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PÉNZ7 thematic week

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Foundation for Financial Culture

H-1011 Budapest, Szalag utca 19.

Phone: +36 1 224 0700

e-mail: gp@apkf.eu

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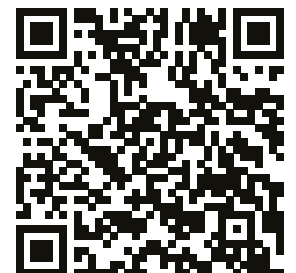
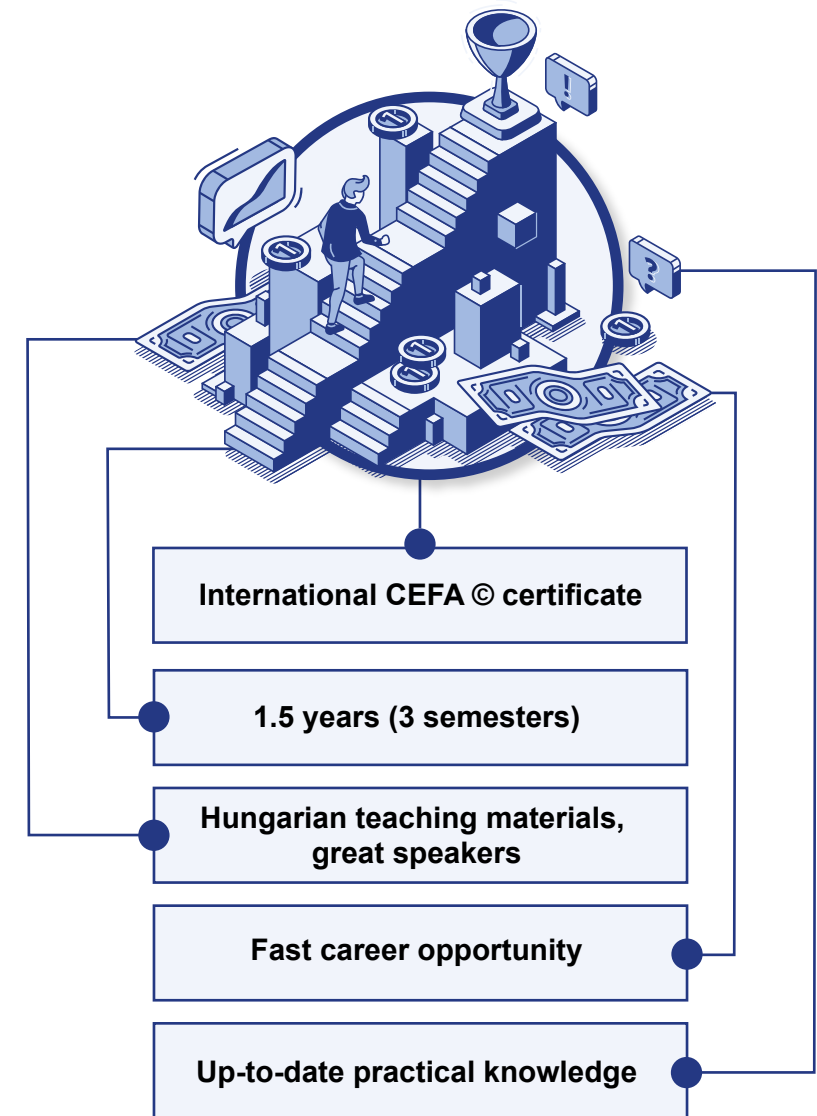
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REFLECTIONS ON THE OCCASION OF THE NINTH 'PÉNZ7'

Mihály Varga¹

The event series 'PÉNZ7' is organised in Hungary for the ninth time from 6 to 10 March 2023. This is often referred to as the week of raising financial and entrepreneurial awareness. The main objective of the world-wide promotional campaign is to prepare youth annually to be aware of financial issues and to obtain the knowledge and skills necessary to make informed financial decisions in their adult life. Primary and secondary school students are in the focus of the programme. As it holds for finance matters just as for every skill and knowledge, one should start learning about them as soon and as young as possible. The thematic week does not provide an academic description of abstract finance concepts or processes, on the contrary, it offers practical knowledge and attitude for everyday life situations through games and lively experience while also encouraging teachers to try new educational methods.

The standard of financial culture allows a glimpse into the attitude of the relevant country's population towards financial products. Recognising its value, Hungary is striving to survey the standard of financial culture in this country, to identify its deficiencies, and to improve financial awareness as part of the government's national strategy via targeted transparent and quality-assured actions. The government's standpoint is clear: the development of financial culture is of national economic interest, as the population's financial awareness can contribute to the stability of the financial system.

From a macroeconomic aspect, it is obvious that families' financial reserves can increase, their financial situation can improve and they can become more resilient to stress under economic hardships if their financial culture reaches a higher standard. It is true in the current dangerous times too: families better informed about finances are looking for more advantageous savings or investments, buying for instance inflation-linked government bonds. Savings finding their way into the financial system – in whatever form – can support and strengthen the whole economy in difficult times through their transformation into loans for growth or capital investment.

1 *Mihály Varga*, Finance Minister of Hungary. E-mail: miniszter@pm.gov.

Financial service provider institutions also have a vested interest in the improvement of the population's financial culture, since the higher popular awareness is, the more private savings can grow which can improve their creditworthiness. Clients with better solvency indicators mean a low-risk source of income and stable business operations of the financial sector.

Financial awareness has got into the limelight as a result of the impact of the 2008 financial-economic crisis. At the same time, the need to improve financial culture has become a more and more pronounced goal in the country. The citizens of Hungary play an important part in the operation of the national economy as financial consumers and potential entrepreneurs; therefore, the government has set the improvement of popular financial awareness an important policy target. In December 2017 it adopted a seven-year Strategy for the Improvement of Financial Awareness. The strategy targets the whole population, but equipping the young age groups with practical financial skills is of special importance. So, the programme 'PÉNZ7' also supports achieving both the goals of the national strategy promoting financial awareness and the SME strategy adopted in 2019 ("The strategy of strengthening Hungarian micro, small and medium-sized enterprises").

Both international and local experience supports that the development of financial culture must be started at primary level and continued throughout in secondary and higher education. Firstly, Hungary joined the initiative *European Money Week* in 2015, which is arranged in about 30 countries in Europe at the same time. Then 'PÉNZ7' joined the event series *Global Money Week* in 2017. The events of 'Global Money Week' had been launched by the international non-profit organisation 'Child and Youth Finance International' in 2012. The significance of 'Global Money Week' is best illustrated by the fact that over 170 countries have taken part in the series over the past ten years and more than 50 million youth have gained improved financial knowledge thanks to high value programmes.

'PÉNZ7' is an outstandingly successful and useful initiative. It reached 170 thousand students at over 1000 schools in Hungary in the last academic year. This ratio is a good achievement by international standards, which has darted Hungary into the TOP 5, the forefront of EU Member States.

In 2023 the activities of 'PÉNZ7' cover electronic banking channels under the title „*State-of-the-art money management – Security of finances in the cyberspace*”, while the business theme is „*Think and start a business*”. Comfortable, fast, and easily available state-of-the-art digital solutions offer many advantages, but they may also carry risks, about which one must be warned, particularly young people who are their most frequent users.

The Ministry of Finance considers the school thematic week 'PÉNZ7' a great opportunity: youth can meet knowledgeable educators, practical experts at classes. The professional volunteers are rich in financial and entrepreneurial experience and present them with some fascinating and useful workshop secrets. Experience over the years has shown that both primary and secondary school students are happy to learn about financial skills. It is also a pleasure to see that many teachers, whether they teach maths, history, or biology, are also enthusiastic and professionally ready helpers of that knowledge transfer in the school. They deserve many thanks for that.

The stability of the financial system is important from the aspect of economic policy too. One of its elements is to have as many people as possible involved in the financial infrastructure. Improving the financial readiness of students, then young adults and also of society as a whole can contribute a lot to the goal, so the programme series 'PÉNZ7' can strengthen economic stability and resilience in the long run. In that spirit, let me recommend this issue of Economy and Finance to readers' attention.

FINANCIAL SECURITY IN CYBERSPACE – PÉNZ7 THEMATIC WEEK

Elemér Terták – Levente Kovács¹

ABSTRACT

The 9th PÉNZ7 (Money Week) event series, raising financial and entrepreneurial awareness with interactive tools, was organised between 6–10 March 2023. We were happy to welcome this year the 1.5 millionth student participating in the financial thematic week, which was the result of almost ten years' efforts and relentless work of about 1700 schools.

The focus of this year's PÉNZ7 was on '*Modern Financial Management and Digital Security*', chosen by consultation with the Ministry of Economic Development, the Ministry of Culture and Innovation, the Ministry of Finance, the Hungarian Banking Association, and the Foundation Pénziránytű and Junior Achievement Hungary together with the responsible project manager Ministry of the Interior. Our paper provides an overview of the different aspects of digital security in finance. Our aim is to share practical knowledge and advice on the topic with teachers and students.

JEL classification: A20, G2, O30

Keywords: financial culture, cyber risk, financial security

1 THE 'EXPLORATION' OF CYBERSPACE

The mechanisms of the economic space that had evolved and got established over hundreds of years started to change in the 1970s upon the appearance of computers. In the 2000s, the emergence of web-based services and widespread access to the Internet (which changed from one personal computer per household to one smartphone per capita, '[allowing] these households to reach digital services at least at a basic level' (Terták–Kovács, 2020:376) opened a new venue for services, commerce, finance and information exchange. That digital space, by nature, can

¹ *Elemér Terták*, Chair of the Supervisory Board of K&H Bank Zrt. E-mail: elemertertak@gmail.com.

Levente Kovács, Secretary General of the Hungarian Banking Association, Professor at the University of Miskolc. E-mail: kovacs.levente@bankszovetseg.hu.

meet existing, induced or imagined consumer needs in a cost-effective way. As such, this novel space offers attractive opportunities and conditions to both service providers and service users and is characterized by continuous evolution and renewal (*Poletaeva et al., 2019*).

As a consequence of the continuous and rapid development of the digital space, legislators cannot keep pace with the constantly changing legal relationships it hosts. One might say jokingly that it's something the Romans had omitted from their law codes. As a result, timely and sufficient regulation of the digital version of traditional and novel services provided and used in this space, and of the associated rules of procedure, processes, guarantees, liabilities and risks lagged behind. In the era of global services, such a deficiency can be remedied only globally (as national-scale regulation alone is not sufficient) which, however, is a lengthier process.

There are three potential limits to the further development of the digital space: scarcity of service solutions that may be digitalized, scarcity of digital solutions on the providers' side, or consumer readiness to embrace new digital solutions. *Sándor Csányi*, CEO of the largest Hungarian Bank identified the limits to development as follows: 'let customers use products and services according to their habits and needs, so that everybody can go through the phases of digitalization at their own pace' (*Kovács–Sipos, 2017:24*). In other words, digitalization can spread only as fast as the adaptive capacity of consumers allows. As the pandemic made working and learning at home, almost fully digital banking, home-delivery of goods etc. widespread, people overcome their aversion to using digital solutions, which meant a decade's progress in only a few months. This affected all areas of the economy (*Terták–Kovács, 2020*).

The digital space now in mass use took in inexperienced users from almost all levels of society, whose reservations against these new platforms were addressed by offering IT solutions which are easy to understand even for beginners and especially user-friendly. However, user's arrival in the digital space and massive use of the new solutions was not accompanied by adequate assessment and awareness of the risks entailed. Cyberspace has thus become a treasure trove for fraudsters, where attempted fraud and different types of fraudulent activities can proliferate – unfortunately with increasing success. Joint effort under a broad cooperation between legislators, IT and finance professionals, and financial education and awareness-raising among consumers is the only effective cure for this epidemic.

2 THE RISKS OF DIGITAL FINANCE

The most ground-breaking changes in the monetary and financial system were also effected by the aforementioned acceleration of technological progress (Bangó–Pintér, 2022). What is conceptually new about the ongoing changes is that they affect the substance of money, while the earlier changes mainly had formal implications. The evolving new technologies contributed primarily to efficiency and convenience also in the area of finance, and a significant facilitator of their spreading was the curiosity, receptiveness and trust of younger generations towards digital solutions.

However, the new technological possibilities, especially instant execution, necessarily come with new risks. Many youngsters lack the necessary knowledge and self-control and succumb easily to temptations from the Internet – with typically irreversible consequences considering instant payment/execution. The consumer awareness blog of a financial institution² provides instructive examples, showing that even the most well-informed consumers can be deluded by attractive discounts. Huge price discounts are misconceived as a once-in-a-lifetime opportunity and often encourage unnecessary purchases. Most readers may be familiar with promotions where a tempting offer (e.g., content services, entry fee etc.) redirects users to a registration page in a foreign language, where they are required to enter their name, card details and/or mobile phone number to get the promotional discount. After a free, however, very short trial period, they suddenly find themselves as subscribers to premium rate text messages or to a monthly subscription fee of EUR 20–40 if not cancelling the service on time. However, not every application or service sends a notification before the end of the free trial, but charges users automatically. Moreover, the cancellation process may be difficult and mostly requires adequate knowledge of a foreign language. ‘Tricky’ applications of this kind are called ‘fleeceware’ in the literature. The European Commission and the Consumer Protection Cooperation Network (CPC) of EU Member States have taken steps against such malicious commercial practices, but it will take time until they could completely be eliminated.

However, even completely fair commercial offers, or ones which are just too enticing for teenagers and young adults not having sufficient funds, may lure them into a debt trap due to the availability of cashless instant payment. The payment methods used in e-commerce, such as payment on delivery, by PayPal, credit card or in interest-free instalments not only make purchases attractive but also easy, as payment can be made in fact with a mouse click, which is definitely a lot simpler

2 See <https://blog.provident.hu/tudatos-vasarlas> (in Hungarian).

than rummaging around in the wallet for money. Impulse buying is hindered but cannot be prevented by two-factor authentication, introduced for security reasons. Therefore, each of us is responsible for developing the necessary self-restraint to avoid impulse buying.

The grave consequences of irresponsible online purchases are elucidated in a 2015 survey by the market research company GfK, carried out on behalf of the Association of German Banks (BdB)³. Based on this survey, 31% of young Germans have run up debt at least once due to goods and services purchased online, and 8% could not repay the accumulated debt with their own resources.

When starting vocational education or earning regular income from work, several youngsters get even worse off financially, as they have to cover a larger share of their costs of living than they are used to from own resources pocketed in the form of student grants or salaries (Szakács et al., 2016). Many are dizzied by the freedom of getting financially independent and tempted into overspending. The result is generally indebtedness to parents, negative bank account balances and high overdrafts with onerous interests (Lentner, 2013). It is because of these risks that experts advocate the inclusion of consumer and financial education as a compulsory subject in school curricula – an idea welcomed by most youngsters. It is also a priority for the PÉNZ7 event series to help young people learn how to manage their finances more responsibly by teaching them relevant knowledge.

Responsible financial and smart money management means much more than avoiding debt – a truth that Generation Z (people now aged 18–25) must swiftly learn. Despite the fact that this generation is the most risk-averse of all, they have scored lowest in a 2018 study of TIAA Institute on financial education.⁴

Only 46% of respondents from Generation Z felt confident in the area of finance – the lowest rate compared with baby boomers (people aged 58–74), Generation X (people aged 42–57) and Generation Y (people aged 26–41). Generation Z were the first for whom life became unimaginable without smartphones and social media, spending approx. 6.5 hours daily on average on their smart devices. Still, they seem to be the least literate in the areas of comprehending risk and insuring.⁵

3 <https://www.schuldnerberatung.de/ebook-verschuldung-jugendlicher.pdf>, 2019 (in German). The Swiss Federal Statistical Office collected similar results in 2020: <https://www.bfs.admin.ch/bfs/de/home/statistiken/wirtschaftliche-soziale-situation-bevoelkerung/einkommen-verbrauch-vermoege/verschuldung.html> (in German).

4 <https://gflec.org/wp-content/uploads/2018/04/TIAA-Institute-GFLEC-2018-PFinIndex-Press-Release-FINAL.pdf>.

5 <https://www.tiaa.org/public/institute/publication/2018/millennial-financial-literacy-and-fintech-use>.

‘Financial awareness’ should be mentioned at this point, which is a more complex concept than ‘financial literacy’. While financial literacy can generally be obtained by learning, financial awareness also has a bearing on mentality, general approach and behaviour – factors which are undeniably even more important in financial decision-making (*Veresné-Varga, 2018*).

In financial education, the methodological focus is often on giving simple advice and general guidelines, while financial awareness cannot be developed without due attention and time dedicated to the complexity of the subject, i.e. making sure that students are made familiar with and understand its depth and nuances.

Now that finance has gone digital, financial competence is inseparable from the appropriate digital competences. While – as mentioned before – younger age groups are digitally well-versed, they are not necessarily equally well-prepared in the area of finance to ensure and maintain an adequate level of security.

2.1 Digital competences

It is not only reckless spending that poses a threat. In a survey on the increasingly widespread use of digital financial services, *Réka Szobonya*, senior lecturer at the Budapest Business School, found that respondents performed almost 30 percentage points lower in their answers to questions regarding digital competences than on a financial knowledge test (*Szobonya, 2021*), while there was a positive correlation of medium strength between financial knowledge and digital competences. It should be highlighted that respondents’ performance showed substantial variation in the respective sub-areas of digital competences, with the weakest results in digital data security (*Table 1*).

Table 1
Average results achieved concerning digital competences (%)

Area of competence	Male	Female	Jointly	Significance
Communication and collaboration	6.85	6.65	6.80	0.91
Obtaining information	34.90	30.79	32.60	0.25
Device protection	37.94	34.55	36.20	0.25
Digital data security	84.44	84.70	84.50	0.91
Digital competences jointly	41.05	39.19	40.05	0.27

Source: *Szobonya, 2021*

Regional differences in digital competences are also significant (see *Table 2*).

Table 2
Distribution of users based on the number of digital financial services used, by type of settlement and region

	Number of digital financial services used			
	3 or more	2	1	None
Capital	13.8	14.9	36.2	35.1
City with county rank	11.9	16.1	30.1	42.0
Other city	7.8	18.6	27.1	46.5
Village	7.4	12.8	22.8	57.0
Budapest	13.8	14.9	36.2	35.1
Southern Transdanubia	19.5	22.1	19.5	39.0
Central Transdanubia	15.8	18.7	25.2	40.3
Southern Great Plain	0.8	11.6	33.3	54.3
Northern Great Plain	0.0	10.5	25.0	64.5

Source: Szobonya, 2021

3 CYBERCRIME AROUND THE WORLD AND IN HUNGARY

The current level of digital competence as presented above is by no means satisfactory. Especially regarding that an increasing trend has been observed in cybercrime in recent years both worldwide and in Hungary, as already mentioned. Cybercrime includes all kinds of malicious attacks aiming at financial gain or damage by unauthorized access to personal data, disruption of digital transactions, or distortion or alteration of information. Insufficiently stored or protected data are an easy target for cyberattacks. The most shocking observation is, however, that in the case of 9 in 10 cyberattacks, the human factor – lack of caution or negligence by users – is at the source of the damage caused. Based on surveys, almost 75% of the damage derives from the opening of phishing emails, billions of which are circulated around the world every day. Although Internet service providers and corporate servers deploy different methods to contain them, unfortunately, almost 20% of the spam mails slip through security filters, half of which are eventually opened by careless recipients, who may even respond to them.

There are very different actors behind cybercrime, including frustrated employees, industrial spies, malicious hackers, drug dealers, illegal gambling operators, criminal organizations, terrorist groups or states in conflict. The offences are

committed using computers, computer networks or other digital communications channels (e.g., social media platforms). They may target individuals, business groups and even governments.

The number of criminal acts committed online almost tripled around the world between 2017 and 2021, and the amount of damage caused by those acts grew almost fivefold. In 2021 alone, more than 847 000 cases were reported to the competent authorities, with an associated total damage of USD 6.9 billion.

Currently, the Criminal Code of Hungary does not include – and will probably not include for some time to come – a separate chapter on cybercrime. The reason for that is that cybercriminals constantly invent novel and previously non-existent practices to commit offences, which the legislation simply cannot keep pace with. However, the provisions of the Criminal Code on the breach of information systems or data may be mentioned for reference⁶. The stale legal definition it provides has in fact a wide practical application and can also be used by law enforcement bodies for these new criminal practices.

For the same reason, Hungary does not keep separate statistics on cybercrime. Of course, instances of ‘breaches of information systems or data’ are recorded in the crime statistics, but they do not differentiate according to how the crime was actually committed, e.g. if there was an increase in the number of ransomware or denial-of-service cases, since they belong under the same offence. According to data of the Criminal Statistics System (Belügyi Statisztikai Rendszer, BSR) of the Ministry of Interior, in 2018, there were only 200 reported cases of breach of information systems or data. In 2020, the number of cases more than quadrupled to 830, and continued to grow in 2021. There was a spectacular increase also in the prevalence of related criminal offences; in 2018, 1 100 and a few cases of information system fraud were reported to the police, while the corresponding figure was 3 400 in 2020 (Cybercrime, 2022).

3.1 Protection against cybercrime in Hungary

As most Hungarians still consider cybercrime as something different from traditional crime, many believe that it is the responsibility of a dedicated police department. In reality, cybercrimes are treated as any other crime, and come within the competence of police stations, or in more serious cases, of police headquarters. Now every station has at least 1 or 2 colleagues who have a good knowledge of

⁶ Offences defined in Section 423 of Chapter XLIII (Breach of Information System or Data) of the Criminal Code (Act C of 2012).

the field. In addition, due to the specificities of cybercrime, a Cyber Crime Division has been established within the National Bureau of Investigation (Nemzeti Nyomozó Iroda, NNI), currently operating with a staff of over 100. The Division having national competence is a centre of expertise for detecting the most serious cybercrimes, and also provides professional support for police investigations, when necessary, as well as training to police personnel. It is an organizational unit of the police and not to be confused with the National Cyber Security Institute of Hungary (Nemzeti Kibervédelmi Intézet, NKI).

The NKI, operating within the Special Service for National Security (Nemzetbiztonsági Szakszolgálat, NBSZ), is responsible for cybersecurity in general. For example, when a critical infrastructure is attacked, the NKI analyses logs, traces back the source of the attack, provides support for recovery and reports to the police whenever a crime is detected. It is also tasked with the operation of a national contact point which is the domestic coordination body for high-impact cyber incidents within the European Union, receiving incident reports and reporting to international partner organizations (Csaba, 2019).

Increased digitalization goes hand in hand with increased cybersecurity risk, which may be mitigated by reinforcing the protection of retail and corporate digital products and services. For that purpose, the Supervisory Authority of Regulated Activities (Szabályozott Tevékenységek Felügyeleti Hatósága, SzTFH) was established in Hungary based on Regulation (EU) 2019/881 on the European Union Agency for Cybersecurity and on information and communications technology cybersecurity certification to perform the official cybersecurity certification tasks of digital products. The aim of certification is to guarantee compliance of the information and communications tools and services available for purchase and use by citizens and businesses with the continuously evolving standards of cybersecurity.

In an international comparison, Hungary's level of development in terms of legal, technical, organizational measures and cooperation in the area of cybersecurity is moderate based on the 2020 survey of the International Telecommunication Union (ITU), operating within the organization of the UN in Geneva⁷. Hungary ranked 35th among the 63 listed countries, preceded by Slovakia and followed by Israel. 17 EU countries ranked higher on the list than Hungary.

7 ITU: Global Cybersecurity Index 2020.

3.2 The most frequent types of cybercrime

Each year, Europol publishes the Internet Organised Crime Threat Assessment⁸, a 40–60 page report on developments in cybercrime. The report is based primarily on trends instead of hard statistical data as cybercrime is characterized by high latency. It is clear from the report that Hungary is affected in the same way as other European countries, showing that cybercrime is a transnational phenomenon, with no specifically Hungarian traits (*Halmai, 2021*).

However, year over year, the frequency and types of the cybercrimes committed changes. The most common types of cybercrime in the last three years were phishing, non-payment and non-delivery scams, and personal data breaches. Phishing means theft and misuse of the personal or financial data of victims. The data are obtained through messages or websites created specifically for that purpose. In non-payment or non-delivery scams, the scammer does not pay for the goods/services ordered, or in the case of the latter, does not fulfil an already paid order. In personal data breaches, data containing confidential information is obtained fraudulently by installing malware or deception of the victim.

A significant share of cybercrimes remains latent, either because victims are too ashamed to report them, or not even realize that they have fallen victim to cybercrime. For example, in a denial-of-service attack (see below), criminals use botnets consisting of tens of thousands of compromised private computers which provide the resources required for the attack. The average user may only notice that his/her computer has become slower, and it takes longer to load data, but has no idea that a virus is behind all that.

Which are the most common mistakes that expose users to cybercrime? According to law enforcement bodies, well- or even tolerably informed users are not so easy to trick. Most attempts are quite unsophisticated and follow the same pattern. Therefore, they are easy to identify.

Many users are hooked in only because they are heedless. For instance, when a provider is requesting personal data in an email, they comply, despite the fact that they are not clients of that provider and the text of the message reveals that it was not drafted by a native Hungarian speaker. Often, users visit websites or download software which are likely to be infected by viruses, and they reckon with it, yet do not take the risk seriously, and fail to update their operating systems regularly or install antivirus software. These examples indicate that the average

⁸ Europol: Internet Organised Crime Threat Assessment (IOCTA). The most recent publication concerns 2021.

level of risk-awareness of many users is fairly low, considering that no specific IT knowledge is required for using the aforementioned security tools.

The risks of such low awareness have been multiplied by the COVID-19 pandemic, forcing many tenderfoots to the Internet to work from home. These new users were not prepared for the perils of the Internet. Readiness to use the new ‘e’-platforms was not accompanied by thorough knowledge of ‘e’-applications, and inexperienced users were often overconfident. As a consequence, many users do not consider data as a most valuable asset, but simply an accessory to their work, used out of necessity.

It is also commonly observed that while cybercriminals continuously come up with seemingly novel tricks, if we strip away the technicalities, we find that there is nothing new under the sun. After all, the essence of cybercrime, too, is to deceive the targeted person. The cause of cybercrime victimization is predominantly the frailty of the victims. Therefore, the best way to limit cybercrime is to prevent it from happening. This may seem a truism applicable to all kinds of crime, nonetheless it has great practical benefit, particularly in cyberspace. The most effective protection for users is to consciously prepare for defending themselves from potential attacks, by regularly updating and installing antivirus software on their computers and smartphones, and by heeding the advice and recommendations communicated periodically by their bank, Internet service provider or cybersecurity organizations.

To contribute to effective defence, the following part of the paper presents some of the newer techniques used by cybercriminals in recent years and relevant advice on protection against them.

3.3 The most harmful types of cybercrime

3.3.1 Business email compromise

In 2021, scams called ‘business email compromise’ or BEC caused the greatest financial damage, amounting to USD 2.4 billion. In these cases, attackers take control of the email server of a company and use it to send messages to potential victims, urging them to pay a certain amount of money by bank transfer under seemingly convincing pretexts. The email addresses of victims are obtained in more and more cases by hacking social media platforms and mail systems. The sums transferred by unsuspecting victims are converted immediately into a cryptocurrency, making it difficult to trace and recover their money. Honest businesses rarely ask for money from their clients in email campaigns. Therefore, when such a request is received from the email address of a well-known company, it is advised to contact them first to check the authenticity of the request.

3.3.2 Romance scams

Victims of confidence or romance scams have also been cheated out of significant sums. These were the third most lucrative form of cybercrime for perpetrators. In confidence or romance scams, perpetrators approach victims through dating services with feigned romantic intentions, and after establishing a closer relationship with them, ask for personal data or money for various invented reasons. Common sense is the most effective defence against such attempts. Rationally, anyone asking for a larger sum from their new partner instead of asking for a bank loan should not be trusted.

3.3.3 Investment scams

Of the different types of cyberspace fraud, investment scams have become increasingly 'popular'. The number of cases rose sharply in recent years. Scammers entice prospective victims with exceptionally lucrative investment opportunities. In most cases, the offer concerns a cryptocurrency investment with the promise of returns several times above the market average. The sum to be invested should generally be provided in a cryptocurrency as well. Initially, the electronic balance statements confirm generous returns in the investment's growing value, but when the time comes for most investors to realize the accrued profit, the bubble pops, and they find themselves waiting in line at liquidators to recover the invested sum and the promised returns – with little hope. Common sense is again the only effective defence against these scams. One must ponder if it is possible to generate returns above the market in the long term in an honest way. And even if it was possible, why would anyone share this knowledge instead of exploiting it entirely for their own benefit?

3.3.4 Ransomware

Ransomware attacks are free of all pretence. A malicious software is used which instantly blocks or encrypts the data stored on the targeted devices or in entire IT systems. Viruses of this type generally land from pornographic or gambling websites on the computers of victims. It also has a reason: perpetrators assume that few of the wronged users will admit to their families or the police that they had visited websites of this kind. The aim of attackers is again to get money by demanding ransom from the owner for returning the stolen information. Recently, the ransom paid each year by victims had amounted to hundreds of millions of US dollars. Ransomware attacks may be fended off by avoiding visits to, and more importantly downloads from, unknown and obscure sites. Files already downloaded should not be installed in any case. Backing up our IT systems and files regularly is also crucially important. This enables fast recovery and minimum

loss of data when the computer system must be reinstalled due to a ransomware attack or crash of the operating system.

3.3.5 Denial of service

Denial-of-service (DoS) attacks are performed by flooding a computer or a network with superfluous information in order to prevent it from fulfilling users' requests. Distributed denial-of-service (DDoS) attacks are basically the same, but the attack comes directly from a network of computers. The technique is employed by some attackers to launch other attacks during the time the network is overloaded. Botnets, or zombie networks as they are called sometimes, target and overload the target's processing resources. Botnets are at different geographical locations and are therefore difficult to track down. Possibilities to prevent these attacks are limited. The smartest thing to do when the network gets suspiciously slow is to disconnect our computer to minimize the risk of viruses sneaking in.

3.3.6 Man-in-the-middle attacks

Man-in-the-middle (MITM) attacks involve hackers intercepting communications between two parties to steal confidential information. MITM attacks are the most frequent when an unsecure Wi-Fi network is used. Attackers insert themselves into the 'middle' of the conversation between the guest user's device and the public Wi-Fi modem, and hijack confidential information or install phishing software onto the guest's device using malicious codes. The most effective protection against such attacks is obviously to avoid communicating sensitive data through public Wi-Fi networks, e.g., connecting to our e-bank or making payments.

3.3.7 Phishing

Phishing attacks deploy misleading communications, e.g., emails, to trick the receiver into opening the message and following its instructions, such as providing their credit card's PIN and/or CVV. Their purpose is to steal sensitive information, e.g., credit card data or online banking credentials, or to install malicious software on victims' computers. They may be tackled by treating these messages with suspicion and refraining from fulfilling the requests included in them, recalling that banks never ask for sensitive personal data in email (Pásztor, 2018).

3.3.8 Password attacks

Attackers may get access to an array of confidential information by obtaining passwords. A strategy used in cyberattacks targeting passwords is trust-based manipulation, drawing heavily on human interactions and usually involving deception of people into breaking standard security rules. Other types of password attacks include gaining access to password databases and brute-force attacks. For the latter, hackers use the method of ‘credentials stuffing’, i.e. inserting user credentials from hacked databases on a series of other platforms. This may harm especially users who use the same password for several different websites, as it provides perpetrators access to multiple accounts. The best protection is to secure connections involving sensitive data transfers with a different password and to avoid using passwords derived from our name, date and place of birth or address.

3.3.9 Spoofing

Cyberattacks of this type are accomplished by creating a replica of the website of the victim’s financial service provider, i.e., a site that closely resembles the original in both appearance and functionality. Victims are manipulated in an email into visiting the ‘spoofed’ website and entering their credentials unawares. Attacks of this kind may be circumvented by closely scrutinizing the URL of the website.

4 CLOSING COMMENTS

In the foregoing, some potential threats in cyberspace have been presented. Targeted training and good practices are the most effective defence against these threats. For the 9th Péncz7, a lecture titled ‘Financial security in cyberspace’ was prepared on commission of the Hungarian Banking Association and made available on the website www.penz7.hu. The lecture formed part of the content of classes held in public schools during the thematic week of 6–10 March 2023. Exciting financial quizzes and content from popular competitions are also available for download from the website.

The class material referred to above was prepared for the financial week in cooperation with the National Cyber Security Institute and the National Bureau of Investigation. Their experts contributed real-life examples and practical advice to the material.

The class is started off with an exciting website (<https://threatmap.checkpoint.com>), showing cyberattacks in progress around the world at the time of opening the website in real-time. It displays the source, target and scale of each ongoing attack. It is a dynamic map revealing in a spectacular manner that millions of

cyberattacks happen in a single day. Attacks are carried out non-stop in different parts of the world, and target governments, companies and individuals alike. The website also shows the main types of malware used in the attacks. The dynamic image helps everybody realize that they may as well be victims if they fail to protect themselves. Although Hungary can be considered safe in some respects (e.g. the number of debit card fraud cases is one of the lowest in Europe), we may get in danger any time, for example, when surfing on foreign websites.

The shocking visit to this website is followed by practical advice on how to navigate safely in cyberspace. Topics discussed in this part of the class include: how to reduce the risks of online payment, what is the most important financial data to protect, where and how to store our data, available/recommended online payment methods, available secure payment solutions, and the ever recurring topic of how to generate a good password/PIN code.

The final part of the class begins with an overview of the most recent types of fraud attempts. Then information on ransomware and recommendations for prevention and protection are provided. At the end of this part and the whole lesson, students are made familiar with types of fraud where (naturally scam) investments with incredibly high returns or prizes are offered. This paper is complementary to the class material.

It serves the same purpose, i.e., to provide – building on the previously prepared class material – a useful aid to raising financial awareness and adequately managing the risks of modern financial services in cyberspace.

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THE POTENTIAL OF ARTIFICIAL INTELLIGENCE IN FINANCE

Péter Bagó¹

ABSTRACT

The world of finance is changing, with digitisation entering all areas of our lives, including finance. It is called fintech, or financial technology, which is now at the stage where we can start talking about the financial applications of artificial intelligence. Financial digitisation is wide-ranging, from core processes, through back- and front-office applications, all the way to the customer. We channel a lot of data into bigdata. The amount of data stored here on a daily basis can no longer be manually processed. This is where solutions such as automation, machine learning and ultimately artificial intelligence come in. In this paper, I will introduce the concept of fintech and its relation to the financial applications of artificial intelligence.

JEL codes: G00, O33, Q55,

Keywords: fintech, automation, digitisation, artificial intelligence, finfluencer

1 THE EVOLUTION OF THE FINTECH PHENOMENON

The development of Fintech can basically be divided into 3 stages. The beginning of Fintech 1.0 dates back to the summer of 1866, when the first telegraph cable was laid across the Atlantic Ocean - In fact, it was the start of the first era of financial globalisation, and it was an invention that enabled the transmission of information not only regionally but also intercontinentally (*Arner et al., 2015*). An important part of this era was the spread of the use of the telex machine (*Ashta-Biot-Paquerot, 2018*). In 1933, Germany introduced the use of teleprinters. By the end of the Second World War, they had grown into a network that covered most of Europe and, by 1957, was present in 39 countries. The next major event of the Fintech 1.0 era was the launch of the first general-purpose credit card in 1950,

¹ Péter Bagó, Assistant Professor, Head of Department, Corvinus University of Budapest, Institute of Entrepreneurship and Innovation, Department of Innovation and Business Incubation. E-mail: peter.bago@uni-corvinus.hu.

which was co-founded by Diners Club co-founders *Frank McNamara* and *Ralph Schneider* (Diners Club International, 2022).

A breakthrough innovation marked the beginning of the second era of Fintech (Ashta–Biot–Paquerot, 2018). The idea was based on a feature of the post-war world: the widespread use of cheques. This meant greater convenience than conducting cash transactions, carrying and counting change. On the other hand, banks had to do a lot of costly accounting work, and the reason for this was economic development, as, of course, rising wages made it more expensive for them to employ more staff. Higher wages increased the demand for leisure activities at the expense of weekend work. In addition, customers continued requesting cash on Saturdays and even on Sundays. Taking these factors into account, they tried to create a system that reduced accounting costs, but, at the same time, allowed them to provide a higher level of banking services. The solution to these problems was the introduction of ATM in 1967. In the beginning, customers could withdraw money against a voucher on any day for 6 months, but this system required manual bookkeeping. The scope of banking functions was reorganised and the work of the retail branches was taken over by central offices. With this move, banks wanted to reduce costs, but the implementation was not as successful as expected.

The next initiative that defined Fintech 2.0 was the implementation of SWIFT (Society for Worldwide Interbank Financial Telecommunication) in 1973 (Ashta–Biot–Paquerot, 2018). As with most of the solutions already mentioned or to be mentioned below, its development was initiated in the hope of working more efficiently and providing a higher level of service. In the 1960s, a number of major US and European banks invested in private networks and various computer equipment to enable cross-border banking. In these international transactions, effective communication between them played an important role, but free text messages often contained minor or major errors, which unfortunately hindered the process. The solution was the standardisation of internal banking procedures. In 1973, on the initiative of the European banks, SWIFT was set up in Brussels as an international financial organisation (initially with 239 banks from 15 countries). It is now an essential part of international transactions. More than 11,000 financial institutions in 200 countries are members of this infrastructure.

Other notable examples from the Fintech 2.0 era include the first commercially available mobile phone in 1983, and the launch of so-called “program trading” in 1987, which acted as a catalyst for the algorithmic trading of securities (Arner et al., 2015; *Mitchell*, 2021). In addition, the emergence of community finance in the 2000s, as mentioned earlier, also had a significant impact on the development of financial technologies (Ashta–Biot–Paquerot, 2018). The spread of the internet played the greatest role in the financial market (*Lee–Shin*, 2018).

The beginning of the economic crisis in 2008 marked the end of the previous era and the beginning of the current one (*Bussmann, 2017*). Banks have been busy dealing with the crisis and complying with the various regulatory requirements following the recession, which has given green light to small start-ups and various innovative solutions.

The launch of Bitcoin in 2009, followed by the emergence of other cryptocurrencies, fundamentally changed people's concept of money, and has been one of the most significant milestones of Fintech 3.0 (so far). In the early 2010s, smartphones appeared the market en masse, giving virtually anyone, anywhere, anytime access to the internet. This phenomenon led almost immediately to the widespread adoption of mobile payment solutions (*Johannes, 2022*).

The start of Fintech 3.5 also goes back to 2008, with the difference that it refers to the financial technology of the developing world (*Arner et al., 2015*). These areas have not been able to develop a high level of banking infrastructure (e.g. Bangladesh), partly due to the fact that the money spent on IT-related improvements is significantly below European and North American levels, and most data protection rules are also less strict (*Energycatalyst, 2020; Arner et al., 2015*). Another obstacle is that financial awareness is below Western standards, wages are lower, and cash transactions predominate over card payments, as, unfortunately, many people do not have access to financial services (e.g. opening a bank account) which are considered to be basic in Europe (*Energycatalyst, 2020*). In these underdeveloped countries, the banking system is state-supervised, but trust in it is very low, partly due to its failure and partly due to numerous corruption scandals (*Arner et al., 2015*). Because of this, the masses are open to different Fintech solutions provided by non-banks, giving them a chance to further develop and catch up with Western financial systems.

1.1 Impact of Fintech innovations on traditional finance

Payments are one of the most commonly used and least regulated financial services (*Lee-Shin, 2018*). There is a strong focus on this topic, it is developing very dynamically and there is a lot of room for innovation in the sector. It concentrates on two main areas, one for retail payments and the other for retail and corporate payments. I intend to highlight several solutions in the area of retail payments. One of them is the mobile wallet. A great example is Barion, a Hungarian company, but of course we could mention Google Wallet or Apple Pay when it comes to Fintech services from the Big4 companies. P2P mobile payments, represented by PayPal, (bypassing the big credit card issuers) also play a prominent role in the field. It is also important to mention the QR code-based mobile payment system,

real-time payment solutions and international transfers in various foreign currencies, for the latter of which Wise offers favourable options. Mobile payments offer significant benefits for both the provider and the user (Lee-Shin, 2018). Fintech companies in this field offer customers a modern, fast and convenient payment experience, while mobile payments allow companies to collect more and more useful data about users, which can later be used as a basis for innovation (Bussmann, 2017; Pintér, 2022).

The next important area to mention is crowdfunding. As its name implies, it focuses on making people helping start-ups, providing financial support for a potential breakthrough or revolutionary idea (Lee-Shin, 2018). The system consists of three participants: the entrepreneur, who initiates the fundraising; the contributors; and the so-called moderating organisation, which acts as an intermediary between the funder and the funded, and whose websites provide information on the different projects that can be funded and the type of support available. There are 3 main types of community funding, the first of which is the reward-based method. This type of support can be a good choice for start-ups and start-up entrepreneurs aiming to develop an innovative product or service. The idea is to deliver the result expected by the „investors” within a predetermined timeframe, however, the contributors are not refunded the money they offered, but rather the promised product instead (European Commission, 2022a). Popular companies in the field include Kickstarter and Crowdfunder. Donation-based funding has the same basis as the previous form of crowdfunding, except that those who help the entrepreneur do not receive a monetary reward for their support (Lee-Shin, 2018). One of the best-known organisations in this area is considered to be GoFundMe. The main idea of equity-based financing is that firms sell a share to an external party in exchange for investment, which may be a popular choice in the SME sector (Lee & Shin, 2018). This form of aid usually involves a significantly larger contribution than the previous two, and therefore the risk is naturally higher. Therefore, it is essential that a convincing business plan is in place, that the conditions for return are made clear in advance, and that the entrepreneur is aware of the rights of shareholders and other aspects (European Commission, 2022b). Several companies, such as Crowdcube or AngelList, are involved in equity-based financing. The role of Fintech in the capital market does not end with crowdfunding. A number of companies (e.g. Robinhood) offer investors the opportunity to trade different stocks and commodities and monitor potential risks in real time (Lee-Shin, 2018).

P2P lending is also an important, core area of the Fintech sector. Organisations in this sector, such as Funding Circle, allow individuals and companies to lend and borrow money to each other easily and efficiently at low interest rates (Lee-Shin, 2018). However, unlike banks, these companies are not involved in the process,

but help the lender and the borrower to find each other and charge them a fee for using the service. Credit risk assessment is not based on the usual process applied by banks either (e.g. they also use the data accumulated on social media for this purpose) (Bussmann, 2017; Deutsch–Pintér, 2018). These Fintech companies represent strong competition for banks and credit institutions, as they are not yet subject to capital requirements regulations, and thus the total amount of lending is not limited, which gives them a significant competitive advantage in this area (Lee–Shin, 2018).

One of the most frequently mentioned areas in the world of Fintech, the concept of blockchain was coined by *Satoshi Nakamoto* in 2008 (Bussmann, 2017). Initially this technology was used as the public ledger for the first cryptocurrency, Bitcoin, but nowadays it is applied in many areas (e.g. smart contracts). The original aim of the project was to create a P2P system that would allow transactions to take place between two parties, bypassing traditional banking institutions. The aforementioned parties do not know each other, they do not have the trust to trade, therefore one of the most important goals when creating the blockchain database was to eliminate this problem. In order to do this, they have developed a technology that allows all parties to see the accounting lines on the blockchain, so that if there is a change, everyone is informed, thus preventing fraud.

One of the most popular Fintech sectors is robo-advice (Lee–Shin, 2018). Robo-advice covers computer algorithms that can provide investors and traders with instant information about news affecting the capital markets, including social media trends, to help them make decisions (Bussmann, 2017). On the FutureAdvisor platform, for example, due to this technology, the desired asset allocation can be developed (e.g. taking into account risk appetite), which the robot keeps in balance in spite of constant market changes (Bussmann, 2017).

The insurance sector has also been influenced by Fintech, as in many of the areas already mentioned, the business model of this industry is based on direct contact between the parties, in this case the insurer and the customer, and flexible, modern service delivery (Lee–Shin, 2018; Pintér, 2008) Personalised premiums for health, accident or even life insurance. In the case of vehicles, a great example is pay-as-you-drive insurance, which requires the usage data of the vehicle and analyses them to calculate the premium to be paid (*Puschmann*, 2017). Major participants in this area include e.g. Clearcover and Next Insurance.

The AFR, Instant Payment System, was implemented in Hungary based on TIPS (TARGET Instant Payment Settlement), and launched on 2 March 2020 with the participation of GIRO Zrt., the National Bank of Hungary and 35 commercial banks (all domestic banks were required to participate in the AFR (the National Bank of Hungary, 2022c; Takarékbank, 2022). The in course of the establishment of the AFR, SEPA was considered to be an example, precisely to ensure that the

changeover would not cause major problems if the euro were to be introduced in Hungary, as well (EPC, 2020). The TARGET Instant Payment Settlement, also known as TIPS, is also an important part of the Fintech world (the National Bank of Hungary, 2022a). Its basis, TARGET2, was created to support the European Central Bank's monetary policy and unity. TARGET2 is a decentralised payment system that allows central and commercial banks to conduct euro-based payment transactions. The TIPS was launched on 30 November 2018, courtesy of the Eurosystem, taking into account the ISO 20022 standards and the common set of rules of the SCT Inst (SEPA Instant Credit Transfer - a pan-European instant payment system) (Bayle, 2018). This is a market infrastructure service, established as an extension of TARGET2, which allows PSP customers to make transfers 24/7 and have the money in the receiving party's account within seconds, in order to preserve the unity of the European payments market. TIPS aims, among other things, to process transactions within a maximum of 10 seconds and to ensure security and continuity (ECB, 2022). Payment service providers can make these instant payments through an account opened for this purpose at their central bank. One can join TIPS as a participant, as a reachable party or as an instructing party (Bayle, 2018). Participants have x number of accounts in TIPS, and reachable parties are eligible for settlement with these x number of participant accounts, however, they do not have such accounts themselves. Through the so-called instructing parties (e.g. clearing houses) transfers between credit institutions can be carried out. In Hungary, the Interbank Clearing System operated by GIRO Zrt. can be considered the instructing party (National Bank of Hungary, 2022b). At present, the system supports only domestic transfers, such as regular or value date transfers, and it is also possible to send and receive payment applications in several financial institutions, also domestically (Vrazsovits, 2022a; 2022b). The relevant requirements are that no date of settlement shall be specified and that the amount of the payment shall not exceed the ceiling of HUF 10 million (EPC, 2020). Under the rules, the amount transferred is irrevocably credited to the beneficiary's account within 5 seconds, and the payer receives a message if the transaction is rejected. If the money does not arrive in the desired account within 5 seconds, 20 minutes are available to carry out a successful transaction (Vrazsovits, 2022a). In addition to their account number, account holders can also assign a secondary identifier to their account, such as their phone number or email address (EPC, 2020). The National Bank of Hungary has recently published the planned elements of the AFR development concept, as reported by *Lajos Bartha*, the National Bank of Hungary's Managing Director for Financial Infrastructures and Banking Operations, and I would like to highlight some of them (Turzó, 2022). All banks will be obliged to accept payment applications, as well as to read QR codes. The codes will be based on a centrally authenticated standard, which will be a major

step forward in security. Following the standardisation of the QR code, the focus will be on NFC (Near Field Communication standard collection) as well as on AFR via deeplink. The upper limit for transactions will be set at HUF 30 million instead of HUF 10 million, and a message will be required after each transfer to confirm its success.

2 ARTIFICIAL INTELLIGENCE IN FINANCE

Before discussing Artificial Intelligence (AI) in finances, it is very important to deal with the idea that financial systems need to be prepared for the high number of financial transactions in today's world. It's worth looking at the figures in the National Bank of Hungary payment statistics:

Table 1
Transactions conducted with payment cards issued in Hungary

Reference period	Number of purchases (pieces)
2021 4th quarter	328,411,165
2022 1st quarter	315,618,368
2022 2nd quarter	363,781,784
2022 3rd quarter	382,500,784
In total:	1,390,312,101

Source: National Bank of Hungary, 2023

Based on the table above, if we examine 1 year, there were 1.4 billion purchases in Hungary in the aforementioned period, which is 44 transactions per second. It is impossible to process this amount of data manually, and it is important that information processing, and ultimately IT, has developed to such extent in recent decades that it is no longer solely processing, but it also means a high level of automation. However, we must go a step further and start thinking about how machines can learn and develop basic structures of thought.

Before detailing the train of thought above, it is important to understand the term BigData, which includes all the systems that manage, store, create or categorise a huge amount of everyday data in a structured or unstructured form. Regarding data, we can talk strictly about data generated electronically, however, in connection with the topic, we must consider all things which have informational value. In view of the above, we also have to take information exchange between people into account, which is not too efficient unless we do this activity in a written and/

or digitalised form. According to the principles described by *Belényesi*: “Big Data is a large amount of unstructured data, the appearance of which is result of accelerated technical development of recent years” (*Belényesi*, 2016). Consequently, when we talk about Big Data, we refer to a set of data that is a raw source of information and almost impossible to grasp and analyse with the naked eye and hand, or to extract from it any information that could support really important decisions. At the same time, we have to admit that, when discussing the potential of this tool, we should also take into account systems and technological innovations which can appropriately organise and sort such data, and finally present them in a clear, structured and visualised form (*Belényesi*, 2016). A prerequisite for the use of Big Data is that raw data are already stored in an organised form, with appropriate metadata tags and features. In the case of most complex systems, preliminary work is done by pre-written mathematical algorithms. In terms of program design and solution implementation, it is important to note that, in the initial phase, software based on possibilities provided by smart algorithm and artificial intelligence may be very similar, however, these types of software cannot be compared. An algorithm that does not use artificial intelligence is written and developed by specialists by means of standardised and proven methods. At the same time, when writing artificial intelligence, the software is created with the so-called deep learning method through simulations and experiments. Later, this software can perform its task on its own, with a minimum error rate. In general, people cannot comprehend the structure and content of such codes (*Hsinchun et al.*, 2012). When creating the algorithm, it is possible to use ready-made artificial intelligence (e.g. tests, simulations), but the final product will not reflect the complexity of a software based on serious artificial intelligence. Despite all this, AI and smart algorithms are often given similar recognition and rank in common language, therefore it is difficult to separate the two when discussing these tools. By processing and organising unstructured data, the use of data will be significantly easier. Such Big Data algorithms can organise data and store them in various data warehouses in a uniform format, from where different users can process them with further programmes according to their needs. The information content and readability of the data extracted from data warehouses have not yet reached their full potential, but with the help of experts, software, algorithms and AI, such data can be easily and quickly assembled into a visualised whole that anyone can interpret. These data are presented to decision-makers in the form of various diagrams and tables. After processing the information, they are able to make decisions (*Yoshua-Yann*, 2007). The structured data available may play a significant role in the operation of companies, such as in optimising corporate operations, developing different stages of the process of sales or taking decisions on planning corporate strategy. Nowadays, the most important thing for organi-

sations dealing with products and services is to retain their customers and consumers. In order to achieve this goal, they need accurate data about users and customers. There are already a lot of methods implemented in everyday products for measuring consumer behaviour related to the products. A significant part of the amount of data generated in countless daily transactions consists of protection protocols and translation packages built around transaction data. In spite of the fact that the issues of data security and personal data are discussed in several places, I will not detail them in this publication, however, I cannot ignore them, either in connection with Big Data, or AI (*Halaska, 2016*). Based on the above, it is clear that structured data provide great help to the professional users of a well-built system.

In order to understand the advantages of artificial intelligence, it is important to describe the features and potentials which distinguish artificial intelligence from the operation of an algorithm rich in possibilities. We should map out when a program can be called artificial intelligence, and what the differences are between the scientific statement and the meaning of the term in common parlance, which can lead to misunderstandings. In order to qualify as AI from a professional point of view, such type of software should be examined in several aspects.

To sum up, artificial intelligence is modernising the whole financial industry by rationalising traditional manual banking processes and providing deeper insight based on generated data, which helps to determine the manner and place of investments. Artificial intelligence also changes customer experience by creating faster contactless interactions, which include real-time credit approval, as well as better fraud protection and cyber security. Regarding cyber security, it is worth studying the details of Act LIII of 2017 on the Prevention and Combating Money-Laundering and Terrorist Financing, the short summary of which is as follows:

- detecting money laundering anomalies,
- stored historical data,
- searching anomalies based on pre-determined parameters,
- filtering out and checking suspicious transactions, taking actions,
- subsequently, not in real time.

Artificial intelligence has a major influence on the way financial organisations manage risk, which includes security, regulatory compliance, anti-fraud, anti-money laundering (AML) and know-your-customer (KYC) policies. Due to the fact that artificial intelligence is part of their infrastructure, banks, investment companies and insurance companies can carry out real-time calculations to predict performance, detect anomalies in spending behaviour or maintain compliance. In addition, they can use artificial intelligence in several other ways.

AI allows financial institutions to accelerate and automate historically manual and time-consuming tasks, such as market research. Artificial intelligence is able to analyse a large amount of data fast in order to identify trends and help the prediction of future performance, enabling for the banks, inter alia, the exploration of lending growth potential and the assessment of risks. The assessment can also be applied to insurance, where personal data can be collected and used to determine insurance coverage and premiums. Artificial intelligence can also be used for cyber security purposes, especially for the identification of fraudulent transactions. By closely observing purchase behaviour and comparing it with past data, AI can indicate abnormal activity, automatically alert both the institution and the client to check the purchase or transfer in real time and take action to resolve the problem if necessary.

For bank customers, AI and ML (Machine Learning) can improve the overall customer experience. The rise of online banking (i.e. contactless banking) minimises the need for face-to-face interactions, but the transition to the virtual can result in vulnerability at several endpoints (e.g. smartphones, desktops and mobile devices). Artificial intelligence can automate many basic banking activities, e.g. payments, deposits, transfers and customer service requests. Artificial intelligence can also handle the application process for credit cards and loans, including approval and rejection, providing almost instant replies.

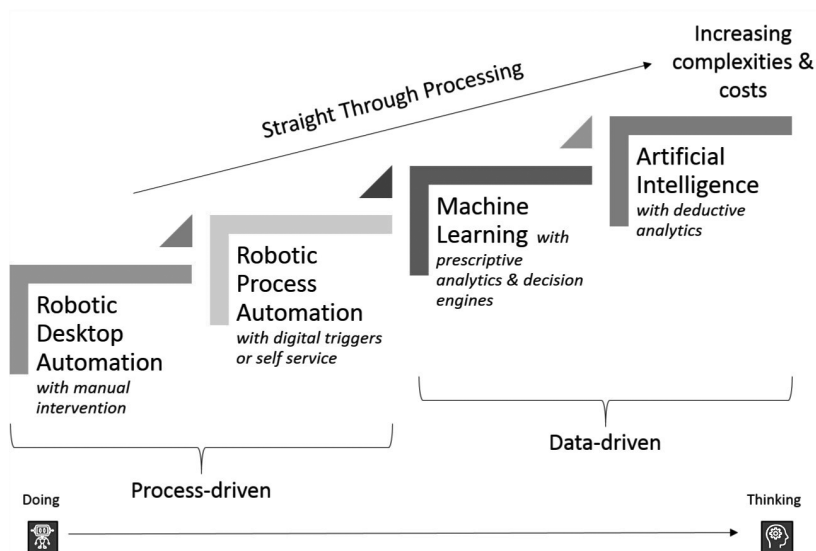
However, most institutions believe that AI and ML can improve the course of business and give them a competitive edge. According to a survey by Forrester, 98% of AI projects - 80%-85% of ML projects do not start due to various logistical and management problems or „last mile” problems, which suggests that institutions should involve IT and AI network professionals to complete AI projects. In addition to logistics, financial organizations also face a high number of security and compliance regulations as they use sensitive and personal data every day. Any AI solution should be able to protect such data and comply with the industry- and region-specific guidelines - as finances are of global significance and cover the majority of companies. The sheer volume of data itself represents a complex challenge. In order to enable any AI solution to work effectively, institutions need to keep all data in arranged pipelines and silos, allowing ML to accurately predict and forecast markets according to specific business objectives.

The following question must be raised: Is machine learning the key to efficient financial operations? Machine learning applications can be used for everything from risk assessment to asset management. By using data, they can gain critical insight and streamline various processes while optimizing results. Applying machine learning in financial applications is a developing practice which is being used in a variety of ways across the industry. The diverse applications of machine learning in finance have also opened up a lot of new finance jobs related to ma-

chine learning. However, this practice helps to understand machine learning in finance and how it can be used in career building. Machine learning belongs to the concept of artificial intelligence. It designs and develops algorithms which can learn from data and make predictions based on such data. Machine learning models provide the technology for the automation of cognitive tasks. Machine learning technology is used in various financial tasks, including credit scoring, tracking and recommendation of investments, fraud detection and algorithmic trading. Machine learning can help financial companies make better decisions on pricing, risk and customer behaviour. Technology can build models which improve the understanding of large data sets and reveal patterns that facilitate the design of new business systems and processes. When working in the financial field, rationalization and automation of various processes with machine learning has several advantages. Financial companies can use these technologies to automate tasks such as paperwork, calculations, data monitoring, and claims processing. As a result, employees can focus on more value-creating activities (Pintér, 2004).

Customer engagement is another critical area where machine learning and AI can be used. IoT (Internet of Things) devices can generate a significant amount of data which can be useful for understanding customer behaviour and preferences. Later, such data can be used to create personalised marketing campaigns or improve customer service. On the whole, better customer service and a better customer experience typically result in more sales and higher customer satisfaction rates. Consequently, it is definitely not worth mixing the concepts artificial intelligence (AI), machine learning (ML) and automation.

Figure 1
From process control to data control



Source: Forbes, 2022

RPA (robotic process automation) refers to the use of preconfigured software that uses business rules and predefined activity choreography to autonomously execute a combination of processes, activities, transactions, and tasks in one or more independent software systems in order to achieve results or provide services with human exception handling.

AI² is a combination of cognitive automation, machine learning (ML)³, reasoning, hypothesis generation and analysis, natural language processing and deliberate algorithm mutation that provides insights and analysis at the level of or above human capabilities.

To put it simply, RPA can be considered as a software robot that imitates human activities, while AI deals with the simulation of human intelligence by machines.

² An example for AI applications: <https://builtin.com/artificial-intelligence/ai-finance-banking-applications-companies>.

³ An example for ML applications: <https://www.projectpro.io/article/projects-on-machine-learning-applications-in-finance/510>.

At the most basic level, RPA is about „doing”, while AI and ML are about „thinking” and „learning”, or, if you like the simile: muscle versus brain.

For example, suppliers send electronic invoices by email, they are downloaded into a folder, the relevant information is sorted out, and, finally, the invoices are created in the accounting software. In this scenario, RPA is suitable for automating the querying of emails (for the sake of simplicity, the query is based on the subject of the email), for downloading of attachments (i.e. invoices) to a specific folder and the creation of invoices in the accounting software (mainly copy and paste operations). On the other hand, artificial intelligence is required to intelligently „read” invoices and gain relevant information such as invoice number, supplier’s name, the due date of the invoice, product description, amounts due and more. Invoices consist of essentially unstructured or, at best, semi-structured data. For example, different suppliers have different invoice templates and formats. Different invoices may contain items with different serial numbers. As every activity in RPA has to be specifically programmed or scripted, it is virtually impossible to teach the robot exactly from where to extract the relevant information for each received invoice. This is why there is a need for AI to intelligently decipher the invoice as a human being would. It is certain that invoice processing can be managed exclusively by means of RPA. In this case, we will deploy what we generally call present automation.

Robotic Desktop Automation (RDA) is like a virtual assistant that works hand-in-hand with human employees. Returning to our example, after the invoices are downloaded, they are passed through a kind of optical character recognition (OCR) software that tries to extract the required information. Later, a human employee validates this information before returning the job to the RPA robot so that it can create the invoices in the system. Based on the above, the main advantage of using an RPA and an AI solution is that direct processing (with minimal human intervention) can be achieved. The disadvantages are the increased costs and the complexity of the project.

RPA is strongly process-oriented - it is about the automation of repetitive, rule-based processes, which typically require cooperation with several different IT systems. Process discovery workshops are usually a prerequisite for the introduction of RPA, the purpose of which is to map and document the existing „current” processes in the process definition document (PDD). In the case of our invoice processing example, we intend to find enough sample invoices to train the ML algorithms, ensure that our samples are of good quality (especially if the invoices are scanned), and that the invoices are representative of the dataset. After that, the task is to select the right ML algorithm and then train it properly so that it can recognize other new accounts faster and more accurately than a human. Ultimately, RPA and AI are nothing but valuable tools to help the digital transforma-

tion of your organization. Whether you introduce RPA or AI (or both) depends on the specific purpose for which you wish to use it, and ensuring “fitness for the purpose” is paramount. In the case of RPA, many organizations mention reasons such as grabbing the „low-hanging fruit”, rapid implementation and time-to-market (typically within weeks or months), low cost and complexity, and other reasons. Many smartly opt for RPA and use it as the first rung on the digital ladder to intelligent automation.

3 SUMMARY

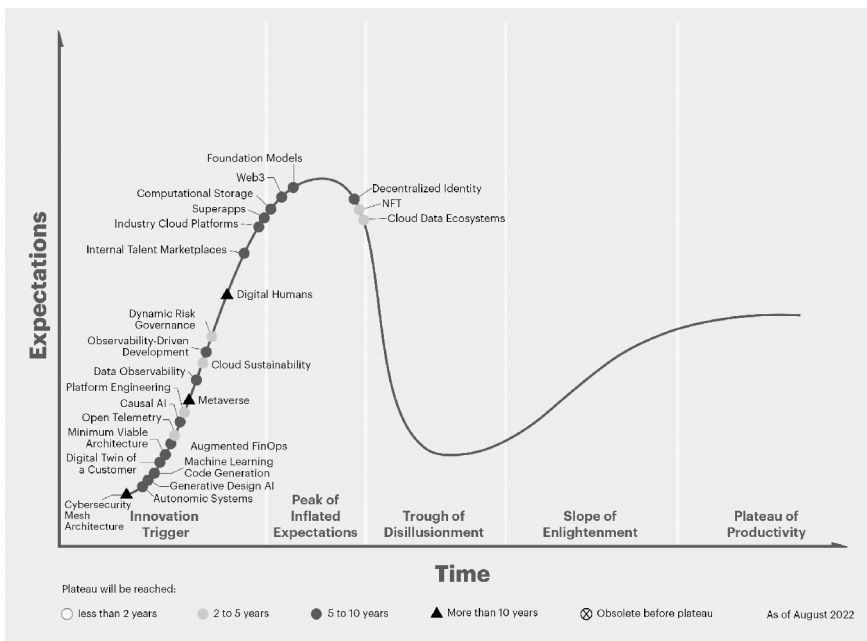
Financial technologies, fintech, financial technology define our current financial world. Fintech advanced through three periods which brought us the era of artificial intelligence, where computers trade with each other and customer interactions are not carried out manually either. The development of fintech was simultaneous with the development of IT. The fintech 1.0 era was brought about by the telegraph, while the start current 3.5 era was marked by technologies such as mobile telephony, big data, internet. Even the increase in computing performance contributed to this development. Therefore, we can safely say that the development of fintech is moving hand in hand with the development of IT. It could also be called evolutionary IT, because we can trace the steps back to the first computer. At the same time, the „mutations” have consciously pushed the development forward and added something to the financial world almost every day. . Here let us think about the development from the first internet bank to the appearance of the of the mobile bank and the related technologies. The digitization of financial solutions is due to evolutionary information technology, and it can be deduced with simple logic that as soon as mobile phones became suitable for mobile banking, mobile banks appeared immediately. But the same can be claimed about internet banking. Internet protocols themselves or their encryption occurred when the technology became capable of carrying out such activities. It would be worth writing a separate study on how old the Internet with IPV4 technology is and how the current applications were built on this old technology, and what security problems this entails to this day.

Financial technologies have measured up to the current level of IT. The first step was digitisation, then RDA, which is robotic desktop automation. Actually, this was when they realized after digitisation that not everything could be manually processed. Then came RPA, robotic process automation, which refers to the use of pre-configured software that applies business rules and predefined activity choreography to autonomously execute a combination of processes, activities, transac-

tions and tasks in one or more independent software systems to deliver a result or service through human exception handling.

It is worth looking at Gartner's hype cycle diagram to see what new technologies will define our future. This is also important because technologies such as NFT (non-fungible token) or the cloud-data ecosystem are already in decline. Of course, one can disagree with this view, but Gartner has been dealing with the „hype cycle” methodology for a fairly long time, therefore we believe that artificial intelligence technologies in the diagram below are really on the rise:

Figure 2
Gartner hype-cycle, 2022



Source: Gartner, 2022

Future trends include terms such as casual AI, which is a branch of artificial intelligence that most closely resembles human choices and decisions. However, terms like sustainable cloud or open telemetry can also be mentioned. Decentralised identity sounds a bit different in Hungarian. At this point, we can rather talk about the usability of separate data, i.e. healthcare, taxation, education and transportation data are all listed separately, but are accessible from a central system. This decentralised identity is really about bigdata, which mostly contains an individual's personal data. It is declining because it is merely a simple data connec-

tion, while AI can do much more than that. Artificial intelligence does not only look for patterns, it can do much more than that. AI reveals connections that we are no longer able to detect manually. The most important aim is that the background data, databases and structured resources are all available and operate stably and reliably. In the case of financial data, it is impossible not to store the data correctly. There is no way to tell the customer that their payment or investment is roughly available. If the basic infrastructure works reliably, then machine learning or artificial intelligence can follow. In the case of financial products, I would definitely emphasize legal regulations, so that they provide adequate information to the operators of the financial sector. This question is also about trust, because around the 2008 crisis, trust in classic financial institutions wavered, which was where fintech solutions started. They were based on fundamental trust, which was required for continued building. After 14 years, complete solutions have already been created. It is worth mentioning Revolut or Wise. Digitisation, evolutionary informatics are what brought about this era, but the way forward is questionable, especially its direction. One of the possible scenarios for development involves artificial intelligence, machine learning and the highest level of automation of those tasks which cannot be done manually anymore.

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ROLE OF TECHNOLOGY IN INNOVATIVE FINANCIAL SERVICES AS REFLECTED IN THE BREAKTHROUGH OF BIGTECH COMPANIES

Éva Pintér – Balázs Herczeg¹

ABSTRACT

Fast digitisation can be observed in everyday life including financial services. The analytical tools of Big Data, such as artificial intelligence and machine learning are able to promote user awareness in terms of the characteristic features of financial products and can offer personally tailored information on how to utilise their financial products and the management of their financial sources. Financial service providers proactively apply artificial intelligence and machine learning in customer support (for instance, virtual assistants are added to telephone customer service). In addition, the appearance of BigTech companies triggers further turbulent development and service innovation in the financial services industry.

Non-bank competitors appearing in the field of financial services and the proliferation of digital innovation and new technologies are a constant challenge and risk to banks' everyday operations and clientele as they must face risks and fight competitor pressure while the regulatory environment places strict limitations on their operations. In this paper the authors offer a comparative status survey of banks and BigTech companies as they investigate the factors, development paths and operational areas that reflect the differences in cross-sectoral and industry regulation and have an impact on the cyber security risks of digitisation.

JEL codes: G20, G21

Key words: digitisation, business intelligence, BigTech

¹ *Éva Pintér* PhD habil, Associate professor, Corvinus University of Budapest, Institute of Entrepreneurship and Innovation, eva.pinter@uni-corvinus.hu.
Balázs Herczeg PhD student, University of Pécs, hebuabk.pte@tr.pte.hu.

1 DIGITISATION IN BANKING SERVICES

The banking sector is a key player for the operation and running of the economy. Digitisation taking off over the past decade has created new service opportunities there coupled with new types and measure of risk exposures, which may affect trust as the most important value of the sector.

The term 'digitisation' has no strict specific definition. By one approach, it means processes that used to be physical or analogue becoming digitised. Digitisation allows the effective implementation of search, analysis, correction, and development; a digitised object can be freely and easily transformed, modified while an unlimited number of exact copies can also be made (*Fichman–Dos Santos–Zheng, 2014*).

In terms of technological development, mobile applications represent one of the most important achievements of digitisation. Almost all people in every part of the world carry smartphones and the banking applications downloaded to them provide access to many financial functionalities (e.g., balance inquiry or money transfer) (*Bagó - Forgács, 2021*).

Table 1
Card payment and cash withdrawal transactions in Hungary (2019–2022)

Reference period	Purchase at POS terminal with a domestic card (traditional transaction)	Purchase at POS terminal with a domestic card (touch transaction)	Online shopping with a domestic card	Cash with drawal at an ATM with a domestic card	Total valu	Change compared to the previous period
1st quarter 2019	15 842 454	151 939 310	15 832 272	23 844 582	207 458 618	
2nd quarter 2019	16 053 552	176 250 552	16 098 321	26 210 148	234 612 573	13.09%
3rd quarter 2019	15 271 883	191 441 365	17 154 767	25 626 446	249 494 461	6.34%
4st quarter 2019	14 314 029	198 685 221	18 987 071	25 959 617	257 945 938	3.39%
1st quarter 2020	12 086 306	193 197 079	22 314 893	22 680 208	250 278 486	-2.97%
2nd quarter 2020	11 829 330	177 827 603	24 249 818	20 063 640	233 970 391	-6.52%
3rd quarter 2020	13 957 916	224 749 052	26 305 474	23 546 162	288 558 604	23.33%
4st quarter 2020	10 388 603	218 653 645	27 974 909	22 265 838	279 282 995	-3.21%
1st quarter 2021	6 293 483	204 918 449	26 866 723	19 288 308	257 366 963	-7.85%
2nd quarter 2021	6 358 224	245 162 157	29 791 201	21 631 824	302 943 406	17.71%
3rd quarter 2021	6 475 525	283 095 367	32 226 597	22 153 690	343 951 179	13.54%
4st quarter 2021	5 042 545	285 405 091	36 395 770	21 742 694	348 586 100	1.35%
1st quarter 2022	4 113 212	272 647 077	37 350 061	19 826 964	333 937 314	-4.20%
2nd quarter 2022	4 943 835	318 334 751	38 855 098	21 422 611	383 556 295	14.86%
3rd quarter 2022	5 680 602	334 168 351	40 921 017	20 920 440	401 690 410	4.73%

Source: data from MNB Tables of Payments (2020, 2021, 2022)

Debit and credit cards are often used in daily life for different transactions such as payment or cash withdrawal. Despite a reduction due to the Corona virus (2.98% and 6.52%, respectively), the number of transactions at POS terminals, Internet purchases or cash withdrawals from ATMs was over 200 million in all quarter years of 2019 and in Q1 2020 (*Table 1*). Compared to 2019, the number of transactions doubled by Q3 2022 including a 2.6 times growth of Internet purchases; on the other hand, traditional card transactions declined to one-third and cash withdrawal was also reduced.

Banks need a variety of IT applications to ensure uninterrupted and efficient operation. Big Data is the term used for the large quantity of different items of information that are generated in an increasing volume and at accelerating speed often from targeted data mining. Proper skills are needed to analyse those data. Data analysts often research the links/connections between the data, which will allow the analysis of data sets of different origin and structure (in terms of Big Data, they can be both structured and unstructured). Large volumes of data may be used in several banking operations, for instance, competitive advantage can be achieved through appropriate data analysis (*Segal, 2019*). The business solutions of artificial intelligence can help the analysis.

The business solutions of AI can be used to connect data originating from different systems, to reveal interconnections or to visualise them for better understanding and helping economic decision-making in that way.

As other firms, financial service providers have a vested interest in meeting their customers' needs at the highest possible standard in a cost-effective way to reach profit, in which business intelligence solutions assist them (*Szedmákné, 2017*). You can see those systems, among others, in producing reports, generating indicators, business models, timeline analyses, data visualisation, data mining or statistical analyses (*Kóvári, 2007*). It is there that data assets held by banks (Big Data) and the solutions of business intelligence are linked, and that is why one must mention it, since financial institutions can have an advantage over their competitors if they can effectively utilise the huge volume of data they have. Analyses made of customers' habits can point at new opportunities for product development to provide better services, which will drive higher profits. The two concepts of Big Data and business intelligence and their connections are an organic part of digitisation in the banking sector.

The use of artificial intelligence (AI) can already be seen in several service areas and is expected to spread fast in future. It can appear, for instance, in the form of a so termed chatbot in a pop-up window on a bank's website, where customers communicate with a talking robot built on AI rather than a real person. The robot can answer questions most frequently occurring in banking, and it can also help users find out what to do next (*Dahiya, 2017*). Significant savings on human

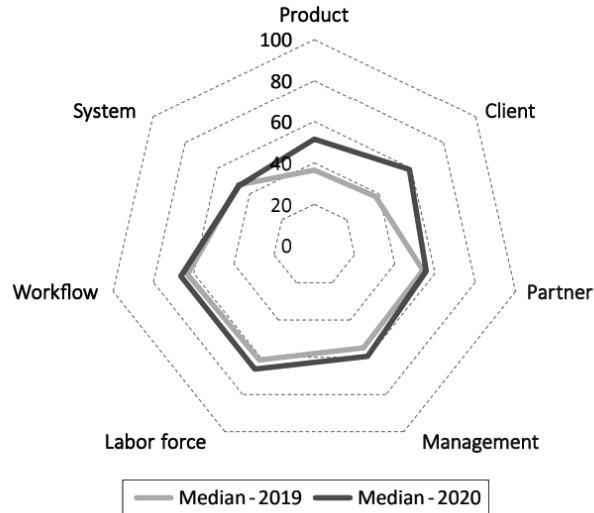
resources can be achieved with its help, which is a real deal for financial service providers if one considers current labour market relations.

The combined use of different technologies (Big Data, AI and machine learning algorithms) offers even more profitable opportunities for service providers (Csiszárík-Kocsir, 2022; Király, 2019). Efficient data analyses and the combination of technologies can generate systems that perfect themselves in operation, since they can become increasingly efficient as they learn from the data continually generated. Banks can apply the process in several parts of their operating cycles. High level knowledge of customers' habits allows for targeted product development, and clients can be offered made-to-measure solutions (Pintér-Bagó, 2021). Risk assessment can also become more exact, so pricing of different loan products will be more attractive since their prices are highly affected by risk factors.

1.1 Status of digitisation in the Hungarian banking sector

The Hungarian banking sector had to act in response to the loss of trust at the time of the 2008 crisis and the start of an explosion of technological development at about the same time. The 50-60 age group is a decisive source of income for banks, so they had to introduce immediate technological improvements for the younger generations so that they could be present parallelly with the product range of their elders who were less open for a digital transfer. However, as a result of the acceleration of digital shift during the pandemic, older generations have also started to use digital solutions actively. Also, a generation has grown up who clearly expect the IT innovations mentioned above (they are the ones termed 'digital natives' in the literature), so IT development has appeared in several fields at the same time.

Figure 1
Digital development index of the Hungarian banking system



Source: MNB, 2022

As for the everyday internal operation of banks, the picture is quite mixed. Internal communication with colleagues and management is highly digitised; in practice, it means correspondence and document management systems. In addition, different systems are available to monitor the processes, which help follow-up projects and tasks preventing several future problems in that way. They are the areas surveyed by the National Bank of Hungary (MNB) in which the digital level of Hungarian banks is the highest. On the other hand, there are specific banking areas (e.g., treasury transactions) where the human factor continues to be significant.

Managing data assets and exploiting their possibilities are at an initial stage, however, providing made-to-measure product offers is increasingly catching on with Hungarian financial institutions. Managers are committed to developments as they appreciate the opportunities they offer. Side by side with the areas in an advanced phase of digitisation, however, there are features in the components of the internal operations of financial institutions with room for improvement (MNB, 2021). Such are, for instance, customer relations or the structured integration of systems. According to a proposal by the Hungarian Bank Association, the government may also contribute to the digitisation of internal operations using different means (e.g., tax reduction) the institutions can spend on electronic development (for instance, on the further improvement of their systems). Since high

IT spending is a major component of operating costs, such stimulus can drive further progress (*Becsei-Bógyi-Csányi-Kovács, 2019*).

A service provider must have the appropriate outward channels so that its customers better perceive the bank's digital solutions.

2 GLOBAL REGULATORY ENVIRONMENT

A financial crisis situation has dominated the agenda of regulators for most of the past decade with financial stability and prudential security in focus. Nevertheless, because of current technological trends, an economic recovery and new customer needs, it has shifted to cross-sectional risks such as cybercrime, fraud and money laundering (*Finsac, 2019*).

At present financial issues are often subject to a combination of sector-specific regulations (obviously in the scope of financial decision makers and regulators) and inter-sectoral ones (partly in the competence of other decision makers in a society). Two categories of finance can be differentiated: specific and inter-sectoral (horizontal) regulations.

The specific regulations of finance target the following goals:

- Financial stability: the framework of the institutional system, recovery and resolution, and operational flexibility (to minimise the impact of institutional errors on the system).
- Prudential principles: capital adequacy and liquidity requirements to ensure companies can resist any unexpected economic incident. Prudent risk assumption and strong risk management are also important.
- Conduct and customer protection: external and internal codes of conduct for the company and its employees, sales practices, pricing, fair treatment of customers and market integrity.

Inter-sectoral and horizontal regulations comprise the following:

- Competition and anti-trust: the regulatory framework on collusion and cartels, market dominance and monopolies, control and reporting of mergers and acquisitions and the protection of intellectual property.
- Data protection and management: standards of data protection, data sovereignty, data management (gathering, retention, use) and inter-sectoral or cross border data interchange or inter-operability.

- **Company management:** standards defining the roles and responsibilities of Boards of Directors and executives, accountability of employees, monitoring and preventing conflicts of interest.
- **Economic and financial crime:** including standards of proper customer due diligence and the „know your customer” (KYC) processes, management of money laundering and terrorism financing related risks, and the prevention of fraud and other economic crime.
- **Cyber security and flexibility:** framework systems and standards on the minimum-security requirements of critical infrastructure. The Digital Operational Resilience Act (DORA) of the EU aims to strengthen and support the secure operation of IT systems at financial institutions in the event cyber risks increase.

There may be a big difference among regions in how they apply the above standards and rules, which is independent of the presence of BigTech companies (e.g., legal environment, stringency or strength of the executive power).

BigTech companies are technology corporations of high capital strength in their mature life cycle. They are engaged in different core operations that may be linked to social media platforms of a non-financial nature. Their common feature is that their core business generates huge volumes of data, and they are highly professional in managing and analysing them. Traditional financial and other service providers tend to respond to the characteristic features of local markets (e.g., penetration of financial services), political goals (competition, innovation) and proportionality (where, for instance, the rules to be applied to different licenses, activities or entities are set suitably for their own risk profile). An obvious consequence of the above is that financial institutions may face different and sometimes overlapping regulatory environments depending on the country they operate in even if they develop similar business offers in every country.

Further, different regulations may apply to banks and non-bank institutions within and without country borders. It largely depends on market position and financial activity mix, as different activities are subject to different licenses (for sector specific regulation), while the diversity and importance of their non-financial activities is another decisive factor (for inter-sectoral regulation).

As the market develops, the legal environment develops too, albeit with a time delay. The 2008-2009 fiscal crisis is an example of efforts made to overcome such differences, but prudential rules have not even been stabilised by now because of Covid-19.

Nevertheless, new products such as personal loans, new procedures such as artificial intelligence and cloud technology, fresh players such as FinTech, BigTech and

telecommunication companies and cross-sectoral and cross-border enterprises keep on testing the limits of legal frameworks and legislators' response time.

Common principles are being laid down in some inter-sectoral areas, such as data protection. However, the lack of national and international bodies particularly in the field of technology may lead to convergence and standard setting, as it happened with financial services following 2008. True, many regulators respond to the challenges independently and only few joint initiatives seem to be appearing.

3 BIGTECH COMPANIES IN FINANCIAL SERVICES

As discussed above, the objectives motivating how BigTech companies appear in financial services are to make as much profit as possible by exploiting the competitive advantage of a large clientele and the volume of data and to offer problem free user experience. It is the reason they offer a wide range of products; it also explains their place in the value chain, and why they refrain from engaging in strictly regulated activities, such as deposit services. Their primary objective does not involve making use of opportunities of regulatory arbitrage or the difference between regions.

The differences are limited in theory. In most cases, both banks and non-bank financial institutions need to obtain the same licenses and must comply with the same regulatory requirements if they are engaged in the same activities. For instance, if a 'non-bank' provides its clients with payment services, it can only do so if it is holder of an operating license for payment services and in compliance with the relevant requirements. The requirements typically apply the principle of proportionality, i.e., the stringency of rules depends on the risk of the activity. In that sense, the rules relating to operating payment services subject to licensing are much more lenient than the ones requiring full-scale banking license also allowing deposit collection.

In reality, however, 'non-banks' – such as BigTech companies offering financial services -, must conform to different legal requirements for two reasons (Wyman, 2022).

The first reason is that BigTech companies often offer innovative products and delivery mechanisms that go beyond the scope of existing financial regulations. This can happen, because their services are similar to traditional financial services, but they have not been fully categorised under the existing legal provisions. One reason is because some regulations are entity-based, i.e., it is unclear which set of requirements should be applied if a given entity does not have the exact license traditionally needed for a given activity. For instance, is issuing a Community loan considered lending, or the mediation of payment transactions? Are the

balances of electronic wallets and monies used for online payment deemed cash equivalents or customer deposits? Must one comply with different requirements if the same activity is performed by an entity holding full-scale banking license or by one having the license needed to operate payment services?

Another reason is that a significant part of the activities of BigTech companies rely on data out of the scope of the finance sector and make use of market positions subject to inter-sectoral rules (e.g., rules relating to data or market competition). In many cases it is a grey area. Given the consequences of the fiscal crisis, they are areas where financial regulators need extended scope, regulatory and supervisory background (for instance, relating to the use of financial data). On the other hand, except within the framework of the given financial license, those rules cannot be applied to 'non-financial' entities. For instance, the data protection requirements stipulated in the Gramm-Leach-Bliley Act mainly targeted financial institutions in the USA. Likewise, BCBS 239 in the European Union explicitly applies to financial institutions.

BigTech companies have proved to be able to assume positions strategically (and flexibly) for performing specific activities or occupying certain parts of the value chain. In addition, as soon as they perceive a new opportunity, they act making use of their large database, being less dependent on legal provisions, company structure and risk appetite. The combination leads to major differences in how BigTech and FinTech companies or banks are affected by the regulatory environment. Regulatory asymmetry and non-existent policy reforms may trigger fast change in market structures and risk profiles.

4 REGULATORY ASYMMETRY BETWEEN BANKS AND NON-BANKS

The rifts hidden in financial regulations are significant in international terms including new products and services (e.g., Community loans, cryptocurrencies, e-wallet balances, etc.) as well as new delivery mechanisms (use of recent technologies) not fully integrated into existing provisions. For instance, regulators are trying to figure out globally how to categorise the new products (are they assets or securities), new services (within or out of the scope of existing licenses) and recent technologies (e.g., licensing credit scoring or other applications).

The imbalance in enterprises and activities includes new products and services. In this case it has not been clarified yet how to ensure proportionality, because the value chains are split up among different players. It hampers accountability from the aspect of companies. For instance, in a SME lending transaction (Csiszárík-Kocsir–Dobos, 2022) there is a BigTech company on the front end (say, it distributes short term loans on its sales platform), a FinTech company providing credit

scoring (say, connects customer data collected on its own platform to external databases and bank data) and a bank performing customer rating and providing the capital for lending, who shall be made responsible if a customer fails to understand risks, their loan defaults or they prove to be swindlers?

The split causes some disturbance when the risk of an activity must be identified. For instance, does the provision of personal loans carry the same risk if it is performed by a specialised FinTech company or a BigTech company (linked to the customer more commercially) or a bank (that also collects deposits)? Does the difference in risk justify the difference in prudential requirements between an independent FinTech company and the subsidiary of a banking group even if the two are engaged in the same activity?

The differences of monitoring and enforcing standards also include anti-money laundering and the fight against terrorism financing, corporate governance and e-commerce, where there are standards, but they are based on self-assertion, i.e., there are no clearly identified actors having enforcement power in each sector. For instance, anti-money laundering and fighting terrorism financing are areas where international standards were established by the Financial Action Task; all signatories from the financial or non-financial sectors have acknowledged them as mandatory. Although practical implementation greatly varies from country to country, (Dziubak, 2018), it is the most developed in the financial sector (using dedicated regulations, on-site inspections, sanctions, ongoing reviews and financial supervision). If customers want to open an account, they have to undergo a strict due diligence process that is the responsibility of the bank in question and is supervised by the relevant authority. On the other hand, if a customer wants to open an online payment account or a trust fund, due diligence is not as strict as in a bank, or at least there is no authority to enforce it. As a result, BigTech companies can offer services built on banking products and services relying on the processes and infrastructure of banks, such as KYC. If the importance of BigTech companies grows, the operating costs of the different players will be disproportionate.

Finally, inconsistencies between countries and industries are increasingly problematic as activities are globalised. At present, legal provisions are still legal system and industrial branch specific, while business and financial operations tend to go across borders, industries or companies, which require cross-sectoral or horizontal regulation such as data protection and data security, cyber security, anti-money laundering and terrorism financing, tax-free zones, uninterrupted provision of vital services and public goods. The application of existing legal provisions at entity and activity level is a challenge. Cooperation and harmonisation are needed, but it is a major challenge if policy goals are diverse.

Market analysis clearly proves that technological changes including the appearance of BigTech companies may be advantageous for consumers. Customer satisfaction may increase because of the new products and services, faster processing of payment transactions or credit rating, financial integration and cheaper services (due to both lower prices and higher yields on e-wallet balances than on bank deposits.) As mentioned above, most BigTech companies arise in uncharted fields, which leads to a growing market even if, in time, they may replace traditional financial products and services.

It may lead to improved effectiveness of the markets, automation, and digital solutions at system level, which may reduce operating costs. But it can also have the result that one must use digital capabilities to maintain robust systems in key areas such as the management of cyber-risk, data security, operational flexibility, and risk management.

To fully exploit advantages, BigTech companies must develop their risk culture, the transparency of data-related business practices and participation in important policy discussions about the industry (e.g., economic crime, cybersecurity). It can help society manage the risks arising from technological changes in the area of financial services, which may be helped by BigTech companies.

To mention just a few, the management of cybersecurity and data security, anti-money laundering and the fight against terrorism financing are still at an early stage particularly with new players. Also, there are other risks. They include blurred authority because of cross-border, cross-industry and cross-company activities, the reduced transparency of risks and the reduced accountability of the players. Consumer protection may also present a problem, as consumers do not necessarily understand the different levels of protection and risk between the products of banks and non-banks, e.g., between e-money balances and deposits.

The concentration of market strength may present a risk for large platform providers, because it reduces the probability that market mechanisms prevail (an equilibrium price evolves) in the field of products and services, and digital capabilities and R&D activities are concentrated. Also, a conflict of interests of financial and non-financial operators may arise (for instance, discount loans if purchase is made on a given platform, or discriminative pricing). Eventually, the new business models may intensify anti-competition monopolising practices such as the application of dumped prices based on financial data and the limitation of services on other platforms (Wyman, 2022). The challenge of large platforms exploiting the network effect and the economies-of-scale is particularly big.

BigTech companies represent a risk for financial stability because of their size, their operations crossing country borders, natural networking effect and dominance in certain parts of the value chain (e.g., risk of operational flexibility around

the cloud platform of a bank). For instance, large platforms can spread viral content quickly, which may increase the risk of growing panic, so banks may suffer liquidity shortage due to the shock.

Viewing financial and commercial activities the question arises how unethical behaviour encouraging risk taking, for instance, targeted adverts appearing days right after wages are paid should be controlled and prevented. We have no idea what the BigTech model can produce if a recession occurs when customers will likely be less supported including the risk of the reduction of credit volumes of banks as proposed by the Bank for International Settlements (BIS). The crisis caused by Covid-19 with its significant and long-term macroeconomic impacts can be a test case, since it is still unclear how such a crisis can affect BigTech companies and their place in the financial markets.

5 BANKING IMPACT, CHALLENGES, AND OPPORTUNITIES

BigTech companies tend to be increasingly active on the market of financial services, which is good news for the market because customer experience improves, consumer values get higher, and operations become more effective. However, traditional companies have to face increased competition for market share. Companies with higher investment capacities than traditional players will be the largest competitors. It may have a significant impact on profitability, business models, the type of demand and customers' expectations of banks.

In response, many traditional institutions have already made major investments into own-developed innovations, more sophisticated business offers and digitisation of internal processes. Online banking applications, contactless payment and many lending applications are everyday practice in the most developed banking systems. They are expected to proliferate as banks start imitating the methods and value creating processes of BigTech companies to improve their position in the market competition. Since such advantages reduce transactional costs, the volume of activities offering financial services is growing. Nevertheless, as explained in Oliver Wyman's report of 2022 (State of Financial Services), traditional institutions must face a challenge: they must design the companies of the future under the pressure of making profit in the short run in a hostile environment of external threats.

5.1 Challenges for traditional actors

The appearance of BigTech companies may render the banks' business models, profitability and competitive edge vulnerable. Their impact is particularly massive as traditional banking models used to rely on providing certain consumer groups with services at increased prices (high risk groups), so that they could attract others with lower pricing (low risk groups). That is termed cross support or cross-subsidisation. The new business models may create high value and redirect profits away from traditional banking players because of low operating costs, networking or economies of scale, or because they can launch or terminate relations with customers. Investments into new technologies and digital capabilities increase the success of response to new challenges, but old infrastructures, systems, investors' scepticism and low budgets may stand in the way. Also, digitisation increases demand for third-party management and cybersecurity. Capital adequacy and accounting standards are often different in some countries, which encourages banks to digitise by developing own software.

Banks, challenger companies, and other stakeholders still recognise the strengths of traditional market leader companies in market competition. These include confidence, physical presence, high volume of available customer data, solid processes (of well-defined standards facilitating cooperation between the banks), adherence to familiar basic banking relations and past information on financial behaviour. Traditional players can exploit those opportunities, although some of the factors do have competitors (e.g., e-wallets vis a vis deposits).

Consumers' trust in financial institutions is particularly important, mainly in the long run and in terms of complex services such as savings, mortgage loans and project financing. Physical presence and customer relations are necessary to develop customers' trust. Confidence in banks may be driven as data abuse committed by BigTech companies has recently become public knowledge. Ongoing monitoring of and compliance with changes in legal provisions may be an advantage in terms of obtaining new licenses, increasing activities, and making use of economies of scale with respect to non-retail functions; the areas involved may be credit risk, customer due diligence, transaction monitoring and banking services provided for wholesalers and corporates. In addition, digital capabilities may convert the data and knowledge gained about customers' financial behaviour into new competitive advantage through, for instance, establishing systems built on open banking standards and communicating with each other, which will allow banks to liaise with other players to offer a wider range of products.

Regulations may present a barrier of entry in many market segments. For instance, deposit collection and central banking financing would be low-cost forms

of funding, but they can only be delivered by players that hold full-scale banking licenses.

The above competitive advantages carry many opportunities for banks (Oliver Wyman, 2020). Most banks are already engaged in or plan to do the following:

- Invest into digitisation to improve the quality and efficiency of offers to customers. Almost all banks have some kind of digital strategy or plan beginning from partial efficiency gain of project portfolios because of automation up to full-scale back-end or IT renewal and front-end innovations (e.g., online banking applications, online payment systems, spending categorising functions, etc.). It is unclear as yet how much of the plans can be implemented by traditional financial institutions, as their market capitalisation and return on equity (ROE) are mostly stagnant and fall short of those of the BigTech companies, so funds to be invested are rather tight in most cases.
- Establish „digital banks” allowing banks to appear on the market with new offers much faster and to serve their customers’ new demands relying on their knowledge and customer data they have access to. Some banks have already started it, for instance, Standard Chartered has obtained virtual bank license in Hong Kong to set up a special (digital) bank.
- Enter into partnership with technological players to be able to provide customers with state-of-the-art offers and to improve their efficiency with, for instance, using data, business-to-business-to-consumer platforms, analyses and new digital distribution channels. One can find many examples among both small and large players, the latter including Apple-Goldman, Google-Citi partnerships and WeBank.
- Perform acquisitions: particularly, acquisition of players whose capabilities supplement their own, such as FinTech companies with expertise in AI or analysis, or minor banks having specialised digital platforms or product focus. It is already in progress; Goldman Sachs, for instance, has acquired many FinTech companies (Clarity Money, Final, Bond Street) to obtain skills necessary for digital retail banking and to establish, at the same time, its own online bank ‘Marcus’; in another example, the Citi Group actively acquires FinTech companies engaged in blockchains (Symbiont, Axoni) to build an open banking infrastructure.
- Make strategic decisions about positioning (market segment, products, value-chain functions) to exploit their competitive advantage and to be less vulnerable. The dominant „universal banking model” based on cross-subsidisation is under pressure in many cases. Different models may develop. Sometimes a market player vows to become a front-end champion (e.g., it invests into im-

proving customer experience) while others may focus on platforms (e.g., offers developed for existing commercial or other platforms).

- Support inter-bank cooperation and consortia to share expenses and mitigate risks in areas where you have a competitive advantage, for instance, building „market-driven” payment infrastructure, digital identity or services related to customer due diligence. There are many examples of the cooperation of banks; some have led to the establishment of consortia to integrate technology and other market players and to jointly contribute to solving key issues such as economic crime, fraud or the challenges of market infrastructure.

There are, naturally, many factors including, for instance, market size, funding sources, product specialisation or market features to define the decisions and capabilities a company may choose from the above options.

6 SUMMARY

To remain viable and competitive, banks must decide which of their capabilities they want to invest into. Wherever they enter competition, their investments will be directed to the use of technologies to improve productivity (e.g., use of higher rate of automation and artificial intelligence for customer analysis and risk management). They will also strive to make their internal systems more flexible (e.g., using cloud-based systems to allow the integration of new proposals, the acquisition of FinTech companies or response to changes on the market or in the regulatory environment) and to develop the ability necessary to measure the profitability of processes and digital investments. Many of them must realise which areas are their strengths, which products, services and value-chain functionalities have proved to be the most profitable so that they could suitably inform strategic decision makers.

Digital capabilities must be applied in any case irrespective of the strategy chosen. Many banks will make a profit from improving their communication towards investors, the public, and legislators – clearly indicating the yield of digital investments and how much values bank offers have generated for consumers. Another factor is the banks’ positive contribution to societal goals through loan mediation and other policy goals, such as financial integration, the mitigation of climate risk and the reduction of economic crime.

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A STUDY OF „UNDERTAKINGS IN DIFFICULTY” IN THE HUNGARIAN SME SECTOR INCLUDING EXPLANATORY VARIABLES¹

Szilárd Hegedűs²

ABSTRACT

The objective of this study is to examine compliance with the definition of „undertaking in difficulty” as identified in EU competitive law in the Hungarian small and medium-sized enterprises sector. The 2019 data of the enterprises were used in the analysis. During the research, „undertakings in difficulty” as per the legal provisions were taken from a sample of about 31,000 companies. The „undertakings in difficulty” were then analysed by geographical area, industry and size. The explanatory variables were identified according to the literature. Classification tree and binary logistic regression were used to reveal the reasons why difficulties had arisen. The models built are highly reliable in predicting the emergence of difficult situations. The key outcome of the research is it has established a set of variables that can describe the emergence of difficult situations.

JEL codes: G28, G33, G38

Keywords: difficulty, capital structure, business analysis, prediction

1 INTRODUCTION

Pursuant to EU regulations, state aid is subject to certain criteria. Companies incurring major loss of capital or under insolvency proceedings are deemed „*undertakings in difficulty*” (NH). They are excluded from a certain group of aid, so economic decision makers must have information about their characteristic features. In this study, the situation of the Hungarian SME sector is surveyed including undertakings in difficulty and special features of their difficulties in the last year preceding the Corona virus pandemic.

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² *Hegedűs, Szilárd* Assistant Professor, BGE-PSZK. E-mail: hegedus.szilard@uni-bge.hu.

In the first part, the relevant legal environment is described followed by a review of the literature on the topic. The methodology is presented in part three. The variables and methods required for the study are derived from widespread models in economic studies to test the legal provisions with reference to companies. The findings are presented in part four. They include the number, regional distribution, structure by company size and industry structure of the businesses affected. Multivariate statistical methods were used to describe the process of entering into difficulty. The paper is closed by the lessons learned, some recommendations and a list of references.

2 THE LEGAL ENVIRONMENT

„*Difficulty*” in the operation of a business is a legal concept identified in Article 3 (5) of Commission Regulation (EU) No 1388/2014 with reference to small and medium-sized enterprises (hereinafter: SMEs); 37/2011. (III. 22.) Government Decree regulates its application in Hungary. Pursuant to the regulation, a company is deemed an „undertaking in difficulty”, if it is unable to prevent loss accumulation through its own efforts. Accordingly, such enterprises cannot be granted state aid or EU co-financed support because of the principle of co-financing.

The set of criteria applies to economic enterprises of both limited or unlimited liability; in addition, it differentiates by company size. In this study, the focus is on SMEs. It should be noted that Section 3, XXXIV of 2004 law about small and medium-sized enterprises, supporting their development is the governing law for regulating the SME sector.

Considering the adverse effects of the Corona virus pandemic, any enterprise that had not been in difficulty prior to 31 December 2019 is eligible for aid/support according to the European Commission (EC, 2020).

The regulation lists a number of criteria both qualitative and quantitative in nature (*Table 1*).

Table 1
Criteria of „difficulty”

Quantitative criteria
<i>Over 50 percent of share capital or subscribed capital has been lost due to accumulated losses (limited liability and unlimited liability companies)</i>
<i>AND 25 percent of subscribed capital was lost over the past 12 months</i>
Qualitative criteria
<i>Insolvency proceedings have been launched by creditors as per the EU regulation</i>
<i>Insolvency proceedings can be launched pursuant to the law of the Member State</i>
Other criteria
<i>Company losses increase, turnover is reduced, stocks/inventories increase, excess capacity rises, orders significantly decline, payments decline, debts increase, depreciation of net asset value declines or net asset value has been depreciated in full.</i>

Source: own design based on Section 6, 37/2011. (III. 22.) Government Decree

The criteria are well defined. However, other non-quantified criteria also characterise company operations. They are included in other, defined criteria, but this study does not cover them, as its scope is limited to the analysis of quantitative and qualitative criteria.

„Difficulty” has many consequences, as such enterprises cannot be granted state aid or EU co-financed support; see in detail in Nyikos (2018). The concept of state aid is defined in Article 107 (1), The Treaty on the Functioning of the European Union (TFEU). „Save as otherwise provided in the Treaties, any aid granted by a Member State or through State resources in any form whatsoever which distorts or threatens to distort competition by favouring certain undertakings or the production of certain goods shall, in so far as it affects trade between Member States, be incompatible with the internal market.”

On the other hand, there are forms of state aid that are compatible with the internal market. They are listed in Article 107, (2) and (3) of Treaty on the Functioning of the European Union (TFEU). As a general rule, state support must be reported to the Commission which – in collaboration with the Member States – monitors Member States’ support programmes. Pursuant to Article 107, Section (3), e) of TFEU, „such other categories of aid as may be specified by decision of the Council on a proposal from the Commission”³

³ <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:12016E107&from=EN>.

With respect to low significance state aid, block exemption was introduced in the EU in 2000 for SMEs and for training support. Pursuant to Commission Regulation 1407/2013/EU (de minimis regulation), the gross value of small amounts of aid granted to one and the same company cannot exceed EUR 200,000 in any three tax-years, or EUR 100,000 for enterprises engaged in commercial road transport (for more details, see *Losoncz*, 2019). The eligibility for support is controlled by the State Aid Monitoring Office.

3 A REVIEW OF RELEVANT LITERATURE

The core idea of the study is based on a paper by *Nagy* (2020). It is a comprehensive description of EU support and state aid to SMEs. It discusses EU support in the corporate sector by industry, company size, and region by analysing the data of a KPMG study on the absorption of EU support in Hungary in 2017.

„Difficulty” has mostly been studied from a legal aspect in the literature. *Schmidt-Köttlers* and *Rademacher* (2011) studied the German, *Lupu* (2014) the Romanian, American, and French bankruptcy laws in comparison with EU practice. *Segura* and *Nerea* (2017) have warned that the relevant authorities must examine compliance with eligibility criteria when they grant support. On the other hand, support cannot be withdrawn if insolvency proceedings are launched against a company after support has been granted.

Szűcs (2020) analysed the legal environment of state aid to undertakings in difficulty with respect to amendments in the EU regulation.

Accumulated knowledge is required for an economic study of „difficulty”. Since the regulation typically analyses the characteristics of capital structure, the rise of a difficulty deduced from capital structure theories seems to be obvious. Another group affected is related to liquidation proceedings, so the Hungarian literature on bankruptcy models may be helpful for the analysis.

Modigliani and *Miller’s* theses (1958) on capital structure theories used to be pioneering. Three main groups of currently accepted capital structure theories are based on selection theory, hierarchy theory and agent theory (see *Brealey–Myers* (2005); *Weston–Copeland* (1995) for the first and *Szemán* (2008) and *Jenson* (1976) for the second and third).

Of the Hungarian literature, *Krénuusz* (2007), *Gál* (2013) and *Szűcs* (2018) are worth mentioning. They break down the factors affecting capital structure to exogenous (taxation, legal provisions, macroeconomic characteristics) and endogenous (company size, age, asset composition, liquidity, business risk, profitability, and effectiveness) factors. With respect to empirical research, in his study *Gál* (2013) has found a positive relationship between equity ratio, asset composition and com-

pany size as well as profitability and liquidity. Equity ratio is important from the aspect of this study, as the criteria of „difficulty” mostly relate to its components.

Company viability is important from the aspect of accounting because different accounting measures must be applied if the principle of going concern is violated (Lentner, 2014; 2022). Bankruptcy models are suitable to assess the principle of going concern.

Of bankruptcy models, *Altman's* (1968) is a core work, which analysed the probability of bankruptcy using discriminant analysis (Asgar, 2011). Pioneers in the Hungarian literature are *Virág and Hajdu*, who studied the bankruptcy of Hungarian large corporates using discriminant analysis and logistic regression on a 1992 database (Virág–Hajdu, 1996; Hajdu–Virág, 2001). *Arutyunjan* (2002) studied the bankruptcy of agricultural companies using discriminant analysis. In his paper, *Kristóf* (2008) generated a bankruptcy model using four multi-variable statistical methods. *Pollák and Popper* (2021) estimated the probability of bankruptcy using a combination of a linear auto-regressive model and a transition matrix. A novelty in Hungary by *Nyitrai* (2016) has been to apply dynamic financial indicators for establishing his model. *Béres* (2017) has set up a bankruptcy prediction model for municipalities based on logistic regression, while *Molnár* (2021) has done the same for municipality-owned economic enterprises based on a similar methodology. *Baranyi et al.* (2018) assessed bankruptcy models for banks. *Pálinkó and Svóób* (2017) analysed the reasons leading to bankruptcy in their paper, in which they emphasised the importance of liquidity to avoid bankruptcy.

4 MATERIAL AND METHODOLOGY

I identified two research objectives at the beginning. The **first research objective** was the identification of the ratio and sectoral distribution of undertakings in difficulty (hereinafter: NH) in the Hungarian SME sector in 2019. I chose year 2019 for the professionally acceptable reason that, partly, it was the last closed-down year prior to the Corona virus pandemic, and on the other hand, effective EU and national regulations also regard it decisive for identifying an „undertaking in difficulty” in addition to the factors presented in the paragraph on the legal environment.

The **second research objective** was to reveal which factors may trigger the rise of „difficulty”, i.e., which factors describing an asset-financial-profitability situation have the most impact on the rise of „difficulty”.

Since my research was explanatory in nature, I could not offer an adequate hypothesis based on the literature. Following my researcher's intuition, however, I

suggest sectoral characteristics and company size may affect the rise of „difficulty” – I tested that in the chapter on findings. Another proposition of my research is that the rise of „difficulty” has reasons that can be predicted well.

I have developed my **research methodology** in line with legal provisions; it is presented in *Table 2*. I used two indicators (*Table 2*: Variable1 and Variable2) to establish „difficulty” relevant to SMEs. If both variables were below the legal threshold value, I considered the given company to be an „undertaking in difficulty” in line with the legal provisions. The variable, in that way, was a dummy; difficulty was marked „1” and proper operation was marked „0”. (*Table 2*).

I selected the explanatory variables based on the ones analysed in theories of capital structure. In addition, I also tried to evaluate the impact of dynamic changes by measuring the changes of variables year on year. The change indicator in the name of variables measures the change from 2018 to 2019.

Table 2
Generation of variables studied

No and description of research objective	Target	Variable
1. Ratio of NH companies	Generate variable describing „difficulty” from variables in legal provisions	<p>Variable1 = Ratio of equity2019/subscribed capital2019 50% or lower Output: 1 or 0</p> <p>Variable 2 = CPTL2019/CPTL2018 negative and higher than 25% Output: 1 or 0</p> <p>NH is 1 if both variables are 1; otherwise, it is 0</p>
2. Reveal reason why NH has arisen	Identify influencing variables	<ul style="list-style-type: none"> • Effectiveness • Liquidity • Profitability • Dynamic

Source: own design based on research concept

The following variables were studied:

- ROA added value indicator 2019
- ROA added value indicator 2018
- Tangible assets turnover 2019
- Tangible assets turnover 2018
- Change in tangible assets turnover
- Change in turnover per capita

- Change in sales revenues
- Relative standard deviation of EBIT
- Liquidity indicator 2019
- Liquidity indicator 2018
- Change in liquidity indicator
- ROA₂₀₁₉,
- ROA₂₀₁₈,
- Change in ROA
- Fixed assets ratio 2018
- Fixed assets ratio 2019
- Cash 2018
- Cash 2019
- Base-10 logarithm of balance sheet total in 2019
- Dynamic liquidity 2018
- Dynamic liquidity 2019
- ROS₂₀₁₈
- ROS₂₀₁₉

Table 3**Research goals, hypotheses and statistical methodology applied**

	Research goal	Hypothesis	Methodology applied
1.	Ratio of NH companies	Sectoral classification and company size affect NH	Chi square test
2.	Reveal reason NH has arisen	NH can be well described using the variables studied	Binary logistic regression, classification tree based on CHAID model

Source: own design based on research concept

For the **first hypothesis** I assumed the ratio of SMEs in difficulty is higher in certain industries and that the category of company size also has a significant impact on the rise of difficulty (NH). I used Chi square to assess the hypothesis in normality (*Table 3*).

For the **second hypothesis** I took major variables affecting capital structure applied in capital structure theories as the basis, and used binary logistic regression for the explanatory variables, since the variable of NH was a dummy (*Table 3*). Variables not directly related to capital structure had to be selected, i.e., the components of the liabilities side were not included in the components of the indicators. To analyse the cross-table, in order to test binary logistic regression and the CHAID model, 490 non-NH companies were selected by random sampling as a control group to 590 NH companies.

The data analysed come from the database of Bureau Van Dijk Amadeus; the following **limiting criteria** were applied to the companies:

- They had been operating for at least three (3) years.
- They were not under liquidation, voluntary liquidation, or bankruptcy proceedings.
- They had sales revenues of at least HUF twelve million (12,000,000).
- They employed at least five (5) people.
- They submitted annual reports in 2019.
- They were partnerships in the category of SMEs.

The three-year operation as a limiting criterion was included because of a regulation in effect when the manuscript was finalised, because bankruptcy proceedings alone generate a „difficulty” (NH) in that case. Those companies were excluded by applying the limiting criterion, so the criteria presented in *Table 2* could be tested. The rest of the criteria were used to prove the companies were genuinely operational, since a company is subject to VAT above HUF twelve million unless it is engaged in exempt activities. Employing five people allows a company to be listed in the national wages statistics. The SME category came from the research objective. The limiting criteria were used to test the companies’ basic operability, i.e., they verified their real, genuine activity. I used limiting criteria so that I could analyse companies engaged in measurable economic activities. Based on the criteria, 31,255 undertakings were included in the sample. I processed the data using the data analysis software SPSS 27 and visualised them using MS Office.

5 FINDINGS

At the beginning of the study, I generated the dummy variable in SPSS to allow the analysis of „difficulty” (NH). In the first step, variables were calculated; if a variable reached the legal threshold, the relevant company was included in the NH category. *Table 4* illustrates the ratio of NH companies to the total sample.

Table 4
Distribution of NH companies in the sample

NH status	Distribution	%
Non-NH	30,665	98.1
NH	590	1.9
Total	31,255	100

Source: own design based on database Amadeus

A mere 1.9 percent of the companies studied were deemed „undertaking in difficulty” (NH). Its reason is that – as presented in the part on methodology – I took into account the two quantitative criteria cumulatively rather than alternatively. I did so because I used 2019 data in the analysis. With respect to the objectives discussed in the part on methodology, I also kept in mind the idea of studying the impact of the Corona virus pandemic via panel tests, however, it had not been possible before the manuscript was finalised.

The logical question arises, how the ratio of NH companies would change if the two variables were studied separately. One can see from the analysis of the data that 651 companies reach the NH threshold value based on *Variable1*, and 628 ones based on *Variable2*. Therefore, „difficulty” can be identified objectively if both aspects are assessed at the same time. Neither of the two variables indicate „difficulty” (NH) for 61 undertakings in the case of *Variable1*, and 38 in the case of *Variable 2*. The ratio of „undertakings in difficulty” (NH) so identified is 10.3 and 6.4 percent, respectively. Therefore, one can conclude considering both variables jointly is a better description of „difficulty” from the aspect of analysis.

The relatively low ratio of NH companies in the sample can be considered to be really good. However, the findings may be what they are because the analysis was made on a limited sample where companies deemed viable were studied. In addition, the impact of the favourable economic environment in 2019 also played a part. I believe the picture is worse than that if the whole SME sector is studied.

An insignificant part of companies meeting the limited criteria are deemed „undertaking in difficulty” (NH), which also means 98 percent are suitable for receiving external sources including state aid or EU support, as they are not subject to administrative restrictions.⁴ Next, I analysed NH companies in-depth broken down by regional distribution, size, and sections of the national economy.

4 NYIKOS [2018] pointed out that only companies under insolvency proceedings are excluded from certain de minimis support.

Table 5
Geographical distribution of NH companies in 2019

Entity	Status of entity	Number of NH companies	% Ratio of NH companies in sample	Number of partnerships in regional entity	% Ratio of partnerships in regional entity	% Ratio of NH companies in sample to total multitude
Budapest	capital region	240	40.7	212,094	40.7	0.11
Pest	county region	95	16.1	81,346	15.6	0.12
Central Hungary	supra-region	335	56.8	293,440	56.3	0.11
Fejér	county	15	2.5	15,948	3.1	0.09
Komárom-Esztergom	county	14	2.4	12,522	2.4	0.11
Veszprém	county	20	3.4	12,142	2.3	0.16
Central Transdanubia	region	49	8.3	40,612	7.8	0.12
Győr-Moson-Sopron	county	24	4.1	19,062	3.7	0.13
Vas	county	13	2.2	8,547	1.6	0.15
Zala	county	9	1.5	10,026	1.9	0.09
Western Transdanubia	region	46	7.8	37,635	7.2	0.12
Baranya	county	19	3.2	15,328	2.9	0.12
Somogy	county	14	2.4	9,955	1.9	0.14
Tolna	county	7	1.2	6,864	1.3	0.10
Southern Transdanubia	region	40	6.8	32,147	6.2	0.12
Transdanubia	supra-region	135	22.9	110,394	21.2	0.12
Borsod-Abaúj-Zemplén	county	19	3.2	18,342	3.5	0.10
Heves	county	19	3.2	9,108	1.7	0.21
Nógrád	county	2	0.3	4,339	0.8	0.05
Northern Hungary	region	40	6.8	31,789	6.1	0.13
Hajdú-Bihar	county	10	1.7	18,498	3.6	0.05
Jász-Nagykun-Szolnok	county	10	1.7	9,611	1.8	0.10
Szabolcs-Szatmár-Bereg	county	11	1.9	14,390	2.8	0.08
Northern Great Plain	region	31	5.3	42,499	8.2	0.07
Bács-Kiskun	county	27	4.6	19,379	3.7	0.14
Békés	county	12	2.0	8,023	1.5	0.15
Csongrád-Csanád	county	10	1.7	15,478	3.0	0.06
Southern Great Plain	region	49	8.3	42,880	8.2	0.11
Northern Hungary & Great Plain	supra-region	120	20.3	117,168	22.5	0.10
Country total	country	590	100.0	521,003	100.0	0.11

Source: own calculations based on data from Amadeus and Central Statistical Office (KSH)

As for distribution, the number and ratio of „undertakings in difficulty” (NH) is the highest in Budapest and Pest County, which could also be predicted from

the national statistical data of partnerships (*Table 5*). In other counties their ratio does not exceed 5 percent, but it is close in Bács-Kiskun County and Győr-Moson-Sopron County. Data analysis did not show correlation between the level of development of a county measured by GDP per capita and the ratio of NH companies. The number of operational partnerships does not indicate a higher number of NH companies, either.

In a regional breakdown, the ratio of NH companies is the highest in the Central Hungary region followed by the Southern Great Plain and Southern Transdanubia, while Western Transdanubia is a close third. Geographical location has no effect on the number of enterprises in difficulty.

There are no geographical attributes with respect to the two factors.

The comparison of the country distribution of partnerships operating in 2019 to the ratio of NH companies is telling. Comparing the data, one can see a slight difference in the ratio of NH companies as opposed to that of nation-wide partnerships. The difference is positive in all regions except for the Northern Great Plain where the ratio of NH companies is lower than the national average mostly because of the distorting effect of Hajdú-Bihar and Szabolcs-Szatmár-Bereg Counties. In county comparison, there is a higher than 1 positive difference in the ratio of NH companies as opposed to regional ratios. The ratio of NH companies exceeds the predicted value in Veszprém and Heves Counties. Aside from those differences, the distribution of NH companies does not deviate much from national ratios; no significant difference prevails as a result of outliers in the Central Hungary region.

2019 data allow the comparison of the number of NH companies to the distribution of partnerships broken down by regions. The ratio of NH companies was 0.11% in 2019. It must be accepted with reservations because of the limiting criteria applied for establishing the sample; it does not reflect the actual ratio. (To be noted: the ratio of companies broken down by regions was 1.9 per cent in the sample.) It is telling that the ratio of companies in Heves County differs significantly from the national average.

Table 6
Distribution by size

Size categories by number of FTEs	Distribution pc	%
Micro enterprise	253	42.9
Small enterprise	298	50.5
Medium-sized enterprise	39	6.6
<i>Total</i>	<i>590</i>	<i>100</i>
Size categories applied as per database Amadeus (compatible with SME law)	Distribution pc	%
Medium-sized company	252	42.7
Small company	338	57.3
<i>Total</i>	<i>590</i>	<i>100</i>

Source: own calculations based on Amadeus

The **database Amadeus** displays statistical data about company size for all three categories of SMEs. In addition, the enterprises in the sample were categorised by the number of FTEs, which is an accepted method in Hungary (*Table 6*). Most NH companies in the sample were small enterprises while the relative weight of micro enterprises was also high. It is significantly different from national figures: the 2018 figures of the Central Statistical Office (KSH) presented 93.8 percent micro-enterprises, 4.5 percent small and 0.7 percent medium-sized enterprises among SMEs. Both limitations were different from national figures. It is because the number of small and medium-sized enterprises was higher in the sample, as inclusion in the sample was subject to basic operating features. The limitation relating to FTE numbers and turnover has a hidden assumption of bigger-sized companies, but it is not a guarantee of profitable operation.

Table 7
Distribution of NH companies by national economic branches

Code	National economic branch	Number of NH companies	% ratio of NH companies	Number of companies operational in 2018	Ratio of companies operational in 2018
A	Agriculture, forestry, fishing	10	1.7	31,140	3.99
B	Mining, quarrying	1	0.2	391	0.05
C	Manufacturing (processing) industry	98	16.6	<i>51,743</i>	<i>6.64</i>
D	Electricity, gas, heat supply, air conditioning	3	0.5	1,042	0.13
E	Water supply, wastewater collection, treatment, waste management, decontamination	10	1.7	1,763	0.23
F	Construction industry	37	6.3	<i>78,168</i>	<i>10.02</i>
G	Trade, vehicle repair	145	24.6	<i>132,382</i>	<i>16.98</i>
H	Transport, storage	42	7.1	<i>29,525</i>	<i>3.79</i>
I	Accommodation and catering	77	13.1	<i>30,232</i>	<i>3.88</i>
J	Information, communication	17	2.9	<i>45,082</i>	<i>5.78</i>
K	Financial, insurance activity	3	0.5	22,471	2.88
L	Real estate transactions	13	2.2	35,075	4.50
M	Professional, scientific, technical activity	52	8.8	<i>132,714</i>	<i>17.02</i>
N	Administrative and service support activities	33	5.6	<i>44,763</i>	<i>5.74</i>
O	Public administration, defence, compulsory social insurance	0	0.0	142	0.02
P	Education	6	1.0	33,153	4.25
Q	Human health and social care	12	2.0	35,473	4.55
R	Art, entertainment, leisure	14	2.4	23,848	3.06
S	Other services	17	2.9	<i>50,642</i>	<i>6.49</i>
Total	National economy total	590	100.0	<i>779,749</i>	100.00

Source: own calculations based on data from Amadeus and Central Statistical Office (KSH)

Table 7 is a distribution of NH companies by national economic branches. **Bold** was used to indicate if the ratio was higher than 5 percent. The KSH figures of operational enterprises in 2018 were available for national comparison. *Italics* were used to indicate branches where the ratio of NH companies was higher than 5 percent.

The analysis of data shows that NH SMEs were typically present in trade and the manufacturing/processing industry. Their ratio was also high in tourism, catering, transport, and scientific activities. It was also higher than 5 percent in construction industry. It can be assumed that market entry barriers and business risk are higher in those branches, however, further research is required to identify them.

An explanation might be that resource requirement is typically higher in branches where the ratio of NH enterprises exceeds 5 percent. Market competition is also fierce there, which causes higher exposure to market trends for the companies.

Losoncz et al. (2020), and Losoncz (2020) pointed out certain areas of manufacturing industry as well as transport, storage, accommodation, and catering that are front-runners of international operations. The considerable relative weight of NH companies is clear in the most international, export-oriented branches. It should be noted the ratio of NH companies was high in tourism, catering and transport worst hit by the Corona virus pandemic even before the pandemic. The ratio is expected to have increased further in the period following 2019. Szabó and Farkas (2011) have found companies accurately assessed the depth of the sub-prime crisis starting in 2009 –which is supported by a survey made in 2020 by MNB (MNB, 2020).

The ratio of NH companies in the processing industry, accommodation, catering and trade is higher than the national average. The ratio of NH companies in other branches is lower than the national average, which supports the difficulties drawn up.

The **first hypothesis** was tested using cross-board analysis and Chi square test based on size category by FTE number and national economy branch. The statistical conditions of the test were met.

Table 8
Chi square test and Cramer V indicator results (n = 1080)

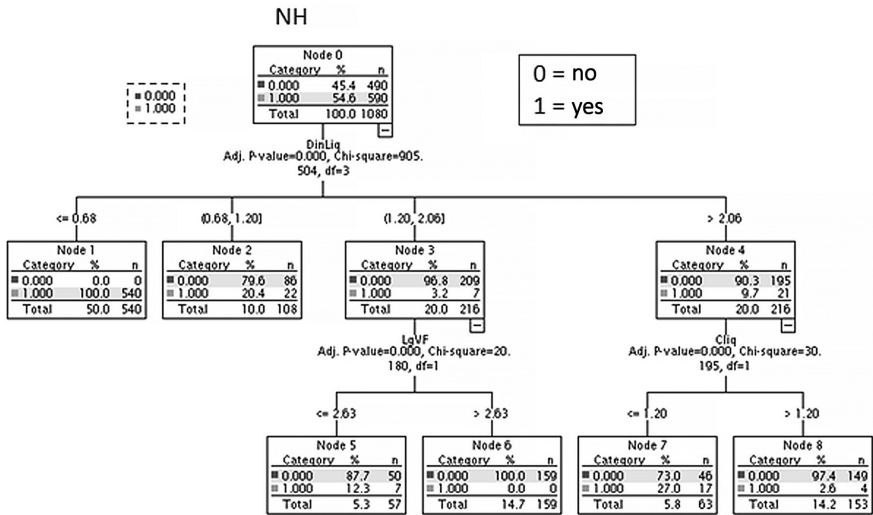
NH*Company size (by FTE number)			
Indicator	Value	df	Sig. (2-side)
Pearson Chi square	27.402 ^a	2	0.000
Cramer V indicator	0.159	n.a.	0.000
NH*National economy branch			
Indicator	Value	df	Sig. (2-side)
Pearson Chi square	497.930 ^a	287	0.000
Cramer V indicator	0.679	n.a.	0.000

Source: own calculation from Amadeus database and SPSS output

The Chi square test has proved a correlation for both variables, but the Cramer V indicator measuring its strength significantly differs (*Table 8*). Regarding statistical tests, the correlation between variables was expected due to the high number of items, however, its strength could not be foreseen. The results prove a higher-than-medium-strong relationship between national economy branch and status of NH, i.e., the nature of activities does have an impact on whether a company becomes NH. (To remember: 490 NH companies were included in the sample by random sampling, leading to 1080 items altogether.) Regarding size category by FTE number, the relationship is weak according to the Cramer V indicator.

I studied the **second hypothesis** using two methods. One is the classification tree tested according to the CHAID model (*Figure 1*). Using the method, the influencing power of variables indicate the accuracy of classification.

Figure 1
Classification tree of NH status



Source: SPSS output

Figure 1 illustrates the „branches” generated through classification, of which 8 have been „grown” by the calculations. The 2019 value (code: Dinliq) of dynamic liquidity had the highest influencing power identified as the ratio of operating profit and short-term liabilities, as per the proposal of Bíró et al. (2016). As in the decision tree, dynamic liquidity 2019 is lower than 0.68, so it influences NH status with an accuracy of 91.5 percent. If the value is higher, the classification is no longer accurate for 50 companies. If the value is higher than 0.68, 100% of the non-NH companies in the control group were accurately classified. The figure shows that including further variables did not have a major impact on accuracy. Thus, one can draw the conclusion the value of dynamic liquidation in the year preceding the research had a major impact on the NH status. It is because if operating profit cannot properly cover short-term liabilities, it will have a direct impact on both profitability and the components of equity causing asset loss for the company.

Table 9
Summary of model accuracy

NH	Prediction		
	No	Yes	Hit
No	490	0	100.00%
Yes	50	540	91.50%
Model accuracy			95.40%
Matching			4.6%
Standard error			0.006

Source: own calculation from SPSS output

Table 9 reiterates the accuracy of classification, because it classifies NH companies by their 2019 values of dynamic liquidity with accuracy of 91.5%, while the non-NH ones in the control group with 100%. The accuracy of the model was 95.4%; matching is the difference between it and total accuracy. Standard error can be considered low.

In addition to the classification tree, I also assessed the factors affecting NH with another method, called binary regression (Table 10). At the initial stage, if no enterprises were considered NH, the accuracy of the estimation would be (590/1080), i.e., 54.5 percent. It differs from 50 percent because the control group comprised 490 non-NH companies. The programme performs a constant test based on the Wald statistics, which is significant, i.e., there is a constant in the initial phase. I applied the „enter” procedure for the logistic regression, during which all variables assessed were included. I only displayed in Table 10 the variables that exert individual impact on the dependent variable by significance level. However, it will not show the combined effect. The Chi square test of Omnibus was significant, which means the variables included in the test also had a combined effect on the dependent variable. The explanatory power of the independent variables in the model was examined using the Cox and Snell and the Nagelkerke R² indicator. The value of the latter indicates the explanatory power of the model is strong. Based on the significance level of the Hosmer-Lemeshow test value, I decided to accept the zero hypothesis. Eventually, the equation included the change of turnover in proportion to tangible assets, the 2019 value of cash liquidity, the 2019 value of base-10 logarithm of the balance sheet total, and the 2019 value of dynamic liquidity. Model accuracy is 94.1 percent; it predicted non-NH companies with accuracy of 92.7 percent and NH ones with 95.2 percent, respectively.

Table 10
Scoreboard of binary logistic regression

	Variables in equation					Exp(B)	95% C.I. for EXP(B)	
	B	S.E.	Wald	df	Sig.		Lower	Upper
D\$perTA (Change turnover in proportion to tangible assets)	0.663	0.147	20.415	1	0	1.94	1.455	2.587
dS1918 (Change turnover)	-0.726	0.259	7.855	1	0.005	0.484	0.291	0.804
Cliq (Cash liquidity2019)	-0.95	0.155	37.432	1	0	0.387	0.285	0.524
LgVF (10-base logarithm of balance sheet total 2019)	-2.222	0.209	112.996	1	0	0.108	0.072	0.163
DinLiq (Dynamic liquidity 2019)	-1.539	0.138	124.048	1	0	0.215	0.164	0.281
Constant	8.55	0.71	145.051	1	0	5167.617		

	Observation		Prediction		
			NH		Accurate classification %
			No	Yes	
Step1	NH	No	454	36	92.7
			28	560	95.2
	Total classification %				94.1

Source: own calculation from Amadeus database, 2021

On the scoreboard of binary logistic regression, I think the signs of ExpB and Column B of the results of the Wald statistics provide the most information. Negative values reduce the change of getting into difficulty. According to Column B, change in turnover, the 2019 value of cash liquidity, the 2019 value of the 10-base logarithm of the balance sheet total and the 2019 value of dynamic liquidity revealed from the decision tree reduce the chance of a difficulty arising. The column Exp(B) shows by how much getting into a difficulty is reduced (in percentage) if the variable in question changes by 1 percent. Thus, one can say change in turnover mitigated the probability of becoming NH by 0.48 percent, cash liquidity in the given year by 0.39 percent and dynamic liquidity in 2019 by 0.22 percent, respectively. Nevertheless, the change of turnover in proportion to tangible assets had the most important impact on getting into difficulty, since a 1-percent change of the indicator raised the probability of becoming NH by 1.94 percent.

6 CONCLUSIONS AND PROPOSALS

The findings of the study and its main proposals are summed up as follows:

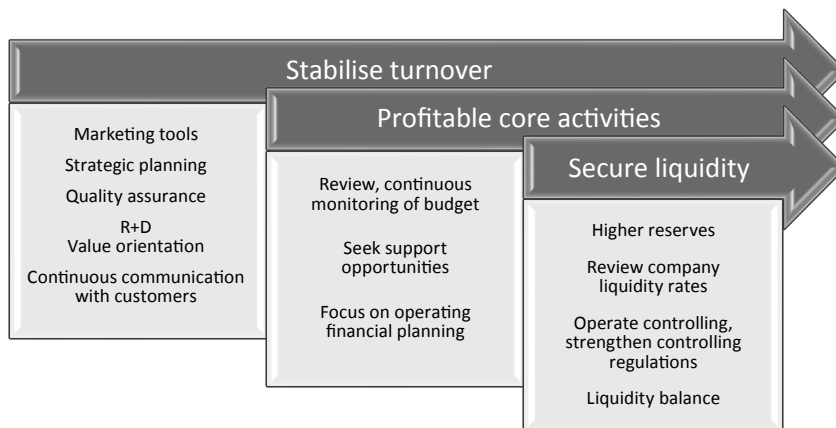
- 1.) **The ratio of „undertakings in difficulty” (NH) is low in the group of operational SMEs engaged in genuine activities.** The results suggest the share of enterprises meeting the definition of „difficulty” was low even in the limited sample. Still, the last year available was 2019, so their number has probably increased based on the empirical experience of the economic crisis triggered by the consequences of the Corona virus pandemic. It can be a further topic of research.
- 2.) **The ratio of NH enterprises is higher in the strategic branches of the national economy.** Their ratio is higher than the national average in the processing industry and services export. It is particularly obvious in services offering accommodation and catering, which reiterated research findings by *Rikovics (2021) and Szemerédi (2021)*, who had already pointed out the vulnerability of the sector before the pandemic.
- 3.) **Geographical characteristics do not define NH of SMEs.** A comparison of „undertakings in difficulty” (NH) and operational partnerships has shown no significant difference by regions. In other words, the nationwide distribution of undertakings defines the distribution of NH enterprises too. Some counties significantly deviate, though (e.g., Heves County)
- 4.) **NH is mostly affected by turnover, followed by liquidity and company size.** An increase of turnover reduces the probability of getting into difficulty; on the other hand, proper liquidity in the given year and liquidity position measured with operating profit can also mitigate the threat. Factors related to turnover and dynamic liquidity can be regarded flow variables in full and in part, respectively. So, one can state getting into difficulty is a process. Its primary factor is the decline of turnover leading to less cash obtained which then will affect access to finance.
- 5.) **Evaluation of the hypotheses: based on mathematical-statistical methods, I believe both hypotheses can be accepted.** It has been proved on the research sample that company size (measured by FTE number) and classification in national economic branches correlate with NH. On the other hand, the relation between the variables is stronger than medium in the latter case only (based on the cross-board analysis and Cramer V indicator). I could also verify that undertakings in difficulty can be reliably detected on the basis of the variables of economic position.

6.) New and innovative results. The methodological approach and the novelty of the study are new results. In addition, the verification of the hypotheses using 2019 data can be regarded a new result.

The findings of the study can be summed up for enterprises as follows: What should they do to avoid getting into difficulty and be excluded from eligibility for EU support and Hungarian state aid because of their status? In this regard, I agree with the opinion of *Zéman* and *Tóth* (2018) and *Zéman–Lentner* (2018), who have stated **liquidity** plays an outstanding part in companies' strategic financial management, because it is the factor that defines if the going concern principle prevails. At the same time, **the stability of turnover** is decisive from the aspect of the management to reach liquidity, so enterprises must strive for that even in the current difficult economic situation. **Tight cost control** is the second important factor, because it helps ensure the profitability of core activities. It is particularly important in industries where the ratio of fixed assets tied up is high leading to high fix costs. It is one of the reasons why the ratio of NH enterprises is high in the processing industry, trade, accommodation, and transport (cf. *Szemán*, 2008). The third factor follows from it: **sales revenues must actually be received to reach a proper liquidity position**, which is subject to the credit policy and market position of the company. The former is an endogenous, the latter an exogenous factor. Enterprises have some room for manoeuvre in credit policy, but market position cannot be neglected, since it is they have to adapt to in the short run. The third factor is, in fact, **the stability of cash and cash equivalent**, i.e., enterprises should budget a higher expected liquidity. *Figure 2* is a summary of how enterprises can intervene.

An important lesson of the study for economic decision makers is that **supporting their enterprises' income generating abilities** through, for instance, bridging loans and/or compensation for lost income to a certain extent may be necessary measures to counter the consequences of the Corona virus pandemic in addition to cost-side support (loan moratorium, tax relief, wage subsidies in certain sectors).

Figure 2
“For the road” for companies to counter the economic crisis
caused by the Corona virus pandemic



Source: own design based on research findings

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