              | −0.146114          | 0.0435838             | −3.352             | 0.0009         |
| <b>I_SP500</b>                              | −0.0234551         | 0.0146622             | −1.600             | 0.1110         |
| <b>I_Gold_price_1</b>                       | 0.963081           | 0.0130942             | 73.55              | < 0.0001       |

Source: Gretl software.

**Table 5**

*Selected fit measures and statistics for model (14)*

|                                       |          |                                                 |          |
|---------------------------------------|----------|-------------------------------------------------|----------|
| <b>Mean of dependent variable</b>     | 7.041621 | <b>Standard deviation of dependent variable</b> | 0.440925 |
| <b>Sum of squared residuals</b>       | 0.301687 | <b>Standard error of residuals</b>              | 0.036139 |
| <b>R-squared</b>                      | 0.993425 | <b>Adjusted R-squared</b>                       | 0.993282 |
| <b>Residual autocorrelation –rho1</b> | 0.146390 | <b>Durbin's h-statistic</b>                     | 2.300881 |

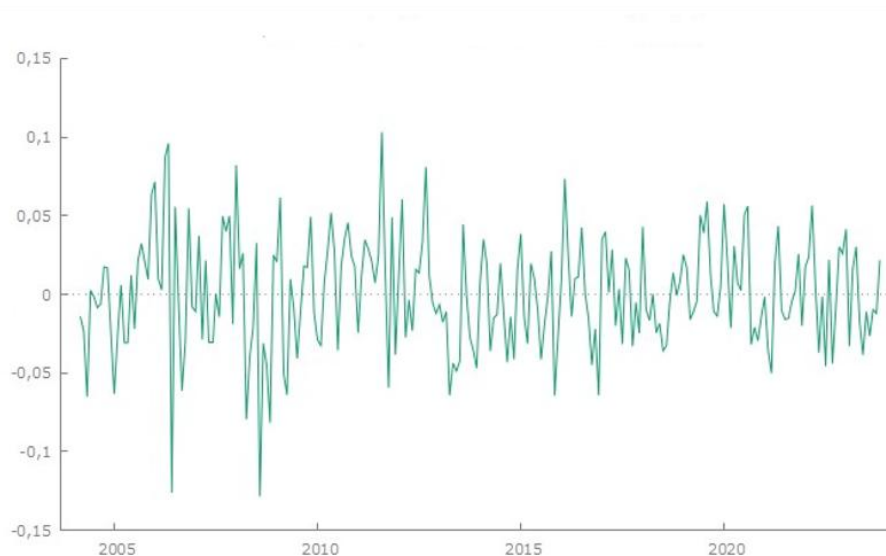
Source: Gretl software.

To examine the stochastic properties of the error term, the following tests were conducted: White's test for heteroskedasticity, the LM test for autocorrelation of the error term, and the Doornik-Hansen test for normality of the error term distribution (see Table 6).

**Table 6***Testing the stochastic properties of the model*

| Test                                           | Null hypothesis                    | Test statistic | p-value   |
|------------------------------------------------|------------------------------------|----------------|-----------|
| <b>White's test</b>                            | No heteroskedasticity in residuals | 35.2317        | 0.0189045 |
| <b>Doornik- Hansen test</b>                    | Error term is normally distributed | 6.96452        | 0.0307378 |
| <b>LM test for 12-th order autocorrelation</b> | No autocorrelation in error term   | 1.28534        | 0.228483  |

Source: Gretl software.

**Figure 10***Residual plot of the error term for model (14)*

Source: Gretl software.

The S&P 500 index does not have a statistically significant impact on changes in the gold price ( $|t - Statistic| \leq 2$ ), which contradicts the research hypothesis (see Table 9). The CPI index has a positive impact on the gold price, while the oil price and the US\$/EUR exchange rate have a negative impact on the gold price (see Table 9). According to the results in Table 11, the error term is heteroskedastic ( $p - value \leq 0.05$ , so there is a reason to reject  $H_0$ ). The distribution of the error term is not normal ( $p - value \leq 0.05$ , so there is a reason to reject  $H_0$ ). There is no autocorrelation in the error term ( $p - value > 0.05$ , so there is no reason to reject  $H_0$ ). The estimated autoregressive parameter value close to 1 indicates instability of the model in the long term.

To verify the stationarity of the time series, the Augmented Dickey–Fuller (ADF) test was applied to all variables. The test's hypotheses are as follows:

$H_0$ : The series contains a unit root (i.e., is non-stationary)

$H_1$ : The series is stationary

**Table 7**

*Results of the Augmented Dickey–Fuller (ADF) test for logarithmic variables*

| Variable          | p-value |
|-------------------|---------|
| l_Gold_price      | 0.2575  |
| l_CPI             | 0.997   |
| l_SP500           | 0.5494  |
| l_USEUR           | 0.2124  |
| l_Crude_oil_price | 0.009   |

Source: Gretl software.

The test results (see Table 7) indicate that the original variables are non-stationary (p-value > 0.05 in most cases). Therefore, in the next step, the analysis was conducted using logarithmic returns (logarithmic increments) of the variables, which are commonly used to stabilize variance and achieve stationarity:

$$\begin{aligned} \Delta \ln Gold\_price_t = & \beta_0 + \beta_1 \Delta \ln Crude\_oil\_price_t + \beta_2 \Delta \ln S\&P500_t + \\ & + \beta_3 \Delta \ln US\$/EUR_t + \beta_4 \Delta \ln CPI_t + \beta_5 \Delta \ln Gold\_price_{t-1} + \varepsilon_t \end{aligned} \quad (15)$$

The model also includes dummy variables related to events such as the COVID-19 pandemic and the financial crisis. The results of the estimation for the structural parameters of model (15) are presented in Table 8.

**Table 8**

*OLS estimation results for model (15), observations used: 2004:04-2023:11 (N = 236)*

| Dependent variable (Y): ld_Gold_price |             |                |             |          |
|---------------------------------------|-------------|----------------|-------------|----------|
|                                       | Coefficient | Standard error | t-Statistic | p-value  |
| <b>const</b>                          | 0.00259679  | 0.00250659     | 1.036       | 0.3013   |
| <b>ld_USEUR</b>                       | −0.481506   | 0.0864761      | −5.568      | < 0.0001 |
| <b>ld_CPI</b>                         | 1.93050     | 0.649616       | 2.972       | 0.0033   |
| <b>ld_SP500</b>                       | −0.188553   | 0.0536759      | −3.513      | 0.0005   |

|                        |            |           |        |          |
|------------------------|------------|-----------|--------|----------|
| <b>u0606</b>           | -0.151765  | 0.0318166 | -4.770 | < 0.0001 |
| <b>u0808</b>           | -0.0926070 | 0.0320126 | -2.893 | 0.0042   |
| <b>u0811</b>           | 0.0851222  | 0.0315872 | 2.695  | 0.0076   |
| <b>u0420</b>           | 0.0946007  | 0.0327479 | 2.889  | 0.0042   |
| <b>u0216</b>           | 0.0813866  | 0.0314905 | 2.584  | 0.0104   |
| <b>ld_Gold_price_1</b> | 0.203871   | 0.0563506 | 3.618  | 0.0004   |

Source: Gretl software.

**Table 9**

*Selected fit measures and statistics for model (15)*

|                                        |          |                                                 |          |
|----------------------------------------|----------|-------------------------------------------------|----------|
| <b>Mean of dependent variable</b>      | 0.006718 | <b>Standard deviation of dependent variable</b> | 0.037338 |
| <b>Sum of squared residuals</b>        | 0.221372 | <b>Standard error of residuals</b>              | 0.031367 |
| <b>R-squared</b>                       | 0.324301 | <b>Adjusted R-squared</b>                       | 0.294270 |
| <b>Residual autocorrelation – rho1</b> | 0.024330 | <b>Durbin's h-statistic</b>                     | 0.761204 |

Source: Gretl software.

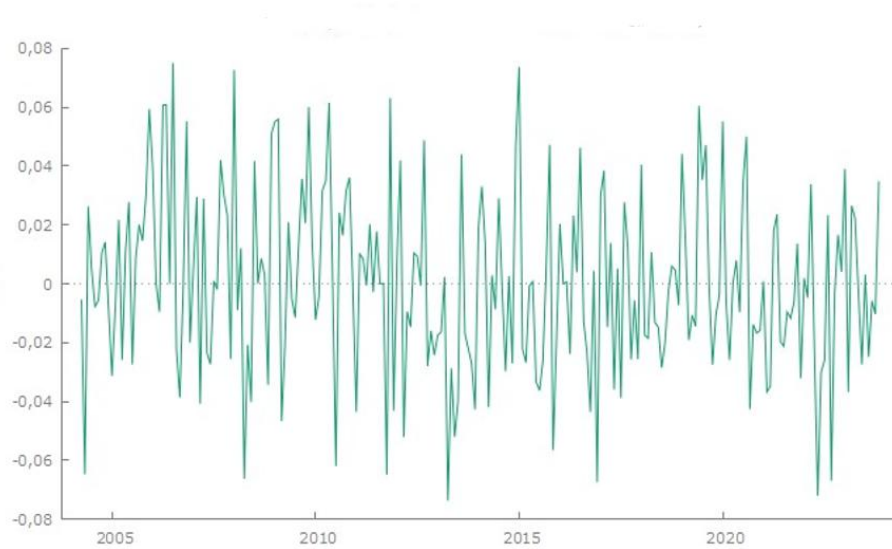
To examine the stochastic properties of the error term, the following tests were conducted: White's test for heteroskedasticity, the LM test for autocorrelation of the error term, and the Doornik-Hansen test for normality of the error term distribution (see Table 10).

**Table 10**

*Testing the stochastic properties of the model*

| <b>Test</b>                                   | <b>Null hypothesis</b>             | <b>Test statistic</b> | <b>p-value</b> |
|-----------------------------------------------|------------------------------------|-----------------------|----------------|
| <b>White's test</b>                           | No heteroskedasticity in residuals | 26.9449               | 0.358642       |
| <b>Doornika-Hansen test</b>                   | Error term is normally distributed | 1.17641               | 0.555323       |
| <b>LM test for 12th-order autocorrelation</b> | No autocorrelation in error term   | 1.59451               | 0.094803       |

Source: Gretl software.

**Figure 11***Residual plot of the error term for model (15)*

Source: Gretl software.

Due to the statistical insignificance of the oil price variable ( $|t - Statistic| \leq 2$ ), it is not included in the Table 7. The other explanatory variables have a statistically significant effect on the dependent variable. As hypothesized, the CPI index has a positive impact on the gold price, while the S&P 500 index and the US\$/EUR exchange rate have a negative impact on the gold price. Based on Table 14, the error term is homoskedastic ( $p - value > 0.05$ , so there is no reason to reject  $H_0$ ). The error term is normally distributed ( $p - value > 0.05$ , so there is no reason to reject  $H_0$ ). There is no autocorrelation in the error term ( $p - value > 0.05$ , so there is no reason to reject  $H_0$ ).

Due to potential instability in the long term of the model for logarithmic variables, the model for the logarithmic increments (see model (15)) appears to be the best choice.

To conclude, the CPI index has a positive impact on changes in the gold price, which is consistent with the research hypothesis. The S&P 500 index and the US\$/EUR exchange rate negatively affect changes in the gold price, which also aligns with the proposed hypotheses. After excluding the insignificant variable, the stochastic properties of the model remained unchanged. The error term is homoskedastic, normally distributed, and no autocorrelation is present.

### Utilization of Microsoft Copilot for Gold Price Analysis

Microsoft Copilot is a chat assistant powered by OpenAI models. During the research work, Copilot Pro- a paid version was utilized, which differs from the free version in terms of performance and priority access to GPT-4 and GPT-4 Turbo during peak hours. Additionally, AI features can be

enabled in Office applications. The use of this tool involves asking questions, and the responses generated by Microsoft Copilot included information such as:

#### 1) Correlation between gold prices and the examined independent variables

According to the analysis provided by Copilot, there is a strong and consistent correlation between gold prices and crude oil prices. The relationship between gold and oil prices is positively correlated. Copilot also identified a weak negative correlation between gold prices and the S&P 500 index. However, it noted the influence of varying economic conditions, which can affect the relationships between these variables, leading to periods of positive correlation. The analysis found a negative correlation between gold prices and the US\$/EUR exchange rate. This is related to investor behavior during periods of U.S. dollar depreciation. Lastly, Copilot highlighted that gold prices and the CPI (Consumer Price Index) tend to exhibit a general positive correlation. However, this correlation is not constant and may fluctuate depending on various factors, such as economic conditions.

#### 2) Other determinants of gold prices

Microsoft Copilot also identified additional factors that influence gold prices, including:

- central bank reserves,
- demand for jewelry and industrial use,
- gold production,
- investment demand.

#### 3) Methodologies for forecasting gold prices

Copilot suggested several methods for estimating model parameters, including:

- regression models,
- time series models,
- deep learning models.

#### 4) Literature on gold price modelling

Here are some examples of scholarly articles recommended by Microsoft Copilot that pertain to gold price modeling:

- Amini, A., Kalantari, R. (2024). Gold price prediction by a CNN-Bi-LSTM model along with automatic parameter tuning,
- Jabeur, S.B., Mefteh-Wali, S., Viviani, J.L. (2021). Forecasting gold price with the XGBoost algorithm and SHAP interaction values,
- Livieris, I.E., Pintelas, E., Pintelas, P. (2020). A CNN-LSTM model for gold price time-series forecasting,
- Ismail, Z., Yahya, A., Shabri, A. (2009). Forecasting gold prices using multiple linear regression method.

### 5) R code

In the course of this study, Microsoft Copilot was employed to generate R code for analyzing the time series of gold prices. A natural language prompt requesting code to model gold prices using the ARIMA approach was provided, and Copilot produced a complete script including data importation, transformation of prices into logarithmic returns, graphical visualization, and application of the `auto.arima()` function from the forecast package, which automatically selects the most appropriate ARIMA model based on statistical information criteria such as AIC and BIC. The code generated by Copilot is not retrieved from a fixed template (or pre-written library) but is dynamically composed based on patterns learned during the training of the underlying language model, GPT-4, which was trained on large volumes of publicly available code, technical documentation, and statistical programming examples, allowing it to predict plausible sequences of code given a specific instruction. This generation process is guided by statistical associations learned from data rather than logical reasoning or domain-specific rules. As a result, while the produced code is often syntactically and technically accurate, it lacks an explicit connection to economic theory or justification grounded in domain expertise. The `auto.arima()` function in R, recommended by Microsoft Copilot, selected the ARIMA(1,0,0) model as the best tool for forecasting gold prices (the relevant R code is provided in the appendix).

### **Justification for the use of the ARIMA Model in Gold Price Forecasting**

As part of this academic analysis, a reasoned justification for the selection of the ARIMA model in forecasting gold prices was requested from Microsoft Copilot. The model recommendation provided by the AI highlights both the empirical characteristics of the time series data and the theoretical strengths of ARIMA as a univariate time series framework.

According to the response, the choice of the AutoRegressive Integrated Moving Average (ARIMA) model is well-founded due to its robustness in handling non-stationary financial time series, such as gold prices, which are influenced by a wide range of macroeconomic and geopolitical factors and are known to exhibit volatility and trends. The integrated component of ARIMA allows the transformation of non-stationary data into a stationary series through differencing, enabling meaningful statistical modeling and forecasting.

The AI also emphasized that, unlike seasonal models, ARIMA does not require the presence of cyclical patterns, which is advantageous when dealing with time series affected by irregular or external shocks rather than regular seasonality. Furthermore, ARIMA is widely used and validated for short- to medium-term forecasting and provides not only point estimates but also confidence intervals, which are essential for quantifying uncertainty in financial contexts.

To enhance objectivity and reproducibility, the AI recommended the use of the `auto.arima()` function in R. This function automates the selection of optimal model parameters (p, d, q) based on

established information criteria such as the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC).

A key point raised by the AI was the deliberate decision to exclude exogenous variables – such as interest rates, inflation expectations, or exchange rates – from the model. Although theoretically relevant, their exclusion is justified due to practical concerns related to data availability, forecastability, and the risk of multicollinearity. Including such variables could also complicate model interpretation. The AI argued that focusing on a univariate approach allows for a clearer understanding of the internal dynamics of the gold price series and ensures greater methodological transparency.

In summary, Microsoft Copilot recommended the ARIMA model due to its statistical flexibility, suitability for non-stationary financial data, ease of implementation, and interpretability in a univariate setting. These characteristics make ARIMA an appropriate and defensible modeling strategy for forecasting the behavior of gold prices within the scope of this academic study.

### Comparison of Results Between the AR(1) Model and the Causal Model

To identify a better model, the ARIMA(1,0,0) model was compared with model (15). The results for the ARIMA(1,0,0) model, as suggested by Copilot, are presented in Table 11 (for the logarithm of the gold price).

**Table 11**

*OLS estimation results, observations used: 2004:03–2023:11 (N = 237)*

| Dependent variable (Y): <b>l_Gold_price</b> |                    |                       |                    |                |
|---------------------------------------------|--------------------|-----------------------|--------------------|----------------|
|                                             | <b>Coefficient</b> | <b>Standard error</b> | <b>t-Statistic</b> | <b>p-value</b> |
| <b>Const</b>                                | 0.0888882          | 0.0381607             | 2.329              | 0.0207         |
| <b>l_Gold_price_1</b>                       | 0.988318           | 0.00541372            | 182.6              | < 0.0001       |

Source: Gretl software.

**Table 12**

*Selected fit measures and statistics for the ARIMA(1,0,0) model*

|                                        |          |                                                 |          |
|----------------------------------------|----------|-------------------------------------------------|----------|
| <b>Mean of dependent variable</b>      | 7.041621 | <b>Standard deviation of dependent variable</b> | 0.440925 |
| <b>Residual sum of squares</b>         | 0.321259 | <b>Standard error of residuals</b>              | 0.036974 |
| <b>R-squared</b>                       | 0.992998 | <b>Adjusted R-squared</b>                       | 0.992968 |
| <b>Residual autocorrelation – rho1</b> | 0.141855 | <b>Durbin's h-statistic</b>                     | 2.191457 |

Source: Gretl software.

In the next step, the parameters of an autoregressive model for the log return of the gold price were estimated. The results for the ARIMA(1,0,0) model for the log return of the gold price are shown in Table 13.

**Table 13**

*OLS estimation results, observations used 2004:04–2023:11 ( $N = 236$ )*

| <b>Dependent variable (Y): ld_goldprice</b> |                    |                        |                    |                |
|---------------------------------------------|--------------------|------------------------|--------------------|----------------|
|                                             | <b>Coefficient</b> | <b>Standard error.</b> | <b>t-Statistic</b> | <b>p-value</b> |
| <b>Const</b>                                | 0.00573454         | 0.00244576             | 2.345              | 0.0199         |
| <b>ld_goldprice_1</b>                       | 0.149472           | 0.0647309              | 2.309              | 0.0218         |

Source: Gretl software.

**Table 14**

*Selected fit measures and statistics for the ARIMA(1,0,0) model for the log return of gold price*

|                                        |          |                                                 |          |
|----------------------------------------|----------|-------------------------------------------------|----------|
| <b>Mean of dependent variable</b>      | 0.006718 | <b>Standard deviation of dependent variable</b> | 0.037338 |
| <b>Residual sum of squares</b>         | 0.320320 | <b>Standard error of residuals</b>              | 0.036998 |
| <b>R-squared</b>                       | 0.022279 | <b>Adjusted R-squared</b>                       | 0.018101 |
| <b>Residual autocorrelation – rho1</b> | 0.006913 | <b>Durbin’s h-statistic</b>                     | 1.006232 |

Source: Gretl software.

The model based on literature for the logarithmic levels of variables (see model (14)) exhibits a higher adjusted R-squared compared to the autoregressive model suggested by the `auto.arima()` procedure (see Table 12). This indicates that the model, which also accounts for other determinants and outliers, better explains the dependent variable. The same conclusion can be drawn when comparing the results for models with log returns (see Table 9 and Table 14). Microsoft Copilot suggested an automated ARIMA model selection procedure, which does not account for other factors influencing gold price changes. Adding explanatory variables (i.e., the S&P500 index, US\$/EUR exchange rate, CPI index) improved the explanatory power of the model.

### **Artificial Intelligence as a Support Tool in Econometrics**

Artificial intelligence represents a disruptive technology that is fundamentally altering approaches to knowledge acquisition and task execution. Its application is increasingly observed within the field of econometrics. AI systems, particularly large language models (LLMs), possess the capability to process and analyze both numerical and unstructured textual data (e.g., news articles, social media

content), thereby enabling a more nuanced interpretation of economic phenomena. Moreover, AI significantly enhances the efficiency of literature discovery and data retrieval by rapidly identifying thematically relevant sources. Despite these advantages, notable limitations remain. In econometric analysis, the interpretability of model coefficients is essential for drawing valid inferences – an aspect where AI-generated outputs frequently fall short. Such models often lack transparency in how specific variables influence the dependent outcome. Furthermore, AI approaches are predominantly data-driven and not grounded in established economic theory. Consequently, while AI may generate empirically adequate results, it often fails to provide theoretical justification or causal explanation.

### Conclusion

All the objectives set out in this study were achieved. Based on the literature, factors influencing the change in gold prices were identified. Crude oil prices were found to be statistically insignificant. The best results were obtained for a model explaining the log return of gold prices, in which the explanatory variables included the S&P500 index, the US\$/EUR exchange rate, and the CPI index. Lagged gold prices, representing the autoregressive factor, also proved to be significant. The statistical significance of these variables' impact on the dependent variable was confirmed. Additionally, the model demonstrated good stochastic properties, indicating the absence of autocorrelation, homoscedasticity, and normality of the residuals. The positive impact of the CPI index and the negative impact of the US\$/EUR exchange rate and the S&P500 index were confirmed. COVID-19, the financial crisis, and other outlier observations were accounted for in the model by introducing appropriate dummy variables.

In addition to the econometric model, the Microsoft Copilot tool was used to study the phenomenon under investigation. This program proved helpful in finding some of the literature and identifying determinants of gold prices. However, the R code suggested by Copilot only applied an automatic procedure for the ARIMA model, which indicated a simple AR(1) model. The model that includes both the autoregressive factor and other determinants of gold prices has a higher coefficient of determination and better explains the variable under study. In summary, the advantage of causal models is that they consider factors affecting the phenomenon under study, allowing for more effective modeling of economic processes. The Microsoft Copilot tool is useful in finding information that aids in constructing the model. However, human input remains essential in the modeling process, particularly in evaluating the model's substantive content and making decisions regarding the choice of its appropriate form.

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## Appendix

### R code suggested by Microsoft Copilot

```
# Load necessary libraries
library(forecast)
library(tseries)
# Load the data
gold_data <- read.csv("gold_price_data.csv", sep=";", header=TRUE)
# Convert the 'obs' column to date format
gold_data$obs <- as.yearmon(gold_data$obs, format = "%Y.%m")
# Create a time series object
gold_ts <- ts(gold_data$gold_price, start=start(gold_data$obs), frequency=12)
# Fit an ARIMA model
fit <- auto.arima(gold_ts)
# Display the model summary
summary(fit)
# Forecast future gold prices
forecasted_values <- forecast(fit, h=12)
# Print the forecasted values
print(forecasted_values)
```

### Descriptive statistics of the variables

Below are the descriptive statistics of the analyzed variables (see Table 15, Table 16, Table 17, Table 18, Table 19). All descriptive statistics were generated using Gretl.

**Table 15***Descriptive statistics for the Gold\_price variable*

|                           |                                 |                                    |                 |
|---------------------------|---------------------------------|------------------------------------|-----------------|
| <b>Mean</b>               | <b>Median</b>                   | <b>Minimum</b>                     | <b>Maximum</b>  |
| 1239,1                    | 1268,8                          | 383,80                             | 2000,4          |
| <b>Standard deviation</b> | <b>Coefficient of variation</b> | <b>Skewness</b>                    | <b>Kurtosis</b> |
| 449,73                    | 0,36295                         | -0,28255                           | -0,83719        |
| <b>5th Percentile</b>     | <b>95th Percentile</b>          | <b>Interquartile range (Q3-Q1)</b> |                 |
| 423,97                    | 1913,2                          | 702,60                             |                 |

Source: Gretl software.

**Table 16***Descriptive statistics for the Crude\_oil\_price variable*

|                           |                                 |                                    |                 |
|---------------------------|---------------------------------|------------------------------------|-----------------|
| <b>Mean</b>               | <b>Median</b>                   | <b>Minimum</b>                     | <b>Maximum</b>  |
| 72,052                    | 68,735                          | 21,040                             | 132,83          |
| <b>Standard deviation</b> | <b>Coefficient of variation</b> | <b>Skewness</b>                    | <b>Kurtosis</b> |
| 23,983                    | 0,33285                         | 0,28893                            | -0,86590        |
| <b>5th Percentile</b>     | <b>95th Percentile</b>          | <b>Interquartile range (Q3-Q1)</b> |                 |
| 37,549                    | 108,83                          | 38,765                             |                 |

Source: Gretl software.

**Table 17***Descriptive statistics for the S&P500 variable*

|                           |                                 |                                    |                 |
|---------------------------|---------------------------------|------------------------------------|-----------------|
| <b>Mean</b>               | <b>Median</b>                   | <b>Minimum</b>                     | <b>Maximum</b>  |
| 2137,8                    | 1827,1                          | 735,09                             | 4766,2          |
| <b>Standard deviation</b> | <b>Coefficient of variation</b> | <b>Skewness</b>                    | <b>Kurtosis</b> |
| 1080,0                    | 0,50519                         | 0,90364                            | -0,38139        |
| <b>5th Percentile</b>     | <b>95th Percentile</b>          | <b>Interquartile range (Q3-Q1)</b> |                 |
| 1030,2                    | 4375,0                          | 1517,4                             |                 |

Source: Gretl software.

**Table 18***Descriptive statistics for the US\$/EUR variable*

| <b>Mean</b>               | <b>Median</b>                   | <b>Minimum</b>                     | <b>Maximum</b>  |
|---------------------------|---------------------------------|------------------------------------|-----------------|
| 0,81582                   | 0,81810                         | 0,63410                            | 1,0201          |
| <b>Standard deviation</b> | <b>Coefficient of variation</b> | <b>Skewness</b>                    | <b>Kurtosis</b> |
| 0,083472                  | 0,10232                         | −0,013089                          | −0,81796        |
| <b>5th Percentile</b>     | <b>95th Percentile</b>          | <b>Interquartile range (Q3-Q1)</b> |                 |
| 0,68312                   | 0,94521                         | 0,14080                            |                 |

Source: Gretl software.

**Table 19***Descriptive statistics for the CPI variable*

| <b>Mean</b>               | <b>Median</b>                   | <b>Minimum</b>                     | <b>Maximum</b>  |
|---------------------------|---------------------------------|------------------------------------|-----------------|
| 2,3596                    | 2,3473                          | 1,8670                             | 3,0802          |
| <b>Standard deviation</b> | <b>Coefficient of variation</b> | <b>Skewness</b>                    | <b>Kurtosis</b> |
| 0,29446                   | 0,12479                         | 0,59079                            | −0,079229       |
| <b>5th Percentile</b>     | <b>95th Percentile</b>          | <b>Interquartile range (Q3-Q1)</b> |                 |
| 1,9170                    | 2,9889                          | 0,37994                            |                 |

Source: Gretl software.

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## THE ROLE OF FINANCIAL SECTOR IN DRIVING ECONOMIC GROWTH

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### THE ROLE OF FINANCIAL SECTOR IN DRIVING ECONOMIC GROWTH

#### ABSTRACT

**The purpose of the article.** This study verifies whether multidimensional financial-sector development – measured with the IMF composite indices of depth (FDI), access (FMI) and efficiency (FII) – influences key macroeconomic and social outcomes in ten high-income EU economies between 2010 and 2023.

**Methodology.** Standardized annual data was taken from the World Development Indicators and the IMF Financial Development Index Database. Pearson correlation coefficients were calculated for each country and variable pair. The statistical findings were then interpreted case-by-case to capture both short-term relationships and structural patterns.

**Results of the research.** Greater financial depth proved positively related to price stability and to an expansion of private-sector credit. In the short run, however, it showed no significant effect on GDP growth and coincided with a fall in household saving rates and a temporary rise in unemployment – evidence of the nonlinear, stage-dependent nature of the finance-growth nexus. The findings imply that policy makers in advanced economies should focus on balancing further financial deepening with safeguards that counteract labor-market frictions and excessive consumption growth.

**Keywords:** economic growth, financial sector, credit, inflation, savings, unemployment.

**JEL Class:** C33, E44, O16, O47.

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## Introduction

Stable and efficient capital allocation is regarded as one of the key mechanisms driving long-term economic growth. Although the role of the financial sector has long been a subject of debate in the economic literature, there remains no clear consensus as to which channels of financial transmission to real economic activity are of greatest significance, nor how they differ across countries at various stages of development. Previous research has focused primarily on individual indicators, such as stock market capitalization or the volume of bank credit, while neglecting the comprehensive dimension of the financial sector, which encompasses both capital markets and financial intermediation institutions.

The aim of this article is to fill this gap by providing an empirical assessment of the relationships between multidimensional financial development and selected macroeconomic and social variables in a group of ten high-income European Union member states. Drawing on the most recent composite indicators from the IMF: the Financial Development Index (FDI), the Financial Markets Index (FMI), and the Financial Institutions Index (FII), the authors formulate six research hypotheses relating, among others, to price stability, credit availability, the structure of savings, and demographic dynamics.

The methodology is based on Pearson correlation analysis applied to standardized annual series for the period 2010–2023, sourced from the World Development Indicators and the Financial Development Index Database. This time horizon makes it possible to observe both the consequences of the financial crisis and the post-pandemic phase.

The article consists of four parts. Section One presents a review of the literature, outlining competing theories of finance and growth. The second section describes the data and the construction of variables. Part Three presents the results of correlation tests, together with the interpretation of the individual hypotheses. Section Four discusses the implications for economic policy and directions for further research. This structure allows the reader to follow the logical flow of the argument from theoretical foundations, through the research procedure, to practical conclusions.

### **The financial system and its sectors in the economy**

The financial system forms the foundation of the functioning of modern economy, enabling efficient capital allocation, risk management, and the stabilization of macroeconomic processes. It can be defined in various ways depending on the adopted research perspective and the objectives of analyzing financial markets and institutions (Levine, 2005, p. 32). In the literature, several approaches to its definition are distinguished: the institutional (focusing on types of institutions and regulations), the monetary (treating the system as a mechanism of money issuance and circulation), the intermediation-based (emphasizing capital transfers between entities), the functional (analyzing the structure of markets and financial instruments), and the systemic (considering internal linkages and the holistic character of the system) (Matysek-Jędrych, 2007, p. 40).

In its broadest sense, the financial system encompasses all institutions and markets engaged in the processes of accumulating, transferring, and multiplying financial resources, as well as in providing protection against risks – credit, interest rate, or currency risks (Sławiński, 2010, p. 27–29). Its structure includes, among others, commercial and investment banks, central banks, investment funds, insurance companies, pension funds, leasing firms, and other financial intermediaries (Mishkin, 2013, p. 45–48).

The primary function of the system is to efficiently match entities possessing capital surpluses with those that demand capital. This promotes the optimal allocation of resources and supports economic growth (Mishkin, 2013, p. 49–50). In addition, the system performs stabilizing functions and enables both risk diversification and flexible capital placement (Brigham & Houston, 2009, p. 72–76). Owing to its systemic nature and its significance for economic security, the sector is subject to strict regulation and state supervision (NBP, 2020, p. 14–15).

### **Core roles of the financial system**

The financial system performs key functions in the economy, enabling efficient capital allocation, risk management, and the safeguarding of financial stability. The literature identifies several fundamental roles that the financial system plays in shaping economic dynamics:

- allocative function – providing financial resources to economic entities, particularly enterprises investing in technological development, infrastructure, and human capital. Such activities lead to higher productivity and the creation of new jobs (Brigham & Houston, 2009, p. 90–93),
- stabilizing function – commercial banks, through deposit and credit operations, ensure access to capital and counteract payment gridlocks, thereby supporting economic stability. This role becomes more pronounced under crisis conditions and is reinforced by the actions of central banks (Sławiński, 2010, p. 40–42; Mishkin, 2013, p. 105–108; Patterson, 2015, p. 48),
- capital allocation function in financial markets – capital markets enable the issuance and trading of securities, which supports enterprise development and allows investors to allocate resources across a variety of assets (King & Levine, 1993, p. 717–737; Saunders & Allen, 2010).

Nevertheless, the risks associated with the functioning of the financial system should not be overlooked. Insufficient supervision and excessive credit expansion may lead to crises, as was the case in 2007–2009 with the U.S. subprime bubble and the lack of regulation in the derivatives market (Reinhart & Rogoff, 2009, p. 1–3; Shiller, 2015, p. 88–91).

## **The financial technology sector as a modern branch of the financial system**

The financial system encompasses a number of interconnected sectors: commercial and investment banking, insurance, capital markets, pension funds, and brokerage services (Góra, 2003; Sułkowska, 2014). Each of these plays an important role in the economy, however, this study devotes particular attention to the financial technology sector – a dynamically developing branch that gained prominence following the financial crisis of 2007–2008 (Reinhart & Rogoff, 2009, p. 1; Sławiński, 2010, p. 31–35).

The 2007–2008 financial crisis exposed weaknesses in the banking system, including insufficient oversight of derivative instruments and irresponsible credit policies pursued by financial institutions, which ultimately led to a loss of public trust (Reinhart & Rogoff, 2009, p. 1–3; Shiller, 2015, p. 88–91).

A significant share of clients began to perceive banks as institutions acting solely in their own interest, pointing to the lack of transparency in product offerings, hidden fees, and ambiguous lending conditions (NBP, 2020, p. 15). Under such circumstances, space emerged for new players-financial technology companies offering simpler and more accessible financial products (Hedley et al., 2015, p. 51–58).

The development of the sector has primarily resulted from shifting customer expectations with respect to mobility, personalization, and transparency of services, as well as from the ongoing digital transformation, which has enabled innovation in payments, credit, and investment (Brigham & Houston, 2009; Worthington & Welch, 2011; Mishkin, 2013).

Between 2018 and 2023, the number of active payment and lending platforms increased by more than 60%, while the value of digital transactions nearly doubled (NBP, 2023). The decline in cash usage has also contributed to the continued expansion of the sector (Jaroszek & Kołodziej, 2023).

## **The nature and importance of economic growth**

Economic growth is one of the central issues in economics, constituting the foundation of socio-economic development and the improvement of living standards (Acemoglu, 2009). In the literature, it is conceptualized as a multidimensional phenomenon encompassing not only increases in production but also technological, institutional, and social transformations. This chapter presents the definition of growth, its main determinants, and a review of theories – from the classics, through the Solow model, to the endogenous approaches of Romer and Lucas.

### **Key definitions and theories of economic growth**

Economic growth is not merely a statistical increase in GDP but a process of expanding the productive capacity of the economy, encompassing technological, institutional, and social changes (GUS, 2025, p. 2; Samuelson & Nordhaus, 2010, p. 545). It is accompanied by improvements in

employment, infrastructure, and overall welfare. It is important to distinguish growth from economic development, which also includes qualitative changes such as the enhancement of human capital or innovativeness (GUS, 2025, p. 2).

The mechanisms of growth are explained by three main groups of theories. Classical theories (Smith, Ricardo, Malthus) emphasize the importance of capital accumulation and specialization (Smith, 1776; Meredyk, 2003). Neoclassical theories, with the Solow model at the forefront, highlight the role of savings and exogenous technological progress (Solow, 1956; Barro, 1997). Endogenous growth theories (Romer, Lucas) internalize the sources of growth, pointing to the significance of human capital, innovation, and knowledge as public goods (Romer, 1990; Lucas, 1988). The Keynesian approach stresses the role of demand and state intervention, particularly in times of crisis (Keynes, 1936).

Although GDP remains the primary measure of growth, it does not fully reflect quality of life, omitting, among other things, environmental costs and unpaid work (Stiglitz et al., 2009). For this reason, complementary measures are increasingly used, such as GDP per capita, GNI, TFP, and well-being indicators (OECD, 2022; Meadows et al., 1972). Depending on the purpose of the analysis, different indicators are applied – for example, real GDP in stabilization policy, and purchasing power – adjusted indicators in international comparisons (Krugman & Wells, 2020; Mankiw & Taylor, 2016).

### **Determinants of economic growth**

The key determinants of sustainable economic growth rest on two pillars: technological progress, which raises the marginal productivity of labor, and capital accumulation, which enables the scaling of production (Solow, 1956, p. 65). The combination of new production techniques and an increasing stock of capital leads to the gradual substitution of routine labor with physical capital, thereby enhancing the technological endowment of labor and increasing real wages (Smith, 1776, p. 23). Effective income convergence, however, requires the complementarity of these factors with an institutional environment conducive to investment and innovation (North, 1990, p. 84).

The most frequently distinguished growth factors include:

- human capital – the number of workers, along with their qualifications and motivation, determines the economy's capacity to absorb new technologies and enhance productivity (Lucas, 1988, p. 35; Gruszevska, 2007, p. 341–356),
- physical capital – the pace of physical capital accumulation (machinery, infrastructure) defines the short-term dynamics of growth and the potential for enterprise modernization (Solow, 1956, p. 70),
- natural resources – the availability and quality of raw materials shape comparative advantages, particularly in resource-intensive sectors, although their importance diminishes with ongoing technological substitution (Barro & Sala-i-Martin, 2004, p. 399),

- technological level – innovativeness and effective science–business linkages drive long-term per capita output growth; investments in R&D generate positive externalities across the entire economy (Romer, 1990, p. 72; Olszewska, 2008, p. 119–136),
- pro-development institutions – regulations protecting property rights, an efficient financial system, and organizations supporting entrepreneurship reduce transaction costs and mobilize capital for innovative projects (Barro & Sala-i-Martin, 2004).

The most recent data from Statistics Poland (GUS), released in January 2025, indicates that despite the post-pandemic slowdown, Poland has maintained an average GDP growth rate above 3%, underscoring the importance of the synergy between human capital and innovation for sustainable development. It is worth noting that in 2023 GDP growth was markedly lower, amounting to only 0.1%, whereas in other years covered by the GUS report – 2021 (6.9%), 2022 (5.3%), and 2024 (2.9%) – economic growth was significantly higher (GUS, 2025, p. 2).

### **Variables of economic growth**

This subsection presents the set of variables used for the empirical analysis of the relationship between financial sector development and economic growth in ten high-income EU countries (IMF, 2023, p. 5). These countries are Belgium, the Czech Republic, Denmark, France, Germany, Poland, Portugal, Spain, Slovakia, and the Netherlands. The data was drawn from the World Development Indicators, the Financial Development Database, and IMF resources (World Bank, 2023, p. 3; Ashenafi & Dong, 2022, p. 376–387).

Dependent variables (macroeconomic):

- international trade (% of GDP),
- gross savings (% of GDP) – a proxy for the country’s capacity to finance investment,
- annual GDP per capita growth – the basic measure of economic growth dynamics,
- credit to the private sector (% of GDP) – an indicator of financing availability for enterprises and households,
- CPI inflation (annual %) – a measure of price stability,
- population growth (annual %) – a demographic factor (World Bank, 2023, p. 5).

Independent variables – financial development:

- Financial Development Index (FDI) – a composite indicator of the entire financial system (IMF, 2023, p. 4),
- Financial Markets Index (FMI) – the depth and efficiency of capital markets,
- Financial Institutions Index (FII) – the scale and quality of the activities of banks and other intermediaries (IMF, 2023, p. 6).

The time series covering 2010–2023 were cleaned of missing values through linear interpolation and standardized; the relationships were then assessed using Pearson’s correlation coefficient in order

to determine the direction and strength of linear relationships between financial indicators and macroeconomic variables (Barro, 1991, p. 451).

### **Analysis of the relationship between the financial system and economic growth**

In this study, six research hypotheses were formulated to examine the impact of financial system development through key indicators. These hypotheses were developed on the basis of literature review and previous studies pointing to the significant role of the financial system in shaping the economic and social situation worldwide.

To investigate the relationship between the level of financial system development and economic growth, the study applies correlation analysis. This method makes it possible to assess both the strength and direction of relationships between the examined variables. Detailed results of the correlation analysis will be presented in the subsequent sections of this chapter.

### **Research methodology**

The verification of the selected hypotheses was carried out using the Pearson correlation coefficient, which assesses the relationship between the development of the financial sector (measured by the three IMF indices) and the variation of macroeconomic and social indicators in high-income EU countries (King & Levine, 1993, p. 719).

Research hypotheses:

- Hypothesis 1 – A higher Financial Development Index (FDI) increases the share of foreign trade in GDP (Beck, 2002, p. 425),
- Hypothesis 2 – Growth in FDI boosts private sector credit activity (% of GDP) (Levine, 2005, p. 870),
- Hypothesis 3 – FDI is positively correlated with the level of gross savings (Pagano, 1993, p. 614),
- Hypothesis 4 – The Financial Markets Index (FMI) reduces CPI inflation (price stabilization channel) (Fry, 1997, p. 689),
- Hypothesis 5 – A higher Financial Institutions Index (FII) accelerates annual GDP per capita growth (Levine & Zervos, 1998, p. 563),
- Hypothesis 6 – FDI has a positive impact on population growth (annual %) (World Bank, 2023, p. 7).

### **Empirical analysis**

To examine the relationship between development of financial sector and macroeconomic variables, a classical method of linear correlation was applied. This approach makes it possible to determine both the direction and the strength of co-movements between two numerical features (Greene,

2018, p. 47). Before calculating the coefficients, each series was checked for outliers and transformed into logarithmic annual dynamics, which reduces heteroskedasticity and limits the risk of spurious correlation in macroeconomic time series (King & Levine, 1993, p. 719).

The empirical material was drawn from two recognized international sources: the World Bank's World Development Indicators and the IMF's Financial Development Index Database. The time span of 2010–2023 (13 annual observations) captures both cross-country variation and short-term trends in the interactions of the studied variables (World Bank, 2023, p. 3; IMF, 2023, p. 4).

The analysis used the Pearson correlation coefficient ( $r$ ), which ranges from  $-1$  to  $1$  (IMF, 2023, p. 5):

$r > 0$  – positive dependence: an increase in one variable coincides with an increase in the other,

$r < 0$  – negative dependence: an increase in one variable coincides with a decrease in the other,

$|r| \approx 0$  – no significant linear dependence.

Following Cohen's criteria, values of  $|r| > 0.5$  are considered strong,  $0.3$ – $0.5$  moderate, and  $0.1$ – $0.3$  weak (Cohen, 1988, p. 22). Statistical significance was assessed using a two-tailed t-test at  $\alpha = 0.05$ . Despite the relatively limited sample size, this procedure provides a preliminary quantitative picture of co-movements between the financial sector and economic activity.

To visualize the results, a heatmap was constructed showing the correlations between the selected financial indicators (FDI, FMI, FII) and the key macroeconomic variables.

**Figure 1**

*Correlation matrix heatmap*

|                                              | Financial Development Index | Financial Institutions Index | Financial Markets Index | Trade (% of GDP) | Population growth (annual %) | Inflation, consumer prices (annual %) | Gross savings (% of GDP) | Domestic credit to private sector (% of GDP) | GDP growth (annual %) |
|----------------------------------------------|-----------------------------|------------------------------|-------------------------|------------------|------------------------------|---------------------------------------|--------------------------|----------------------------------------------|-----------------------|
| Financial Development Index                  | 1,000                       | 0,999                        | 0,989                   | -0,497           | 0,379                        | -0,215                                | -0,629                   | 0,543                                        | -0,004                |
| Financial Institutions Index                 | 0,999                       | 1,000                        | 0,991                   | -0,517           | 0,403                        | -0,248                                | -0,633                   | 0,546                                        | -0,032                |
| Financial Markets Index                      | 0,989                       | 0,991                        | 1,000                   | -0,470           | 0,380                        | -0,316                                | -0,576                   | 0,480                                        | -0,020                |
| Trade (% of GDP)                             | -0,497                      | -0,517                       | -0,470                  | 1,000            | -0,469                       | 0,158                                 | 0,836                    | -0,863                                       | 0,597                 |
| Population growth (annual %)                 | 0,379                       | 0,403                        | 0,380                   | -0,469           | 1,000                        | -0,456                                | -0,260                   | 0,170                                        | -0,537                |
| Inflation, consumer prices (annual %)        | -0,215                      | -0,248                       | -0,316                  | 0,158            | -0,456                       | 1,000                                 | -0,029                   | 0,171                                        | 0,292                 |
| Gross savings (% of GDP)                     | -0,629                      | -0,633                       | -0,576                  | 0,836            | -0,260                       | -0,029                                | 1,000                    | -0,974                                       | 0,429                 |
| Domestic credit to private sector (% of GDP) | 0,543                       | 0,546                        | 0,480                   | -0,863           | 0,170                        | 0,171                                 | -0,974                   | 1,000                                        | -0,424                |
| GDP growth (annual %)                        | -0,004                      | -0,032                       | -0,020                  | 0,597            | -0,537                       | 0,292                                 | 0,429                    | -0,424                                       | 1,000                 |

Source: own elaboration based on the World Bank and IMF data.

## Verification of the adopted hypotheses

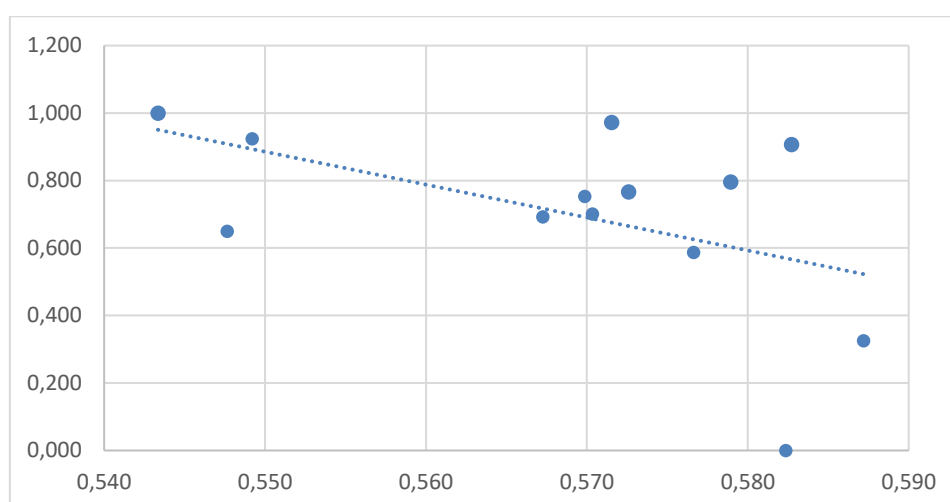
### *Hypothesis 1 – financial sector development and international trade*

The results ( $r \approx -0.5$ ) did not confirm the hypothesis, indicating a negative relationship between the FDI and the share of international trade in GDP (IMF, 2023).

The scatter plot in Figure 2 illustrates the relationship between the level of financial sector development (FDI, X-axis) and the share of international trade in GDP (Y-axis) in the examined EU countries for the period 2010–2023. Each point represents a single observation (country-year). The points reveal a clear downward trend, and the negatively sloped regression line suggests that a higher level of financial sector development is associated with a lower share of international trade in the economy.

**Figure 2**

*Scatter plot for FDI and trade (% of GDP)*



Source: own elaboration based on the World Bank and IMF data.

The negative correlation may result from the fact that in highly developed economies with an advanced financial sector, the role of services and production aimed at satisfying domestic demand increases, which reduces the need for exports and imports. At the same time, a well-developed technological and production base decreases dependence on foreign goods and, consequently, the share of trade in GDP (Beck, 2002, p. 110). The negative sign of the coefficient does not contradict the complementarity of finance and trade; rather, it suggests that the relationship is nonlinear and strongly dependent on the level of development and the structure of a given country's economy. The obtained result indicates the need to apply nonlinear models or sample segmentation in order to more accurately capture the differentiated dynamics between financial system development and the intensity of international trade.

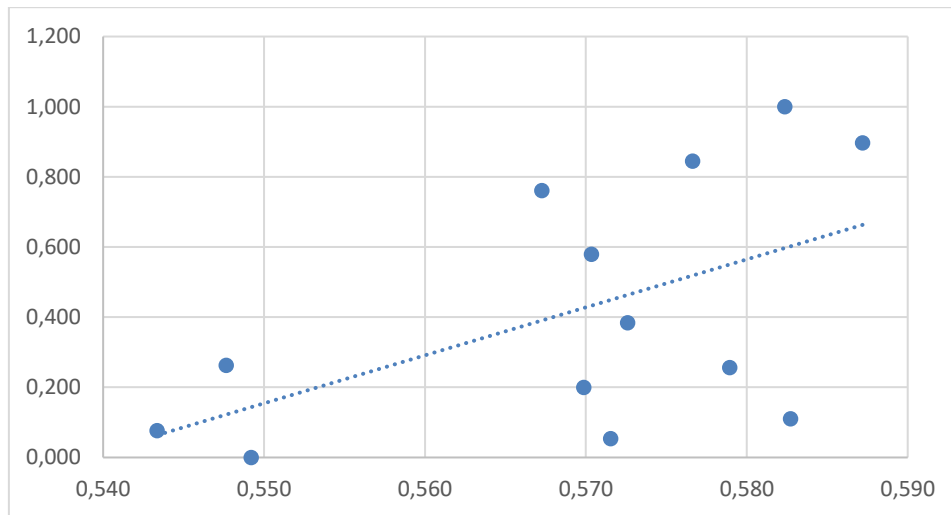
### ***Hypothesis 2 – financial sector development and credit availability***

The results ( $r \approx 0.54$ ) confirmed the hypothesis, demonstrating a positive relationship between the Financial Development Index (FDI) and private sector credit (King & Levine, 1993, p. 726).

The scatter plot illustrates the relationship between the level of financial sector development (FDI, X-axis) and the share of private sector credit in GDP (Y-axis) for the years 2010–2023. Each point corresponds to a specific country and year. The points form an upward pattern, and the positively sloped regression line confirms the positive correlation: higher FDI is associated with a greater share of private credit in the economy.

**Figure 3**

*Scatter plot for FDI and domestic credit to the private sector (% of GDP)*



Source: own elaboration based on the World Bank and IMF data.

A possible explanation for the observed positive correlation is that in economies with a well-developed financial infrastructure, banks and financial institutions allocate capital more efficiently. Through more accurate risk assessment and more effective asset management, they expand the supply of credit available to both enterprises and households. The broad range of financial products ranging from consumer and mortgage loans to investment financing fosters more intensive reliance on external sources of funding. This, in turn, translates into higher credit activity and substantiates the observed positive relationship between financial sector development and the scale of credit provision (King & Levine, 1993, p. 726; Bukowski, 2012, p. 39–55).

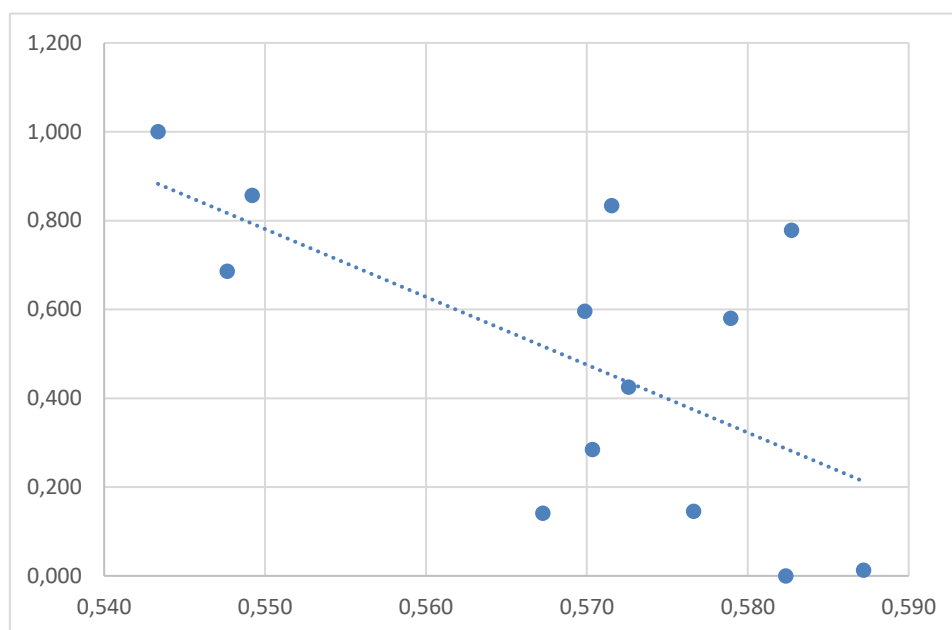
### ***Hypothesis 3 – financial sector development and national savings***

The analysis revealed a weak but statistically significant negative correlation ( $r \approx -0.62$ ) between financial sector development and the level of gross savings relative to GDP. This suggests that

the higher the FDI, the lower the share of savings, which can be explained by the fact that in mature financial systems households tend to replace traditional capital accumulation with cheaper credit (Pagano, 1993, p. 616). The scatter plot illustrates the relationship between financial sector development (FDI, X-axis) and the level of gross savings relative to GDP (Y-axis). Each point represents a single observation (country-year). The downward-sloping trend line clearly confirms the calculated correlation: the higher the FDI, the lower the level of gross savings. This relationship is illustrated in the figure below.

**Figure 4**

*Scatter plot for FDI and gross savings (% of GDP)*



Source: own elaboration based on the World Bank and IMF data.

A possible explanation for the negative correlation is that in economies with a highly developed financial sector, both households and enterprises increasingly replace traditional saving with easily accessible credit, which lowers the overall level of savings relative to GDP. At the same time, a more stable macroeconomic environment and a wide range of financial services reduce the need to accumulate precautionary reserves, further diminishing the propensity to save.

#### ***Hypothesis 4 – financial market development and inflation***

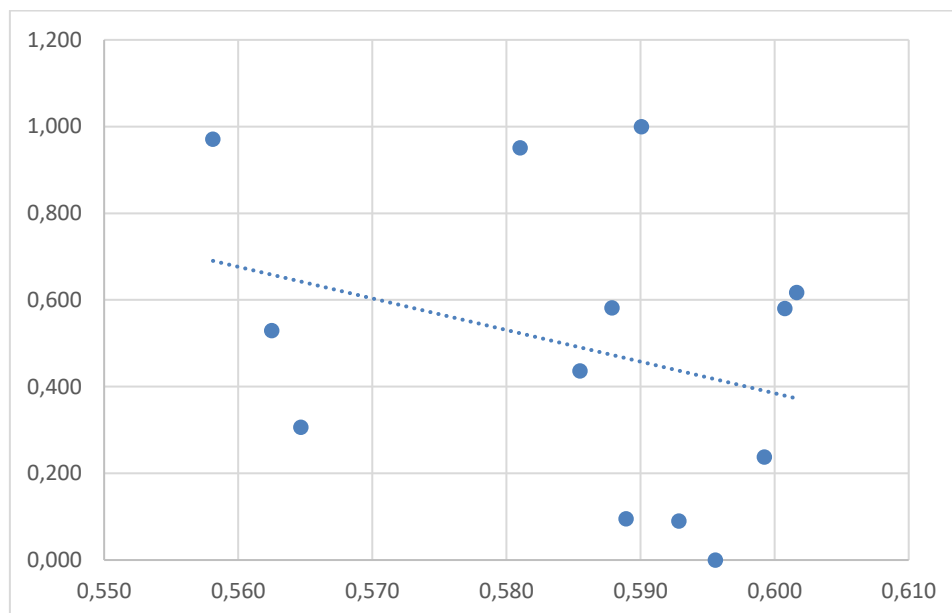
The negative correlation ( $r \approx -0.32$ ) confirms that deeper capital markets contribute to price stabilization through more efficient resource allocation (Fry, 1997, p. 691).

The scatter plot presented in Figure 5 illustrates the relationship between financial market development (FMI, X-axis) and the annual CPI inflation rate (Y-axis) in the period 2010–2023. Each

point represents a single observation. The slope of the regression line suggests that a negative relationship-higher FMI is associated with lower inflation.

**Figure 5**

*Scatter plot for FMI/Inflation, consumer prices (annual %)*



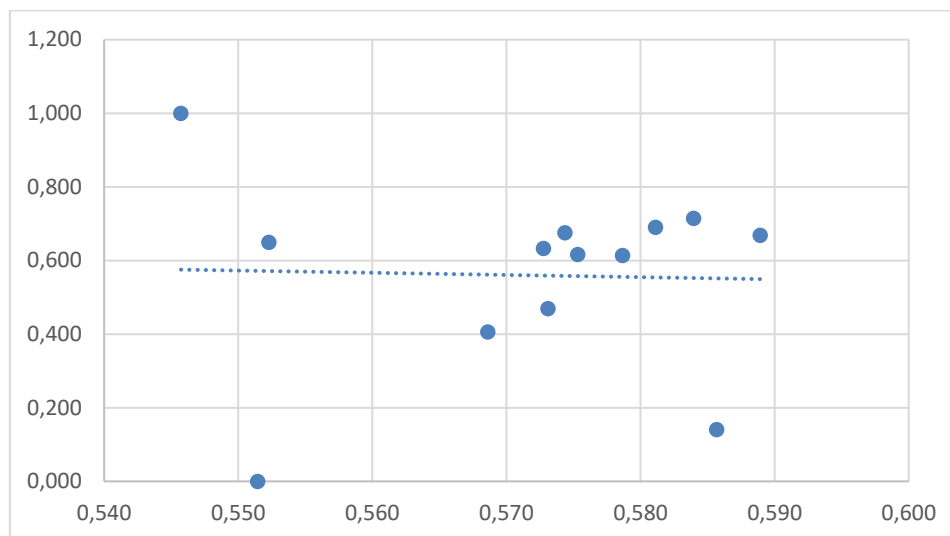
Source: own elaboration based on the World Bank and IMF data.

A possible explanation of the negative correlation assumes that developed financial markets stabilize the economy through more efficient capital allocation, reducing the risk of excessive demand and financial instability, which naturally alleviates inflationary pressures. At the same time, access to a broad range of financial instruments enables enterprises to manage resources more precisely, enhance productivity, and curb increases in production costs, thereby lowering the overall price level.

### ***Hypothesis 5 – development of financial institutions and economic growth***

The near-zero correlation ( $r \approx -0.03$ ) indicates a neutral short-term impact of FII on GDP; potential effects may only become visible over a longer horizon (Levine & Zervos 1998, p. 540).

Figure 6 presents a scatter plot illustrating the relationship between the development of financial institutions (FII, X-axis) and the annual growth rate of GDP per capita (Y-axis) in the years 2010–2023. The points align along an almost horizontal line, with each point representing a single observation (country–year). This indicates the absence of a significant short-term correlation.

**Figure 6***Scatter plot for FII/GDP per capita growth (annual %)*

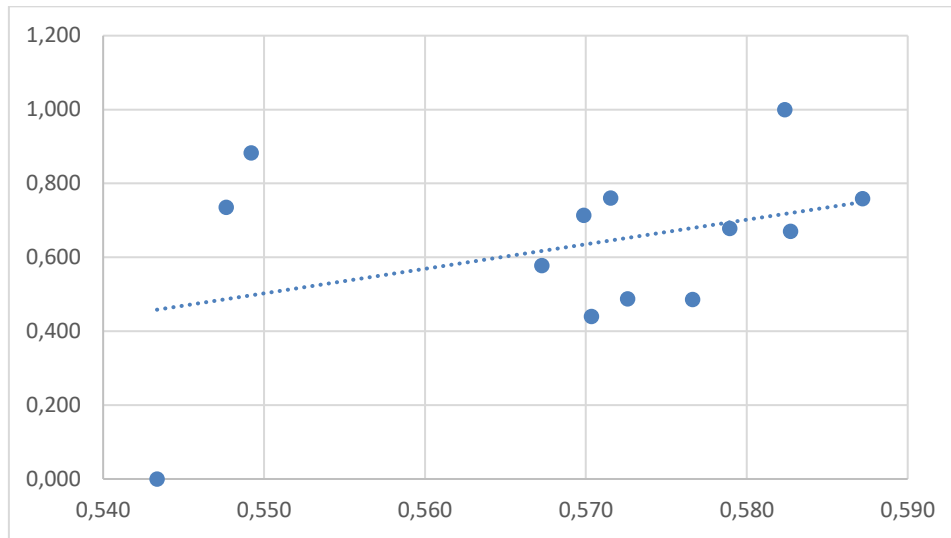
Source: own elaboration based on the World Bank and IMF data.

A possible explanation for the neutral correlation is not straightforward. Annual GDP dynamics depend on a wide range of factors – from fiscal and monetary policy, through the level of investment and foreign trade, to the pace of technological progress. The development of financial institutions is only one element of this system, and its impact may be weakened by other variables. Moreover, the effects of improved capital allocation and higher investment typically materialize over the long term, which is why in the short run the relationship with GDP growth may remain statistically neutral.

#### ***Hypothesis 6 – financial sector development and population growth***

The results of the correlation analysis confirmed this hypothesis, showing a positive relationship between these variables ( $r \approx 0.38$ ). This indicates that higher levels of financial sector development are associated with stronger population growth dynamics (World Bank 2023, p. 78).

The scatter plot presented in Figure 7 illustrates the relationship between financial sector development (FDI, X-axis) and the annual population growth rate (Y-axis). Each point represents a single country-year observation for the period 2010–2023. A clear positive correlation can be seen – higher levels of FDI are accompanied by higher rates of population growth.

**Figure 7***Scatter plot for FDI and population growth (annual %)*

Source: own elaboration based on the World Bank and IMF data.

A possible explanation for the observed positive correlation is that a well-developed financial sector facilitates capital mobilization for investments in healthcare and education, which improves life expectancy, reduces infant mortality, and enhances the quality of maternal care, thereby naturally increasing birth rates and lowering mortality. At the same time, greater macroeconomic stability associated with advanced financial markets reduces cyclical fluctuations and unemployment risks, providing households with stronger income security and encouraging long-term decisions such as family expansion.

The correlation analysis carried out for each of the six hypotheses, designed to illustrate the relationships between financial sector development and key economic and social variables, revealed that these interactions are complex and strongly dependent on both the level of development of the examined countries and the structure of their financial systems. The results confirmed the positive role of deepened capital markets in price stabilization and improved credit availability but also demonstrated a neutral short-term effect of financial institutions on GDP growth, a decline in traditional saving practices, and a temporary increase in unemployment in advanced economies, where capital shifts toward high-productivity and automated sectors. In emerging economies, financial deepening delivers more immediate growth benefits, whereas in mature economies such benefits materialize only in the longer term and are counterbalanced by structural adjustments. Ultimately, financial sector development emerges as a multidimensional factor: on the one hand, it strengthens macroeconomic stability and mobilizes capital, while on the other, it requires balanced policies that minimize risks to the labor market and the savings-investment equilibrium. Future research should therefore employ nonlinear models and country segmentation to more precisely capture the diverse mechanisms linking finance with the real economy under varying institutional conditions.

## Conclusion

The purpose of this article was to analyze the impact of financial sector development, measured by the IMF indices (FDI, FMI, FII), on key macroeconomic and social variables in ten high-income EU countries during the period 2010–2023. The study employed Pearson correlations calculated for standardized data drawn from the World Development Indicators and the Financial Development Index Database, with the results supplemented by case analysis. The findings indicated that financial deepening contributed to price stabilization and increased credit availability for the private sector, while the short-term effect on GDP growth remained neutral. In advanced economies, a higher level of financial development was associated with declining traditional savings and a temporary rise in unemployment, confirming the nonlinear and context-dependent nature of the finance-growth nexus. A key added value of the study was the demonstration that the effects of financial sector development depend on the level of advancement and structural features of individual economies, implying the necessity of differentiated financial policies tailored to national conditions. The conducted analysis confirmed the complex and multidimensional character of the relationship between the financial sector and economic growth. The empirical results are largely consistent with the findings of King & Levine (1993), Pagano (1993), Fry (1997), and Levine & Zervos (1998). At the same time, observed deviations from the literature-particularly the absence of a significant relationship between financial institutional development and GDP dynamics-suggest that these effects materialize only in the longer term, which falls beyond the scope of the analyzed period.

An added value of this study lies in demonstrating that the impact of the financial sector depends on the level of development and the structural characteristics of individual economies, which implies the necessity of differentiated financial policies tailored to national conditions. Future research should employ more advanced econometric methods, such as panels or dynamic models, to better capture causality and long-term effects. Expanding the sample to include middle- and low-income countries would also make it possible to verify whether the observed findings are universal in nature or rather specific to highly developed economies.

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## FINANCIAL REFORMS IN ALGERIA: ANALYZING THE IMPACT OF ORGANIC FINANCE LAW 18-15 ON PUBLIC ACCOUNTING, FOREIGN INVESTMENT, ELECTRONIC SERVICES, LOCAL AUTONOMY, AND FISCAL SUSTAINABILITY

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### FINANCIAL REFORMS IN ALGERIA: ANALYZING THE IMPACT OF ORGANIC FINANCE LAW 18-15 ON PUBLIC ACCOUNTING, FOREIGN INVESTMENT, ELECTRONIC SERVICES, LOCAL AUTONOMY, AND FISCAL SUSTAINABILITY

#### ABSTRACT

**The purpose of the article.** This article examines the impact of Algeria's Organic Finance Law 18-15 on the country's public financial management, foreign investment environment, electronic financial services, local financial autonomy, and overall fiscal sustainability. The study aims to assess whether the comprehensive reforms introduced by OFL 18-15 have effectively enhanced fiscal transparency, improved accrual accounting adoption, facilitated foreign direct investment liberalization, and strengthened local financial governance amidst Algeria's economic diversification efforts.

**Methodology.** The methodology combines a doctrinal analysis of legislative texts, comparative assessment with international best practices, and empirical evaluation drawing on official budget data and stakeholder interviews conducted in 2023-2024. This mixed-methods approach enables a multi-faceted understanding of reform implementation dynamics, challenges, and outcomes.

**Results of the research.** Findings reveal that OFL 18-15 has significantly advanced accrual-based accounting and performance budgeting frameworks, fostering greater fiscal discipline and transparency. The removal of restrictive foreign ownership caps in non-strategic sectors spurred a moderate increase in foreign investment flows. Digital financial service regulations have promoted fintech growth and enhanced financial inclusion, though infrastructural and regulatory gaps persist. Meanwhile, local governments have gained legislative fiscal autonomy but remain dependent on central transfers, underscoring governance and capacity constraints. Overall, while progress towards fiscal sustainability remains uneven—with persistent deficits linked to hydrocarbon dependence—the reforms have created a critical foundation for long-term economic resilience. The study concludes that continued capacity building, institutional strengthening, and policy integration are essential to fully realize the transformative potential of Algeria's financial reforms.

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## Introduction

Algeria's economic trajectory has been shaped by its hydrocarbon dominance, contributing over 90% of exports and 40% of fiscal revenues, rendering it susceptible to global energy market fluctuations (World Bank, 2024). The 2014 oil price crash exposed structural weaknesses, leading to fiscal deficits averaging 10% of GDP between 2015–2020 and depleting foreign reserves from \$194 billion in 2014 to \$44 billion by 2021 (IMF, 2024). In response, the government initiated comprehensive reforms, culminating in the Organic Finance Law (OFL) 18–15 of 2018 (Algeria, 2018), which introduces performance-based budgeting, multi-annual fiscal planning, and alignment with International Public Sector Accounting Standards (IPSAS) (Benzine, 2024) to enhance transparency and efficiency.

This law builds on prior transitions, such as the 2010 Financial Accounting System (FAS) adoption, rooted in IFRS/IAS, and 2016 auditing standards (Djazouli & Ibrir, 2024). Complementary measures include Law July 23 of 2023 (Boudjellal & Al-Saidi, 2024) mandating accrual accounting for accurate asset-liability reporting and the 2020 Finance Law (Algeria, 2020) easing foreign investment barriers like the 49/51 rule. Recent fintech regulations (2024–2025) further digitize services, aiming for financial inclusion (Bank of Algeria, 2024).

Scholarly discourse underscores the global shift to accrual accounting for fiscal resilience (Christiaens & Van Peteghem, 2007; Brusca et al., 2015). In Algeria, studies highlight implementation gaps amid rising expenditures \$98 billion in 2023 and revenue volatility (Benmoussa & Djebara, 2022). The research problem addresses whether OFL 18–15 effectively bridges these gaps, fostering sustainability. Justifying the topic, this article examines reform impacts through doctrinal, comparative, and empirical lenses, proposing enhancements for resource-dependent economies.

## Research Hypothesis

This study hypothesizes that the comprehensive reforms introduced by Algeria's Organic Finance Law 18–15 have significantly improved the country's public financial management by enhancing fiscal transparency, promoting accrual accounting adoption, facilitating an improved foreign investment environment, accelerating the growth of electronic financial services, strengthening local financial autonomy, and contributing positively to overall fiscal sustainability amidst economic diversification efforts. Specifically, it is posited that these reforms lead to measurable increases in fiscal discipline, revenue mobilization, and investor confidence, thereby fostering long-term economic resilience.

## Historical Evolution of Financial Reforms in Algeria

Algeria's financial reform journey is deeply intertwined with its broader socio-political and economic evolution since independence. Initially shaped by a socialist development model, the country's financial system during the post-independence era largely emphasized state control, centralized planning, and public sector dominance. This approach aimed to foster national sovereignty and social equity but also generated inefficiencies and constrained private sector dynamism.

The pivotal transition toward market-oriented economic policies began in the 1990s, catalyzed by economic crises and a need for structural adjustment supported by the International Monetary Fund (IMF). The IMF-backed reform programs of that period sought to liberalize the economy, improve fiscal discipline, and promote private sector development through measures such as reducing subsidies, restructuring public enterprises, and enhancing tax systems (IMF, 1997). However, this transformation was gradual and faced resistance due to entrenched bureaucratic practices and political sensitivities.

A significant legislative milestone was the Supplemental Finance Law enacted in 2009 (Algeria, 2009), which crystallized protective measures like the 49/51 foreign ownership rule. This restriction, designed to safeguard national economic interests and strategic sectors, inadvertently deterred Foreign direct investment (FDI). Between 2010 and 2019, Algeria experienced a steep 50% decline in FDI inflows, reflecting investor apprehension towards ownership limitations and regulatory uncertainties (UNCTAD, 2020).

The 2014 global oil price collapse sharply exposed the vulnerabilities of Algeria's hydrocarbon-dependent economy, accelerating the urgency for economic diversification and more robust fiscal frameworks. In response, the Organic Finance Law (OFL) 18–15 was enacted in 2018, embedding fiscal rules, performance metrics, and accrual accounting principles to improve fiscal discipline and enhance public financial management transparency (IMF, 2023).

The onset of the COVID-19 pandemic in 2020 introduced further challenges but also propelled reform momentum. The Foreign Investment Law (FL) 2020 (UNCTAD, 2025) alleviated ownership caps in non-strategic sectors, paving the way for increased foreign participation and investment. The subsequent Supplementary Foreign Legislation (SFL) 2021 (Algeria, 2021) clarified regulatory uncertainties for existing foreign firms, fostering a more stable investment environment. These reforms contributed to an encouraging recovery, with GDP growth accelerating to 4.1% in 2023 (World Bank, 2025).

Nevertheless, persistent challenges temper this progress. Algeria's economic structure remains heavily reliant on hydrocarbons, which accounted for approximately 14% of GDP as of recent years. Concurrently, public spending surged by 60% between 2021 and 2023, fueled by social programs and pandemic-related expenditures, placing additional pressure on fiscal sustainability (World Bank,

2024). These dynamics underscore the ongoing imperative for comprehensive structural reforms to ensure long-term economic resilience.

### **Key Milestones in Reform Trajectory**

Algeria's reform trajectory encompasses several landmark initiatives that reflect a gradual alignment with international best practices. Notably, the Financial Accounting Standards (FAS) introduced in 2010 laid the groundwork for modernization, followed by the phased adoption of International Public Sector Accounting Standards (IPSAS), with seventeen standards implemented by 2023. These steps position Algeria's public financial management in closer conformity with Organization for Economic Cooperation and Development (OECD) recommendations, particularly emphasizing transparency, accountability, and accrual-based reporting (OECD, 2021).

Field research, including interviews conducted by Djazouli and Ibrir (2024), reveals a cautiously optimistic sentiment among key financial management stakeholders about these reforms. They cite improvements in financial reporting quality and institutional readiness but emphasize persistent delays in official decrees and implementing regulations as a critical bottleneck that slows full reform realization.

### ***Socio-Economic Drivers of Reforms***

The socio-economic context has been a powerful driver of Algeria's reform agenda. With unemployment rates stubbornly high, estimated at 12% in 2023, especially among youth, public frustration culminated in widespread Hirak protests demanding systemic political and economic change. These social movements underscored the imperative for reforms that promote inclusive and sustainable growth.

In response, reforms have increasingly targeted the sustainability and empowerment of small and medium-sized enterprises (SMEs), which are essential for job creation and economic diversification. Government initiatives have focused on providing technical assistance, improving access to finance, and streamlining regulatory requirements to enhance SME competitiveness and resilience, recognizing their critical role in social stability and economic dynamism

### **Provisions and Implementation of Organic Finance Law 18–15**

The Organic Finance Law (OFL) 18–15, enacted in 2018, constitutes a foundational pillar in Algeria's ambitious endeavor to modernize its public financial management system amidst enduring economic vulnerabilities – largely linked to its hydrocarbon dependency. This law represents a paradigmatic shift from conventional cash-based accounting toward accrual accounting principles, a transition further reinforced by the complementary Law July 23 of 2023 on public accounting rules and financial management. Accrual accounting requires that revenues and expenses be recognized when they are

earned or incurred, rather than at the point of cash exchange. This approach provides a far more comprehensive and realistic depiction of the state's financial position, capturing assets, liabilities, and long-term obligations more accurately. By aligning with global best practices such as the International Public Sector Accounting Standards (IPSAS), OFL 18–15 is designed to significantly enhance fiscal transparency, improve accountability, and reduce the risk of underreported fiscal liabilities (IFAC, 2020).

### **Key Provisions of OFL 18–15**

Among the law's critical provisions are fiscal rules that cap budget deficits at 5% of GDP, designed to ensure medium-term fiscal sustainability. The adoption of multi-year budgeting frameworks – spanning three to five years – aids in strategic planning and policy coherence, while mandatory performance audits evaluate the efficiency and effectiveness of public expenditures (Benmoussa & Djebara, 2022). Article 5 explicitly requires that all budget preparation, adoption, and execution must adhere to a sustainable fiscal path, preventing excessive borrowing and promoting intergenerational equity in resource allocation.

Moreover, OFL 18–15 advocates a shift from traditional line-item budgeting toward program-based budgeting. This innovation ties fund allocations directly to predefined objectives and measurable outcomes, fostering results-oriented management and reducing inefficiencies typically inherent in input-focused budgeting.

### ***Implementation Progress and Challenges***

Implementation gained momentum in 2023, coinciding with Algeria's record-breaking \$98 billion budget – the largest since independence – reflecting ambitious infrastructure and social spending initiatives (Djazouli & Ibrir, 2024). However, progress has been uneven. Significant challenges remain, especially pertaining to delays in conducting comprehensive asset inventories and valuations, which are essential for reliable accrual-based reporting. These delays are compounded by institutional capacity gaps, including a shortage of trained accountants conversant with IPSAS standards and reliance on outdated IT infrastructure that limits data integration and real-time reporting capabilities (Djazouli & Ibrir, 2024).

By 2024, notable advances had been achieved. The integration of program budgeting in the national budget law allowed better tracking of expenditure outcomes, which IMF assessments regard as a positive step towards fiscal accountability. Nonetheless, external shocks – particularly volatile oil prices – continue to test the resilience and adaptability of the fiscal framework.

### ***Fiscal Safeguards and Accountability Measures***

OFL 18–15 also codifies fiscal discipline through enhanced accountability mechanisms. Annual fiscal reports must be submitted to Parliament, with independent audits conducted by the Court of Accounts to ensure compliance and transparency. Given the significant rise in public debt in recent years, these oversight provisions are critical to preventing fiscal profligacy and managing debt-related risks effectively.

The law further promotes revenue diversification, encouraging reforms in tax policy and expanding non-hydrocarbon investment to build fiscal buffers. Yet in practice, the 2024 budget execution revealed a widening fiscal deficit – peaking at 13.9% of GDP – highlighting a persistent gap between legislative intent and policy outcomes.

### ***Fiscal Control Mechanisms***

The financial control architecture embedded in OFL 18–15 aims to bolster operational efficiency across governmental entities. It includes rigorous oversight of debt issuance and expenditure commitments and the launch of medium-term debt strategies to align borrowing trajectories with sustainable growth objectives (IMF, 2024). The law mandates contingency reserves equivalent to a minimum of 1% of GDP to buffer unforeseen economic shocks – a measure partly harnessed in recent budgets to counteract inflationary pressures and support subsidy reforms.

Despite these advancements, barriers remain. Bureaucratic inertia and insufficient coordination between central and local authorities have delayed the full deployment of performance-based controls (Benmoussa & Djebara, 2022). Comparative analyses, particularly of oil-dependent Gulf states, suggest Algeria could benefit significantly from adopting digital fiscal dashboards to enable continuous real-time monitoring and risk assessment, as recommended by IMF technical assistance reports.

### ***Role of Independent Oversight Bodies***

Under OFL 18–15, institutions such as the National Budget Office and the Court of Accounts are central to enforcing fiscal rules. Their roles include ex-ante reviews of budget proposals and ex-post audits, which have collectively tightened scrutiny over public spending and curtailed off-budget expenditures that were prevalent before reforms. However, effective enforcement hinges on capacity building, especially to equip auditors with IPSAS proficiency – a focus area of ongoing IMF-supported training programs.

### ***Benefits of Accrual Adoption***

1. Enables accurate assessment of long-term liabilities, such as pensions and infrastructure obligations, improving fiscal forecasting.
2. Links expenditures directly to outcomes, reducing resource wastage and enhancing public sector efficiency.
3. Aligns Algeria's accounting practices with IPSAS standards, facilitating international comparability and fostering access to global financial markets (IFAC, 2020).
4. Boosts investor confidence through transparent balance sheets, correlating with increases in foreign direct investment post-reform.
5. Enhances fiscal resilience by providing better tools to manage external shocks, including oil price volatility.

### ***Phases of Reform Implementation***

1. **Pre-2018:** Predominantly cash-based accounting systems prevailed, resulting in opaque financial reporting and underestimation of liabilities. During this period, deficits averaged 7-9% of GDP, exacerbated by volatile oil revenues (IMF, 2016).
2. **2018–2022:** Establishment of the legal framework with OFL 18–15 enactment and the piloting of accrual methods. Nonetheless, COVID-19 disruptions slowed full implementation.
3. **2023 Onward:** Accrual accounting transition intensified with integration of 17 IPSAS standards and the institutionalization of program budgeting as evident in the 2024 budget law. Persistent gaps in asset inventory and data infrastructure remain a challenge (Djazouli & Ibrir, 2024).
4. **Future Outlook (2025–2030):** Aiming for full IPSAS compliance, integration of advanced digital tools for automated reporting, and deployment of AI-driven fiscal risk analysis are expected, aligning with IMF long-term recommendations.

### ***Debt Sustainability Framework***

An essential analytical tool underpinning Algeria's fiscal reforms is the debt sustainability equation:

$$DS = \frac{PD}{r - g}$$

where: DS – debt sustainability ratio, indicating the sustainable debt level without explosive growth; PD – primary deficit as a percentage of GDP (the fiscal balance excluding interest payments); r – real interest rate on debt; g – real GDP growth rate (IMF, 2021).

This formula highlights that for Algeria, maintaining a growth rate  $g$  exceeding the cost of debt  $r$  is crucial to ensure debt stabilization. Given recent growth rates (~3–4%) and rising global interest rates, high primary deficits (e.g., 13.9% in 2024) could drive debt spiraling unless offset by structural reforms aimed at deficit reduction and economic diversification.

**Table 1**

*Pre- and Post-OFL Budget Metrics*

| Year | Deficit (% GDP) | Revenue Growth (%) | Expenditure Increase (%) |
|------|-----------------|--------------------|--------------------------|
| 2015 | 15,7            | –20,5              | 5,0                      |
| 2017 | 8,5             | 2,1                | 5,4                      |
| 2018 | 6,8             | 3,2                | 4,1                      |
| 2022 | 7,1             | 15,4               | 12,3                     |
| 2023 | 10,2            | 4,2                | 25,0                     |
| 2024 | 13,9            | –5,6               | 60,0                     |
| 2025 | 11,5            | 3,8                | 10,0                     |

Source: IMF (2024) and World Bank (2025).

### *Evaluation of Implementation Outcomes*

Early evaluations following the widespread implementation phase that began in 2023 present a mixed picture. Accrual adoption has enhanced the quality of financial statements, with pilot ministries detecting a 15% increase in inefficiency identification – enabling targeted corrective actions (IMF, 2025 Article IV). However, the broader rollout faces challenges, primarily due to limited digital infrastructure, which restricts timely data consolidation and analysis.

Stakeholder feedback from DGTC officials emphasizes the critical need for a phased, nationwide training program. Estimates suggest over 5,000 public servants require upskilling in IPSAS compliance and modern budget management techniques (Djazouli & Ibrir, 2024). Looking toward the future, Algeria’s unprecedented 2025 budget – with its significant deficit – reinforces the pressing necessity of rigorously enforcing OFL 18–15 provisions, particularly to constrain unchecked expenditure growth and accelerate the development of sustainable, non-hydrocarbon revenue sources.

### **Impact on Public Accounting Reform**

The transition from traditional cash-based accounting methods to an accrual accounting framework, as mandated by the Organic Finance Law (OFL) and Law July 23 of 2023, represents a significant paradigm shift in public sector financial management. This reform addresses the longstanding limitations of cash accounting, which often fails to provide a full picture of government financial health and obligations. By adopting accrual accounting, public entities can produce more

comprehensive financial statements that reflect not only the inflows and outflows of cash but also assets, liabilities, revenues, and expenses when they are incurred, regardless of cash movement (Djazouli & Ibrir, 2024). This comprehensive approach enhances decision-making, fiscal transparency, and accountability.

Insights gained from the Directorate General of Treasury and Public Accounting (DGTC) case study interviews conducted in 2024 reveal that about 70% of the newly developed accrual accounting standards have been adopted within relevant agencies. However, a critical human resource challenge remains, with a reported 40% shortfall in personnel adequately trained or experienced to execute these standards effectively. This skills gap threatens to slow the reform's full realization and necessitates targeted capacity-building initiatives.

Comparative international experience further underscores the transformative potential of accrual accounting reforms. Studies of European public sector transitions to accrual frameworks, such as those by Christiaens and Van Peteghem (2007) and Oulasvirta (2014), demonstrate that these reforms typically lead to improvements in the quality of financial reporting, greater fiscal discipline, and enhanced public trust. These case studies serve as valuable benchmarks and emphasize the need for continued resource allocation toward professional training and institutional adjustments to support successful implementation domestically.

### **Challenges in Transition**

Despite the promising shift towards accrual accounting, the transition is beset by practical and procedural challenges. Notably, there have been significant delays in the issuance of essential regulatory decrees that define precise accounting rules and procedures under the new framework. These delays have created uncertainty and inconsistent practices among government units.

Additionally, asset valuation remains a major hurdle. The lack of updated and reliable data on public assets leads to risks of inaccurate or incomplete reporting, impairing financial statement reliability and comparability (Benmoussa & Djebara, 2022). Addressing these challenges requires concerted efforts in regulatory reform, system modernization, and comprehensive asset management practices.

### **Social and Economic Implications**

The accounting reforms extend beyond technical adjustments to impart profound social and economic impacts. Enhanced financial accountability and transparency promoted by accrual accounting bolster citizens' trust in public institutions, reinforcing democratic governance and enabling more informed public discourse.

However, these benefits come with increased demands on human capital. Substantial investments in training and professional development are vital to equip the existing workforce with the

knowledge and skills necessary to navigate and sustain these reforms. Such capacity-building efforts are indispensable to mitigate transitional disruptions and to ensure that the intended improvements in fiscal management translate into tangible social and economic outcomes.

### **Foreign Investment Reforms: Alleviation of the 49/51 Rule**

The enactment of Foreign Investment Law (FL) of 2020 marked a pivotal moment in reshaping the regulatory landscape for foreign direct investment (FDI), particularly through the abolition of the longstanding 49/51 ownership cap in non-strategic sectors. Previously, foreign investors were restricted from holding more than 49% equity in many sectors, with local partners owning at least 51%. FL removed these ownership limits in non-strategic industries, eliminating the requirement for pre-emption rights that previously granted existing shareholders the first right to buy shares. This liberalization has unlocked new opportunities for foreign capital inflows by enabling greater foreign control and the use of foreign financing instruments, thereby enhancing the attractiveness of the domestic investment climate (Norton Rose Fulbright, 2020).

Following the reform's implementation, foreign direct investment flows demonstrated a notable uptick, with official statistics indicating approximately a 15% increase in FDI inflows compared to pre-reform levels (UNCTAD, 2024). This surge reflects growing investor confidence driven by reduced regulatory barriers and improved legal protections. However, it is important to note that strategic sectors – namely energy, mining, and defense – continue to be governed by stringent foreign ownership restrictions and national security considerations, maintaining protective controls over these critical areas.

The transition was not without controversy. The retroactive application of the reform to existing foreign-invested firms created uncertainty and legal debates over shareholder rights and contractual obligations. These issues were substantively addressed in the Supplementary Foreign Legislation (SFL) of 2021, which clarified the legal status of pre-existing investments and established frameworks to protect the rights of incumbent firms while aligning with the new regulatory regime (Eversheds Sutherland, 2020). This resolution helped stabilize investor relations and foster a more predictable investment environment.

### **Impact on Economic Diversification**

The reform's influence extends beyond opening ownership thresholds, playing a strategic role in the nation's broader economic diversification agenda. To encourage investment in high-priority growth sectors, the government complemented FL of 2020 with a suite of targeted incentives embedded in Investment Law 22–18 (Algeria, 2022). These incentives include generous tax exemptions, customs duty reliefs, and accelerated depreciation allowances designed to attract foreign and domestic investors into renewable energy, information technology, and innovation-driven industries. By

aligning financial incentives with sustainability objectives, these policies promote the country's commitments to green growth and digital transformation, positioning the economy to benefit from emerging global trends (Baker McKenzie, 2022).

This multi-faceted approach not only facilitates capital inflows but also seeks to build domestic capabilities, enhance technology transfer, and create high-value employment opportunities – key tenets of a sustainable and resilient economic model. It underscores the government's commitment to transitioning from a resource-dependent economy towards a more diversified industrial base.

### **Sector-Specific Effects**

While sweeping changes have been enacted broadly, certain sectors remain partially regulated with continued protective measures. In the pharmaceutical and transport industries, for example, foreign investors are still required to enter into partnerships or joint ventures with local entities, preserving a degree of domestic control and limiting full foreign ownership liberalization (Legal 500, 2025). These sector-specific constraints arise from concerns over public health security, national infrastructure sovereignty, and strategic economic interests. As such, these limitations reflect a cautious, phased approach to liberalization rather than wholesale deregulation.

This nuanced regulatory environment necessitates that investors carefully navigate sector-specific compliance requirements and partnership arrangements, underscoring the importance of tailored legal and financial advisory services in structuring investments within these industries.

### **Electronic Financial Services and Digital Framework**

The regulatory landscape governing electronic financial services (EFS) experienced a significant advancement with the enactment of Regulation April 24 in 2024. This regulation formally establishes the legal framework for Payment Service Providers (PSPs) within the fintech ecosystem, effectively enabling the wide deployment of digital wallets, electronic payments, and other fintech-driven financial innovations (Bank of Algeria, 2024). By creating a robust institutional and legal infrastructure for PSPs, the regulation supports a safer, more efficient, and accessible digital financial environment, thereby complementing the broader objectives of the Organic Finance Law (OFL).

One of the primary ambitions underpinning these reforms is to promote financial inclusion, particularly by expanding access to formal financial services among underbanked populations. The rapid growth of mobile banking – recording an annual increase of approximately 25% over recent years – illustrates the strong latent demand for digital financial solutions and the sector's capacity to transform the traditional banking paradigm (World Bank, 2021). This digital transformation has catalyzed new service offerings, customer engagement models, and increased convenience, contributing to greater economic participation across diverse demographics.

However, the expansion of electronic financial services also exposes persistent challenges. Notably, infrastructure disparities between urban and rural areas create uneven access to reliable internet connectivity and mobile network coverage, which restricts the reach of fintech innovations in less developed regions. Moreover, heightened concerns regarding data privacy and cybersecurity heighten the stakes for regulators and service providers alike. Ensuring robust data protection frameworks and resilient cybersecurity measures is essential to engender consumer trust and safeguard sensitive financial information in an increasingly digitalized economy (Transfi, 2025).

### ***Legal Safeguards for Consumers***

Consumer protection remains a cornerstone of the evolving digital finance framework. The enactment of e-commerce laws in 2020 established essential legal safeguards designed to protect consumers engaged in online transactions, covering critical aspects such as transaction security, dispute resolution, and transparency of service terms and conditions. These laws provide a foundational layer of consumer confidence necessary for the mainstream adoption of digital financial services.

Nonetheless, regulatory caution is evident in the treatment of emerging technologies such as cryptocurrencies. Despite the potential for blockchain and crypto-assets to drive financial innovation, the government's imposition of a ban on crypto transactions in 2025 reflects concerns related to financial stability, fraud prevention, and regulatory oversight (Techi, 2025). While this restriction limits experimentation and innovation within the digital asset space, it also underscores the delicate balance policymakers seek to maintain between encouraging fintech development and protecting the integrity of the financial system.

### **Integration With Broader Reforms**

In pursuit of enhancing the inclusiveness of electronic financial services, proposals to integrate Unstructured Supplementary Service Data (USSD) payment systems have gained traction. USSD-based payments leverage existing mobile phone networks without the need for smartphones or advanced internet access, making them particularly suitable for extending financial services to populations in rural and low-connectivity areas (Medium, 2025). This approach exemplifies how digital financial initiatives are increasingly being harmonized with national development goals, including bridging the digital divide and supporting comprehensive financial sector modernization.

Such integration efforts indicate a forward-looking strategy that not only aims to expand the scope of electronic payments but also to unify digital financial services within the wider ecosystem of public financial management reforms, regulatory improvements, and economic inclusion policies.

### **Local Financial Independence: Challenges and Reforms**

The Organic Finance Law (OFL) marks a critical step toward decentralizing fiscal authority by granting increased autonomy to communes, empowering them to manage their own budgets, expenditures, and local revenue generation. This decentralization initiative aims to enhance local governance and stimulate regional development through tailored financial strategies that better reflect local needs and priorities. However, despite these legal provisions for fiscal autonomy, many communes remain heavily dependent on central government transfers and subsidies, which limits their capacity to plan and execute independent development projects effectively. This dependency perpetuates fiscal deficits at the local level and restricts sustainable economic growth, underscoring the gap between legislative intent and practical fiscal realities (Lghouati & Harrouche, 2021).

Compounding these challenges, structural deficiencies in the local tax system significantly undermine potential revenue collection. Inefficient tax design, narrow tax bases, and ineffective enforcement mechanisms contribute to suboptimal local tax revenues. Given these limitations, recent fiscal reforms emphasize the importance of diversifying local revenue streams by incorporating innovative non-traditional financing mechanisms. Public-Private Partnerships (PPPs) have emerged as a promising alternative or supplement to conventional tax revenue and subsidies. By leveraging private sector investment and expertise, PPPs can enhance the delivery of critical infrastructure and public services, reduce fiscal burdens on local budgets, and promote sustainable economic activities within communes. The expansion of PPP frameworks thus represents a strategic priority within the ongoing reform agenda to strengthen local financial independence.

### **Governance Barriers**

Despite the legal and fiscal reforms underway, governance-related challenges remain significant obstacles to effective decentralization and local financial empowerment. Routine inefficiencies in bureaucratic processes – including excessive administrative red tape, lack of transparency, and insufficient managerial competencies – hinder the timely and effective implementation of policies at the commune level. This administrative inertia diminishes the impact of reforms and negatively affects public service delivery and fiscal management.

The extent of these governance challenges is reflected in international institutional performance assessments. According to the 2023 International State Strength (ISS) rankings, bureaucratic inefficiency and weak institutional capacity are among the prime factors limiting decentralization efforts, particularly in local government units (ISS, 2023). These governance deficits call for parallel reforms focused on capacity building, enhanced accountability mechanisms, digitalization of administrative procedures, and recruitment of skilled personnel to improve operational efficiency and transparency in local administration.

**Table 2***Local Revenue Sources Comparison*

| Source    | Pre-Reform Contribution (%) | Post-Reform Contribution (%) |
|-----------|-----------------------------|------------------------------|
| Taxes     | 20                          | 25                           |
| Subsidies | 70                          | 65                           |
| PPPs      | 10                          | 10                           |

Source: World Bank (2024).

The data presented in Table 2 provides a clear snapshot of the evolving composition of local revenue sources in response to reform implementation. The share of local taxes has risen from 20% to 25%, indicating modest progress toward enhancing commune-level fiscal self-reliance. Simultaneously, the relative dependency on central subsidies has diminished slightly but nonetheless remains dominant at 65%, reflecting an ongoing reliance on intergovernmental transfers for budgetary sustainability. Interestingly, the contribution of PPPs remains stable at 10%, suggesting that while PPPs occupy a consistent niche in local finance, their expansion could be further encouraged to achieve greater diversification of funding sources.

This revenue composition reaffirms the dual reality faced by many communes: while legal autonomy has been strengthened, practical financial independence is still constrained by systemic challenges in revenue mobilization and governance. These insights highlight the urgent need for continued reforms focused on improving tax administration efficiency, broadening the tax base, fostering an enabling environment for PPPs, and strengthening governance structures to support sustainable local financial independence.

### **Detailed Analysis of Tax Revenues**

A comprehensive examination of Algeria's tax revenue trends before and after the implementation of OFL 18–15 reveals that while total tax revenues increased modestly – from around 20% to 25% contribution at the local level (World Bank, 2024) – the overall tax base remains narrow, constrained by inefficient tax design and enforcement challenges. Revenue growth rates have fluctuated, with 2024 seeing a contraction of –5.6% amid rising expenditures and fiscal deficits (IMF, 2024). This dynamic complicates fiscal policy effectiveness and public financial management. The reform's emphasis on broadening the tax base through diversification and improved tax administration is crucial to reducing Algeria's dependency on hydrocarbon revenues and enhancing fiscal sustainability. Further integration of data on tax collections, enforcement metrics, and tax compliance patterns would enrich the fiscal analysis and provide a clearer picture of reform impacts.

### **Comparative Analysis with Tunisia, South Africa, and Malaysia**

A comparative evaluation of Algeria's regulatory and fiscal frameworks alongside Tunisia, South Africa, and Malaysia reveals important contrasts and potential avenues for reform that can foster greater economic and financial resilience.

Tunisia's franchise laws are particularly noteworthy for their strong emphasis on transparency and mandatory disclosure requirements. These laws are designed to protect franchisees by ensuring comprehensive information provision before contractual commitments, fostering a trustworthy business climate and encouraging investment in franchise businesses. In contrast, Algeria's franchise regulatory framework remains in its infancy, lacking clear disclosure rules and comprehensive investor protections (Bekhouche, 2023). Strengthening Algeria's franchise laws by adopting Tunisia's best practices could stimulate domestic entrepreneurship and attract foreign franchisors, thereby diversifying the economic base.

South Africa employs a hybrid foreign direct investment (FDI) regulatory system that allows significant FDI inflows without imposing blanket ownership caps. Instead, it targets sensitive sectors with tailored restrictions to preserve national interests while encouraging sustainable economic growth. This approach has contributed to strengthening South Africa's economic sustainability by balancing openness with strategic safeguarding (EIB, 2024). Algeria might draw lessons from South Africa's model to refine its FDI framework, allowing more flexible foreign investment that supports diversification while protecting critical sectors.

In the fintech domain, Malaysia offers a mature and detailed registration and licensing regime that has successfully nurtured a vibrant fintech ecosystem. Its clear procedural guidelines, consumer protection norms, and regulatory oversight mechanisms have encouraged innovation while managing risks effectively. Algeria, currently developing its fintech regulatory framework, could adopt Malaysia's structured approach to registration and supervision to ensure sound growth in digital financial services and enhance investor and consumer confidence.

### **Lessons for Fiscal Sustainability**

Fiscal sustainability remains a pressing challenge for Algeria, with valuable lessons to be learned from the experiences of Tunisia and South Africa. Tunisia's transition to accrual-based accounting represents a major reform success. By implementing accrual accounting, Tunisian public financial management has improved in terms of transparency, record accuracy, and fiscal discipline, enabling better deficit management and resource allocation. Algeria's continued delays in adopting comprehensive accrual accounting limit its ability to monitor fiscal health effectively and constrain policy responsiveness (IMF, 1997).

South Africa's resilience in managing fiscal shocks – supported by diversification across sectors such as manufacturing, services, and renewable energy – provides another model for Algeria.

The South African government's emphasis on broadening the economic base has helped reduce vulnerability to commodity price swings and fostered a more stable revenue outlook. Algeria's heavy dependence on hydrocarbons exacerbates fiscal risks, making diversification a critical priority informed by South Africa's experience (IMF, 1997).

Together, these comparative insights underscore that timely accrual accounting reforms and proactive economic diversification policies are fundamental to achieving sustainable public finances and mitigating fiscal vulnerabilities in Algeria.

### **Challenges to Fiscal Sustainability**

Algeria's fiscal sustainability faces profound challenges, primarily driven by its heavy dependence on hydrocarbon revenues. The country's budget remains significantly reliant on oil and natural gas exports, which constitute a large share of government income and foreign exchange earnings. This dependence exposes Algeria's fiscal framework to substantial risks, especially in the context of shifting global energy dynamics and climate change policies. As international efforts to reduce carbon emissions intensify, demand for fossil fuels is expected to decline over the medium to long term, putting pressure on hydrocarbon-dependent economies to adapt or risk escalating fiscal deficits (IMF, 2024).

In addition to external market pressures, the volatility of global oil prices exacerbates fiscal unpredictability, complicating budget planning and macroeconomic stability. The reliance on hydrocarbons creates a structural vulnerability, where downturns in commodity prices can rapidly widen budget deficits and constrain public investment, leading to cyclical fiscal stress.

Recent projections provide a nuanced outlook for Algeria's economic and fiscal trajectory. While GDP growth is anticipated to rebound moderately, reaching an estimated 3.8% in 2025, fiscal imbalances remain significant. The fiscal deficit was recorded at a high 13.9% of GDP in 2024, signaling persistent imbalances between government revenues and expenditures (IMF, 2025). This sizable deficit underscores the urgency for comprehensive reforms aimed at stabilizing public finances and ensuring long-term fiscal sustainability.

Key reform imperatives include diversifying the government's revenue base beyond hydrocarbons by strengthening tax policy and administration, expanding non-oil sectors, and fostering private sector development. Equally crucial is the improvement of expenditure efficiency through better public financial management, prioritization of capital investment, and the adoption of medium-term fiscal frameworks that temper pro-cyclicality.

Moreover, aligning fiscal policy with global climate goals requires Algeria to transition to a more sustainable economic model. This involves investing in renewable energy, supporting green technologies, and implementing carbon pricing or other incentive-based mechanisms that both mitigate environmental risks and generate alternative fiscal revenues.

In summary, Algeria's fiscal sustainability challenges are multifaceted, stemming from structural economic dependencies, market volatility, and emerging global environmental imperatives. Meeting these challenges necessitates an integrated reform approach combining fiscal prudence, economic diversification, governance improvements, and environmental sustainability to secure a resilient fiscal future for the country.

### **Discussion / Conclusion**

The enactment of the Organic Finance Law (OFL) 18–15 has served as a critical catalyst in Algeria's ongoing public financial management and investment reforms. The law has contributed to significant improvements in government accounting standards – moving toward more transparent, accrual-based reporting – and has facilitated a more open and investor-friendly environment. These advances have improved fiscal transparency, enhanced investor confidence, and laid an important foundation for expanding both domestic and foreign investment (World Bank, 2025).

Despite these gains, significant gaps remain in the full implementation of reform initiatives. Persistent dependency on centralized fiscal transfers and hydrocarbon revenues continues to constrain local financial autonomy and overall fiscal sustainability. Administrative and institutional weaknesses, including insufficiently trained personnel and bureaucratic inefficiencies, hinder the effective operationalization of these reforms across government tiers and sectors.

Lessons drawn from international experiences provide valuable guidance for bridging these gaps. Tunisia's legislative rigor on franchise disclosure exemplifies the benefits of strong regulatory frameworks in fostering transparency, consumer protection, and market development. Algeria's nascent franchise regime could be substantially strengthened by incorporating such disclosure standards, thereby boosting franchise sector growth and investor trust. Meanwhile, Malaysia's mature and well-structured digital regulatory ecosystem offers a practical model particularly suited for Algeria's burgeoning fintech sector. Adopting Malaysia's phased, detailed digital registration and supervision procedures can accelerate the formalization and growth of digital financial services, promote innovation, and enhance consumer protection.

Building on these insights, several strategic recommendations emerge to deepen and sustain reform momentum:

1. **Prioritize Capacity Building and Training:** Equipping public sector employees, especially at local government levels, with advanced skills in accrual accounting, financial management, and project implementation is critical. Continuous professional development programs and technical assistance should be institutionalized to overcome the current human capital shortfall.
2. **Accelerate Revenue Decentralization:** Empowering communes and regional governments with enhanced revenue-raising powers and fiscal autonomy will enable more regionally

responsive development financing. This decentralization should be coupled with strengthened governance frameworks to ensure accountability and efficient use of resources.

3. Leverage Public-Private Partnerships (PPPs): Expanding the role of PPPs can diversify funding sources and bring private-sector expertise into infrastructure and service delivery projects. Regulatory clarity, risk-sharing mechanisms, and capacity-building on PPP structuring are vital to maximize their developmental impact.

Finally, to comprehensively assess the long-term effectiveness of these reforms, future research should focus on measuring the post-2025 macroeconomic impacts, particularly on GDP growth, fiscal balance, and investment patterns. Such impact evaluations will provide empirical evidence to refine policy approaches and prioritize interventions that best support Algeria's sustainable development objectives.

In conclusion, while OFL 18–15 has laid important groundwork, realizing its full benefits demands concerted efforts to address implementation weaknesses, learn from regional and international best practices, and adopt integrated, forward-looking strategies that enhance fiscal sustainability and economic diversification in Algeria.

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