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The Implications of the Fourth Industrial Revolution for Information Asymmetry on the Market: Selected Aspects

Abstract

Objectives: The identification and systematisation of the phenomenon of information asymmetry on the market in theory and practice, and anticipating the impact of this phenomenon on the market and socio-economic relations in the era of the Fourth Industrial Revolution.

Research Design & Methods: Theoretical and cognitive studies, case studies, and inductive reasoning.

Findings: In the era of the Fourth Industrial Revolution, the innovation and information sector determines changes in the direction, dynamics, and structure of socio-economic development, which means that information has become an independent resource of special value. In the face of changes, the asymmetry of information on the market will deepen. This is due to the growing gap between the exponential increase in knowledge and anti-knowledge, and the limited, constant perception of the human brain and human tendency to opportunism, which means that in the field of information processing, artificial intelligence will be winning against human intelligence. Against this background, new threats are emerging that require new knowledge, skills, and competences from market participants and the state.

Implications / Recommendations: Solving the problem of information asymmetry is a common economic good that should be co-created by all sides of social, market, and public relations through regulatory and educational mechanisms. It is better to anticipate the cooperation of human intelligence with that of machines rather than engage in a conflict. The use of rich information resources, including the selection of irrelevant, manipulated, or false information will become a key skill of market participants, and the state should, through its tools, eliminate the negative effects of information asymmetry.

Contribution / Value Added: The subjective evolution of approaches to the phenomenon of information asymmetry from classical economics to behavioural economics, the identification of the relationship between information asymmetry and moral hazard and their consequences, the exemplification of problems on the basis of positive economics in the conditions of the Fourth Industrial Revolution.

Article classification: theoretical and review article

Keywords: information asymmetry, the Fourth Industrial Revolution, moral hazard, negative selection, behavioural economics, artificial intelligence

JEL classification: D82, D91, D81, B25, D01

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Introduction

The growing volume of information poses the need to ask about its utility and cognitive value in the conditions of 'big data'. The American futurists F. Fukuyama and A. Toffler rightly stated that "with the technological development of communication tools, reliable information will replace the unreliable (…) and the information revolution will lead to universal changes (…)" (Fukujama, 2004, pp. 49–50). In a similar vein, American sociologist Manuel Castells (2000) claims that "the information and technological revolution will reveal its transformational potential (…). The share of wealth that goes to individuals will depend on their access to education and society as a whole – from their innovation system" (pp. 600–601). Against this background, the problem of information asymmetry will emerge.

Information asymmetry is a situation in which one of the parties to the relationship has more or better information knowledge regarding the subject of the transaction than the other party (see, e.g., Akerlof, 1970; Rothschild & Stiglitz, 1976). It has been a common phenomenon in social, market, and public relations since the dawn of history. It can be considered an objective and natural phenomenon resulting from the fact that certain people or social groups are better-informed than others. However, in the case of market transactions, which is the area of research presented below, asymmetry of information might be a source of market advantage, which is associated with moral hazard (*ex-ante* factor) and negative selection (*ex-post* factor) (Mróz, 2016).

Moral hazard occurs when the better-informed party uses hidden information and has a material incentive to use the other party's incomplete information to gain additional benefits at the other party's expense.

Negative (adverse) selection is a situation in which the asymmetry of information causes an imbalance of power and position in the functioning of specific transaction markets (Czochański, 2017). In general, it causes the displacement of a better product by a worse one, disturbing the functioning of the market, social relations, and the state.

The aim of this article is to identify and systematise the phenomenon of information asymmetry in the market, doing so in the context of theory and practice, and to anticipate the impact of this phenomenon on the market and socio-economic relations in the era of the Fourth Industrial Revolution.

The following research theses were formulated as part of the study:

- behavioural economics is a research trend that most adequately explains the phenomenon of information asymmetry, undermining the neoclassical model of rationality;
- the economy of excess implies the deepening of the asymmetry of information on the market;
- in the conditions of an overload of information, procedural and emotional reasoning supersedes optimisation and rational reasoning;
- artificial intelligence introduces new dimensions of relations associated with possible information asymmetry;
- the state can and should mitigate the negative effects of information asymmetry in market transactions.

Information asymmetry in retrospect

Information asymmetry is a phenomenon that historically always occurred in social, economic, and political relations, but this empirically known problem had not been explained on the basis of mainstream economic theories until the end of the 19th century. The classical and neoclassical economic model explains the behaviour of economic entities, based, *inter alia*, on the assumption that decision-making units (*homo oeconomicus*) are rational, i.e. that they operate relying on complete and perfect information (Solek, 2010, p. 22). At the turn of the 19th and 20th centuries, representatives of the Austrian school, and their followers, rejected the concept of *homo economicus* as inadequate to the then current activities. C. Menger (1871) drew attention to the influence of the process of obtaining information and learning as scarce

resources which constitute significant constraints on the rationality of actions and decisions of market entities. A later representative of the Austrian school, L. von Misses (1949), claimed that "people subjectively define goals that they want to achieve through their actions, and under such assumption they do not necessarily lead to maximization of the benefits achieved" (p. 45). The 1974 Nobel Prize winner F. von Hayek claimed that "resource allocation (…) is a problem of using knowledge not given to everyone in the whole community" (1945, pp. 6–11).

As early as in 1947, American economist H. A. Simon, the 1978 Nobel Prize laureate in economics, criticised the assumptions of neoclassical thinkers about the unlimited ability to process information, creating the theory of human-bounded rationality in the face of increasingly limited knowledge, perception, subjective expectations, or preferences. Simon argued that

> the principle of bounded rationality [is] the capacity of the human mind for formulating and solving complex problems is very small compared with the size of the problems whose solution is required for objectively rational behaviour in the real world — or even for a reasonable approximation to such objective rationality. (1947, p. 198)

As the author continues in his later work, "The first consequence of the principle of bounded rationality is that the intended rationality of an actor requires him to construct a simplified model of the real situation in order to deal with it" (Simon, 1957, p. 198).

In the conditions of an overload of information, he proposed procedural rationality instead of optimisation reasoning, i.e. the separation of procedures under the conditions of a limited set of decision variables.

J. K. Galbraith, in his concept of the *Affluent Society* (1998 [1958]), drew attention to the growing influence of corporations manipulating information and advertising messages in order to shape excessive consumer demand.

In the second half of the 20th century, the problem of information asymmetry was reflected in numerous scientific papers and was acknowledged with Nobel prizes. Information economics as a new field of science was appreciated in 1996 with the award of the Nobel Prize to J. Mirrles and W. Spencer Vickrey for research on economic situations, whose participants have asymmetric information at their disposal. The same line of research was also recognised in 2001 by awarding George A. Akerlof, A. M. Spence, and J. E. Stiglitz with the Nobel Prize for their analysis of markets with information asymmetry.

These researchers have shown that the asymmetry of information at the micro-level (irrational decisions) has consequences at the macro-level (market failure, country failure), thus challenging the neoclassical model of rationality, which assumed that market participants had full information and did not incur the costs of obtaining information.

Under these conditions, in economic theories and in practice, instead of the classic *homo oeconomicus* assumption, the emotional human paradigm (*homo sapiens oeconomicus*) is more and more often taken into account (Wach, 2010). Here, emotional reasoning dominates over rational reasoning.

This reasoning is exemplified in the publications of R. Thaler (1980) and Susttein (Thaler & Susttein, 2008), which initiated the development of behavioural economics. Thaler was recognised with the Nobel Prize in 2017. In the mainstream of behavioural economics, information asymmetry is already a kind of *ex-ante* assumption, because anomalies, weaknesses of the human mind, and potential cognitive errors which can arise as a result of these weaknesses are its main research problem.

The dynamic development of behavioural economics has resulted in important scientific theories, introducing an interdisciplinary, holistic developmental approach, using knowledge from psychology, sociology, and economics, and taking into account social, ecological, and emotional factors. An interesting research trend is ecological adaptation and social rationality (Gigerenzer,

2000, 2007, 2008, 2015; Katsikopoulos, Schooler, & Hertwig, 2010).

Unlike the neoclassical theorists of expected utility, psychologists D. Kahneman and A. Tversky (1974) explained, with the help of experimental research, the mechanisms and heuristics of decision-making and the actual behaviour of people towards risk.

Behavioural economics is a research trend that most adequately explains the phenomenon of information asymmetry, representing a positive trend in economic research and undermining the neoclassical model of rationality. This results in the diversification of its trends, which include: *the Michigan school* (G. Kanton), *psychological economics* (D. Kahneman – Nobel Prize winner from 2002; A. Tversky, who did not live to the award, and C. Camerer, R. Thaler, E. Fehr), *behavioural macroeconomics* (G. Akerlof – Nobel Prize winner from 2001), *evolutionary economics* (R. Nelson, S. Winter), *behavioural finance* (R. Shiller – Nobel laureate in 2013), and *experimental economics* (V. Smith – Nobel Prize winner in 2002) (more in: Solek, 2010; Dudziak, 2013).

Information asymmetry and its consequences

In an economy based on knowledge, skills and competences that transform the possessed information into added value are and should be a source of competitive advantages in the market and non-market relations (Płonka, 2008; Dziekański, 2012; Godlewska-Majkowska, Skrzypek, & Płonka, 2016; Santarek, 2017; Wiktor, 2018; Stanienda, 2019). In the education system, it is desirable to enhance skills and competences in order to develop the ability to identify anti-knowledge and shape the competence to eliminate it (Paprocki, 2019).

The problem is moral hazard and treating information as a tool of power and manipulation. Here, instead of partners in the exchange of goods and values, there are "tricksters" and "phools", and the economy of equilibrium transforms into the "economy of manipulation and deception" (Akerlof & Shiller, 2015)[1]. Irregularities and even pathologies and crimes related to this problem pose potential threats to the integrity and transparency in market, public-private, and social relations.

From the epistemological point of view, three normative situations can be ascribed to the phenomenon of information asymmetry and moral hazard. These are presented in Table 1.

In the first two cases, the asymmetry of information does not have negative consequences, building and petrifying trust in the axionormative system (system of values and social norms) in market relations as well as in the public and the social spaces. Only the third case implies phenomena that disrupt the functioning of the market, the state, and the society. It is important to distinguish between the phenomena that accompany moral hazard:

– 'being cheated' (real, penalised fraud, e.g. identity theft);
– 'feeling cheated' (no actual cheating, but there is a subjective feeling of being harmed);
– not causing the effect of 'feeling cheated' (usually due to the lack of awareness of this fact).

The above statements can be exemplified by three cases observed in financial market transactions, where the asymmetry of information has particularly unfavourable and visible social implications, because financial institutions are perceived as public trust institutions, or might be perceived as such.

The case of Amber Gold is one of 'being cheated'; extreme, penalised dishonesty which was inherent in the incomplete information contained in the advertising message, which included, among others, keywords such as: trust, security, profit up to 16.5% per annum, 100% guarantee of security, and capital invested in gold. It was a typical financial pyramid without foundations based on risk awareness, which in 2012 did not exist for

[1] Both terms are taken from Akerlof's book (1970), where fools, spelled as "phools", are understood as naive victims, suckers, while the "tricksters" are deceivers, fraudsters, information manipulators, cheaters.

Table 1. Relationships between information asymmetry and moral hazard – their premises and consequences on the market and in the public and the social spaces

	Information asymmetry occurs	Potential "trickster" Motives, conditions, consequences	Potential "phool" Motives, conditions, consequences
1	There is no moral hazard; No tricksters and no fools; Benefit-sharing.	Fairness of market transactions; Transparency of the public space; Sharing, support, trust in the social space.	
2	There is a moral hazard, but it cannot be realised (the costs of moral hazard are higher than the benefits of implementing it.)	Fear of losing trust; Fear of penalisation; The conviction that the moral hazard is not profitable.	No "phools" (knowledge, education, awareness); Strong legal and institutional protection of fools; No negative selection.
3	There is a moral hazard and opportunities to implement it (the benefits of moral hazard are higher than the costs of its implementation); There are tricksters and fools.	Greed (appetite for profit) outweighs the fear of losing trust and even the fear of being penalised; There is a regulatory and mental space (consent) for abuse.	Greed and naivety; Poor legal and institutional protection of "phools"; Loss of trust in fraudsters or public institutions; Anomy of the axionormative system.

Source: own elaboration.

11,000 victims, who were scammed for a total of 660 million PLN. However, it could have been found that since December 2009 this entity had been placed on the list of public warnings from the Polish Financial Supervision Authority.[2] The mirage of extraordinary profits excluded any rational thinking by the victims, who filed a class action against the state in 2014, which was then rejected by the court. These events resulted in a decline in confidence in the state and in banks (although Amber Gold was not a bank) as a consequence of using information asymmetry to implement the moral hazard.

The case of Amber Gold is an exemplification of many financial pyramids that also appear today, which proves that society does not learn from the mistakes of its predecessors and that emotions (greed) exclude rational actions.

The situation of 'feeling cheated' is exemplified by cases of Polish customers of mortgage loans denominated in Swiss francs. This feeling arose as a consequence of the lack of awareness of the potential loss resulting from the exchange rate risk when submitting declarations of will in agreements with the bank. The advertising and media message from 2007–2008 suggested that the exchange rate risk would not be realised to the same extent as it was in the previous years (Szewczyk & Hajkowski, 2019).

However, there are many abuses that do not cause the effect of 'feeling cheated' by the other party to the transaction, because they are not aware of it. A typical abuse that does not constitute a crime but uses the phenomenon of asymmetry of information is 'misselling', i.e. selling products which the buyer does not need. This situation most often occurs in the markets of professional services. For example, when concluding an insurance contract, the policyholder or the insured is not aware that the concluded insurance contract contains unnecessary additional products or contractual clauses unfavourable to the client. A financial intermediary, architect, doctor, lawyer, or other entity with specialist knowledge might be

[2] https://www.bankier.pl/wiadomosc/Amber-Gold-od-powstania-do-decyzji-o-likwidacji-2614344.html (accessed: December 2020).

tempted to abuse it and, for example, recommend unnecessary products in a situation where the other side of the market does not have the professional knowledge to be able to notice it.

Information asymmetry can also apply to situations in which it is the buyer who has an information advantage. For example, when concluding an insurance contract, the insurer does not know about the intentions of the other party, who might act with the intention of extorting compensation, benefits, or take advantage of the opportunity to extort or to perform an criminal activity (more in: Pawłowska-Szawara, 2020; Stanienda, 2020; Jedynak, 2020; Strupczewski, 2020; Klonowska, Małecka-Łyszczek, Snarska, & Wyrobek, 2020; Płonka, 2019, 2020).

The Fourth Industrial Revolution and its impact on the scale of information asymmetry

As a result of successive industrial revolutions, which marked the development of civilisation (steam, electricity, digitisation, the Internet), the society of 'excess', consumption, and intensive information transmission on a global scale (mass media, means of transport) was formed. The Fourth Industrial Revolution (Industry 4.0) initiated the widespread use of the Internet, which changed technological, economic, and social relations on the global scale, especially in the area of information transmission and storage[3].

From 2000 to 2018, the computing capacity of supercomputers recorded growth of 3,500%, while data storage costs decreased by 99.5%, which led to a rapid increase in the amount of data generated by humanity: 80% of data in world history was created between 2015 and 2018, and, on average, the computing power of computers doubles every two years[4]. In 1995, storing 1GB of data cost about USD 10,000/year, while in 2018 it cost only 3 cents a year[5].

This data proves that Industry 4.0 opens the way to increasing information potential through three development paths, namely:

- *The Internet of Things* (IoT) – it allows for global access to machines connected to the network, giving the possibility of registering emotions and sharing all available information;
- *Smart Factory* – it allows for autonomous coordination of production through personalised adaptation to market needs (mass customisation) on the global scale (Schwab, 2016). The available applications create augmented reality, i.e. digital visualisation of invisible elements on real objects, autonomous robots, and intelligent networks of contacts in the value chain (Bujak, 2017);
- *Machine Intelligence* – based on artificial intelligence, Big Data, the Internet of Things, robotics, and cloud computing, it allows for autonomous communication regardless of the location of users. Artificial Intelligence is digital awareness that can independently assess the situation, learn about human emotions and behaviour, has a virtual personality and its own autonomy, and has the ability to learn through data analysis[6].

The growing number of mobile devices connected to the Internet and the operation of a set of immense databases (Big Data) – the size of which exceeds the capabilities for recording, storing, managing and analysing by traditional systems and people – create cyberspace which, owing to

[3] *Przemysł 4.0 PL Szansa czy zagrożenie dla rozwoju innowacyjnej gospodarki?* (2016). Boston Consulting Group. https://docplayer.pl/24443942-Przemysl-4-0-pl-szansa-czy-zagrozenie-dla-rozwoju-innowacyjnej-gospodarki.html (accessed: July 2020).

[4] Ramię w ramię z robotem, jak wykorzystać potencjał automatyzacji w Polsce (2018). *Forbes*. Raport McKinsey&Company.

[5] https://www.hbrp.pl/b/czwarta-rewolucja-przemyslowa-zmiana-juz-tu-jest-1/2/OmImRGYW (accessed: July 2020).

[6] Człowiek ustępuje pola maszynom. Do 2040 roku mogą nam dorównać inteligencją, Business Insider, www.https://businessinsider.com.pl/technologie/czym-jest-sztuczna-inteligencja/qzgz0wt (accessed: July 2020).

the Cloud infrastructure, is independent of place, time, distance, and administrative borders. It also ensures relative user anonymity and the tracking of both equipment and people connected to this equipment.

New civilisational opportunities resulting from the Fourth Industrial Revolution lie in the construction of autonomous vehicles, advanced robots working autonomously or together with people, and technologies, in which Polish companies have a significant share (3D printing, graphene, fighting against the coronavirus[7]).

Under these circumstances, information-processing functions are more and more often taken over by robots that 'think' for humans, support them in making decisions, and even have a quasi-personality. The humanoid robot Sophia, activated on April 19, 2015, became a citizen of Saudi Arabia in 2017, being the first robot to obtain citizenship of any country. Gifted with artificial intelligence, Sophia adapts to human behaviour and to working with people. For instance, in 2018 she took part in discussions during the "Impact '18" congress in Cracow, Poland[8]. In 2017, in turn, the anthropomorphic robot Fran Pepper became the first robot to be granted citizenship of the European Union (Belgium). He/It was trained to work as a receptionist on the university campus[9]. In India, at a cost of 700 USD, a humanoid robot has been created that can work as a receptionist, assistant, friend of lonely people, etc.[10]

The market for humanoid robots is growing and it is predicted that by 2025, one-third of traditional workforce will have been replaced by artificial entities[11].

There is no doubt that the amount of information that robots are equipped with is greater than the perception of the human mind, which is why artificial intelligence introduces new dimensions of relations linked to possible information asymmetry: human–artificial intelligence relations and artificial intelligence–artificial intelligence relations. If robots were market participants, the conditions of the neoclassical rationality, *homo oeconomicus*, would be met to a greater extent.

However, it is good that robots do not make decisions about purchasing many market products, because in the conditions of rational purchasing, most companies operating in the sector of elective goods would have to file for bankruptcy. Scientific research confirms the commonly understood fact that in the conditions of the economy of excess, most frequent purchases are made under the influence of emotions and as such they have no logical justification. On the basis of these behaviours, the trend of emotional marketing appeared, from which new trends emerged, namely neuromarketing and behavioural neurology. They are based on studies of the brain and the unconscious pattern of buyer emotions and behaviours that initiate the buying process[12]. Monitoring and managing the emotions of customers in the purchasing process is a new, developmental area that implies a specific information market and new ways of manipulating the recipients, who are not only tracked via mobile devices, but who themselves publish on social media data that has value on the information market. The Internet of Things opens the possibility of continuous profiling of buyers, tracking their interests, views, and preferences in order to offer personalised advertising.

In this context, behavioural economics is a research trend that most adequately explains

[7] https://www.sztucznainteligencja.org.pl/datawalk-z-wroclawia-rusza-na-koronawirusa/ (accessed: July 2020).

[8] https://www.forbes.pl/wiadomosci/konferencja-impact-w-krakowie-spotkanie-z-sophia-humanoidalnym-robotem/100gmtz (accessed: December 2020).

[9] https://noizz.pl/nauka-i-technologia/robot-obywatelem-belgii-zobacz-jak-wyglada-i-co-potrafi/4hf2c0w (accessed: December 2020).

[10] According to: *The Hindustan Times*; https://www.rt.com/news/435986-hindi-speaking-rashmi-humanoid/ (accessed: July 2020).

[11] https://www.forbes.pl/biznes/roboty-do-2020-roku-zabiora-5-mln-miejsc-pracy-na-swiecie/smz1z38 (accessed: July 2020).

[12] https://pieknoumyslu.com/marketing-emocjonalny/ (accessed: July 2020).

the phenomenon of information asymmetry, undermining the neoclassical model of rationality.

New technologies based on neuromarketing allow, for example, an X manufacturer of T-shirts using a brainwave analysis scanner to track customers' reaction to images displayed on the screen of their smartphone or computer, owing to which they can offer an assortment adequate to their emotional preferences. Cosmetics brand Y has created an m-commerce (mobil commerce) application that allows customers to search for available products based on their current mood[13]. These examples lead to the conclusion that the asymmetry of information can be enhanced by the behaviours and emotions of the buyers themselves, confirming in them the paradigm of the *homo emotionalis*.

Against this background, one can risk a thesis that the scale of information asymmetry is largely dependent on the scale of emotions accompanying knowledge, competences, selection, and information-processing skills, as well as preferred values. Emotions accompanying people distort the decision field, contributing to behaviours consistent with the principle of bounded rationality.

The human tendency to simplify things means that in the conditions of an informational overload, they narrow down their perception of the environment and stimuli (e.g. preferring one TV channel, social networking site, doctor, service technician, advisor, product brand, influencer) as a result of being anchored in the original information. As long as they are convinced about the correctness of their choice, they do not bother to consider other, perhaps more favourable, alternatives. Emotional purchases, made in conditions of deep asymmetry of information, generally do not bear the 'being cheated' sign, but they are often accompanied by a feeling of 'being happy' (often for both parties to the transaction). This is one of the interesting heuristic facts of behavioural economics.

Concluding remarks and contribution to the discussion

Information has a specific economic value and as such can be a source of competitive advantage for its holder.

Modern technologies deepen both the democratisation of access to information and the possible asymmetry of information, and the overload of information does not go hand in hand with the increase in knowledge and skills for how to use it effectively. This is due to the growing gap between the exponential increase in information and the limited, constant perception of the human brain and human tendency to opportunism, explained on the basis of behavioural economics (limited rationality, emotions, values, anchoring effects in the context of decisions, etc.) Under these circumstances, an influencer can become a quasi-authority who creates a moral hazard. It is not without significance that the marginal cost of obtaining additional information is increasing, while the marginal benefits of obtaining additional information are decreasing. These facts confirm the thesis that the economy of excess implies the deepening of the asymmetry of information on the market. However, it is not this fact itself that is dangerous as much as the lack of information management skills and possible monopolisation of know-how on the part of technology-and-information distributors. The thesis that in the conditions of an overload of information procedural and emotional reasoning supersedes optimisation and rational reasoning can be empirically tested on the basis of research tools and techniques used in behavioural economics.

The development of artificial intelligence creates conditions for both cooperation and competition with human intelligence. Certainly, robots will win against humans in terms of the ability to process information, but the competitive advantages on the market also result from other factors, including from using emotions, with which artificial beings can cope even less. The advantage of a human being may also

[13] https://www.mediafeed.pl/zakupy-pod-wplywem/ (accessed: July 2020).

be intuition, unexplained on the basis of rational data analysis. One can imagine a futuristic fight (competition) between humans and robots, but it is better to anticipate the cooperation of human intelligence with the intelligence of machines. This is a contribution to the discussion on the thesis that artificial intelligence introduces new dimensions of relations associated with possible information asymmetry.

Solving the problem of information asymmetry is a common economic good that should be co-created by all sides of social, market, and public relations. This is achieved by IT tools (Internet resources, search engines, social networks, databases, public registers, comparison engines, applications, etc.), which enable quick use of knowledge resources, but at the same time the gap between the information available and the information needed is growing exponentially, creating an even greater distance between knowledge and anti-knowledge. Technological solutions also limit access to information for people without skills, competences, or authorisations to certain functions and resources of the IT system, which implies a gap between the growing level of IT technology and inadequate skills of network users. The possible digital, technological, and mental exclusion can be reduced through systemic solutions implemented by various institutions.

Moral hazard on the part of bidders is reduced by market instruments (e.g. image, brand, reputation), warranty (e.g. warranty, certification, standardisation, accreditation), and legal means (e.g. consumer protection, public registers, including the threat of penalisation). On the buyers' side, moral hazard is reduced by consumer awareness.

The Fourth Industrial Revolution translates into growing expectations and new functions of the state in solving the problems of information asymmetry. In addition to traditional public goods, new public goods continue to appear, such as digitisation, cybersecurity, consumer protection, access to information, respect for the constitutional information autonomy[14]. All this implies the need to build an adequate education system and legal regulations enabling inclusive and sustainable development of society.

Technology is way ahead of regulation; there is no codification of norms and legal effects of acts committed by artificial intelligence. The problem is noticed by lawyers, e.g. 'Who is responsible for any damage caused by an automatic vehicle?'[15] Taczkowska-Olszewska (2020) quotes "Asimov's laws", the first of which is: "A robot cannot harm a person or allow a person to suffer harm by failure to act…" (p. 223).

In this context, the thesis that the state can and should mitigate the negative effects of information asymmetry in market transactions is indisputable; it is only the methods and tools of influence that are debatable. The state, having at its disposal a wide range of financial, administrative, regulatory, and penal instruments, and being equipped with control functions, can and should limit the impact of negative effects of information asymmetry. The EU and various national regulations impose certain information obligations of financial institutions on their clients under the penalty of criminal sanctions. The state is also responsible for the supervision and subject-and-object licensing of market activities of public trust institutions as well as the creation of central databases (public information databases, registers of prohibited clauses, public warnings). However, these tools become useless in the case of low public awareness, which is why it is necessary to build a system and solutions that strengthen consumer awareness and protect all parties to the transaction against the negative effects of information asymmetry.

[14] Art. 51 of the Constitution of the Republic of Poland of April 2, 1997 (Journal of Laws 1997.78.483 with follow-on amendments).

[15] In March 2018, an autonomous vehicle belonging to the Uber company fatally hit a pedestrian. One year after the accident, it was found that there was no possibility of bringing charges against the vehicle owner. More in: Taczkowska-Olszewska, 2020.

Information asymmetry leads to selection. It is the effectiveness of the state in mitigating its effects that determines whether this selection will be negative or positive.

References

Akerlof, G. A. (1970). Market for "Lemons": Quality Uncertainty and the Market Mechanism. *The Quarterly Journal of Economics*, *84*(3), 488–500.

Akerlof, G. A., & Shiller, R. J. (2015). *Phishing for Phools: The Economics of Manipulation and Deception*. Princeton University Press.

Bujak, A. (2017). Rewolucja przemysłowa – 4.0 i jej wpływ na logistykę XXI wieku. *Autobusy*, 6, 1338–1344.

Castells, M. (2000). *Information Age: Economy, Society, Culture*. High School of Economy in Moscow.

Czochański, J. T. (2017). Asymetria informacji i jej znaczenie w gospodarowaniu przestrzenią. *Rozwój Regionalny i Polityka Regionalna, 37*, 11–25.

Dudziak, S. (2013). Ekonomia behawioralna. Interdyscyplinarne podejście do zachowań ekonomicznych. *Studia i Prace Wydziału Nauk Ekonomicznych i Zarządzania, 32*(2), 23–3.

Dziekański, P. (2012). Informacja jako dobro ekonomiczne będące źródłem przewagi konkurencyjnej. *Nierówności Społeczne* a *Wzrost Gospodarczy, 24*, 387–403.

Fukuyama, F. (2004). *Trust: Social virtues and the path to prosperity*. LLC Publishing house ACT: ZAO NPP 'Ermak'.

Galbraith, J. K. (1998 [1958]). *The Affluent Society*. Houghton Mifflin Company.

Gigerenzer, G. (2000). *Adaptive Thinking Rationality in the Real World*. Oxford University Press.

Gigerenzer, G. (2007). *Gut Feelings: The Intelligence of the Unconscious*. Viking.

Gigerenzer, G. (2008). Why Heuristics Work. *Perspectives on Psychological Science, 3*(1), 20–29.

Gigerenzer, G. (2015). *Simply Rational: Decision Making in the Real World*. Oxford University Press.

Godlewska-Majkowska, H., Skrzypek, E., & Płonka, M. (2016). *Przewaga konkurencyjna w przedsiębiorstwie. Sektor – wiedza – przestrzeń*. Wydawnictwo Texter.

Hayek, F. A. (2009). *Individualism and Economic Order*. The Ludwig von Mises Institute.

Jedynak, T. (2020). Społeczna akceptacja popełniania przestępstw ubezpieczeniowych jako przesłanka sprzyjająca przestępczości na rynku ubezpieczeniowym. In R. Koszewski, B. Oręziak, & M. Wielec (Eds.), *Wdrożenie metod i instrumentów zapobiegania przestępczości w organizacjach* (pp. 205–229). Wydawnictwo IWS.

Katsikopoulos, K. V., Schooler, L. J., & Hertwig, R. (2010). The Robust Beauty of Ordinary Information. *Psychological Review, 117*(4), 1259–1266.

Klonowska A., Małecka-Łyszczek, M., Snarska, M., & Wyrobek, J. (2020). Oszustwa finansowe – współczesne trendy. In R. Koszewski, B. Oręziak, & M. Wielec (Eds.), *Możliwe przyczyny i rodzaje przestępczości w przyszłości i przygotowania prewencyjne* (pp. 141–172). Wydawnictwo IWS.

Menger, C. (1871). *Grundsätze der Volkswirtschaftslehre.* Wilhelm Braumüller.

Misses, L. (1949). *Human Action: A Treatise on Economics*. Yale University Press. [Polish Ed. (2007), *Ludzkie działanie, traktat o ekonomii.* Fundacja Instytut Ludwiga von Misesa.

Mróz, C. (2016). Wpływ asymetrii informacji na strukturę kapitału. *Inżynieria Mineralna, 17*(2), 37–44.

Paprocki, W. (2019) Archipelag rozwoju katalizatorem przemian systemowych. In J. Hausner & W. Paprocki (Eds.), *Dewiacje finansjalizacji* (pp. 86–113). CeDeWu.

Pawłowska-Szawara, E. (2020). *Asymetria informacji na rynku bankowych kredytów konsumenckich w Polsce*. Difin.

Płonka, M. (2008). Kapitał intelektualny jako przesłanka konkurencyjności podmiotu na rynku. *Zeszyty Naukowe Małopolskiej Wyższej Szkoły Ekonomicznej w Tarnowie, 1*(11), 57–77.

Płonka, M. (2019). Potencjalne obszary i metody zarządzania ryzykiem przestępczości na rynku ubezpieczeń – aspekty behawioralne i ekonomiczne. In M. Płonka, B. Oręziak, & M. Wielec (Eds.), *Rynek Ubezpieczeniowy. Zapobieganie przyczynom przestępczości* (pp. 15–47). Wydawnictwo IWS.

Płonka, M. (2020). Przyczyny powstawania sytuacji implikujących patologie w sektorze ubezpieczeń i propozycje ich zwalczania. In R. Koszewski, B. Oręziak, & M. Wielec (Eds.), *Identyfikacja przyczyn przestępczości w wybranych obszarach gospodarki w Polsce i na świecie* (pp. 253–276). Wydawnictwo IWS.

Rothschild, M., & Stiglitz, J. (1976). Equilibrium in Competitive Insurance Markets: An Essay on

the Economics of Imperfect Information. *The Quarterly Journal of Economics, 90*(4), 629–649.

Santarek, K. (2017). *Rola asymetrii informacji w zarządzaniu*. PDF.

Schwab, K. (2016). *The Fourth Industrial Revolution*. World Economic Forum.

Simon, H. A. (1947). *Administrative Behaviour*. The Free Press.

Simon, H. A. (1957). *Models of Man: Social and Rational-Mathematical Essays on Rational Human Behavior in a Social Setting*. John Wiley & Sons.

Solek, A. (2010). Ekonomia behawioralna a ekonomia neoklasyczna. *Zeszyty Naukowe Polskiego Towarzystwa Ekonomicznego, 8*, 21–34.

Stanienda, J. (2019). *Przedsiębiorczość społeczna. Wiedza – umiejętności – kompetencje*. Wydawnictwo Bernardinum.

Stanienda, J. (2020). Propozycje poprawy skuteczności metod zapobiegania przestępczości w ubezpieczeniach komunikacyjnych. In R. Koszewski, B. Oręziak, & M. Wielec (Eds.), *Metody zapobiegania przestępczości* (pp. 179–205). Wydawnictwo IWS.

Strupczewski, G. (2020). Cyberterroryzm jako nowe wyzwanie dla branży ubezpieczeń w Polsce. In R. Koszewski, B. Oręziak, & M. Wielec (Eds.), *Możliwe przyczyny i rodzaje przestępczości w przyszłości i przygotowania prewencyjne* (pp. 195–219). Wydawnictwo IWS.

Szewczyk, J., & Hajkowski, L. (2019). Oszustwo w ekonomii. *Biuletyn Polskiego Towarzystwa Ekonomicznego, 2*(85), 56–59.

Taczkowska-Olszewska, J. (2020). Internet rzeczy, sztuczna inteligencja i robotyka w transformacji przedsiębiorstw a potrzeba penalizacji nowych typów przestępstw – zakres regulacji. In R. Koszewski, B. Oręziak, & M. Wielec (Eds.), *Możliwe przyczyny i rodzaje przestępczości w przyszłości i przygotowania prewencyjne* (pp. 221–240). Wydawnictwo IWS.

Thaler, R. (1980). Toward a Positive Theory of Consumer Choice. *Journal of Economic Behavior & Organization, 1*, 39–60.

Thaler, R., & Susttein, C. R. (2008). *Impuls. Jak podejmować właściwe decyzje dotyczące zdrowia, dobrobytu i szczęścia*. Wyd. Zysk i s-ka.

Tversky, A., & Kahneman, D. (1974). Judgement under uncertainty: Heuristics and biases. *Science, 185*(4157), 1124–1131.

Wach, K. (2010). Od człowieka racjonalnego do emocjonalnego. Zmiana paradygmatu nauk ekonomicznych. *Horyzonty Wychowania, 9*(17), 95–105.

Wiktor, J. W. (2018) Asymetria informacji w procesie komunikacji marketingowej. Próba identyfikacji problemu. *Marketing i Rynek, 4*, 593–602.