ZESZYTY NAUKOWE POLITECHNIKI POZNAŃSKIEJ
Nr 90 Organizacja i Zarządzanie 2024

Dawid BANAŚ[1]

POSSIBILITIES OF INCREASING THE EFFECTIVENESS OF SUPERVISION OVER THE PENSION MARKET THROUGH THE USE OF SUPTECH[2]

DOI: 10.21008/j.0239-9415.2024.090.03

The pension system in Poland is extensive. On the one hand, this provides participants with many opportunities for additional savings for old age. On the other hand, it increases the scope of responsibilities of supervisory institutions. Additionally, citizens expect their funds to be secure. However, the possibilities of controlling these institutions is limited due to constrained human resources. Therefore, it is worth paying attention to the benefits offered by modern technologies, i.e., SupTech (supervisory technology). The author focused on this topic because entities operating within the Polish pension system are required to provide various data regarding their functioning over different periods. The aim of the article was to demonstrate how SupTech can improve the effectiveness of supervision over the pension market. Through a critical analysis of the literature a study of legal acts, the author used the descriptive method and logical inference. This approach allowed him to answer the research question: How does the implementation of SupTech increases the effectiveness of pension market supervision?

Among the most important conclusions, it can be indicated that SupTech tools allow for better identification of market risk and reduction of costs associated with fraud detection. They also reduce errors resulting from human factors, while increasing the probability of finding anomalies. The use of modern technologies will contribute to the systematization of processes, allowing supervisory bodies to exercise more effective supervision over the pension market.

Keywords: modern technologies, supervisory institutions, SupTech, supervision of the pension market, digitalization of financial supervision, automation of supervisory processes

[1] Poznań University of Economics and Business, Institute of Finance, Department of Money and Banking. ORCID: 0000-0002-8568-3861.

[2] Supported by funds granted by the Minister of Science of the Republic of Poland under the „Regional Initiative for Excellence" Programme for the implementation of the project "The Poznań University of Economics and Business for Economy 5.0: Regional Initiative – Global Effects (RIGE)".

1. INTRODUCTION

Regulations are necessary for the functioning of the financial sector because they ensure transparency as well as a sense of stability and security, especially from the point of view of individual participants. Thanks to this, both investors and the integrity of the market are protected (Szpringer, 2022, p. 113). This increases the confidence of people who decide to save for retirement by investing in selected financial instruments while also reducing the risk of fraud. However, events that took place in the 21st century, i.e., the global financial crisis, the COVID-19 pandemic, and the war in Ukraine, led to dynamic changes in legal regulations (usually as a response to these events). This has resulted in the phenomenon known as "legislative tsunami" or "legal inflation" (Banaś, 2022, pp. 8-9; Pawłowska, 2022, p. 87). This dynamic increase in regulation is indicated as an incentive for the use of modern technologies – RegTech[3] (regulatory technology) and SupTech (supervisory technology) (Batista, Ringe, 2021; Mroczyński-Szmaj, 2024, p. 443). Adding to this the rapidly progressing technological changes that can also be observed in the financial sector and the emergence of FinTechs in an increasing number of industries, it can be concluded that market control and supervision are becoming an increasing challenge. This is particularly relevant given the growing opinions that FinTechs need greater regulation to ensure the competitiveness of the market (Szczepański, 2022).

Kasiewicz (2018, pp. 222-223) noted that the role of the regulator is currently changing. For many years, it was perceived primarily as the guardian of public goods, and today it is faced with new challenges and expectations, requiring them to adapt quickly. One way to achieve this adaptation may be the use SupTech tools. They enable the digitization of reporting and regulatory processes, while also supporting and improving market supervision, especially in real-time.

Referring to the supervision of the pension market in Poland, it is evident that the sector is heavily regulated. Except for Individual Pension Accounts (IKE) and Individual Pension Security Accounts (IKZE), each financial product used for additional retirement savings is governed by a separate legal act that specifically regulates its functioning. Many regulations that are subject to change should also be taken into account, e.g., regarding annual maximum contribution limits. These legal acts, which directly regulate these pension products, provide detailed information on the frequency and type of data reporting required for compliance. These pension products also differ in participation levels, as they offer various incentives (including tax breaks, and subsidies), or quasi-obligatory participation.

The article aimed to show how SupTech can improve the effectiveness of supervision over the pension market. Its structure was adapted to its implementation,

[3] More on RegTech, among others: Banaś (2022), Colaert (2021), McCarthy (2023).

which, apart from the introduction and conclusion, consists of three parts. The first section indicates the need financial sector supervision, the essence of SupTech, and the possibilities it provides. Then the author examined the supervision of the Polish pension system, including the frequency of data reporting based on applicable regulations. The last part presents how SupTech tools can improve the effectiveness of supervision within this sector. This approach allowed the author to answer the research question: How does the implementation of SupTech increases the effectiveness of pension market supervision? The methods used include desk research and analysis of legal acts, along with descriptive methods and logical inference.

2. SUPTECH – MODERN TECHNOLOGIES IMPROVING SUPERVISION

Practically from the beginning of statehood, there have been noticeable examples of regulation and control of various aspects of public life. In economic history, various approaches to the role of the state and its supervision can be identified. A clear contrast exists, for example, between laissez-faire economics and mercantilism. Proponents of laissez-faire, including A. Smith and D. Ricardo, postulated the minimal state interference in the economy. However, mercantilists believed that the state was obliged to intervene to maintain economic growth (Stiglitz, Rosengard, 2015, pp. 6-7). As economic thought evolved, so did the role of regulators, whose main task was to safeguard the public good. Today, state intervention, and therefore supervision, is often justified by market failures. According to Stiglitz and Rosengard (2015, pp. 83-99), these failures include: failure of competition, public goods, externalities, incomplete markets, information failures, and unemployment. The complexity of the economy, as well as the interconnection of many sectors necessitate specialized state bodies operating at both macro-prudential and micro-prudential levels. In the case of the latter, three organizational models of supervision can be distinguished (Grodziska-Modzelewska, 2020, pp. 93-95):

- sectoral (fragmented);
- integrated;
- twin peaks (bipolar).

Poland employs the integrated supervision model, supervised by the Polish Financial Supervision Authority under the Financial Market Supervision Act[4]. This model covers supervision of banking, pensions, insurance, capital market,

[4] Other acts regulating the issue of supervision should also be mentioned: On capital market supervision (Journal of Laws 2005, No. 183, item 1537), and on insurance and pension supervision (Journal of Laws 2003, No. 124, item 1153).

and electronic money institutions (Article 1, Journal of Laws 2006, No. 157, item 1119). However, the EU predominantly utilizes a sector-based model. Therefore, it is possible to indicate individual institutions that are specialized and delegated to specific financial institutions: the European Insurance and Occupational Pension Authority (EIOPA), European Banking Authority (EBA), and European Securities and Markets Authority (ESMA). It should be noted that, following EU law, the Polish Financial Supervision Authority transfers some information to EU supervisors, for example, selected data regarding the pension market is sent to EIOPA. Therefore, this data must be complete, as up-to-date as possible, and directly suitable for validation.

Despite the various organizational forms of supervision, it is important to recognize that regulators, in the vast majority of cases, aggregate reports and summarize information obtained from individual institutions. Direct, real-time access to files, which would allow for capturing nuances, anomalies, and trends, is rare (Szpringer, 2022, p. 35). This problem is extremely important because sampled data may not always contain problematic issues, making it more difficult to identify irregularities. Additionally, this approach demands greater financial, time, and human resources. Another challenge is the potential data manipulation to avoid criminal liability. This lack of transparency on the market is becoming an increasing challenge for regulators, as financial institutions take actions aimed at increasing the digitalization of their offers, as well as their technological resources. These activities result in progressive algorithmization[5], which is evident not only in the financial sector but across various industries.

Another aspect that contributes to the growing importance of supervision in the financial sector, including the pension market, is the increasing prevalenece of personalized products and services. According to Łańcucki (2019, p. 8), this results from the desire to attract customers. Although conscious people dominate among owners of additional retirement savings products, research shows that greater financial knowledge also correlates with a higher likelihood of owning such products (Bucher-Koenen, Lusardi, 2011; Pieńkowska-Kamieniecka, Kowalczyk-Rólczyńska, Rutecka-Góra, 2021). It is also worth taking into account the issue of quasi-voluntariness, which occurs in the case of Open Pension Funds (OFE) or Employee Capital Plans (PPK) (Banaś, 2023, p. 44). As a result, these systems include participants with lower levels of financial literacy. However, this should not serve as a barrier to long-term retirement savings. The state should actively encourage all citizens to accumulate funds for retirement, regardless of their financial expertise. However, this constitutes an additional challenge for supervisory authorities, as the number of participants and the amount of accumulated capital increase. One may suspect that the protection of such participants should translate into higher trust in the financial sector. However, higher

[5] More on this topic, among others: Szpringer (2020).

trust should be reflected in the tendency to save additional money, as indicated by the results of research by Pieńkowska-Kamieniecka, Wojewódka, Kolek and Walczak (2017).

The ongoing digitization and computerization of financial markets have increased the demand for more proactive, faster, and more effective market supervision. The solution to this challenge lies in modern technologies, known as SupTech (Supervisory Technology), which are used by regulatory authorities. SupTech tools are used to digitize reporting and monitoring processes, and contribute to predictive analysis in a broad sense. These technologies also enable better database management and downloading relevant information directly from specific institutions. By utilizing SupTech for reporting, data aggregation is significantly simplified, enabling a seamless transition from the micro to the macro level, which allows for the demonstration of connections between various entities in near real-time, as well as the estimation of the level of risk exposure. There is still no universally recognized definition of SupTech in the literature on the subject. However, three approaches can be distinguished (Mroczyński-Szmaj, 2024, p. 447):

- use of modern technology;
- prediction through reporting;
- organizational influence.

The different approaches to defining SupTech stem from the large number of tools that can be used within this framework (fig. 1). Their use allows supervisory authorities to make decisions, even critical ones, almost in real time. The multitude of technologies that can be used by regulators not only improves their ability to analyze data from different financial institutions but also allows for the deployment of chatbots. These chatbots can, e.g., solve simple problems indicated by investors or consider their complaints. In addition, it is possible to point out the joint use of cloud computing, which would serve as a bridge between RegTech and SupTech. This would enable the use of any data in real-time, making it easier to observe anomalies and prevent risky situations faster.

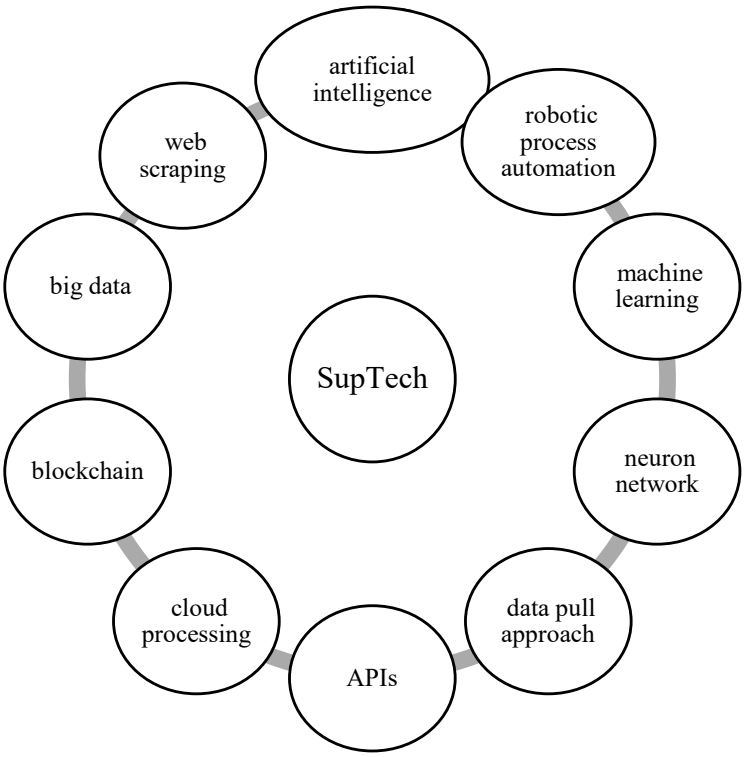

Fig. 1. Modern technologies classified as SupTech tools
(own study based on Flotyński, Marchewka-Bartkowiak, 2021, pp. 104-108)

In addition to the high financial costs required to implement modern technologies, such as RegTech and SupTech, security concerns remain a significant barrier. This is especially relevant when cloud computing are involved, as they may raise legitimate concerns regarding data security, and vulnerability to cyber threats (Beerman, Prenio, Zamil, 2021). In particular, the issue of misuse of personal data can significantly negatively impact trust in technology (Nair, 2019). Therefore, it is crucial to ensure an appropriate level of security. Of course, in the initial stage of SupTech implementation, the level of various risks will be higher, which results from misunderstandings, lack of appropriate knowledge, and little experience. Sharing experiences between supervisory authorities may be helpful. As McCarthy (2023, p. 188) noted, the EU's regulatory technology sector is less developed than that of the UK. Therefore, despite Brexit, this article suggests that cross-border cooperation between supervisory authorities remains beneficial, as it would enhance the stability of the entire financial sector. Moreover, international cooperation is also promoted by the Financial Stability Board (FSB), which argues that such cooperation can help reduce discrepancies in legal regulations and limit market fragmentation (Folwarski, 2019, p. 118).

Experts from the World Bank (2021, p. 30) indicate that the lack of appropriate knowledge in the field of data management may also constitute a significant barrier to the implementation of SupTech. They suggest scientific expertise may be required, either through the establishment of a central unit or integration with existing institutions, ensuring data security. Both solutions would need to be analysed for cost-effectiveness. This may mean greater integration with science so that theoretical research can gain a practical aspect. Additionally, such integration would positively impact a country's intellectual capital, as the demand for specialists in this field would increase. Ultimately, these activities should have a positive impact on economic development.

3. SUPERVISION OVER THE POLISH RETIREMENT SYSTEM

The pension system in Poland is highly complex, and even cumbersome (Pieńkowska-Kamieniecka, Kowalczyk-Rólczyńska, Rutecka-Góra, 2021, p. 82; Rutecka-Góra, 2021, p. 93). This is largely due to frequent reforms that took place in the solutions already in force (e.g., OFE reforms from 2011 and 2014). They are caused primarily by demographic, economic and practical changes. The issue of accumulating funds for retirement from the obligatory part is complicated by the fact that under the second pillar, a decision must be made to save on a sub-account at the Social Insurance Institution[6] (ZUS) (7.3% of the calculation basis) or the ZUS sub-account and in OFE (4.38% of the calculation basis and 2.92% of the assessment basis, respectively). However, under the third pillar, individuals have the option to save for retirement through five different products:

- Employee Pension Programs (PPE);
- Individual Retirement Accounts (IKE);
- Individual Pension Security Accounts (IKZE);
- Employee Capital Plans (PPK);
- Pan-European Individual Pension Product (OIPE).

They began operating in different years, in different forms (including group or individual saving), and they use various incentives for participation, which translates into the number of participants and the amount of capital they have accumulated (tab. 1). It is practically impossible to determine which of these forms is the most popular in Poland, as the law permits participation in each of them, provided certain conditions are met. While individuals must enrol in IKE, IKZE, and PEPP on their own, the PPK system automatically enrols people between the ages of 18 and 55, as stipulated by the Act (Article 23, Journal of Laws 2018, item 2215), due to the use of auto-enrolment[7].

[6] The analysis on the sub-account was conducted by Jakubowski (2018).

[7] Other behavioural economics mechanisms used in PPK were discussed, among others: Cycoń, Filiczkowska, Jedynak, 2022; Kawiński, Sieczkowski, 2022.

Table 1. Participants in voluntary savings for old age in Poland and the capital they accumulated

Retirement product	Year of commencement of operations	Number of participants (in thousands) (as of December 31, 2023)	Value of accumulated assets (in PLN million) (as of December 31, 2023)
PPE	1999	676	25 595,4
IKE	2004	860	18 222,4
IKZE	2012	515	9 189,0
PPK	2019	3 892	21 783,4

Note: Due to the short period of operation of the OIPE, no data were available.

Source: own study based on UKNF, 2024, pp. 24 and 28.

Both OFEs and institutions within the third pillar invest funds in the capital market to multiply savings and provide financial support during retirement. They have various options for investing funds, often regulated by specific legal acts. For example, following the pension reforms of 2011 and 2014, OFEs are subject to statutory investment limits (tab. 2). As a result, some scholars argue that they function similarly to traditional Polish equity funds (Błaszczyk, 2020, pp. 26-27; Kolek, Sobolewski, 2021, p. 153). However, in PPK, these limits change with the participant's age to prevent the so-called "risk of the wrong date". As participants grow older, a larger portion of their funds is allocated to safer securities, such as bonds. For instance, when a participant is over 55 but under 60 years old, 70% to 90% of their portfolio is invested in such assets, compared to only 20% to 40% for participants under 40 years old (Journal of Laws 2018, item 2215).

Table 2. Investment limits by OFE

Maximum limit	Type of asset
40%	municipal bonds admitted to public trading secured corporate bonds admitted to public trading
30%	assets denominated in a currency other than the national currency
20%	municipal bonds not admitted to public trading
10%	investment certificates issued by closed-end investment funds
No limit	shares of companies listed on the regulated market of the Warsaw Stock Exchange

Source: own study based on art. 140-142 Journal of Laws 1997 No. 139 item 934.

The complexity of the Polish pension market is also reflected in legal regulations. Virtually every product has a separate act (the exceptions are IKE and IKZE)

that determines its functioning. These legal acts also include information on the frequency of data reporting (tab. 3). This does not mean that these are the only legal acts regulating pension products, as there are often additional regulations of the Council of Ministers or the relevant minister. For example, the limit on contributions to IKE, IKZE and OIPE changes every year, as it depends on the forecast average salary. Additionally, the Act of August 28, 1997, on the organization and operation of pension funds (Journal of Laws 1997, No. 139, item 934) should be mentioned. This further complicates the task of comprehensively addressing all the regulations to which entities operating in the pension market are subject.

Table 3. Reporting frequency for individual pension products available on the Polish market

Retirement product	Frequency	Type of data	Legal basis
OFE	– on each valuation date – monthly – semi-annual – annual	– value of the accounting unit – net asset value – investing capital – rate of return – financial statements	– Art. 166, 169, 170, 190 and 193 Journal of Laws 1997, No. 139, item 934
PPE	– annual (taking into account half of the year)	– asset value – a number of participants – value of basic and additional payments – value of transfer payments – value of withdrawals	– Art. 23, Journal of Laws 2004, No. 116, item 1207 – Journal of Laws 2022, item 1989
IKE	– semi-annual – annual	– number of IKEs divided into age groups and gender of the owner – number of open IKE accounts – number and value of withdrawals – number and value of returns (including partial ones) – number and value of transfer payments	– Art. 17, Journal of Laws 2004, No. 116, item 1205 – Journal of Laws 2011, No. 222, item 1327
IKZE	– semi-annual – annual	– number of IKZE divided into age groups and gender of the owner – number of open IKZEs – number and value of withdrawals – number and value of returns – number and value of transfer payments	– Art. 17, Journal of Laws 2004, No. 116, item 1205 – Journal of Laws 2011, No. 222, item 1327

Retirement product	Frequency	Type of data	Legal basis
PPK	– quarterly	– a number of participants – the sum of basic and additional payments, divided into payments from the PPK participant and the employing entity – asset value – number and value of withdrawals – number and value of transfer withdrawals – number and value of returns – achieved rates of return for the last 12, 24 and 60 months	– Art. 49 and 52 Journal of Laws 2018 item 2215
OIPE	– annual	– list of member states where subaccounts are offered – number of reports about transfer to another country – number of applications to open a sub-account and number of operating sub-accounts – number of requests to change supplier – number of transfers to another supplier – information necessary to obtain or receive benefits and reliefs granted in respect of contributions and benefits.	– Art. 40 Regulation (EU) 2019/1238

Source: own elaboration.

The issue of supervision is not made any easier by the fact that the regulator has to control various entities that, by applicable legislation, may offer particular products in the pension market. For example, both IKE and IKZE may be operated by (Article 8, Journal of Laws 2004, No. 116, item 1205): an investment fund, a voluntary pension fund, an entity conducting brokerage activities, an insurance company, or a bank. These institutions offer products in various formulas, as demonstrated by the significant interest and investment in them. For example, IKE and IKZE in are offered through a bank account that works similarly to a standard savings account (with a variable interest rate). Similarly, insurance companies offer life insurance with an insurance capital fund to interested parties.

In addition to traditional entities operating in the pension market, attention should be paid to the emergence of FinTechs, which often leverage technological

advancements to offer competitive solutions. A notable example is Finax, which is the only entity offering PEPP in Poland and Slovakia (as of June 30, 2024, it was not possible to use this product in other EU countries at the time of writing this article).

4. SUPTECH AND THE EFFECTIVENESS OF PENSION MARKET SUPERVISION

As presented in the previous point, the frequency and type of data reporting to the supervisory authority vary depending on the pension product. However, regardless of these differences, the reporting process itself remains relatively similar (fig. 2). The process begins with data collection within the organization, followed by data transformation in accordance with the supervisory authority's guidelines. Then, the data is transferred to the regulator, where it undergoes analytical processing, typically incorporating information from all relevant institutions. There are three approaches used in this process: diagnostic analysis, predictive analysis, and prescriptive analysis.

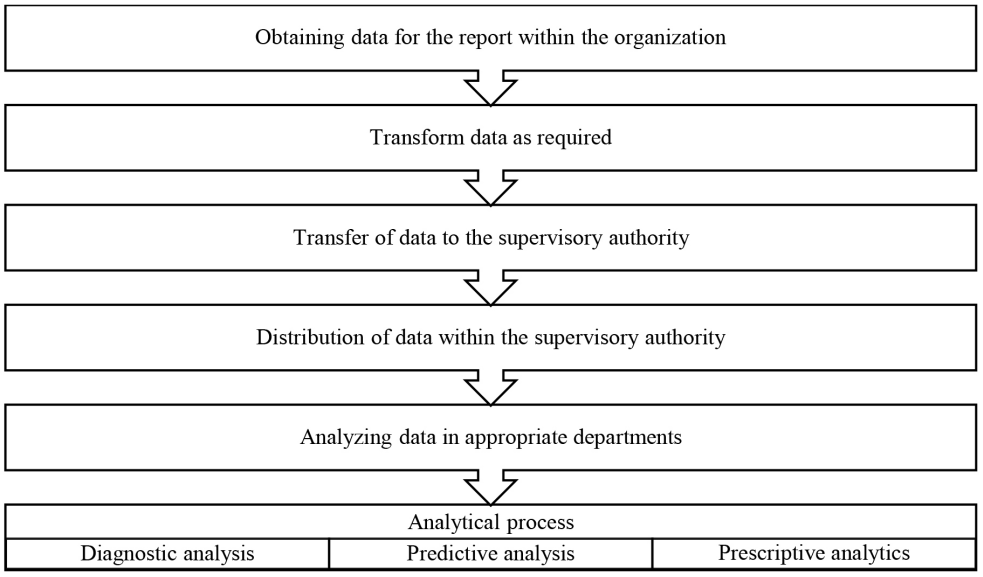

Fig. 2. The process of reporting to the supervisory authority
(own study based on Gal, Rubinfeld, 2019; Monkiewicz, Monkiewicz, 2022)

SupTech tools can play a crucial role data validation, which is extremely important from the point of view of supervisory authorities. These tools utilize machine learning, algorithms, neural networks, and big data technologies to enable faster control of data completeness, accuracy, reliability, and consistency. In addition to faster verification of the received data, there is a greater likelihood that anomalies that a human

could miss will be detected. It is worth noting that nowadays the supervisory authority very often sanctions or penalizes ex-post. The use of SupTech tools would enable more near real-time activities. The technology used could generate the desired data, and at the same time, with appropriate software, it would verify whether any extraordinary situations had occurred. Using machine learning in this way would allow algorithms to draw appropriate conclusions from the data they collect and, at the same time, be able to report them appropriately. This would result in less burden on the supervisory institution. Of course, we should not forget about a rather important issue, which is the ambiguity of applicable legal acts. This would cause algorithms to have problems interpreting some acts. Therefore, certain regulations should be simplified. According to the author, it would also be beneficial for the general public.

Other benefits resulting from the implementation of modern technologies include a reduction in the costs of collecting, storing, processing and exchanging data (Goldfarb, Tucker, 2019). This may translate into reduced costs of searching, replicating and tracking data. Therefore, it can be concluded that the technologies used help reduce market failures, including: information asymmetry and transaction costs.

The implementation of modern technologies, i.e., big data, machine learning, and artificial intelligence would allow supervisory authorities to assess the understandability of contracts offered for long-term saving products. This action is now possible using appropriate software. This is evidenced by research conducted by Hadryan, Rutecka-Góra (2023) or Pieńkowska-Kamieniecka, Rutecka-Góra, Kowalczyk-Rólczyńska, Hadryan (2021). The results of these analyses indicate that these contracts are complex and require higher education to fully understand. Therefore, it is worth considering solutions that would make the contracts offered by financial institutions clearer and more understandable for an average citizen.

Another benefit, in the author's opinion, that would be useful from the point of view of society as a whole, is a list or ranking of institutions offering long-term savings products or the products themselves. The use of SupTech tools would allow such a list to be updated in a relatively short time, taking into account key determinants, e.g., rate of return, management costs, and investment risk levels. Such standardized information with a high level of probability would be helpful for people who want to save for retirement, because currently in Poland, it is necessary to independently gather and compare information across various entities.

This undoubtedly influences the reluctance of some people to participate more in the third pillar. According to the author, easily accessible and regularly updated information from a supervisory authority trusted by citizens could foster further development of the voluntary segment of the pension system. Current participants in additional pension products could also benefit from such a ranking, as they often struggle to assess the profitability of their investment. Another benefit of conducting such a ranking would be the improvement of competitiveness among the offered products, as the data would be more easily comparable, thereby helping participants select the most attractive options from the perspective of individual pension system members.

SupTech tools would also enable regulators to regularly review pension plans. Such audits would show whether institutions offering retirement savings products offer benefits adequate to the contributions made, and whether any additional fees are not charged that would reduce the accumulated retirement wealth.

Supervisory authorities face challenges in utilizing modern technologies for data processing and the development of appropriate algorithms. However, it can already be observed that reporting processes within supervisory bodies have become more efficient due to the implementation of SupTech. Therefore, it can be concluded that the implementation of SupTech enhances the effectiveness of supervision over the pension market. Taking into account the dynamic development of modern technologies, the author is convinced that these processes will accelerate even faster.

5. CONCLUSIONS

Until the global financial crisis in the early 21st century, significant legislative changes, particularly in financial markets, were implemented. By taking advantage of technological progress, entities operating in this market want to gain a competitive advantage. This evolution has been further accelerated by FinTech companies, which adapt quickly to changing conditions. This results in a greater burden on supervisory authorities, which must supervise an increasing number of entities. One of the solutions that are intended to facilitate control processes is the implementation of modern technologies, collectively known as SupTech.

The financial sector, including the pension market, has to deal with many challenges, including an uncertain political environment, and unpredictable events, such as the COVID-19 pandemic or the war in Ukraine. In addition, there are new regulations, which are often a response to crises. Therefore, the adoption of modern SupTech technologies is becoming increasingly necessary. Its use allows for better identification of market risk and reduces the costs of fraud detection. Additionally, without the implementation of these tools, there is a risk that supervisory authorities will struggle to keep up with new regulations and the emergence of new entities in the market, particularly FinTechs. Generalizing the conclusions from the use of SupTech by supervisory authorities, it can be concluded that it positively impacts supervisory processes. Furthermore, it is important to highlight that automation represents the future, offering the potential to save both time and money, particularly by reducing compliance costs.

Improving the organization of reporting processes to be fully digital, with a focus on automation, algorithm use, and process systematization, will reduce the reliance on the human factor. This shift will lead to a change in the approach of supervisory authorities, allowing them to dedicate more time to active supervision of the pension market, rather than performing formal oversight based on outdated or delayed data.

The author's proposed creation of a ranking of products for retirement savings products using SupTech tools should provide the public with more understandable information regarding these products. Not only would this enhance competition between entities, but it would also reduce information asymmetry through regular data updates. This would simplify the decision-making process of choosing a pension product, which could translate into greater participation in the voluntary part of the pension system.

The topic of supervision of the pension market, according to the author of this article, is a future research direction. Among the issues of future analyses, for example, we can indicate the identification of barriers that limit the implementation of SupTech, apart from the quite obvious budget constraints. Their demonstration may contribute to a more dynamic development of modern technologies. In further research, it is also worth taking into account international regulations, which have an increasing impact on the functioning of national supervisory institutions and entities subject to this supervision. This is important because the issue of machine-readable legislation is increasingly being pointed out. The presentation of good practices, based on the experience of other countries, may also be of interest. It will facilitate the decision-making process regarding the implementation of actions and the avoidance of others. This allowed him to answer the research question of how the implementation of SupTech increases the effectiveness of supervision in the pension market.

LITERATURE

Banaś, D. (2023). Open Pension Funds vs Employee Capital Plans, which solution is more effective? *Social Insurance. Theory and Practice*, 159(4), 43-60, https://doi.org/10.5604/01.3001.0016.3022.

Banaś, D. (2022). RegTech jako sposób poprawy efektywności instytucji rynku emerytalnego. *Zeszyty Naukowe Politechniki Poznańskiej. Organizacja i Zarządzanie*, 86, 5-20, https://doi.org/10.21008/j.0239-9415.2022.086.01.

Batista, P.M., Ringe, W.G. (2021). Dynamism in financial market regulation: harnessing regulatory and supervisory technologies, https://doi.org/10.2139/ssrn.3711618.

Beerman, K., Prenio, J., Zamil, R. (2021). *SupTech tools for prudential supervision and their use during the pandemic*. Financial Stability Institute Insights on Policy Implementation, Bank for International Settlements, No. 37.

Błaszczyk, B. (2020). Filar kapitałowy w polskim systemie emerytalnym. Od OFE do PPK. *Gospodarka Narodowa. The Polish Journal of Economics*, 301(1), 9-54, https://doi.org/10.33119/GN/116616.

Bucher-Koenen, T., Lusardi, A. (2011). Financial literacy and retirement planning in Germany. *Journal of Pension Economics and Finance*, 10(4), 565-584, https://doi.org/10.1017/S1474747211000485.

Colaert, V. (2021). 'Computer says no' – benefits and challenges of RegTech. In: I.H.-Y. Chiu, G. Deipenbrock (eds.). *Routledge Handbook of Financial Technology and Law*. New York: Routledge, 431-446.

Cycoń, M., Filiczkowska, J., Jedynak, T. (2022). *Pracownicze plany kapitałowe jako element systemu emerytalnego w Polsce*. Kraków: Wydawnictwo Uniwersytetu Ekonomicznego w Krakowie.

Flotyński, M., Marchewka-Bartkowiak, K. (2021). Non-Technological and Technological (SupTech) Innovations in Strengthening the Financial Supervision. In: I. Boitan, K. Marchewka-Bartkowiak (eds.). *Fostering Innovation and Competitiveness with FinTech, RegTech, and SupTech*, 97-127. IGI Global, https://doi.org/10.4018/978-1-7998-4390-0.ch006.

Folwarski, M. (2019). *Sektor FinTech na europejskim rynku usług bankowych. Wyzwania konkurencyjne i regulacyjne*. Warszawa: Poltext.

Gal, M., Rubinfeld, D.L. (2019). Data Standardization. *NYU Law and Economics Research Paper*, 19-17, https://doi.org/10.2139/ssrn.3326377.

Goldfarb, A., Tucker, C. (2019). Digital Economics. *Journal of Economic Literature*, 57(1), 3-43, https://doi.org/10.1257/jel.20171452.

Grodziska-Modzelewska, B. (2020). Zintegrowany model nadzoru nad rynkiem finansowym w Polsce jako wypadkowa historycznych koncepcji nadzoru. *Kwartalnik Prawno-Finansowy*, 3, 88-108.

Hadryan, M., Rutecka-Góra, J. (2023). Readability and Clarity of Individual Pension Product Contracts. *International Journal for the Semiotics of Law*, 36, 1749-1777, https://doi.org/10.1007/s11196-023-09997-8.

Jakubowski, S. (2018). Sub-Account of the Insured Person as an Instrument of Income Allocation Over the Life Course – Legal Aspects. In: F. Chybalski, E. Marcinkiewicz (eds.). *Contemporary problems of intergenerational relations and pension systems: a theoretical and empirical perspective*. Lodz: Lodz University of Technology Press, 110-119.

Kasiewicz, S. (2018). Koncepcje regulacji RegTech w bankowości. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, 531, 221-230, https://doi.org/10.15611/pn.2018.531.20.

Kawiński, M., Sieczkowski, W. (2022). Ekonomia behawioralna w polskim systemie emerytalnym. *Studia BAS*, 4(72), 103-121, https://doi.org/10.31268/StudiaBAS.2022.29.

Kolek, A., Sobolewski, O. (2021). *Polski system emerytalny. Prawne uwarunkowania trzech filarów*. Warszawa: Wolters Kluwer.

Łańcucki, J. (2019). Wpływ innowacyjnych technologii na funkcjonowanie rynku ubezpieczeniowego. *Prawo Asekuracyjne*, 2(99), 6-22, https://doi.org/10.5604/01.3001.0013.5659.

McCarthy, J. (2023). The regulation of RegTech and SupTech in finance: ensuring consistency in principle and in practice. *Journal of Financial Regulation and Compliance*, 31(2), 186-199, https://doi.org/10.1108/JFRC-01-2022-0004.

Monkiewicz, J., Monkiewicz, M. (2022). Financial Sector Supervision in Digital Age: Transformation in Progress. *Foundations of Management*, 14(1), 25-36, https://doi.org/10.2478/fman-2022-0002.

Mroczyński-Szmaj, Ł. (2024). FinTech z perspektywy organów nadzoru (RegTech, SupTech). In: K. Szpyt (ed.). *FinTech. Nowe technologie w sektorze bankowym*. Warszawa: C.H. Beck, 443-455.

Nair, S. (2019). *Trust in Tech is Wavering and Companies Must Act*. Edelman Research. Retrieved from https://www.edelman.com/research/2019-trust-tech-wavering-companies-must-act.

Pawłowska, M. (2022). *Techniki cyfrowe w sektorze finansowym. Wpływ na strukturę rynku i ryzyko*. Warszawa: Oficyna Wydawnicza SGH.

Pieńkowska-Kamieniecka, S., Kowalczyk-Rólczyńska, P., Rutecka-Góra, J. (2021). Wpływ poziomu wiedzy o ubezpieczeniach społecznych na dodatkowe oszczędzanie na emeryturę w Polsce. *Wiadomości Ubezpieczeniowe*, 4, 79-100, https://doi.org/10.33995/wu2021.4.6.

Pieńkowska-Kamieniecka, S., Rutecka-Góra, J., Kowalczyk-Rólczyńska, P., Hadryan, M. (2021). Readability, efficiency and costliness of individual retirement products in Poland. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, 16(1), 45-74, https://doi.org/10.24136/eq.2021.002.

Pieńkowska-Kamieniecka, S., Wojewódka, M., Kolek, A., Walczak, D. (2017). Zaufanie na rynku finansowym a oszczędzanie na starość przez gospodarstwa domowe w Polsce. *Zarządzanie i Finanse. Journal of Management and Finance*, 15(2), 109-122.

Regulation (EU) 2019/1238 of the European Parliament and of the Council of 20 June 2019 on a pan-European Personal Pension Product (PEPP).

Rozporządzenie Ministra Rodziny i Polityki Społecznej z dnia 19 września 2022 r. w sprawie zakresu rocznej informacji dotyczącej realizacji pracowniczych programów emerytalnych, trybu jej przekazywania organowi nadzoru oraz jej wzoru. Journal of Laws 2022, item 1989.

Rozporządzenie Rady Ministrów z dnia 28 września 2011 r. w sprawie przekazywania przez instytucje finansowe oraz organ nadzoru półrocznych i rocznych informacji o prowadzonych indywidualnych kontach emerytalnych oraz indywidualnych kontach zabezpieczenia emerytalnego. Journal of Laws 2011, No. 222, item 1327.

Rozporządzenie Rady Ministrów z dnia 23 stycznia 2014 r. w sprawie obowiązków informacyjnych funduszy emerytalnych. Journal of Laws 2014, item 142.

Rutecka-Góra, J. (2021). Individual pension products offered by banks in Poland – a multidimensional comparative analysis. *Financial Internet Quarterly*, 17(4), 91-104.

Stiglitz, J., Rosengard, J. (2015). *Economics of the public sector*. London: W. W. Norton & Company Inc.

Szczepański, M. (2022). Fintech in the financial services market – opportunities and threats. Case study of Poland. *Industry 4.0*, 2(15), 149-153.

Szpringer, W. (2020). *Zarządzanie przez algorytmy*. Warszawa: Poltext.

Szpringer, W. (2022). *Platformizacja gospodarki cyfrowej 5.0. Nowe wyzwania dla regulacji*. Warszawa: Poltext.

UKNF (2024). *Raport o stanie rynku emerytalnego w Polsce na koniec 2023 r*. Retrieved from https://www.knf.gov.pl/?articleId=89729&pid=18.

Ustawa z dnia 28 sierpnia 1997 r. o organizacji i funkcjonowaniu funduszy emerytalnych. Journal of Laws 1997, No. 139, item 934.

Ustawa z dnia 22 maja 2003 r. o nadzorze ubezpieczeniowym i emerytalnym. Journal of Laws 2003, No. 124, item 1153.

Ustawa z dnia 20 kwietnia 2004 r. o indywidualnych kontach emerytalnych oraz indywidualnych kontach zabezpieczenia emerytalnego. Journal of Laws 2004, No. 116, item 1205.

Ustawa z dnia 20 kwietnia 2004 r. o pracowniczych programach emerytalnych. Journal of Laws 2004, No. 116, item 1207.

Ustawa z dnia 29 lipca 2005 r. o nadzorze nad rynkiem kapitałowym. Journal of Laws 2005, No. 183, item 1537.
Ustawa z dnia 21 lipca 2006 r. o nadzorze nad rynkiem finansowym. Journal of Laws 2006, No. 157, item 1119.
Ustawa z dnia 4 października 2018 r. o pracowniczych planach kapitałowych. Journal of Laws 2018, item 2215.
World Bank (2021). *The next wave of SupTech innovation. SupTech solutions for market conduct supervision' technical note*. Retrieved from https://documents1.worldbank.org/curated/en/735871616428497205/pdf/The-Next-Wave-of-Suptech-Innovation-Suptech-Solutions-for-Market-Conduct-Supervision.pdf.

MOŻLIWOŚCI ZWIĘKSZENIA EFEKTYWNOŚCI NADZORU NAD RYNKIEM EMERYTALNYM POPRZEZ WYKORZYSTANIE SUPTECH

Streszczenie

System emerytalny w Polsce jest rozbudowany. Z jednej strony daje to uczestnikom wiele możliwości dodatkowego oszczędzania na starość, a z drugiej zwiększa zakres odpowiedzialności instytucji nadzorczych. Do tego dochodzą oczekiwania obywateli, którzy chcą, aby ich środki były bezpieczne. Jednak możliwości kontrolowania tych instytucji mają swoje granice, co wynika z ograniczonych zasobów ludzkich. Warto zatem zwrócić uwagę na korzyści, jakie oferują nowoczesne technologie, czyli SupTech (ang. Supervisory Technology). Autor skupił się na nich, ponieważ podmioty działające w ramach polskiego systemu emerytalnego muszą dostarczać różnych danych dotyczących swojego funkcjonowania w różnych okresach. Celem artykułu było wykazanie, w jaki sposób SupTech może poprawić skuteczność nadzoru nad rynkiem emerytalnym. Opierając się na krytycznej analizie literatury przedmiotu, a także studium aktów prawnych, autor zastosował metodę opisową i wnioskowania logicznego. Pozwoliło mu to odpowiedzieć na pytanie badawcze, w jaki sposób wdrożenie SupTech zwiększa skuteczność nadzoru nad rynkiem emerytalnym. Wśród najważniejszych wniosków można wskazać, że narzędzia SupTech pozwalają na lepszą identyfikację ryzyka rynkowego i obniżenie kosztów wykrywania oszustw. Zmniejszają również błąd wynikający z czynnika ludzkiego, a jednocześnie zwiększają prawdopodobieństwo znalezienia anomalii. Zastosowanie nowoczesnych technologii przyczyni się do usystematyzowania procesów, dzięki czemu organ nadzoru może sprawować rzeczywisty nadzór nad rynkiem emerytalnym.

Słowa kluczowe: instytucje nadzorcze, nowoczesne technologie, SupTech, nadzór nad rynkiem emerytalnym, digitalizacja nadzoru finansowego, automatyzacja procesów nadzorczych