Lisbon School of Economics & Management
Universidade de Lisboa

MASTER IN MANAGEMENT (MIM)

MASTER'S FINAL WORK

DISSERTATION

IMPACT OF ARTIFICIAL INTELLIGENCE ON THE BANKING SECTOR AND REGULATION

SARA MARGARIDA CAMISÃO SARAIVA NUNES

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GLOSSARY

AI – Artificial Intelligence

AML – Anti Money Laundering

BoE – Bank of England

BoP – Bank of Portugal

BIS – Bank for International Settlements

ECB – European Central Bank

EU – European Union

GAI – Generative Artificial Intelligence

GDPR – General Data Protection Regulation

LLM – Large Language Models

ML – Machine Learning

USA – United States of America

ABSTRACT

This thesis approaches the impact of Artificial Intelligence (AI) on the banking sector and its regulation, highlighting the different contributions it could have in the sector, such as the use of robo-advisors in asset and investment management, fraud detection, and credit decision-making. It also examines how Portuguese banks, and the central bank are responding to this innovation. It also analyses the role of regulation in the sector, given the new challenges posed by this technology and the differences in legislation across regions, comparing the regulatory strategies of China, the United States, and the European Union. Using a qualitative methodology based on semi-structured interviews with experts in the banking sector, the results show that while AI offers significant efficiency and productivity gains, it also poses challenges in terms of the transparency, explainability, and accountability of models in decision-making processes. Finally, the research concludes that the implementation of internationally recognized regulation is crucial to ensure the safety of AI models and the protection of customers in a globalized environment. The findings highlight the importance of striking a balance between innovation and the development of technologies and maintaining customer safety and privacy.

Keywords: Artificial Intelligence, Banking sector, Regulation, Supervision

JEL Codes: F55, G21, G28, K24, L50, O33

RESUMO

Esta tese investiga o impacto da Inteligência Artificial (IA) no setor bancário e na respetiva regulação, realçando as diferentes contribuições que esta poderá ter no setor, designadamente, na utilização de *robo-advisors* na gestão de ativos e investimentos, na deteção de transações fraudulentas e na tomada de decisão dos créditos. A pesquisa explora ainda como os bancos portugueses e o banco central estão a reagir perante esta inovação. Para além disto, analisa o papel da regulação do setor perante os desafios emergentes desta tecnologia e as diferentes legislações em diversas regiões, comparando as estratégias de regulação da China, Estados Unidos e União Europeia. Através de uma metodologia qualitativa, com entrevistas semiestruturadas realizadas com especialistas do setor bancário os resultados indicam que, embora a IA ofereça ganhos significativos de eficiência e produtividade, surgem desafios relacionados com a transparência, clareza e responsabilidade dos modelos nos processos de tomada de decisão. Por fim, conclui-se que a implementação de uma regulação internacionalmente reconhecida é essencial para garantir a segurança dos modelos de IA e a proteção dos clientes num ambiente globalizado. Desta forma, se alcançará um equilíbrio entre a inovação e a evolução das tecnologias com a preservação da segurança e privacidade dos clientes.

Palavras-chave: Inteligência artificial, Setor Bancário, Regulação, Supervisão

JEL Codes: F55, G21, G28, K24, L50, O33

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1. INTRODUCTION

1.1 Relevance of the study

Since the Industrial Revolution, driven by new technologies, the global economy has been advancing rapidly for more than two centuries. Each technological wave favors growth, and productivity and generates new business opportunities, although in some cases it can also have negative effects, such as unemployment (Matuzeviciute et al., 2017). Despite history proving otherwise, there are those who believe that automation and AI evolution will be more of a disruption than past developments. But the truth is that there are similarities between current automation and developments such as the Industrial Revolution. As history has proven, adopting new technologies in the long term can boost employment and productivity (Lund & Manyika, 2017).

From the Industrial Revolution, marked by the Luddite movement, to contemporary debates on automation and artificial intelligence, the fear that technology will lead to job losses has been a constant concern. However, although technology can replace certain functions, the economic theory points to compensatory mechanisms that can not only generate new jobs but also increase the demand for labor. This occurs through the creation of new tasks related to technological innovations and increased productivity, which can boost the generation of more jobs (Hötte et al., 2023).

Thus, the term Artificial Intelligence (AI) was born in the last century when John McCarthy decided to describe it as “thinking machines”. Nowadays, AI is known for doing tasks usually associated with human tasks but more quickly (Bahoo et al., 2024).

The rapid growth of computational technologies in the last decade is not indifferent to anyone. This evolution allowed AI to rapidly emerge and become an integral part of daily life, from simple tasks such as parking cars to more complex applications such as performing important surgeries (Fletcher & Le, 2022). The AI market is expected to grow significantly, rising from $86.9 billion in 2022 to $407 billion by 2027 (Haan & Watts (2023), reflecting a robust expansion of this technology. Additionally, Haan & Watts (2023) also estimates that one in 10 cars will be self-driving by 2030 and 64% of businesses anticipate a tremendous growth in their productivity.

Furthermore, Buchanan & Wright (2021) claim that the presence of AI firms and their growing revenue in an economy has several benefits, such as improving economic and social growth and productivity. In fact, it argues that the USA has the highest number of AI firms (with 5093 AI firms) followed by the UK, India, Germany, and China. In case of Portugal which has only 54 AI firms, occupies the 20th position in Europe.

Following Leitner et al. (2024) people's interest in AI technology has grown enormously and so has been the target of many sectors and industries because of its capability to contribute to different applications (Bahoo et al., 2024). Therefore, resulting from the huge growth of AI and the fact that it can contribute to different activities, it can revolutionize different industries and sectors since AI algorithms have the potential to increase productivity and efficiency and decrease costs (Leitner et al., 2024). Kamalnath et al. (2023) estimate that AI could contribute an annual $2.6 trillion to $4.4 trillion across industries, a significant impact that could transform the global economy.

Moreover, the financial industry does not stand aside since AI can make a huge difference due to its capacity to quickly process huge quantities of data. Thus, making AI algorithms "valuable tools for financial institutions where time is money and data is king" (Fletcher & Le, 2022, p.291).

Regarding banking, Machine Learning (ML), one of the subfields of AI, can help banks in their daily tasks, such as "making credit decisions, fighting fraud, identifying illicit financial transactions, design investment strategies, trading securities, and enhancing personal banking, among other tasks." (Fletcher & Le, 2022, p.291).

Additionally, Kamalnath et al. (2023) say that of all industries banks can benefit from the huge spread of Generative AI (GAI), another subfield of AI. It is expected that the banking sector will grow with "(…) an annual potential of $200 billion to $340 billion largely from increased productivity." (Kamalnath et al., 2023). Polireddi (2024) affirms that banks that use AI strategically in their activities have growing profits, some examples are, Capital One, JPMorgan, Chase, Citibank, Wells Fargo, and Barclays Bank Plc. On the other hand, also claims that besides the different opportunities AI can offer to banks, it can offer challenges as well.

Additionally, the banking sector is fundamental to the operation and advancement of an economy. Its key functions encompass safeguarding financial assets, extending credit

to individuals and businesses, and facilitating domestic and international payment systems. Banks promote investment and consumption by allocating capital efficiently, thereby driving overall economic growth (Hall, 2023). A well-structured banking system sustained economic development across all types of economies, whether industrial, emerging markets, or low-income nations. As economies expand and mature, their financial sectors must adapt to address increasingly sophisticated and diverse demands (Krueger, 2004). Moreover, banks are integral to the payment system and play a crucial role in money creation, further influencing economic activity (Gobat, n.d.).

This way, due to the great importance that banks represent for an economy, it is urgent to balance what AI brings to this sector, such as opportunities or even challenges. AI can impact financial performance and the role of supervisors but at the same time, help regulate violations and anticipate the impact on regulation (Polireddi, 2024).

This research will focus on the emergence of AI and the potential transformations for the banking sector. The relevance of this study lies in the implications and challenges that accompany these transformations.

The banking sector can adopt AI algorithms in its processes and activities, but this adoption presents also implications for the various players, whether for the banks themselves, consumers, or even regulators, so it is important to consider the different perspectives of the different stakeholders.

This work wants to study the interplay between AI and the banking industry, focusing on the roles of regulators and their potential challenges. The approach of this work is to address the critical need to understand the regulator's points of view and its strategic plan to deal with the challenges provided by AI. The main objective of this work is to understand how the banking system will be affected by the spread of AI technologies and how our supervisors and regulatory entities will react to these changes. Specifically, it aims to provide insights and a deeper understanding of the following questions:

What are the implications, opportunities, and challenges of AI for the banking sector?

How has banking regulation addressed these challenges?

1.2 Methodology

The data collection for this research will involve semi-structured interviews with Portuguese experts across diverse perspectives, with specialists in the banking sector, the regulatory field, and even bank clients. A total of 10 interviews will be conducted under strict anonymity, with transcripts prepared solely for analytical purposes. Using the principal topics and questions addressed by the literature it is possible to prepare the study and with the specialist's insights, to understand on a deeper level their perspective and how the banking system will be transformed and the implications for consumers and supervisor's entities.

The choice of interviews as the research method is based on the possibility of independent insights from experts that will offer a more nuanced and comprehensive understanding of the impact of AI applications in the banking sector and how regulation will react to emerging challenges. The semi-structured interviews will offer in-depth perspectives from experts in the banking and regulatory sectors, enabling a nuanced understanding of how AI affects the industry and regulatory frameworks.

1.3 Structure of the work

This research is composed of four sections. Chapter one provides a concise introduction to the primary topics of the study, the impact of artificial intelligence in the banking sector, and its regulation, highlighting their academic and business significance and outlining the investigation's objectives. Chapter two focuses on a comprehensive Literature Review, exploring how AI will affect the future of bank activities and its various applications such as in credit decisions, fraud detection, and investment strategies. Furthermore, increasing questions about the crucial role of supervisors in dealing with these new challenges will be approached. Moreover, the literature review will explore also these questions that arise with AI expansion addressing the Portuguese context and consequently the European Union (EU) context and comparing it with China, and the United States of America (USA). Chapter three details the structure of the methodology, and the details of the sample selection, and delivers a thorough analysis of the collected data, presenting key findings and discussion of results. Chapter four summarizes the main conclusions, discusses limitations, and offers thoughtful recommendations.

2. LITERATURE REVIEW

2.1 The impact of artificial intelligence on the banking system

The rapid advancements in technology are represented by the trend toward automation and data exchange in manufacturing technologies and processes living in the 21st century, which is present in almost every corner of the world. The profundity of this evolution is changing entire systems of production, management, and governance (Schwab, 2016). This, also known as the Fourth Industrial Revolution, is developing exponentially through different areas including AI and its subfields. The rapid growth of the velocity, volume, and variety of data led to the great development of AI which has gained a reputation due to its ability to make conclusions based on limited information and quickly (at least quicker than a human being) (Buchanan & Wright, 2021). AI is well-known as an algorithm that makes decisions and tasks that typically would be done by humans (Daníelsson et al., 2021). The Bank for International Settlements (BIS, 2024) considers AI systems as, "highly refined prediction machines, possessing a remarkable ability to detect patterns in data and fill in gaps." (BIS, 2024, p.91).

Since the rapid evolution of AI, it has become more and more common in several industries (Haan & Watts, 2023). The financial industry is not an exception, AI can be a strategy to revolutionize Financial Services. There are several ways in which AI can contribute to this fundamental sector and can greatly impact finance in different ways (Buchanan & Wright, 2021). One example of this is how AI helps JP Morgan save $150 million per year in fraud detection (Huber, 2020). The Bank of England (BoE, 2019) argues that "ML is increasingly being used in UK financial services." with the banking and insurance industries strongly involved (BoE, 2019, p.2).

Aldasoro et al. (2024) claim that the financial system plays an important role in ensuring economic health, financial stability, and social welfare. Furthermore, financial policy and regulation are designed to address system issues, maintain liquidity, and support economic stability. The development of information processing technology from the launch of computers to the advancement of computational power has an important role in financial stability since they can process information more efficiently and solve economic problems and complicated tasks.

Beyond what has been mentioned, AI encloses several subfields and systems, with their rapid development driving lower costs and the rise in efficiency (Leitner et al., 2024). A pivotal subfield is ML made up of algorithms based on experience and training including a problem, data, a model, an optimization algorithm, and validation (Chakraborty & Joseph, 2017). ML strengthens most AI activities by understanding all the information and circumstances about the environment in which AI must intervene to make optimal decisions and predictions (Daníelsson et al., 2021). Additionally, the financial system takes advantage of ML algorithms that enhance sets of complex data analysis improving efficiency and resulting in markets becoming more fast-paced and powerful (Aldasoro et al., 2024).

Another subfield is GAI which is competent in creating new content, such as text, images, and audio with minimal or even no human contribution (Leitner et al., 2024). A popular example of GAI is ChatGPT based on Large Language Models (LLM). LLM can contribute to many sectors by generating and analyzing text, coding, translating, and summarizing data. Furthermore, GAI offers applications in the financial sector in robo-advising, fraud detection, customer experience, and regulatory technologies (Aldasoro et al., 2024).

Moreover, AI Agents are another AI subfield also based on LLM in development with planning mechanisms, long-term memory, and the ability to execute computer code and trade (Chan et al., 2024). With state-of-the-art LLM technology, AI agents can revolutionize the financial systems in the trading area and become autonomous trading agents (Aldasoro et al., 2024).

Additionally, the financial sector is a great user and investor of AI services and technologies. While AI initially gained prominence in the financial system due to its contribution to hedge funds and trading firms, it has since spread to other fields, such as banks and regulator entities (Buchanan & Wright, 2021). AI can reshape the banking industry due to its ability to raise efficiency and lower costs in regulation processes, fraud detection, customer service, and back-end processing (BIS, 2024). Notably, AI models can fundamentally alter activities like "(i) fraud detection and compliance; (ii) credit risk analysis and prediction of financial distress and (iii) banking chatbots and robo-advisory services." (Buchanan & Wright, 2021, p.539).

2.1.1 Fraud detection and compliance

With the development of technologies, it is not only the activities and operations of businesses that can be revolutionized. Fraud strategies for financial crime are also changing and developing. For instance, around 1.35 billion operations were potentially fraudulent at HSBC Bank (Calvery, 2024). To avoid penalties and reputational damage, banks are investing in advanced strategies to combat financial crimes (Buchanan & Wright, 2021). As a result, approaching Financial Fraud must be a top priority for financial organizations (Polireddi, 2024).

Accordingly, it is expected that banks are exploring other ways to combat financial crimes, especially more efficiently and productively. Since AI algorithms can analyze large sets of data quickly and at lower costs, banks consider that these technologies can be an ally in improving their activities and combating fraud (Buchanan & Wright, 2021). Therefore, AI can revolutionize the way financial crime is addressed throughout the industry (Calvery, 2024). The necessity to combat financial crime is one of the motivations of banks to implement AI in their transactions (Polireddi, 2024). AI technologies have a great impact on fighting financial crime since has more accuracy and efficiency in all the process. They are more precise in identifying fraud transactions, analyzing them, in less time, and having fewer effects on clients (Calvery, 2024). In addition, Banks want to take advantage of the capabilities of AI algorithms and subfields for anti-money laundering (AML) and anti-fraud due to their ability to transform these operations since AI software analyzes both structured and unstructured transaction data from various sources, including phone numbers, addresses, company directors, and news reports, to identify potential suspicious links (Arnold, 2018).

Thanks to AI, and ML, it is possible to detect Credit Card fraud, one of the most effective uses of ML. Algorithms using past credit card information can identify and detect fraudulent activities and block them instantly (Buchanan & Wright, 2021). Associated with severe preventive strategies are false positive results (Lee, 2020). False positive outcomes happen when suspicious transactions are unfairly rejected, this is a menace to financial institutions because, as well as affecting their reputation, it also affects their relationship with consumers (Buchanan & Wright, 2021).

Aldasoro et al. (2024) also consider traditional analytics have played a significant role in fraud detection but required extensive human oversight and offered limited effectiveness. By contrast, ML algorithms, while more powerful, often function as "black boxes" (Aldasoro et al., 2024, p.10). The black box problem is usually associated when decisions are made, and the results are not clear and perceived by humans (Rudin & Radin, 2019). On the other hand, it is expected that challenges such as hallucinations, consumer market concerns, and market concentration will emerge alongside these advancements (Aldasoro et al., 2024).

Consequently, there are already several regulatory institutions exploring AI capabilities to combat fraud and AML. Accordingly, ML can trail individuals and firms suspected of money laundering practices. In fact, several monetary entities, such as The Australian Securities and Investments Commission (ASIC) and the Monetary Authority of Singapore (MAS) are exploring the application of AI to allow regulators to analyze suspect transactions of fraud and money laundering (Lee, 2020).

AI algorithms detect fraud by analyzing customers' financial behavior and their spending patterns (Bahoo et al., 2024). In other words, AI algorithms find patterns in client data and transactions helping financial institutions to deal with challenges such as fraud detection and security vulnerabilities. Known for its capacity to increase efficiency, AI can help banks in these tasks through its great speed and productivity (BIS, 2024).

2.1.2 Credit decisions and analysis

Banks play a central role in the economy. Since one of their businesses is lending money, it is expected the level of loans issued is often seen as a sign of economic health (Magnuson, 2020). A major financial risk, known as credit risk (Montagnani et al., 2024) is considered one of the main engines of financial crises (Buchanan & Wright, 2021). When a client seeks a loan, the lender must assess the client´s capacity to repay the loan principal and interest expenses (Partridge et al., 2017).

Thereby credit risk is the risk that a lender faces if they do not receive their loan repayments. For this reason, lenders need to manage this type of risk to avoid defaults and loan loss (Peterdy, n.d.). Historically, poor management of credit risk could be the source of big crises such as the 2007-2008 financial crisis where the poor performance of the credit risk measures techniques played a significant role. Thus, ML techniques can

help to change this problem by building a credit risk profile for each consumer based on credit scoring (Buchanan & Wright, 2021).

For example, between two loans, in which one has high profitability levels and high leverage and the other has low profitability levels and low leverage, which one the lender should choose? It is a complex decision that banks face, so it increases the need to consider other factors to score the client's potential to not default. It is difficult to include different factors in a simple score, but ML can make it possible (Partridge et al., 2017). AI can make a huge difference in the risk management area, predicting bankruptcy and credit risk of consumers, firms, and even financial institutions. Algorithms can make warning models that supervise all the financial systems preventing and predicting global financial crises or financial disorders (Bahoo et al., 2024). Following the fact that ML can operate with huge sets of different data it is considered that these systems can minimize credit underwriting costs and guarantee credit for more consumers and clients than were previously denied (Aldasoro et al., 2024).

The difference between traditional statistical learning tools and ML is that the traditional ones are based on the form of mathematical equations and ML does not need rules-based programming. Consequently, ML technologies can easily adapt to patterns in data and submit better insights than traditional models and human analysts (Partridge et al., 2017). AI technologies give additional possibilities to get better credit scoring activities since can incorporate unstructured data in decision processes. AI tools allow banks to judge borrowers' potential and employ other types of data such as consumer bank transactions, rental, utility, telecom payments, or even the applicant's educational background or online shopping behavior. Using this unusual type of data permits banks to anticipate loan defaults and improve financial inclusion (BIS, 2024). These refined techniques concede to credit scoring decisions the possibility to measure the level of profitability to the bank or the risk associated with the loan (Polireddi, 2024).

Similarly, AI algorithms such as ML and Big Data are more and more present in the activity of some central banks given it has seen a new generation of techniques and approaches in risk assessment. An example of this is the presence of models capable of overcoming the traditional models to better score risk. Since AI algorithms can analyze

structure and unstructured data, they can contribute to credit risk predictions and decisions, such as calculating the probability of credit default (Rosalino, 2023).

On the other hand, the disadvantage of adopting this type of model is, for example, when an AI model is deciding if it should accept a loan or not those decisions can be suspicious and questionable (Aldasoro et al., 2024). ML technologies present the "black box" problem in credit scoring, due to their results that are dubious and hard to understand (Partridge et al., 2017). Moreover, the spread of these techniques can increase challenges such as bias and discrimination. AI model's decisions can be unfair and exclude access to credit due to algorithm discrimination (BIS, 2024). In other words, AI can also make bad decisions, for example, can be influenced by racial bias in credit decisions for loans and not accept credits that should be accepted (Daníelsson et al., 2021).

Furthermore, despite all the advantages AI algorithms can bring, they can also present challenges such as being susceptible to "hallucinations" (when generating false information), and the risk of herding behavior. Furthermore, the adoption of these technologies can increase the risk of market concentration and competition and consumer privacy concerns (Aldasoro et al., 2024).

Taking everything into account, if AI is good enough to make these important decisions helping banks and consequently the financial system it is important that regulators deal with the challenges of AI, previously mentioned, and do not let them worse (Fletcher & Le, 2022).

2.1.3 Asset Management, Investment Strategies and Robo-advisors

The fast development of AI models is changing countless industries and processes, and the banking industry is not lagging. Another banking function that can benefit from AI capabilities is asset management. Due to its ability to process huge amounts of data quickly, ML can be used in asset pricing, forecasting returns, analyzing risk-return trade-offs, portfolio optimization, and opening the door to algorithm trading (Aldasoro et al., 2024). Since AI has the potential to analyze big sets of data quickly and attribute different characteristics to information, it can analyze data in an efficient way for investors. This way, investors can have access to more accurate information in a faster way but at a lower cost (BIS, 2024).

ML technology has a crucial role in the financial sector since it can help financial institutions, such as banks by increasing efficiency in their processes and customer service (Buchanan & Wright, 2021).

Regarding GAI that can increase the clarity of the new types of data, as already mentioned - unstructured data can refine the prediction and asset management processes. Furthermore, GAI can make machines communicate with customers and advise them through robots. In fact, some agents have already adopted GAI such as Bloomberg, which launched a financial assistant based on LLM (large language models), and other firms use GAI to give financial advice to their clients (OECD, 2023).

Based on the client's investment preferences Robo-advisors manage the client's portfolio pulling out the interplay between the human financial advisor and the client. This investment advising type presents a better experience to the investor when compared to traditional human advisors. What sets apart the robo-advisors and human advisors are the lower cost and the better availability due to their capacity to be accessed at any moment and anywhere. In fact, “The advantages of robo-advisory services are: (i) passive market access with strategic asset allocation strategies, that often include more client customization than the traditional risk profiles used by banks, (ii) cost-efficient implementation of a diversified asset allocation, and (iii) a reduction of behavioral biases.” (Buchanan & Wright, 2021, p.552)

Moreover, (Lee, 2020) claims that AI can allow more investment opportunities and access to finance through robo-advisors, especially for people who usually do not invest. The financial advice gap occurs when clients do not have access to financial advice and direction at the time of investing, this can happen because they have a lower level of assets or due to the fact there are not enough human advisors. Robo-advisors can solve this problem since they can advise investors without human intervention, at a lower cost than a human advisor, reducing conflicts of interest and improving consumer protection. Thus, robo-advisors in comparison with human advisors present some advantages to investors and banks since they can avoid conflicts of interest that can exist between human advisors and investors. Moreover, decreases costs such as salaries and can decrease behavioral bias, since they operate and manage different categories of assets. On the other hand, robo-advisers can fail and not achieve the investor's goals (Lee, 2020).

Interestingly, the UK has been the leader in the European robo-advisor industry since 2015 that robo-advisors have been used in UK banks such as Barclays, NatWest, and RBS (Buchanan & Wright, 2021). The robo-advisors market has become broad, with new entrants such as Wealthify owned by Aviva, Nutmeg acquired by JP Morgan Chase, and Scalable Capital which operates independently but has partnerships with financial institutions such as Barclays. These tools have expanded significantly, targeting both seasoned investors and beginners. For instance, Wealthify allows for micro-investments, while Nutmeg offers diversified portfolios with varying risk levels. Robo-advisors are increasingly used not just in wealth management but also in mortgages and pension planning, with around 15 million UK consumers showing interest in automated advice solutions (Sharma et al., 2017) (Crabtree, 2024).

Alternatively, these models can present challenges despite the opportunities they offer to the financial industry. For example, decisions made by ML can be blurred and difficult to understand and decipher. Furthermore, also presents problems, such as "hallucinations" – as explained in the previous section. Besides that, their growing adoption also increases the risks of herding behavior and procyclicality, market concentration, and competition. Even though AI can help avoid crises by detecting fraudulent transactions and preventing financial disorders, as mentioned above, adopting this type of adviser can raise the risk of flash crises, fraud, and cybersecurity concerns due to correlated behaviors (Aldasoro et al., 2024). Consequently, investors who use robo-advisors must be protected by a strong legal and regulatory framework (Lee, 2020).

2.2 The Portuguese Case

Baecker et al. (2024) study projects that AI technologies implemented in the global banking and finance industry have the potential to generate $100 billion in revenue by 2032 (Leitão, 2024). Notably, with the development of digital transformation, AI technologies are widely adopted and enthusiastically embraced in the banking sector (Pinto, 2023). Therefore, banks still have a fundamental role in keeping up with the evolution of AI to reinvent their banking processes and functions (Marvão, 2024).

The Bank of Portugal (BoP) and the European Central Bank (ECB) have advised banks to adopt strategies of digital transformation considering their business and risk profiles, taking advantage of the possibilities of technological innovation. In Europe, the

use of artificial intelligence is widespread although still in the early stages of exploration (Pinto, 2023). The Portuguese case is not far behind specifically the private bank BPI where AI is already being explored and being used in four main areas at the bank, in personalizing the customer experience through predictive analysis, optimized risk management, process automation, and exploiting the potential of AI in areas such as technical support, marketing, and IT development making the bank more efficient mitigating the impact of excessive paperwork (Marvão, 2024). In addition, Novo Banco is also focused on innovation and digital transformation, so it has created a team dedicated to the exploration of innovation and AI. Through this initiative, the main objective is to integrate AI to improve the consumer experience and satisfaction and likewise increase operational efficiency while ensuring security for customers. The bank is committed to adopting AI to personalize campaigns for customers, which has already been proven to bring productivity gains (Mira Vaz, 2024).

In addition, to prove the contribution that AI can have in Central banks, AI has become an integral part of the daily operations at BoP. The Bank launched an AI tool in 2023 named Alya, which has contributed to enhancing the central bank's and had a significant role in streamlining the bank's activities (Bandeira, 2024).

Consequently, BoP received recognition for the best digital transformation initiative in the public administration sector at the Portugal Digital Awards 2023, thanks to this tool. Alya allows instantaneous document analysis, which boosts the central bank's operational efficiency. This platform can contribute to supervision and monetary policy by swiftly and securely analyzing documents, initially verifying the requirements of credit contract drafts, and supporting asset management by accurately assessing market sentiment. The BoP views this tool as a means of saving resources and time while ensuring a more transparent, clear, and consistent approach, all while maintaining the institution's commitment to responsible and ethical practices (Banco de Portugal, 2023).

Therefore, Pinto (2023) states that the BoP confirms its dedication to contributing to the banking sector as a member of the European System of Central Banks and its role within the Single Supervisory Mechanism. In addition, it believes that the banking sector can capitalize on the advantages of technological transformation by facing the challenges that come with it, ensuring the interests of the banking system and its customers. The

Bank will resolutely fulfill its duties as a supervisory authority, encouraging the recommended procedures to ensure the continued stability and resilience of the financial system.

2.3 Role of Regulation

Supervisors need to be aware and prepared in the current context of rapid technological innovation. A different response will be needed in the role of supervisor and regulator in the face of the emergence of new products, processes, players, and more interconnected and dynamic markets. Moreover, regulators and supervisors will also be able to benefit from new technologies (including AI) to improve their processes and activities, reacting more quickly to the challenges posed by digital transformation (Guedes de Oliveira, 2024).

In this context, SupTech is the term used for the utilization of innovative technologies in supervision processes by supervisory entities and RegTech is used when technologies are present in financial regulation procedures (Broeders & Prenio, 2018). The emergence of terms like SupTech and RegTech underscores the growing role of new technologies in regulation and supervision. As discussed above, the banking system is being greatly impacted by the growth of AI, this way regulators and supervisors need to demand a more accurate risk assessment and reporting of information (Rosalino, 2023).

Since AI use has been growing it is important to discuss its repercussions in the financial sector and how the legal framework should intervene. The principal motivation of regulators is to ensure an equity, efficient, and stable financial system but is not an easy task (Magnuson, 2020). In addition, it is imperative to have a good understanding of the risks and limitations of SupTech tools that could be evident in the financial system and threaten its stability (Guedes de Oliveira, 2024).

The rapidly growing evolution of AI implies challenges to the agents involved highlighting the unpredictability and the autonomy of AI algorithms. Accordingly, it is difficult for authorities to lead and establish a strong framework due to these features of AI being unstable and always changing (Montagnani et al., 2024).

As a result, challenges in financial institutions that use AI models, as mentioned above, such as hallucination, lack of transparency and explainability and algorithm bias can make it difficult to evaluate the risk of institutions. Thus, these challenges will impact

financial stability so regulatory entities must have strict monitoring (Leitner et al., 2024). Furthermore, building trust among all the agents of the financial system should be a priority when AI models are used. This requires an adequate regulatory framework with protective jurisdiction. The framework must accompany the AI latest technologies and have strong risk management to ensure financial stability (Buchanan & Wright, 2021). Cao (2022) affirms that it is necessary to explore computational regulation and establish acts to better control the challenges of AI. Similarly, Rosalino (2023) claims that technology can be present in the regulatory processes to make their interventions more effective.

Moreover, some regions/nations have already launched some frameworks to regulate AI systems. We can analyze some examples of frameworks launched by the EU, China, and the US, and after a comparison of how they position themselves to face the AI revolution. On a global level it was in May 2019, the OECD adopted AI principles and recommendations for regulators intending to encourage AI's innovative and reliable use while ensuring respect for human rights and democratic values. By using these OECD AI principles, countries establish legislation and policies, and international cooperation and interoperability between jurisdictions can be achieved. In the face of increasing regulatory fragmentation of AI between countries, AI principles have emerged as a fundamental basis for international cooperation (OECD, n.d.).

The EU launched the EU AI Act (EU, 2024) and the Assessment List for Trustworthy Artificial Intelligence (Ala-Pietil et al., 2020). The US launched the NIST's AI Risk Management Framework (NIST, 2024) while China developed several frameworks such as the Interim Measures for the Management of Generative Artificial Intelligence Services - Interim GAI Measures (China Law, 2023) and the "Governance Principles for a New Generation of Artificial Intelligence: Develop Responsible Artificial Intelligence" (Zhang, 2019).

Regarding the case of China, the Party-State uses an instrumental approach focusing on efficiency and social stability. While policies encourage AI development, legislation can be ambiguous, oscillating between permissive and restrictive to maintain state control (Liu et al., 2024). China has enacted various frameworks targeting specific AI applications such as the Algorithmic Recommendation Management Provisions, the

Interim Measures for the Management of Generative AI Services, the Deep Synthesis Management Provisions, the Scientific and Technological Ethics Regulation, and the Next Generation AI Development Plan but there is no specific AI regulatory framework focusing on the banking sector or financial sector (Sentinella & Jones, 2024). China has a vertical approach focusing on the regulation in the specific systems which can lead to doubts about compliance. With this type of regulation, the approach can be considered that there is a certain control of information in a specific way and focus on ensuring economic and technological development forgetting the ethical concerns (Cihanová, 2024).

The U.S. regulatory approach to AI is decentralized, involving both federal and state-level initiatives (Chun et al., 2024). In 2023, the Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence was signed, which established guidelines for AI implementation in federal agencies, emphasizing accountability and transparency. These efforts align with parallel initiatives in Congress aimed at advancing and regulating the domestic use of AI (Sentinella & Jones, 2024). Federal agencies like the Federal Trading Commission (FTC) and Consumer Financial Protection Bureau (CFPB) provide sector-specific oversight, particularly in consumer protection and financial services (Chun et al., 2024). While no specific framework exists for AI in the financial sector, the CFPB considers that existing regulations for client protection also apply to AI implementation. Key concerns include addressing discrimination and bias to ensure transparency and compliance with credit access rules. However, there are no new rules regulating AI in the financial sector, leaving financial institutions to scrutinize AI systems under current legislation, which is not adapted to AI (Welch & Levi, 2024).

The decentralized U.S. approach, involving various federal agencies, states, and even cities, focuses on specific use cases and applications, encouraging self-regulation by AI companies. The goal is to balance innovation while ensuring safety, trust, consumer privacy, equity, and civil rights (US Department of Commerce, 2024;The White House, 2023). This fragmented system reflects a balance between fostering innovation and addressing AI-related risks, making consistent oversight challenging (Chun et al., 2024). The lack of a comprehensive U.S. law can hinder innovation and complicate compliance for companies navigating federal and state rules (Anstey, 2024). However, upon his return

to the White House, President Donald Trump rescinded the 2023 executive order signed by Joe Biden, which required creators of AI models to share details of those models with the government before they were released to the public (O´Brien, 2025). Similarly, Trump has demonstrated his stance on innovation by announcing a $1 billion investment in AI in order to become a world leader in the development of this technology (Jacobs, 2025).

Regarding the EU case, it was in April of 2021 that the European Commission proposed the first legislation of the EU to AI to guarantee safe, transparent, and unbiased AI models (Parliament, 2024). The AI Act was signed in June 2024 and was the first binding horizontal regulation on AI worldwide, establishing a common framework for using and supplying AI systems within the EU (Madiega, 2024). The AI Act aims to mitigate the negative impacts of AI, promote innovation, and guarantee the unrestricted flow of AI-driven products and services among member states, preventing market fragmentation due to inconsistent national regulations (EU, 2024). Furthermore, the Act classifies AI systems according to risk level, following a risk-based approach. This way, the rules for each system vary according to their risk level. The AI Act considers AI systems used in essential private services such as banking areas to be at high risk. (Parliament, 2024). The financial sector will be strongly impacted since it is considered a high-risk AI use case, and this way AI systems in the banking area will have stricter rules to operate. Since the rapid development of AI systems in the financial sector and the new rules of AI systems in the sector, the European Commission plays a crucial role in the supervision and implementation of the rules. Complementing the AI Act, the Digital Operational Resilience Act (DORA) ensures compliance and reinforces operational resilience in the financial sector (Parente, 2024).

Appropriately, the AI Act introduces a unified regulatory framework not only for entities based in the EU but also for third-country providers offering AI systems in the EU market. Additionally, it establishes standardized transparency obligations for specific AI systems to ensure that users are adequately informed about their use and functioning (Sentinella & Jones, 2024).

Nevertheless, the horizontal approach of the EU evaluating the level of risk of each AI system can make it difficult to understand the requirements of every AI application. Moreover, its focus on safeguarding fundamental rights, privacy, and ethical concerns

may inadvertently hinder innovation (Cihanová, 2024). Furthermore, McCaul (2024) emphasizes the need for European banking supervision to adapt to AI's growing influence by considering social, political, and technological factors. The Single Supervisory Mechanism's 2024–2028 tech strategy, with its emphasis on people and technology, aims to address these challenges by fostering agility and resilience in the evolving financial sector.

Regulating AI is vital to ensuring its ethical and transparent use. With laws like the General Data Protection Regulation (GDPR) and the AI Act, the EU sets a high standard for AI regulation, but there are concerns that excessive regulation may stifle innovation and harm the competitiveness of Europe (Marvão, 2024). In accordance with Montagnani et al. (2024) highlight the importance of AI liability in ensuring consumer protection and compensating for damages. However, the AI Act's risk-based framework may create gaps in liability, as it does not always align individual risks with broader societal impacts, complicating legal redress. The financial services sector faces particular challenges due to the variation in liability rules across Member States. Harmonization is essential to integrate AI effectively into financial services at the international level. Furthermore, Montagnani et al. (2024) claim that since AI opportunities change between sectors, a common framework for all industries is not suitable, and liability rules adapted to each industry and its AI challenges are more appropriate.

To conclude and provide a better understanding of these regulations and the stance of each region mentioned above, a comparative analysis is presented in Table A. 1 in the Appendix. The table recaps the principal features of each region's AI regulation approach, focusing on the launched frameworks, regulatory approach, impact on innovation, and key goals.

3. METHODOLOGY

This research uses qualitative methodology through semi-structured interviews. This approach was chosen for this research since it allows it to investigate participant's personal experiences and perspectives, understand the different interpretation meanings of each one, delve into topics that have not been extensively studied, and approach the study of phenomena in a comprehensive and integrated manner (Corbin & Strauss, 2015). Similarly, semi-structured interviews balance consistency and flexibility allowing certain literature-based themes to be addressed. In addition, interviewees can add relevant ideas and researchers can ask clarifying and follow-up questions (Corbin & Strauss, 2015).

The data was collected utilizing semi-structured interviews with banking sector professionals and clients between December 2024 and January 2025. This method was chosen because it allows a combination of predefined and open-ended questions enabling a more in-depth understanding through the expertise of each specialist. The main aim of the methodology used was to address three different perspectives to answer the research questions. The interviews were conducted from three perspectives: the banking regulator's perspective, the bank customers, and the conception of the models responsible for developing and implementing AI models within Portuguese banks. A different set of open-ended questions was prepared to analyze each perspective and is presented below in Tables A.4, A.5, and A.6 in the Appendix. Besides this, the questions asked in each interview emerged based on the relevant issues presented earlier in the literature review. In addition, each interview began with a brief explanation of the research subject, an opportunity for participants to ask questions, and anonymity was ensured to protect the interviewee’s privacy.

The professionals interviewed were chosen intentionally based on their relevant published literature, experience, function, and the relevance of the institution they represent and following the snowball method. In the case of the clients, they were chosen according to criteria such as age, gender, and area of work. It was organized 10 interviews, among them 2 from the conception perspective, 5 from the client perspective, and 3 from the regulator perspective, with an average duration of 31:13min. Table A. 2 shows some general information about the interviewees, such as their age, role, and functions of the

interviewed and the duration of each interview, and Table A. 3 presents some excerpts from the interviews.

The first set of questions in Table A. 4 is from the perspective of the model grantors to understand how Portuguese banks are using AI in their processes and whether it could be applied in the future. The second set of questions in Table A. 5 from the perspective of customers, has the key objective of realizing the trustworthiness of clients to AI models and aims to understand how consumers react to the implementation and adoption of AI tools in the different processes of the banking sector. The third set of questions in Table A. 6 refers to the perspective of the regulator and aims to try to understand whether AI can be used in central banks and how, what challenges the different applications of AI in the banking sector present for the consumer and for financial stability, how regulation will deal with these challenges and the EU's stance.

4. FINDINGS

4.1 Perspective of Models Grantors

Expert interviewee I4 agrees that the use of AI can bring benefits to the banking system but also challenges. She says that many Portuguese banks have already adopted AI in their processes. Regarding the adoption of AI by the Portuguese central bank, they also adopt AI tools in some activities and have even won an international award recognizing their reputation in technology at the European level. Some examples of how they have adopted AI are the automatic classification of requests for information from the bank's customers, automatic response drafts that are then validated by an analyst, the automatic classification of complaints, the validation of draft credit agreements, and the creation of Alya, the BoP's AI platform. In addition, BoP directors have spoken out on this subject several times, demonstrating the bank's position on AI and the financial sector.

From a private perspective, I9 says that the banking sector invested in the implementation of AI from an early stage, with marked growth in recent years, for example with the creation of departments specifically for this purpose. The banking sector is one of the areas that can benefit the most from these tools and at a national level we can see investments in the area, but the level of maturity of each bank's tools varies from bank to bank. Interviewee I9 says that at his bank the AI tools are already significantly

mature, and they are no longer so concerned with implementing the models, but rather with maintaining them with high levels of quality, security, and responsibility. He adds that to use these types of models, they do not just have to deploy them, they must follow a set of policies and processes and ensure that they do not make decisions that they are not supposed to. From an international perspective, the interviewee said that other countries may have more developed implementations due to other factors that influence the implementation of these tools, such as the size of economies, the level of investment, and culture, giving the example of the UK, which is in a more favorable position for implementing innovations.

Regarding the application of AI in fraud detection, both interviewees agree that this is one of the areas where there is the greatest potential for implementing AI. Expert interviewee I4 states that it can be used in two ways. One is the use of AI in fraud detection by Central Banks to enable posterior detection through information from supervised entities. On the other hand, there are many improvements that banks can make that do not involve AI. On the other hand, private banks can also use AI to make a series of correlations and detect anomalous operations or situations since AI is very powerful at capturing relationships that are not obvious, and its predictive capacity is much higher than others. In this way, private banks can act preventively and ex-ante to detect fraud.

Expert I9 emphasizes that there is a team dedicated to combating economic crime, covering areas such as fraud and money laundering. However, he points out that the main challenge facing the fight against fraud is the constant emergence of new forms of fraudulent activity. I9 shared several examples of how artificial intelligence (AI) tools have contributed to fraud detection, mentioning the use of biometrics, screening tools that use AI to identify whether a customer's name matches one on sanctions lists, and payment screening, in which transactions are analyzed in real-time, with millisecond precision. He also highlighted other applications, such as entity resolution, analyzing connections between different people, and other advanced forms of monitoring. According to I9, machine learning (ML) models provide a broader and more detailed view, as they can integrate different variables and understand the relationships between them, making it possible to accurately calculate the likelihood of a transaction or individual being involved in fraudulent activities. He also emphasized that AI could help in the preparation of investigation reports, making processes more efficient. The interviewee says that this

makes the work of specialists much easier and says that having people involved in the processes is essential. In the same way, expert I4 believes that there needs to be a balance because AI can bring many benefits, but natural intelligence is the most important thing; banks need to be able to think and reflect on new solutions that do not rely exclusively on AI.

Concerning the use of AI in credit decisions, both experts agreed that it can make an effective contribution. I4 stated that AI can be an accelerator but mentioned two important aspects also included in the AI ACT. Firstly, it is important to realize that these models are based on training data sets with a history, so any biases present in this history will be reflected in the algorithm's results. Therefore, when classifying an individual to make a credit decision, it is important to remove these biases from the data sets to avoid biased results. Another important aspect mentioned is the presence of a human being in the decision-making process. In addition to the numerical result of the algorithm, it is important to ensure that the final decision is not made solely by the model and that there is always a final assessment made by a specialized human credit analyst.

On the other hand, I9 states that AI is already being used to identify low-risk clients and offer pre-approved loans, particularly for small amounts. This approach facilitates loan subscriptions through digital channels, promoting a self-service model. Additionally, I9 highlights that AI tools automatically extract information from documents submitted by clients, streamlining processes and eliminating repetitive and time-consuming tasks, such as manual paper analysis. He further added that, in the case of companies with large volumes of data in reports, AI centralizes and organizes this information into detailed and automated reports, providing a consolidated and comprehensive view of the company's financial situation, including cash flow and transactions. This facilitates subsequent analysis by specialists, allowing them to focus on critical information without needing to examine lengthy documents in full. I9 emphasizes that while AI optimizes and accelerates the process, it does not replace human analysis. As such, final decisions, particularly for high-value or complex loans, remain with analysts. The goal is to facilitate work, enabling more critical and thorough analyses.

Regarding asset management and robo-advisors, interviewee I4 notes that the results are based on historical data sets of product performance, profitability, and trends.

The expert highlights that a significant advantage is the ability to anticipate movements, whether losses or gains, due to the ease with which information such as performance and profitability can be complemented with qualitative data, such as analysts' opinions and news. Consequently, the interviewee believes it will be possible to capture financial market sentiment, which will act as a catalyst for portfolio managers, enabling them to stay ahead of others. I9 states that they are developing a virtual customer support assistant to make it increasingly intelligent, capable of directing customers and providing information, for example, branch operating details. In the future, this assistant could perform more advanced tasks, such as offering financial advice. I9 also mentions that, depending on client needs and the importance of those needs, the human element will always exist. However, day-to-day tasks, such as daily financial management, will become increasingly automated, with bots readily available to assist customers. Both experts agree that AI can contribute to banking processes by improving the customer experience and that regulation will play a crucial role in ensuring responsibility and transparency in AI-driven models and decisions. I4 highlights that AI can benefit banks by optimizing their processes and replacing manual and repetitive tasks with automation, which improves efficiency and productivity. Additionally, using AI in the banking sector can enhance the offering of more efficient products and services, deliver a more personalized and suitable customer experience, and increase customer satisfaction.

From a regulatory perspective, I4 believes that behavioral supervision must ensure that banks do not use AI to discriminate against customers and that all operations comply with the AI ACT. Regarding prudential supervision, it is essential to monitor financial stability and solvency, ensuring these ratios remain robust even as private banks adopt AI. Conversely, I9 believes AI will bring numerous benefits to the sector, including convenience, efficiency, value generation, and cost reduction. Customers will gain access to perform a range of tasks more simply and conveniently, while bank employees will be able to focus their time on more valuable activities and processes. However, the expert notes that people must adapt to changes and the sector's transformation. He also acknowledges a challenge associated with AI implementation: the rise of deepfakes and improvements in tools used for scams and fraud. Despite this, he maintains an optimistic outlook on this innovation.

I9 asserts that banks must commit to maintaining high levels of security and responsibility in their services to continue protecting their customers. All models produced by his bank are explainable, ensuring traceability throughout the process and guaranteeing the quality of outcomes. He also underscores the importance of regulators in adapting to this innovation, stressing that regulation is crucial as long as it does not hinder innovative and higher-quality services for customers. Furthermore, he states that the AI ACT represents a minimum level of accountability and argues that all models, regardless of their risk level, should be inherently transparent and explainable.

4.2 Perspective of Clients

All the banking clients interviewed are familiar with AI in general, but specifically in the banking sector, they did not mention all the applications of AI that can be made; overall they mentioned chatbots for customer support, the presence of AI in credit decision-making, and personalization of the product offer for the customer were mentioned.

Concerning AI applications, banking customers in the younger age group felt that using AI for fraud detection would jeopardize customer privacy and data protection. On the other hand, the customer interviewed from a higher age group considers that this application would add a lot of value to society and the economy.

The majority of interviewees agreed that AI could optimize credit decision-making, but they would not trust a bank that exclusively used an AI model. The customers interviewed consider the intervention of a credit analyst crucial in the credit process.

Most respondents agree that they would not trust a robo-advisor to recommend them on investment decisions, considering that they would rather discuss this matter with a manager than a ‘machine’, on the other hand, one of the interviewees said that could benefit from this application of AI.

4.2.1 Worker of a private bank

The expert affirms that more and more of the bank's campaigns and customer offers are personalized to meet the customer's needs and profile as a consumer. The interviewee believes that AI benefits banking processes by making them more practical, objective, and targeted. They also waste less time on tasks that distract them, increasing

efficiency. However, I7 believes that AI also brings challenges, such as the loss of the personal relationship between manager and client. She also mentions the risk of dependency on this technology and the risk of job losses.

The interviewee believes that using AI to detect fraud is a plus, as she believes it is increasingly common and that the better and faster, they can react to these situations, the better for both the bank and its customers. As for robo-advisors, the interviewed think they are a good option because they can be better adapted to the client's profile, taking greater advantage of profitability and reducing any losses on financial investments. She also believes that the use of AI in the credit decision-making process could be more rigorous. As for the perception of customer trust in these tools, the interviewee believes that customers still prefer human relationships. They would prefer to talk and discuss solutions with a manager rather than a machine.

The interviewee believes that in general AI could bring benefits such as significant productivity gains, greater rigor, and a lower risk of error compared to manual analysis work. She added that the biggest challenge will be to ensure a balance between applying AI and maintaining human relationships. The interviewee believes that the regulator will play a fundamental role in protecting customers and banks while ensuring innovation and keeping pace with the evolution of technologies.

4.3 Perspective of Regulators

Regarding the first question about the use of AI tools at the central bank, all interviewees confirmed their application across various functions of the BoP. Practical examples cited include analyzing documents and contracts—such as credit agreements—to verify compliance with legal requirements, validating the advertising of banking products, and classifying complaints. They agreed that repetitive, mechanized manual tasks could be replaced by AI, resulting in improved efficiency and quality outcomes.

Specifically, I5 highlighted BoP’s investment in SupTech tools to enhance more efficient supervision enabling oversight of more processes, entities, markets, and products. This allows technical staff to focus on critical issues and respond more swiftly. I8 emphasized the importance of human involvement and judgment, particularly in decision-making processes that affect the financial ecosystem. According to I8, ALYA an AI tool of BoP is responsible for several tasks as those mentioned above, although is

a tool that needs improvements. This way, ALYA functions as an alert system, identifying red flags but not serving as sole decision-makers. I8 expressed optimism about AI's implementation, advocating that should not be afraid to implement but rather be careful with planning and ensuring the necessary checks and balances to ensure safe usage.

I5 considers that, despite the challenges and contributions AI can bring, the overall balance is positive, but it is necessary to supervise AI models. Her perspective on these technologies is optimistic, even though risks are involved, such as errors in validation and classification. Therefore, subsequent validation by a technician is essential to ensure a controlled environment. Similarly, interviewee I10 adds that AI can assist in decision-making effectiveness but should only aid the decision-making process, not produce decisions. I10 also states that there is a margin for error, which means a technician's intervention to filter decisions is always necessary. Additionally, they mention that they are already using AI, but with caution and care, as automated responses cannot be relied upon, and they must comply with GDPR.

Regarding the question about the use of AI in credit decision-making, the interviewees stated that there is potential in this application. Interviewee I5 noted that this is a new area of intervention and is currently under discussion. Additionally, the interviewees agreed that AI models rely on historical data, which means there is a likelihood of bias, as they can replicate societal biases. Interviewees I5 and I10 further emphasized that these models must be subject to rules to ensure transparency and explainability in decision-making. They mentioned BoP is debating this issue: determining what the tool should or should not do and establishing the boundaries for decision-making processes. I5 also mentioned that in line with the AI Act and OECD principles, such as balance, transparency, and explainability, it is unlikely that a model would autonomously make decisions. Interviewees I8 and I10 also highlighted that data protection and GDPR will play a crucial role in this matter. I8 added that for these tools to be implemented, legislators must try to ensure all safeguards are in place, guaranteeing that factors that cannot be used are not included in the models. Interviewee I5 also stated that decision-making will have limits and will always require human specialists to be involved in the processes. Similarly, I8 stressed that people must be engaged in the process.

On the other hand, interviewee I10 argued that AI models must not exclude certain clients from accessing credit, as these algorithms risk being opaque in their construction and may contain biases. She believes the solution lies in developing algorithms as rigorously as possible, avoiding biases, ensuring transparency, and guaranteeing that a person filters the final decision. I5 and I8 agreed that AI could play a fundamental role in credit decision-making if it is properly legislated, regulated, and supervised.

Expert I5 states that financial advising is a reality, and the challenge lies in offering advice freely amidst the proliferation of the internet and social networks. She gives the example of "finfluencers," who share, advise, and disseminate financial decision-making perspectives. I5 notes that "bots" will be another domain, with the main challenge being the greater difficulty in identifying them. She advocates for investing in financial literacy to enable clients to determine whether proposed solutions are suitable for them, thus protecting them from the widespread dissemination of financial information.

Conversely, interviewee I8 believes implementation will be more challenging because decisions regarding savings and investments are highly specific to each client. These decisions depend on factors such as risk aversion, age, household size, and wealth, making it difficult for a robot to provide advice. She suggests that AI might be useful for an initial triage phase to guide clients toward a specialist. I8 also mentions that free technological zones could be a good option for testing such tools while exploring an appropriate regulatory and legislative framework. Interviewee I10 admits she is less familiar with this application of AI but emphasizes the need to be cautious in distinguishing between true and false information. She believes this is a key risk of using AI, as it could mislead clients, particularly in the financial sector. I10 points out the example of a bank failure, highlighting the risk of contagion and the critical need to avoid eroding trust in this sector, which could cause significant harm.

Regarding the question about the use of AI in fraud detection, the interviewees hold a positive perspective on the use of AI in this context. Interviewee I5 considers it a significant advantage, as it serves as an accelerator for detecting patterns, anomalous movements, and situations requiring deeper investigation. Given that resources are limited, it is impossible to monitor everything, but focusing on flagged risk sources is a

tremendous benefit. Interviewee I8 highlights that the problem with fraud is that perpetrators are quick and efficient; while regulators address one instance, fraudsters are already planning the next. Therefore, having AI with the capacity to evolve, anticipate potential next steps, and help regulators take preventive measures could be crucial. She also noted that false positives might even serve as useful signals or red flags. As long as they trigger alerts without immediately leading to punitive actions, this is an area where AI can be particularly effective. Interviewee I10 emphasizes that applying AI to fraud detection faces challenges related to GDPR and personal data protection. However, she argues that these regulations should not hinder solutions in the public interest. She stresses the need to balance the impact on individuals' privacy with the benefits of combating fraud, adopting the principle of proportionality. Excessive or intrusive monitoring measures should be avoided, while rational, transparent, and well-grounded use of available information can enable effective solutions. Privacy must be preserved, but proportional and justified sacrifices in the name of public interest are acceptable.

Regarding the main challenge of AI for regulation and ensuring transparency and accountability in decision-making, interviewee I5 states that there are still no concrete rules regarding AI implementation by banks. The main challenges for supervisors are understanding AI's role and determining its limits of use. While AI offers benefits, it also presents risks, such as biased decisions and low-quality information. Therefore, to address issues of AI's lack of transparency and accountability, investment in AI explainability is necessary. Since AI operates as a "black box," it is crucial to explain exactly what data is used and how it is processed to produce outputs.

On the other hand, expert I8 identifies numerous challenges, one of which is ensuring the protection of data subjects. She notes that there have been some regulatory advances, such as DORA and MICA, but the major challenge lies in the uncertainty about how to regulate AI. It is difficult to strike a balance between over-regulation and under-regulation, highlighting that regulation is AI’s greatest challenge. To ensure transparency, I8 explains that BoP plans to implement an internal good practices manual and closely monitor private entities. They aim to include these entities in conferences on the topic, building an ecosystem to advance collaboratively and healthily. Additionally, I8 states that they are at the forefront of monitoring regulatory and technological developments across Europe.

I8 also points out that everything incorporated into LLM models has a very different implication from simply performing a Google search. The real challenge arises when working in a regulatory entity handling extremely sensitive information about individuals, confidential data, and privileged information. Similarly, interviewee I10 stresses the need for caution in using AI models due to the sensitive and highly confidential nature of the information involved. She believes that the regulatory process will need to take a different approach.

To ensure AI transparency and accountability, I10 suggests conducting impact assessments for all AI applications, following AI regulations. She emphasizes the importance of involving the data protection officer as early as possible in these impact assessments and rigorously adhering to rules to ensure transparency and equality while avoiding criteria that could lead to biased outcomes. This entails striving to fully comply with GDPR and AI regulations. I10 also underlines that institutions should not focus solely on "efficiency" and innovation; it is essential to ensure decisions are carefully considered.

Regarding the AI Act, I5 and I8 state that the challenge will be finding a balance, but they argue that banning these technologies is not the way forward. Interviewee I5 believes that the AI Act is balanced in that it does not hinder innovation but regulates it. The Act identifies areas of higher and lower risk for AI implementation and those that may jeopardize individual characteristics. She believes the focus should be on research areas for AI applications and ensuring a balance between the benefits and potential harms to society. On the other hand, I8 points out a significant challenge for the EU and the ECB, which the AI Act may not resolve is that most of these models are developed in the U.S. or China, complicating regulation and the imposition of rules. She believes Europe must tread carefully, working collaboratively and as a bloc. It must avoid falling behind in implementing these technologies while protecting who must protect, which is central to European decision-making through the inclusion of necessary checks, balances, and limits.

Interviewee I10 highlights that the challenges of European AI regulation lie in harmonizing innovation with data protection. The ECB said that the European Data Protection Supervisor will also be responsible for AI. She notes that Portugal has yet to

designate the entity responsible for compliance with the AI Act and GDPR, unlike other countries that have already done so and created new entities. She emphasizes that the AI Act is not independent of GDPR but rather a tool that requires careful consideration of risks and a balance between innovation and privacy. I10 adds that creating new regulatory entities or specific AI functions within institutions may lead to conflicts between them. She also warns of the risks associated with relying on low-quality or false data, which could undermine algorithm effectiveness and create paradoxes. While seeking progress and efficiency, the lack of trust in data sources can distort results and decisions. Finally, I10 argues that although AI promises advances and greater efficiency, achieving balance is crucial. She underscores the potential multiplier effect of large-scale incorrect decisions and stresses the need for caution, ethics, and transparency in developing and implementing these technologies.

4.4 Findings and Discussion

According to Marvão (2024) and the conducted interviews, there is a growing adoption of AI by the private Portuguese banks and the Portuguese central bank. In general, as Daníelsson (2021) and some interviewed experts mentioned, AI can be essential in eliminating repetitive tasks that humans would otherwise carry out. On the other hand, some interviewed experts specify that natural intelligence is also important, and it was shown by all the interviewees and clients that the presence of humans in these processes is indispensable.

Most of the experts consider that the use of AI could be an added value to fraud detection just as Buchanan & Wright (2021) said. Conversely, a challenge mentioned by the interviewed experts and Lee (2020) is the false positive results, but one of the experts defended this type of result can serve as important alerts in fraud detection. Other challenges mentioned by the experts are the new forms of fraud that could be improved with the use of AI and the fact that the GDPR plays an important role in this application although it may conflict with fraud detection. This way a balance will have to be struck between data protection and fraud detection. The interviewed clients mentioned their concern about the security of their data in this regard, but some felt that this application would be worthwhile and could increase social welfare and contribute to society.

According to Partridge et al. (2017) and several of the experts interviewed agreed that the use of AI in credit decision-making could be a plus. Some of the interviewees and BIS (2024) mentioned that the problems that can arise with these models when approving loans are the biases in the models and the problem of black boxes (Aldasoro et al., 2024). On the other hand, customers were not very comfortable with this application and mentioned that the presence of a person in the decision-making process was essential, as the other experts also mentioned. In addition, GDPR was also mentioned by some experts as essential in these processes to protect bank customers as much as possible.

When it comes to the use of AI for financial advice, namely robo-advisors, experts, and Lee (2020) say it could be an accelerator in this area. However, some experts consider it difficult to implement, and it is necessary to invest in financial literacy for customers to be able to discriminate what suits them best. Moreover, there is a danger of being wrongly influenced in such an important sector in an economy where trust is essential. In addition, customers demonstrate their need and preference to be approached and counseled by a human expert despite one that thinks that could benefit from this application of AI. Thus, one of the interviewees' experts demonstrates that for now, the focus is on developing a bot for customer service and that the human component will always exist.

Overall, the interviewees showed that, in line with BIS (2024), the use of AI can be an asset for banks as it optimizes their processes and increases efficiency and productivity. Although some argue that customers always prefer human relationships, the main advantages mentioned by the interviewees for customers are improved customer experience and satisfaction.

According to the literature review and the interviewees, regulation will play an important role in ensuring compliance with the rules of the AI ACT. On the other hand, some believe that the role of regulation is important, but that it must be regulated without hindering innovation and progress, and all interviewed believe that banks have a fundamental role to play in guaranteeing the security, responsibility, and explainability of the models used. In addition, one of the experts also mentioned that the AI ACT is the minimum of accountability, as he believes that all models, regardless of the level of risk associated with them, should be transparent and explainable.

Some of the interviewees agreed that one of the challenges for regulation will be to assess what the role of AI will be and how far it can be used in a way that neither regulates too much nor too little. In addition, they agreed with the literature review that biases, poor quality information, and the lack of transparency and accountability of AI models challenge the role of the regulator. They also agreed that the difficulty will be to strike a balance between progress and responsibility, but the way forward should not be to ban these technologies. Another difficulty mentioned by one of the experts is that there is still no organization in Portugal responsible for regulating these models and the creation of new regulatory bodies within the institutions could lead to conflicts.

This way, the interviewees said that the regulatory path should involve closely monitoring banking organizations, carrying out impact assessments of the models, ensuring the presence of a data protection officer, and keeping up with European regulatory developments. Concerning AI ACT, it was mentioned that the European challenge will be how to regulate these models if they come from outside Europe, so according to Montagnani (2024) and the experts, Europe will have to be careful and work together and harmonize innovation with data protection.

5. CONCLUSION

This thesis was conceived in alignment with the prevailing trends of artificial intelligence, especially in the banking sector. The focus was to understand how AI is going to transform the banking sector and how regulation is reacting in the face of this evolution. Bearing in mind the significance of the financial sector and consequently, the banking sector in the economy, it is crucial to anticipate the opportunities and challenges of this emergent technology.

The study highlighted that the adoption of AI in the banking sector is more than only a technological issue, it is a strategic opportunity for the sector to become more inclusive and innovative. The results show that AI is transforming the banking sector, and could do so even more profoundly, by automating processes, reducing costs, improving productivity and efficiency, and enhancing the customer experience. Despite all these advantages for the sector this innovation also raises concerns related to transparency and accountability of models and privacy and protection of personal data. Consequently, regulatory entities face the challenge of balancing innovation with safety, ensuring the protection of all those involved in the financial system, and the need to evolve to keep up with the rapid adoption of these technologies.

This analysis contributed to an understanding of the role of AI in the banking sector, highlighting the areas of greatest impact, such as AI's contribution to credit decision-making processes, investment advice through robo-advisors, and fraud detection processes. Banks can use the findings of this study to guide the implementation of AI ethically and efficiently while prioritizing the human relationships between clients and bank workers. Additionally, it will only be possible to take advantage of these benefits if financial institutions prioritize ethics and responsibility in the implementation of models and if regulators adopt flexible and collaborative approaches to meet the challenges of this emerging technology. In this way, regulators can consider the challenges identified, such as biases and transparency issues, when designing policies that promote innovation without compromising safety and consumer protection. Regulators have the challenging role of ensuring compliance with the AI Act and following European and international regulatory developments while closely monitoring the banking institutions and their innovations.

In addition, regulators can benefit from greater international collaboration to address the challenges of AI models that transcend borders, ensuring a balance between data protection and the promotion of innovation through paths towards more effective regulatory alignment at a national and international level. Therefore, the way forward should not be to forbid the use of this technology, but rather to identify the body responsible for regulating AI and to promote a collaborative approach at European and, ideally, global level.

Lastly, the impact of AI in the banking sector represents both an unprecedented opportunity and a regulatory challenge. The capacity to balance innovation with responsibility will be key to shaping a more inclusive, efficient, and resilient banking sector and consequently the economy. In the end, the real challenge will not just be to implement AI in the sector, but to do so in a way that strengthens trust and security in the banking sector, while driving the economy towards a more innovative and inclusive future.

5.1 Limitations of the research

Despite the valuable contributions of the experts, this work has some limitations, such as the focus on the interviewed perspectives and the study of specific cases, which may restrict the universality of the conclusions. In addition, the speed with which AI is evolving could mean that the trends identified could change rapidly. Beyond that, the regulation and supervision of the banking sector can be a complex theme and subject to local and global variations, which can hinder concrete predictions. Aligned with that, the study focuses more on the Portuguese and European reality, not covering all geographies and banking institutions which may limit the findings of the study. Furthermore, it can be considered another limitation of this study the small number of interviews carried out, especially from consumers' perspective, which may restrict the scope and diversity of the perspectives captured. Although the interviews provided valuable insights into the impact of Artificial Intelligence on the banking sector and its regulatory implications, a greater number of participants could have enriched the analysis and increased the representativeness of the conclusions.

5.2 Suggestions for future research

Future research could deepen the impact of AI through more comparative analysis between regions or countries with different levels of technological and regulatory maturity, different cultures, and even different attitudes to innovation. It could also examine other emerging technologies that could further impact the banking sector and extend the study to capital markets and the development of algorithmic trading. Furthermore, it would be a valuable addition to exploring in more depth how AI affects bank customers and their attitudes towards this innovation, including issues of privacy and digital exclusion, through a different approach, for example, using a quantitative approach, such as large-scale questionnaires, could help to capture a broader perspective of consumers and improve the representativeness of the results. In addition, it could be interesting to explore the different existing AI models and their respective impacts and contributions to the sector.

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APPENDICES

Table A. 1: Comparative analysis of EU, USA, and China AI legislation

Aspects	European Union	United States of America	China
Frameworks/Initiatives	AI Act, Digital Operational Resilience Act (DORA), Assessment List for Trustworthy AI	NIST AI Risk Management Framework, Executive Order on AI	Interim Measures for the Management of Generative Artificial Intelligence Services, AI Governance Principles, Algorithmic Recommendation Management Provisions, Deep Synthesis Management Provisions, Scientific and Technological Ethics Regulation, and the Next Generation AI Development Plan
Regulation Approach	Horizontal approach, based on risk (classification on risk level)	Decentralized approach, with federal, state, and sector-specific initiatives	Vertical approach focusing on specific applications over state control
Innovation Impact	Can limit innovation due to emphasis on ethics, privacy, and fundamental rights	Incentive innovation but with the risk of inconsistent regulations between states	Focus on technology development and state control can inhibit ethical and decentralized innovation
Main Objectives	Ensuring the safe, transparent, and ethical use of AI, promoting innovation, and preventing market fragmentation.	Balancing innovation with security and trust, guaranteeing privacy and civil rights.	Focus on technological and economic development and social stability, with state control
Impact on Financial Sector	High-risk sectors such as finance are regulated with strict requirements for AI	Financial sector regulated by agencies such as the FTC and CFPB but without a specific regulation for AI	There are no specific regulations for the banking sector, but there are general AI frameworks
State Role/cooperation	Centralized supervision by the European Commission and national regulations. Adoption of a common regulatory framework for member states and external providers	Decentralized approach with an emphasis on self-regulation by companies. Regulatory fragmentation between states, making uniformity difficult	Strong regulation with a focus on state control, without direct supervision in the banking sector
Challenges	Complexity in implementation due to the risk-based approach, which can make compliance difficult	The lack of unified national legislation can be an obstacle for companies	Potential conflicts between specific regulation and technological innovation
Human rights and ethics	Central to the AI Act, with rules for mitigating ethical, social, and legal impacts.	Dependent on state regulations and private self-regulation initiatives	Less focus on ethical concerns in favor of stability and efficiency

Table A. 2: General information about interviews

No. #	Gender	Age	Perspective	Organization	Role	Date of interview	Duration of interview
Interview 1 (I1)	Female	26	Client	University	PhD student	3 December 2024	15:53 min
Interview 2 (I2)	Male	23	Client	Private Company	Financial Technician	8 December 2024	15:37 min
Interview 3 (I3)	Female	23	Client	University	MSc Student	10 December 2024	12:59 min
Interview 4 (I4)	Female	48	Conception	Central Bank	Department Director	13 December 2024	21:26 min
Interview 5 (I5)	Female	45	Regulatory Entities	Central Bank	Supervision Department	17 December 2024	48:56 min
Interview 6 (I6)	Male	52	Client	Private Company	CEO	22 December 2024	19:27 min
Interview 7 (I7)	Female	52	Client	Private Bank	Worker of a private bank	23 December 2024	30:36 min
Interview 8 (I8)	Female	52	Regulatory Entities	Central Bank	Administrator	13 January 2025	36:06 min
Interview 9 (I9)	Male	36	Conception	Private Bank	Director of a private bank	15 January 2025	57:54 min
Interview 10 (I10)	Female	59	Regulatory Entities	Central Bank	Data Protection Department	16 January 2025	53:14 min

Table A. 3: Excerpts from the interviewees

No. #	Excerpts
Interview 1	"I think having a virtual machine deciding whether or not to lend me the money... I do not think I would trust it 100%. It would put me off a bit…"
Interview 2	"I realize that it could be good in part for detecting fraudulent transactions, but I would not want my data to be shared and so I do not think I really agree with this type of AI application. I think it jeopardizes data protection and customer privacy."
Interview 3	"As far as investment proposals are concerned, I think it would be quite useful, at least for me as I do not have a great knowledge in this area, and I think having a robot advising me would be a good idea."
Interview 4	"From the regulator's point of view, there are 2 perspectives here: as a behavioral supervisor responsible for protecting the banking customer, it is about understanding that the Bank does not use artificial intelligence mechanisms to discriminate against customers... And that everything is compliant with the AI ACT. From the point of view of a prudential supervisor, it is about looking at financial stability and solvency, the indication of ratios and realizing how these indicators of the Bank's solvency and sustainability continue to be ensured even with artificial intelligence"
Interview 5	"We not only supervise the behavior of banking institutions and financial institutions, but we also manage to supervise, regulate in essence... establish rules in the tools that the institutions themselves use. So, it is a new area of intervention that's completely on the agenda for discussion."
Interview 6	"I think artificial intelligence is very welcome and I do not think we can take a defensive stance towards it.... because 30 years ago I could also have taken a defensive stance towards the Internet... So let AI bring all the possible advantages, both for banks and for consumer clients...but I still believe that the basis of a business is the relationship between people."
Interview 7	"The benefits are, from a more practical point of view, more objective, more focused and we end up wasting less time on other tasks or wasting time on situations that distract us. So, in essence, it is greater efficiency. That is how I see artificial intelligence."
Interview 8	"There are things that I think are worrying for us, Europe and the European Central Bank, and that I do not see how ACT is going to solve, which is the fact that this is all American or Chinese...So I think the main challenge is going to be for us to move in a world and regulate a world and want to put rules on something that is not ours."
Interview 9	"There has to be a commitment on the part of the banks to continue to be responsible in their services and to continue to provide services with a high level of security and responsibility. So, it is about investing in all the processes that enable us to protect our clients... And regulation, as long as it is not excessive and as long as it does not prevent what it is innovation, as long as it does not block better quality services for our customers. I think it should exist..."
Interview 10	"I think we have to think a little bit about not just seeing the facility. I am in favor of progress, I am in favor of things, but we also have to be careful, see several dimensions, that balance is just finding it. It is finding balance."

Table A. 4: Interviews Questions – Conception Perspective

Conception Perspective	1. How is AI being conceived in the Portuguese banking sector? Do you think we're keeping up with other European countries? Which European countries?
	2. How could your organization use AI for fraud detection? Do you think this could be something to implement in the future? What specific AI techniques or tools can be used to identify fraudulent transactions?
	3. Do you think that AI models can contribute more efficiently to the credit decision-making process (of your bank)? And for predicting credit risk? Do you think this is an important tool that should be implemented?
	4. How is AI applied to asset management and investment strategies through robo-advisors? What will be the role of robo-advisors in banks and how do you expect clients to embrace them?
	5. What are the main advantages and challenges of using AI in these activities and processes for banks, customers, and regulators?
	6. Do you think that the regulatory bodies themselves could use AI models in their activities and processes?

The questions in this perspective were developed based on the literature about the impact of artificial intelligence in the banking sector and regulation. Key sources include authors such as Lee (2020), Bahoo et al. (2024), Pinto (2023), Buchanan & Wright (2023), and Partridge et al. (2017).

Table A. 5: Interviews Questions – Clients Perspective

Clients Perspective	**Worker of a private bank**	1. Would you like to understand more about your day-to-day life and whether you interact with Artificial Intelligence-based tools in your work at the bank?
		2. What benefits do you think the use of AI could bring to your work at the bank?
		3. What challenges and problems do you think the use of AI could bring to your work?
		4. Do you think AI models add value in activities such as the credit decision-making process, fraud detection, and robo-advisors for investment strategies?
		5. Will customer behavior remain the same when AI is used in these activities? What is your perception of customer confidence in these new tools?
	Client	1. Are you familiar with AI tools in general? And in the specific case of the banking sector?
		2. How do you think AI could contribute to the activities of your bank?
		3. If you knew that credit decision-making depended on an AI model, would this influence your choice of a bank?
		4. Would you trust robo-advisors to advise you on investment strategies?
		5. Would you trust a bank that used AI models to analyze customer information and thus detect possible fraudulent transactions?

The questions in this perspective were developed based on the literature about the impact of artificial intelligence in the banking sector and regulation. Key sources include authors such as Kamalnath et al. (2023), Haan & Watts (2023), Daníelsson et al. (2021), and Fletcher & Lee (2022).

Table A. 6: Interviews Questions – Regulation Perspective

Regulatory Authorities	1. I would like to know if any AI tools are already being used in the bank's tasks, and if so, in which tasks?
	2. Do you think AI can contribute to banking supervision and regulation?
	3. What could be the problems associated with AI tools in credit decisions? Could bias in AI-based credit models be a problem? How can regulation address these issues?
	4. Could AI be applied to asset management and investment strategies through robo-advisors to affect investment decisions? And can the problems of transparency and lack of control of these models affect these decisions?
	5. What challenges might regulators face with the use of AI in fraud detection (e.g. false positives, interpretability of results, consumer privacy, safety, and lack of transparency)?
	6. How can the use of AI models and tools affect regulatory compliance? In other words, do you think there are any specific regulatory challenges to the use of AI in the banking sector other than those mentioned?
	7. How can the central bank guarantee transparency and accountability in AI-driven decisions?
	8. What do you think should be the EU/ECB's next steps in relation to the AI ACT? What do you consider to be the most negative and most positive points of this ACT?

The questions in this perspective were developed based on the literature about the impact of artificial intelligence in the banking sector and regulation. Key sources include authors such as Aldasoro et al. (2024), Cao (2022), Guedes de Oliveira (2024), Rosalino (2023), and Madiega (2024).